

# Lecture 2: IGMP

7COM1030 – Multicast and Multimedia Networking

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# Topics

- ▶ Multicast Addresses
- ▶ IGMP Protocol

# IP Multicast Addressing

- All Class D addresses are multicast addresses:

Class D

|         |   |   |   |                    |
|---------|---|---|---|--------------------|
| 1       | 1 | 1 | 0 | multicast group id |
| 28 bits |   |   |   |                    |

| Class | From      | To              |
|-------|-----------|-----------------|
| D     | 224.0.0.0 | 239.255.255.255 |

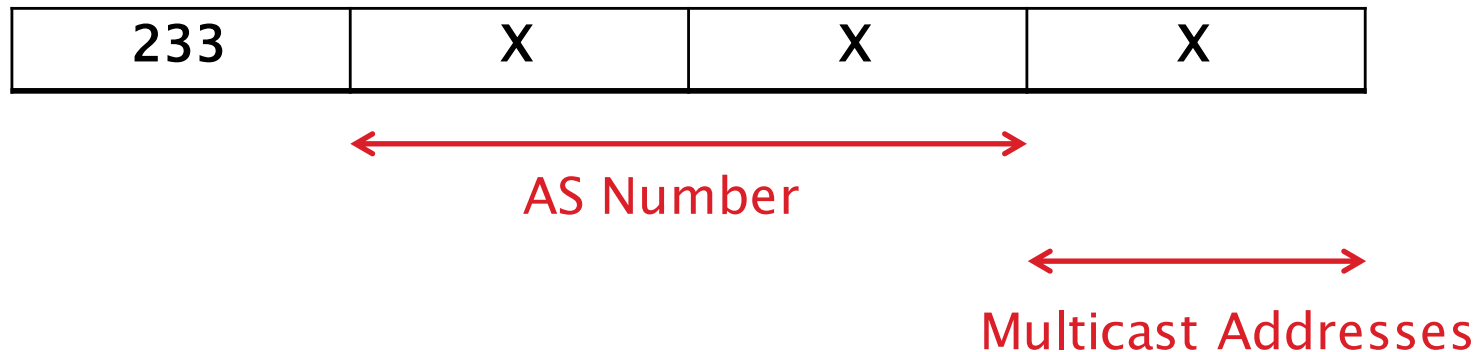
- Multicast addresses are dynamically assigned.
- If an application is terminated, the multicast address is (implicitly) released.

# Reserved IP Multicast Addresses

- ▶ The range of addresses between 224.0.0.0 and 224.0.0.255, inclusive, is reserved for the use of routing protocols and other low-level topology discovery or maintenance protocols
- ▶ Multicast routers should not forward any multicast datagram with destination addresses in this range.
- ▶ Important permanent multicast groups:
  - 224.0.0.1** All hosts and all routers on a network
  - 224.0.0.2** All routers on a network
  - 224.0.0.22** IGMPv3
- ▶ Permanent multicast groups reserved by protocols:
  - 224.0.0.9 All RIP2 routers on a network
  - 224.0.0.4 All DVMRP routers on a network
  - 224.0.0.13 All PIM routers on a network

# IP Multicast Addresses for AS

AS: Autonomous System



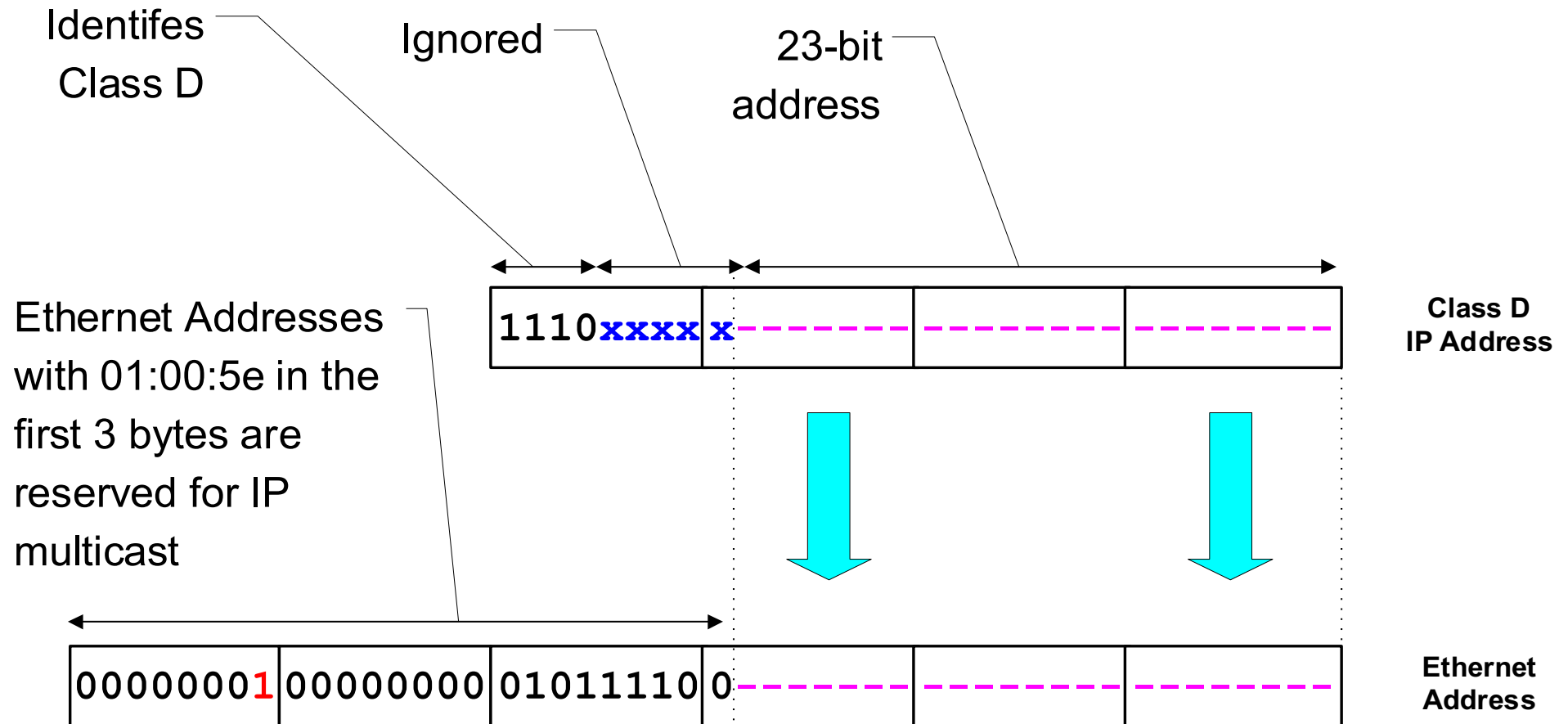
- ▶ For example, the AS with the number of 0x8080 will own the multicast address range of:

233.128.128.0 ~ 233.128.128.255

# A Quick Revision of MAC Address

- ▶ The MAC address consists of 12 hex digits (48 bits).
- ▶ There are 3 different types of Ethernet addresses:
  - **Unicast:** A unicast frame contains the unique MAC address of the destination receiver.
    - The first six digits are assigned by the IEEE which identifies the manufacturer. The last six are assigned by the manufacturer and represent a unique hardware ID number for the NIC.
  - **Broadcast:** A broadcast frame contains all binary 1's as the destination address (FF:FF:FF:FF:FF:FF).
  - **Multicast:** A multicast frame contains the unique multicast MAC address of an application, protocol, or data stream.

# Mapping Multicast Address: IP → MAC



# netstat

`netstat` can be used with three options, `-n`, `-r`, and `-a`. The `-n` option gives the numeric versions of IP addresses, the `-r` option gives the routing table, and the `-a` option gives all addresses (unicast and multicast). This example only shows the fields relative to our discussion.

```
$ netstat -nra
```

Kernel IP routing table

| Destination | Gateway       | Mask          | Flags | Iface |
|-------------|---------------|---------------|-------|-------|
| 153.18.16.0 | 0.0.0.0       | 255.255.240.0 | U     | eth0  |
| 169.254.0.0 | 0.0.0.0       | 255.255.0.0   | U     | eth0  |
| 127.0.0.0   | 0.0.0.0       | 255.0.0.0     | U     | lo    |
| 224.0.0.0   | 0.0.0.0       | 224.0.0.0     | U     | eth0  |
| 0.0.0.0     | 153.18.31.254 | 0.0.0.0       | UG    | eth0  |

Any packet with a multicast address from 224.0.0.0 to 239.255.255.255 is masked and delivered to the Ethernet interface.



## netstat -g

- ▶ This command will display all multicast group memberships for all interfaces in the current host.

```
cs-xc15aad-01:~ xc15aad$ netstat -g
Link-layer Multicast Group Memberships
Group                                Link-layer Address      Netif
1:0:5e:0:0:fb                        <none>                  en0
33:33:0:0:0:fb                       <none>                  en0
1:0:5e:0:0:1                         <none>                  en0
33:33:ff:75:c9:b9                   <none>                  en0
33:33:0:0:0:1                       <none>                  en0
33:33:ff:39:9:8                     <none>                  en0
1:80:c2:0:0:3                       <none>                  en0
33:33:0:0:0:fb                       <none>                  en1
1:3:93:df:b:92                      <none>                  en1
33:33:0:0:0:fb                       <none>                  awdl0
33:33:0:0:0:1                       <none>                  awdl0
33:33:ff:75:c9:b9                   <none>                  awdl0
33:33:ff:5:bd:bb                     <none>                  awdl0
33:33:80:0:0:fb                      <none>                  awdl0

IPv4 Multicast Group Memberships
Group                                Link-layer Address      Netif
224.0.0.251                          <none>                  lo0
224.0.0.1                            <none>                  lo0
224.0.0.251                          1:0:5e:0:0:fb          en0
224.0.0.1                            1:0:5e:0:0:1           en0

IPv6 Multicast Group Memberships
Group                                Link-layer Address      Netif
ff02::fb%lo0                         <none>                  lo0
ff02::2:ff33:9cc0%lo0                <none>                  lo0
ff01::1%lo0                          <none>                  lo0
ff02::1%lo0                          <none>                  lo0
```

# Topics

- ▶ Multicast Addresses
- ▶ IGMP Protocol

# IGMP

- ▶ The **Internet Group Management Protocol (IGMP)** is a simple protocol for the support of IP multicast.
- ▶ IGMP operates on a physical network (e.g., single Ethernet Segment).
- ▶ IGMP is used by multicast routers to keep track of membership in a multicast group. Multicast router keeps a table on the multicast groups that have joined hosts. The router only forwards a packet, if there is a host still joined. Router does not keep track which host is joined.
- ▶ Support for:
  - Joining a multicast group
  - Leaving a multicast group (v2 and v3 only)
  - Query membership
  - Send membership reports

# Versions of IGMP

## ▶ IGMPv1

- No way to explicitly leave a multicast group. Router will timeout a group membership

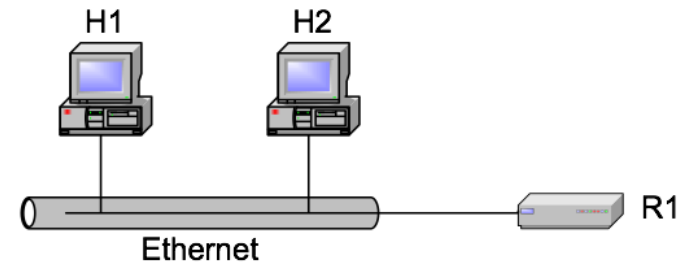
## ▶ IGMPv2

- Includes a “leave processing” mechanism
- Routers can make group-specific query
- Currently as the default for many systems

## ▶ IGMPv3

- Support source-filtering, enabling receivers to signal a router about a traffic source

# IGMP Messages



## ▶ IGMP query

- **General query:** Used by routers to learn which groups have members on an attached network (group address is set to zero). *“Anyone still there?”*
- **Group-specific query.** Used by routers to learn if a particular group has any members on an attached network. *“Anyone still in group xx?”* (N/A in IGMPv1)

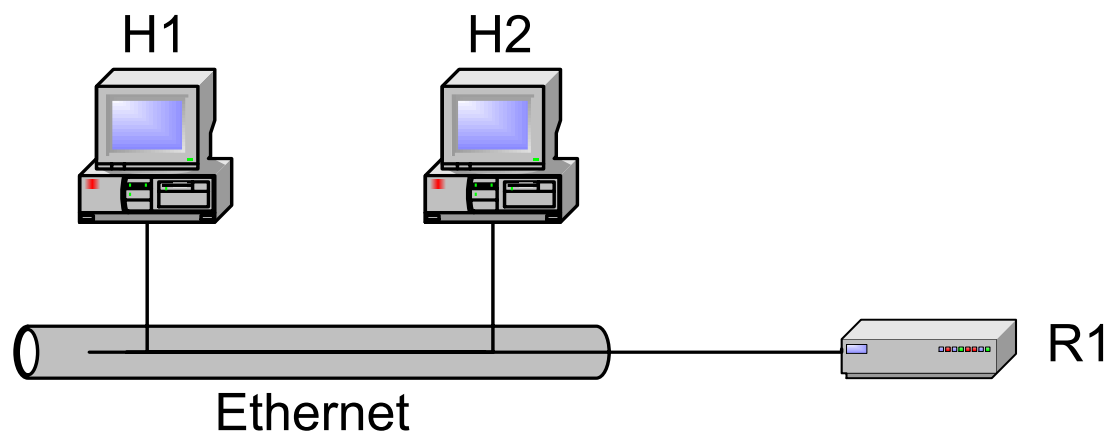
## ▶ IGMP report

- **Membership report.** A host responds to an IGMP query: *“Yes, I’m still in group xx.”*
- **Join report.** A host sends an IGMP report when it joins a multicast group (Note: multiple processes on a host can join. A report is sent only for the first process). *“I want to join group xx.”*

## ▶ IGMP leave

- *“I want to leave group xx”*
- No report is sent when a process leaves a group in IGMPv1.

# IGMP Protocol



## IGMP group join

IGMP group address = **group address**  
 Destination IP address = **224.0.0.2**  
 Source IP address = host's IP address

## IGMP group leave (N/A in IGMPv1)

IGMP group address = **group address**  
 Destination IP address = **224.0.0.2**  
   **(224.0.0.22 for IGMPv3)**  
 Source IP address = host's IP address

## IGMP membership report

IGMP group address = **group address**  
 Destination IP address = **group address**  
 Source IP address = host's IP address

## IGMP general query

IGMP group address = 0  
 Destination IP address = **224.0.0.1**  
 Source IP address = router's IP address

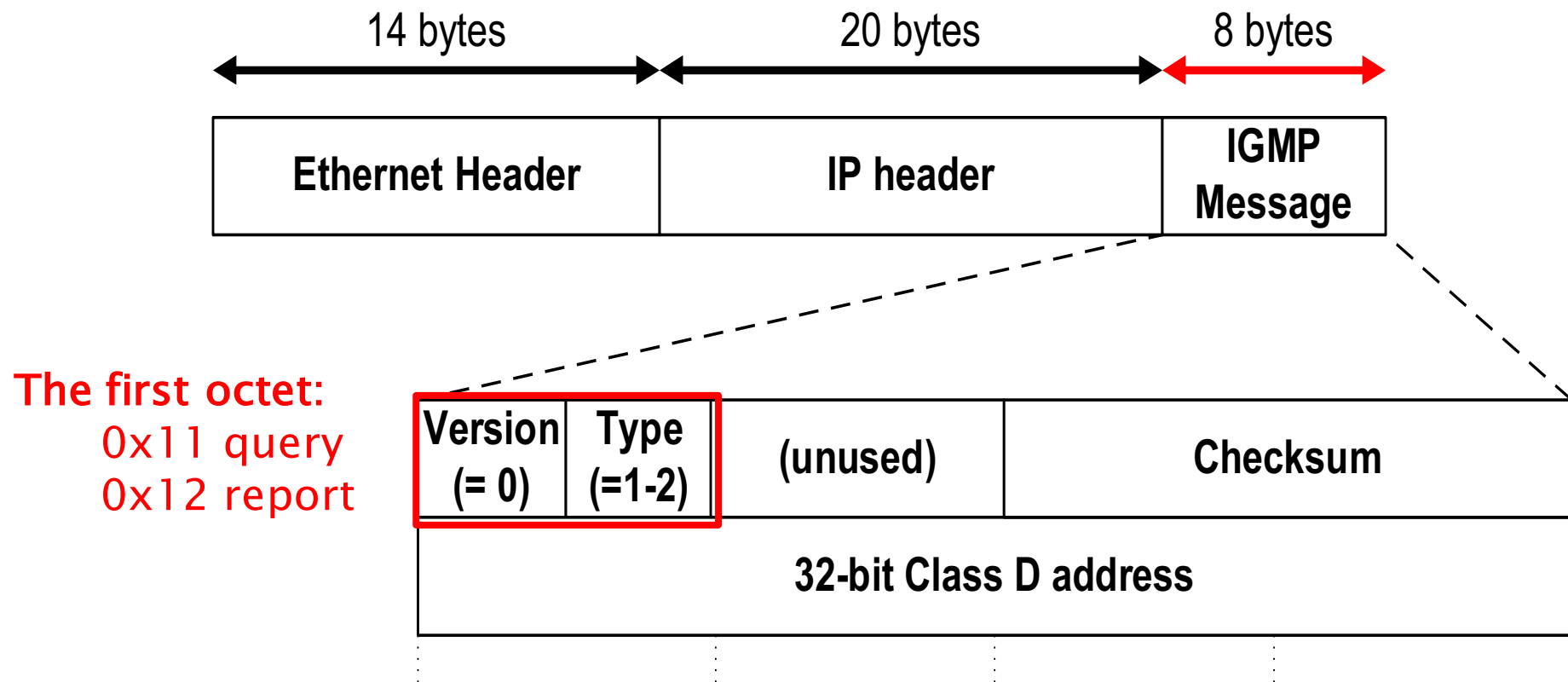
## IGMP group-specific query (N/A in IGMPv1)

IGMP group address = **group address**  
 Destination IP address = **group address**  
 Source IP address = router's IP address

Destination address is  
 224.0.0.22 for IGMPv3

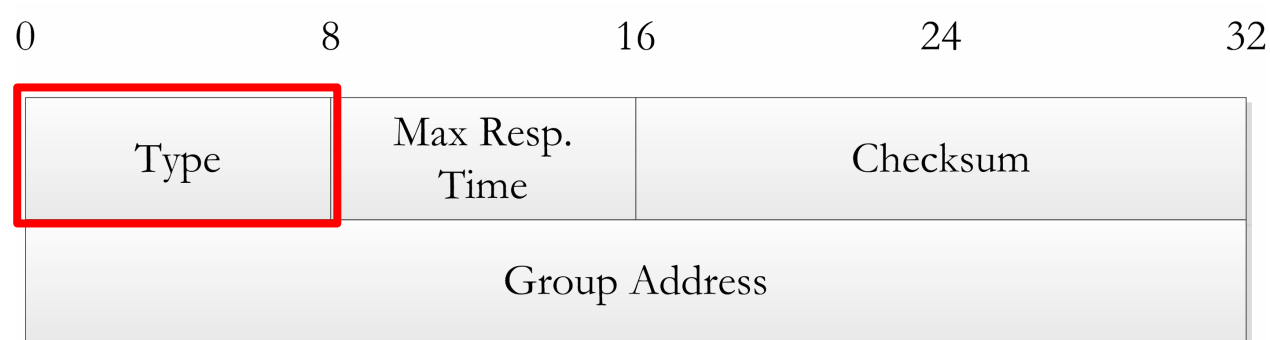
# IGMPv1 Packet Format

- ▶ IGMP messages are only 8 bytes long



- Type: 1 = sent by router, 2 = sent by host

# IGMPv2 and IGMPv3 Packet Format



The first octet:

|           |          |      |
|-----------|----------|------|
| Query     | 00010001 | 0x11 |
| Report v1 | 00010010 | 0x12 |
| Report v2 | 00010110 | 0x16 |
| Report v3 | 00100010 | 0x22 |
| Leave     | 00010111 | 0x17 |



# Timing Issues

- ▶ **Query Interval:** When a host receives a query, rather than sending reports immediately, it starts a report delay timer with a randomly-chosen value between zero and  $D$ . When a timer expires, a Report is generated for the corresponding host group. Thus, Reports are spread out over a  $D$  second interval instead of all occurring at once.
- ▶ **Maximum Response Time ( $D$ ):** The maximum time a host can wait before responding a query.
- ▶ **Report Suppression:** If the host receives another host's Report (version 1 or 2) while it has a timer running, it stops its timer for the specified group and does not send a Report, in order to suppress duplicate Reports.

# Time To Live (TTL)

- ▶ Scope-limiting parameter for IP Multicast datagrams
- ▶ Controls the number of hops that a IP Multicast packet is allowed to propagate
- ▶ TTL = 1: local network multicast
  - IGMP messages are sent with TTL = 1; therefore **IGMP messages are never forwarded by routers**
  - The addresses of 224.0.0.0 ~ 224.0.0.255 are always sent with TTL = 1 to limit the corresponding groups to the local network.
- ▶ TTL > 1: Multicast router(s) attached to the local network forward IP Multicast datagrams

# Summary of Comparison

| Feature   | IGMPv1                                       | IGMPv2  | IGMPv3   |
|---|--|---|--|
| First Octet Value for the Query Message               | 0x11   | 0x11  | 0x11   |
| Group Address for the General Query                   | 0.0.0.0                                      | 0.0.0.0   | 0.0.0.0  |
| Destination Address for the General Query             | 224.0.0.1                                    | 224.0.0.1                                       | 224.0.0.1  |
| Default Query Interval                                | 60 seconds                                   | 125 seconds                                     | 125 seconds  |
| First Octet Value for the Report                      | 0x12   | 0x16  | 0x22   |
| Group Address for the Report                          | Joining multicast group address              | Joining multicast group address                 | Joining multicast group address and source address |
| Destination Address for the Report                    | Joining multicast group address              | Joining multicast group address                 | 224.0.0.22   |
| Is Report Suppression Mechanism Available?            | Yes  | Yes   | No   |
| Can Maximum Response Time Be Configured?              | No, fixed at 10 seconds                      | Yes, 0 to 25.5 seconds                          | Yes, 0 to 53 minutes                               |
| Can a Host Send a Leave Group Message?                | No   | Yes   | Yes  |
| Destination Address for the Leave Group Message       | —  | 224.0.0.2                                       | 224.0.0.22   |
| Can a Router Send a Group-Specific Query?             | No   | Yes   | Yes  |
| Can a Host Send Source- and Group-Specific Reports?   | No   | No  | Yes  |
| Can a Router Send Source- and Group-Specific Queries? | No   | No  | Yes  |
| Rule for Electing a Querier                           | None (depends on multicast routing protocol) | Router with the lowest IP address on the subnet | Router with the lowest IP address on the subnet    |
| Compatible with Other Versions of IGMP?               | No   | Yes, only with IGMPv1                           | Yes, with both IGMPv1 and IGMPv2                   |

# Questions?

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