

## Unit III: Network Layer



Course: Computer Networks  
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March 17, 2021

- IGMP

- IGMP
- ICMPv6

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- Delivery, Forwarding and Routing

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- The **Internet Group Management Protocol (IGMP)**: one of the necessary, but not sufficient, protocols used for multicasting.
- IGMP is a companion to the IP protocol.
- **Topics to discuss**
  - ▶ Group Management
  - ▶ IGMP Messages
  - ▶ Message Format
  - ▶ IGMP Operation

# Group Management

- For multicasting in the Internet, routers are needed.
- The routing tables must be updated by using one of the multicasting routing protocols (to be discussed).
- IGMP is **not** a multicasting routing protocol.
- It is a protocol that **manages group membership**.
- IGMP protocol gives the multicast routers information about the membership status of hosts (routers) connected to the network.
- **Solution:** keep a list of groups in the network for which there is at least one loyal member.
- IGMP helps the multicast router create and update this list.

# IGMP Messages

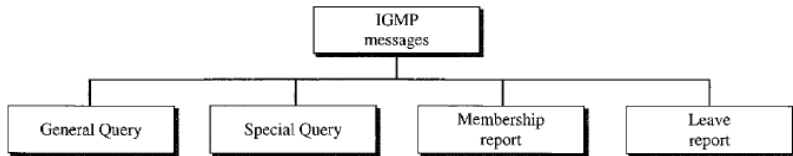


Figure: IGMP Message Types

- There are two versions of IGMP.
- **Current version** is IGMPv2.
- IGMPv2 has three types of messages: **query**, **membership report**, and **leave report**.
- Two types of query messages: **general** and **special**.



# IGMP Message Format

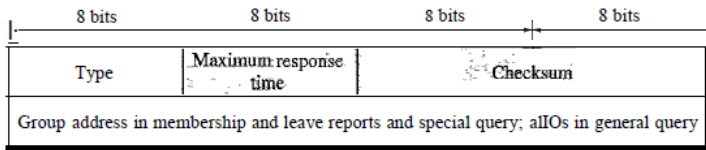


Figure: IGMP Message Format

- **Type:** This 8-bit field defines the type of message
- **Maximum Response Time:** This 8-bit field defines the amount of time in which a query must be answered.
- **Checksum:** It is a 16-bit field carrying the checksum. The checksum is calculated over the 8-byte message.
- **Group address:** The value of this field is 0 for a general query message. The value defines the groupid (multicast address of the group) in the special query, the membership report, and the leave report messages.

# IGMP Operation

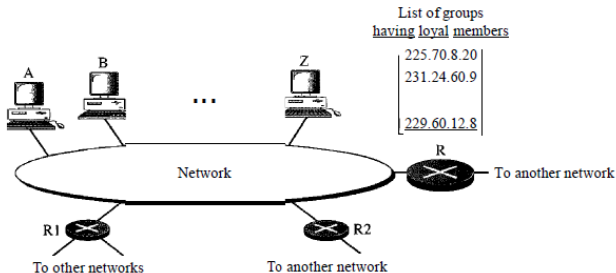


Figure: IGMP Operation

- IGMP operates locally.
- A multicast router connected to a network has a list of multicast addresses of the groups with at least one loyal member in that network.

# IGMP Operation

## ● Joining a Group

- ▶ A host or a router can join a group.
- ▶ A host maintains a list of processes that have membership in a group.
- ▶ When a process wants to join a new group, it sends its request to the host.
- ▶ The host adds the name of the process and the name of the requested group to its list.
- ▶ If this is the first entry for this particular group, the host sends a membership report message.
- ▶ If this is not the first entry, there is no need to send the membership report since the host is already a member of the group.
- ▶ The protocol requires that the membership report be sent twice, one after the other within a few moments.
- ▶ This way, if the first one is lost or damaged, the second one replaces it.

# IGMP Operation

## • Leaving a Group

- ▶ When a host sees that no process is interested in a specific group, it sends a leave report.
- ▶ When a multicast router receives a leave report
  - it cannot immediately purge that group from its list because the report comes from just one host or router.
  - there may be other hosts or routers that are still interested in that group.
- ▶ The router sends a special query message and inserts the groupid, or multicast address, related to the group.
- ▶ The router allows a specified time for any host or router to respond.
- ▶ If no interest (membership report) is received, the router assumes that there are no loyal members in the network and purges the group from its list.

# IGMP Operation

- **Monitoring Membership**

- ▶ The router periodically (by default, every 125 s) sends a general query message.
- ▶ In this message, the group address field is set to 0.0.0.0.
- ▶ This means the query for membership continuation is for all groups in which a host is involved, not just one.

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## ● Delayed Response

- ▶ To prevent unnecessary traffic, IGMP uses a delayed response strategy.
- ▶ When a host or router receives a query message
  - it does not respond immediately
  - it delays the response
- ▶ Since the report is broadcast
  - the waiting host or router receives the report and knows that there is no need to send a duplicate report for this group.
  - the waiting station cancels its corresponding timer.

# ICMPv6

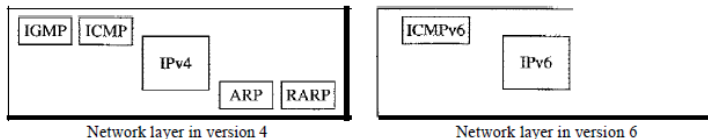


Figure: Comparison between ICMPv4 and ICMPv6

- ICMPv4 has been modified to make it more suitable for IPv6.
- ARP and IGMP protocols in version 4 are combined in ICMPv6.
- RARP protocol is dropped from the suite.
- Just as in ICMPv4, we divide the ICMP messages into two categories.
- Each category has more types of messages than before.

# Delivery, Forwarding and Routing



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- **Delivery:** way a packet is handled by the underlying networks under the control of the network layer.

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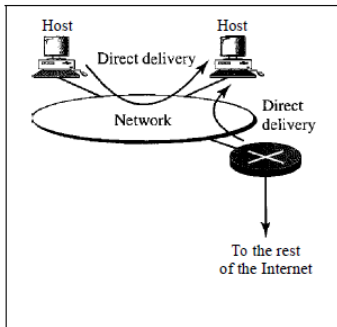
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# Delivery, Forwarding and Routing

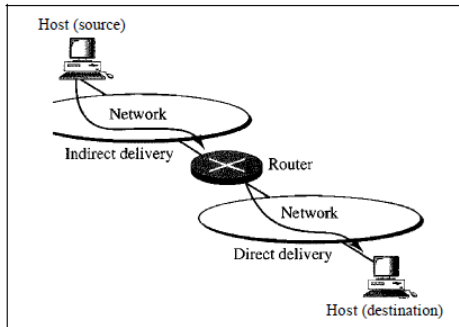
- **Delivery:** way a packet is handled by the underlying networks under the control of the network layer.
- **Forwarding:** way a packet is delivered to the next station.
- **Routing:** way routing tables are created to help in forwarding.

# Delivery

- The network layer supervises the handling of the packets by the underlying physical networks.
- Types:** Direct, Indirect



a. Direct delivery



b. Indirect and direct delivery

Figure: Direct and Indirect Delivery

# Forwarding

- Forwarding means to place the packet in its route to its destination.
- Forwarding requires a host or a router to have a routing table.
- **Forwarding Techniques**
  - ▶ Next-hop method vs Route method

## a. Routing tables based on route

Destination	Route
HostB	R1, R2, host B

Routing table  
for host A

Destination	Route
HostB	R2, host B

Routing table  
for R1

Destination	Route
HostB	HostB

Routing table  
for R2

## b. Routing tables based on next hop

Destination	Next hop
Host B	R1

Destination	Next hop
HostB	R2

Destination	Next hop
Host B	

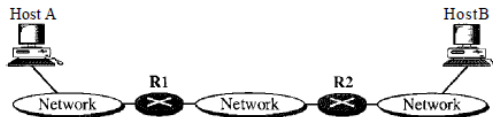


Figure: Next-hop method vs Route method

# Forwarding

## • Forwarding Techniques

### ► Network-specific method vs Host-specific method

Routing table for host S based  
on host-specific method

Destination	Next hop
A	R1
B	R1
C	R1
D	R1

Routing table for host S based  
on network-specific method

Destination	Next hop
N2	R1

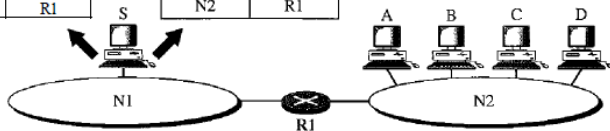


Figure: Network-specific method vs Host-specific method

# Forwarding

- Forwarding Techniques

- Default Method

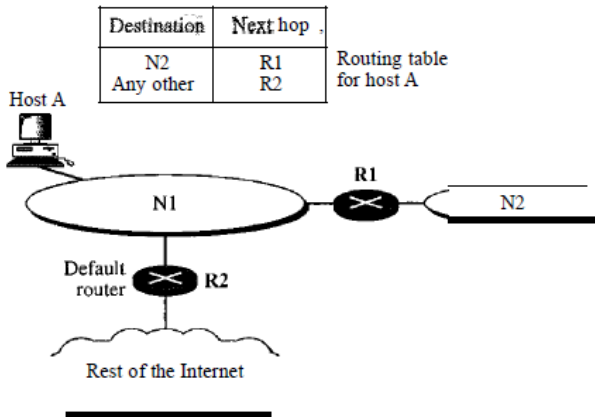


Figure: Default Method

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- The routing table can be either **static** or **dynamic**.
- **Static Routing Table**
  - ▶ A static routing table contains information entered manually.
  - ▶ The administrator enters the route for each destination into the table.
  - ▶ When a table is created, it cannot update automatically when there is a change in the Internet.
  - ▶ The table must be manually altered by the administrator.
  - ▶ **Limitation:** It is poor strategy to use a static routing table in a big internet such as the Internet.

# Routing Table

- **Dynamic Routing Table**

- ▶ Dynamic routing table is updated periodically by using one of the dynamic routing protocols.
- ▶ Changes in the Internet such as
  - shutdown of a router, or
  - breaking of a link
- ▶ Dynamic routing protocols update all the tables in the routers (and eventually in the host) automatically.

# Routing Table

- Format

Mask	Network address	Next-hop address	Interface		Reference count	Use

Figure: Common fields in routing table

- ▶ **Mask:** defines the mask applied for the entry.
- ▶ **Network address:** defines the network address to which the packet is finally delivered.
- ▶ **Next-hop address:** defines the address of the next-hop router to which the packet is delivered.
- ▶ **Interface:** shows the name of the interface.

# Routing Table

## • Format

Mask	Network address	Next-hop address	Interface		Reference count	Use

Figure: Common fields in routing table

- ▶ **Flags:** defines up to five flags. Flags are on/off switches that signify either presence or absence.
  - **U (up):** router is up and running.
  - **G (gateway):** destination is in another network.
  - **H (host-specific)** indicates that the entry in the network address field is a host-specific address.
  - **D (added by redirection):** indicates that routing information for this destination has been added to the host routing table by a redirection message from ICMP.
  - **M (modified by redirection):** indicates that the routing information for this destination has been modified by a redirection message from ICMP.
- ▶ **Reference count:** gives the number of users of this route at the moment.
- ▶ **Use:** shows the number of packets transmitted through this router for the corresponding destination.