CSC465 – Computer Networks Spring 2004

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These slides were produced almost entirely from material by Behrouz Forouzan for the text "TCP/IP Protocol Suite (2nd Edition)", McGraw Hill Publisher

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Chapter 10

Internet Group Management Protocol (IGMP)

Multicasting

- Processes may have to send the same message to a large numbers of receivers simultaneously
  - Example: Video-on-demand
  - Informing multiple stockbrokers about changes to a stock price
  - IGMP is necessary but not sufficient for multicasting
  - IGMP is a companion to the IP protocol

Position of IGMP in the network layer

CONTENTS

- **GROUP MANAGEMENT**
- **IGMP MESSAGES**
- **IGMP OPERATION**
- **ENCAPSULATION**
- **IGMP PACKAGE**

10.1

GROUP MANAGEMENT

Multicasting and Routing

- To support multicasting there needs to be routers capable of routing multicast packets
- Routing tables must be updated using a multicasting routing protocol
- IGMP is *not* a multicasting routing protocol
- IGMP manages *group membership*
- *Group membership:* hosts and routers and the groups they are "interested" in (subscribe to)
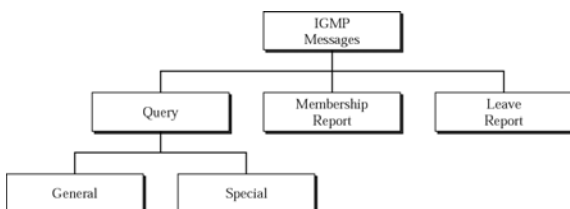
Multicasting and Routing

- IGMP protocol gives the multicast routers info about the membership status of hosts (routers) connected to the network.
- A multicast router may receive thousands of multicast packets every day for different groups
- If a router has no knowledge about the membership status of the hosts it must broadcast all of the multicast packets (excess traffic)
- Better to maintain list of groups in the network for which there is at least one "loyal" member
- ICMP helps the multicast router create and update the group lists related to each interface

IGMP is a group management protocol. It helps a multicast router create and update a list of loyal members related to each router interface.
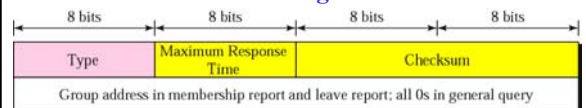
10.2

IGMP v2 MESSAGES

IGMP Message Types

IGMP Message Format

8 bits	8 bits	8 bits	8 bits
Type	Maximum Response Time	Checksum	
Group address in membership report and leave report; all 0s in general query			

Groupid (multicast address of the group) in the "special query" and "membership" and "leave" reports (0 in general query)

MRT defines amt of time available to answer query (0 in reports)

Checksum is calculated over the 8-byte message

10.3

IGMP OPERATION

IGMP Operation

- IGMP operates locally, i.e., within a network
- For each group there is only one router connected to the network that has the duty of distributing the multicast packets destined for that group
- A host has "membership" if one of its processes receives receives multicast packets from some group
- A router has "membership" means that there is a network attached to some *other* interface that receives multicast packets for the group

IGMP Operation

- R is distributing router
- R1 & R2 are multicast routers
- Possibly receive packets from R
- Forward to other networks

List of groups having loyal members

225.70.8.20
231.24.60.9
⋮
229.60.12.8
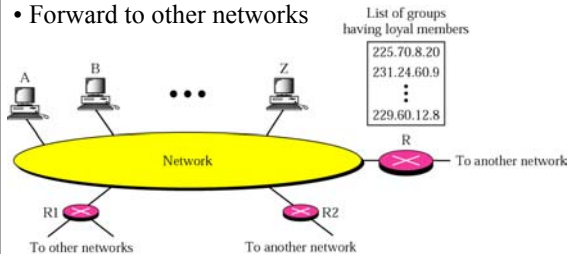
Joining a Group - Host

- A host or router can join a group
- A host receives requests from processes to join a group
- If no previous request from another process, a *membership report* message is sent
- Otherwise, no membership report need be sent as the host already receives multicast packets for this group

Joining a Group - Router

- A router also maintains a list of groupids that show membership for the networks connected to each interface
- If a multicasting router receives a membership report from a device attached to an interface for a network where there was not already interest, the router will issue a *membership report* message to a device on the network that supplies the multicast packets for this group
- Router acts like host but group list is much broader (accumulation of all loyal members that are connected to its interfaces)

Membership report

Host or Router | Membership Report | Router

0x16 | 0
Group address

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

Leaving a Group

- There must be a mechanism for a device to report that it no longer wishes to have membership in a group

- When a host sees that no process is interested in a specific group, it send a *leave report*.

- When a router determines that none of the networks connected to its interfaces is interested in a specific group, it sends a leave report about that group

Leaving a Group (con't)

- There must be a mechanism for a device to report that it no longer wishes to have membership in a group
- When a multicasting router receives a leave report on an interface it cannot assume that all devices are disinterested in membership, just the device that sent the *leave report*
- The router must send a special query message that includes the *groupid* (multicast address)
- The router then waits for membership reports; if none arrive within the time interval the router purges the the group from its list
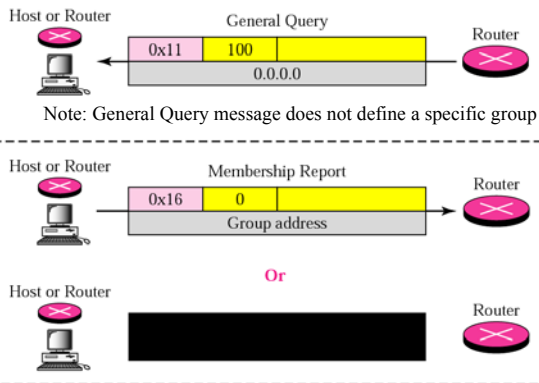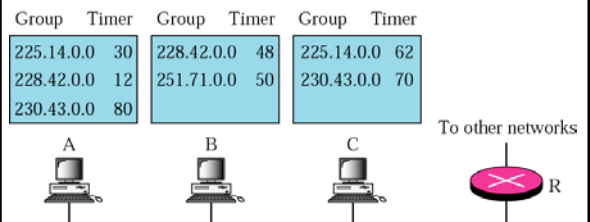
Leave report
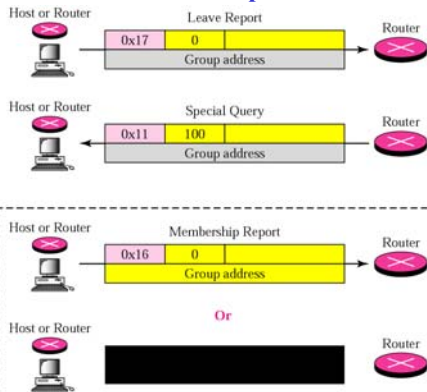
Monitoring Membership

- Hosts and routers use membership and leave reports to join and leave groups
- However these messages are not enough
  - Consider the case where a host is taken offline before it can send its leave report
  - The multicast router will never receive a leave report
- A multicast router is responsible for monitoring all of the hosts and routers on a LAN to see if they wish to continue their membership in a group
- The *general query message* is issued periodically

General Query Message

Note: General Query message does not define a specific group

Example 1

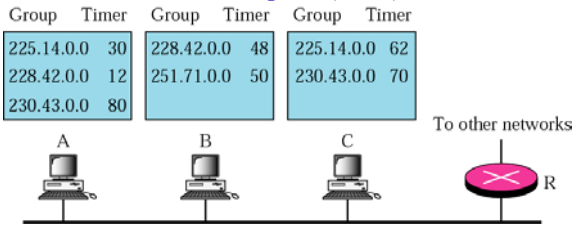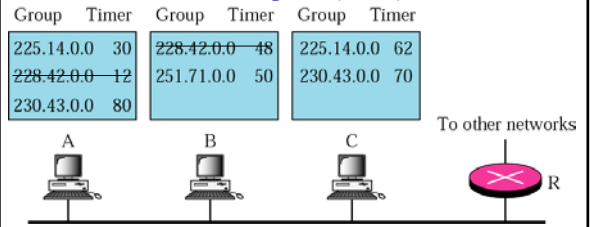| Group	Timer	Group	Timer	Group	Timer
225.14.0.0	30	228.42.0.0	48	225.14.0.0	62
228.42.0.0	12	251.71.0.0	50	230.43.0.0	70
230.43.0.0	80				

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. What report messages will result?
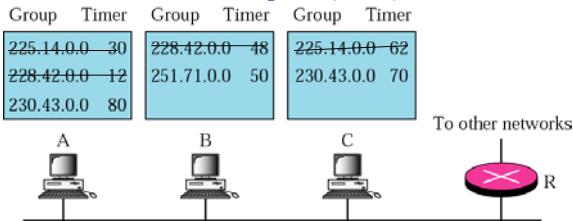
Example 1 (con't)

Group	Timer	Group	Timer	Group	Timer
225.14.0.0	30	228.42.0.0	48	225.14.0.0	62
228.42.0.0	12	251.71.0.0	50	230.43.0.0	70
230.43.0.0	80				

A   B   C

To other networks

R

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.

Example 1 (con't)

Group	Timer	Group	Timer	Group	Timer
225.14.0.0	30	228.42.0.0	48	225.14.0.0	62
228.42.0.0	12	251.71.0.0	50	230.43.0.0	70
230.43.0.0	80				

A   B   C

To other networks

R

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

Example 1 (con't)

Group	Timer	Group	Timer	Group	Timer
225.14.0.0	30	228.42.0.0	48	225.14.0.0	62
228.42.0.0	12	251.71.0.0	50	230.43.0.0	70
230.43.0.0	80				

A   B   C

To other networks

R

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

Example 1 (con't)

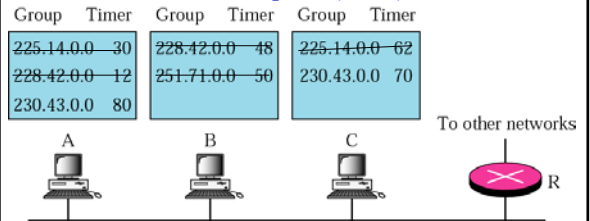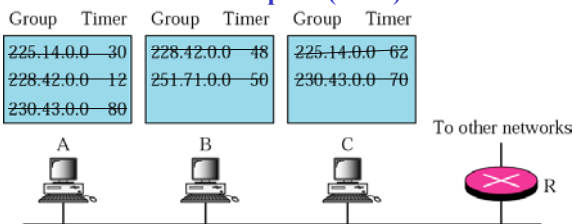| Group	Timer	Group	Timer	Group	Timer
225.14.0.0	30	228.42.0.0	48	225.14.0.0	62
228.42.0.0	12	251.71.0.0	50	230.43.0.0	70
230.43.0.0	80				

A   B   C

To other networks

R

Time 70: The timer for 230.43.0.0 in host A 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.

Example 1 (con't)

Group	Timer	Group	Timer	Group	Timer
225.14.0.0	30	228.42.0.0	48	225.14.0.0	62
228.42.0.0	12	251.71.0.0	50	230.43.0.0	70
230.43.0.0	80				

A   B   C

To other networks

R

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.
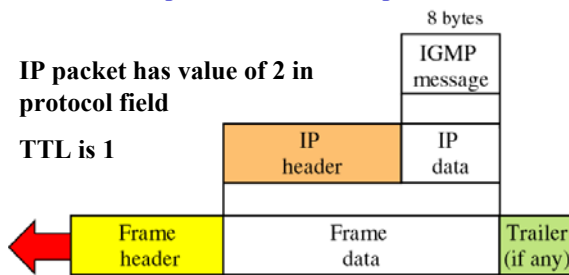
10.4

ENCAPSULATION

Encapsulation of IGMP packet

IP packet has value of 2 in protocol field

TTL is 1

8 bytes

IGMP message

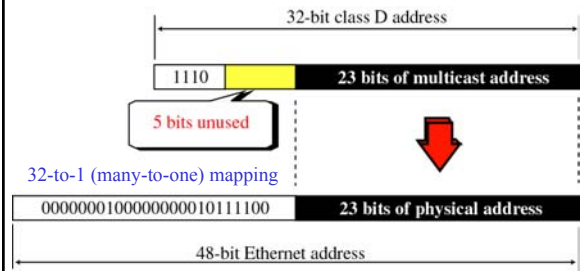| IP header | IP data |

| Frame header | Frame data | Trailer (if any) |

Query msg destination: 224.0.0.1 (all systems on subnet)

Membership report destination: multicast address of relevant group

Leave report: 224.0.0.2 (all routers on subnet)

Mapping class D to Ethernet physical address

32-bit class D address

| 1110 | | 23 bits of multicast address |

5 bits unused

32-to-1 (many-to-one) mapping

| 00000001000000000010111100 | 23 bits of physical address |

48-bit Ethernet address

Hosts can receive frames for groups for which they don't subscribe
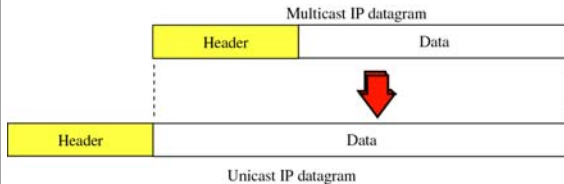
Host must check IP addresses and discard packets

Tunneling

Technique applicable when no physical multicast support
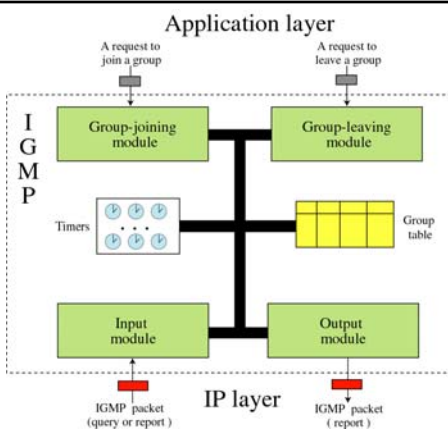
Emulate physical multicast support

Multicast packet encapsulated within unicast packet

Multicast IP datagram

| Header | Data |

| Header | Data |

Unicast IP datagram

10.5

IGMP PACKAGE

IGMP package

Application layer

A request to join a group

A request to leave a group

I G M P

Group-joining module

Group-leaving module

Timers

Group table

Input module

Output module

IP layer

IGMP packet (query or report)

IGMP packet (report)

Group table

State	Interface No.	Group Address	Reference Count
....	....	....	....
....	....	....	....
....	....	....	....

State: Free, Delaying, Idle

Reference Count: Number of processes interested