Lecture 9
ARP & RARP

Protocols to support Internet Protocol

Topics Covered

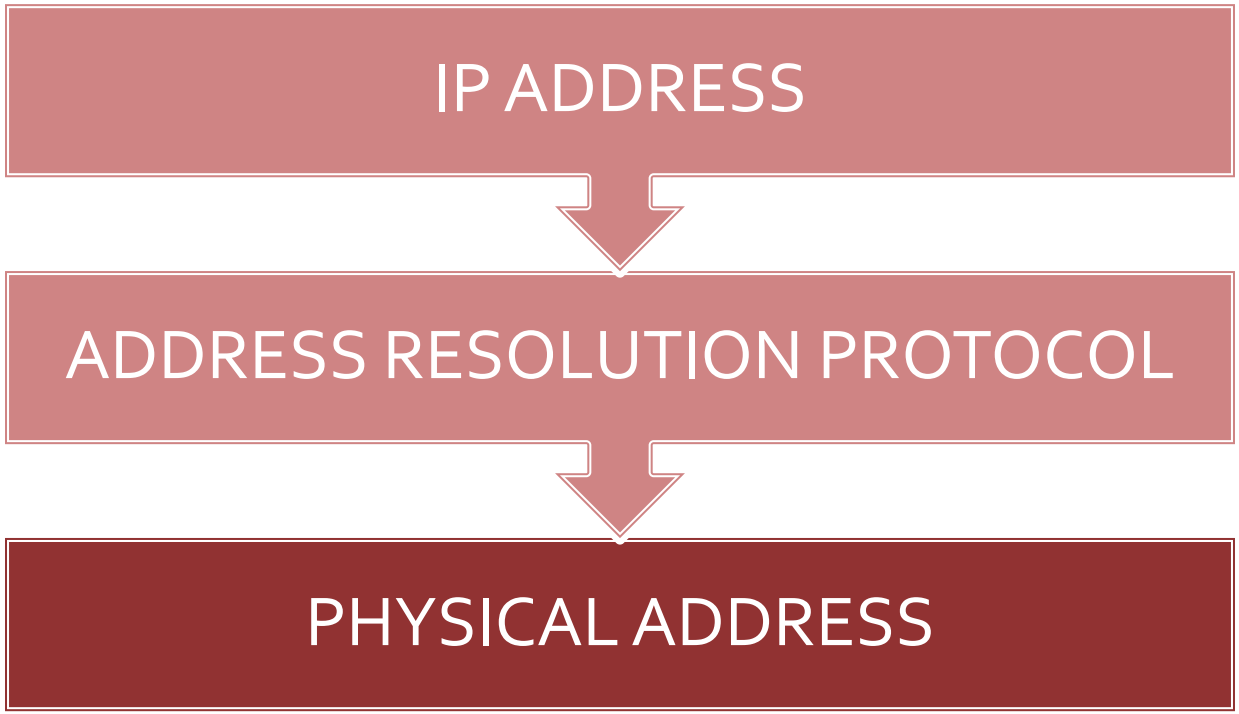
- ARP
- ARP packet format
- Operations of ARP on internet
- Reverse Address Resolution Protocol (RARP)
- ICMP
- Message Format
- Error Reporting
- IGMP
- Applications

Introduction

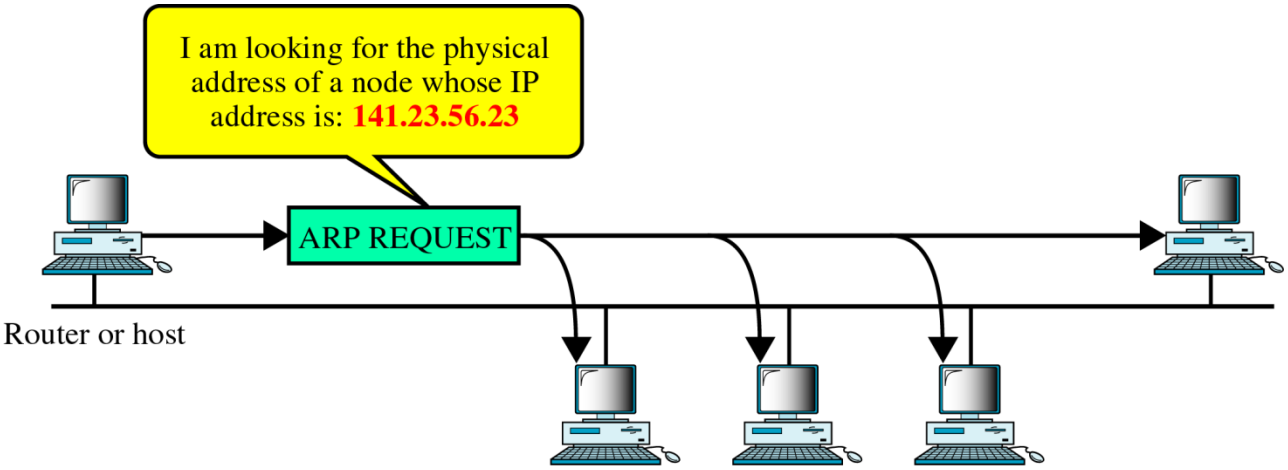
- IP needs services of
  - ARP to find the MAC(physical) address ,
  - RARP to find IP address ,
  - ICMP for query and error reporting messages and
  - IGMP for the simultaneous transmission of a message to a group of receivers.

ARP

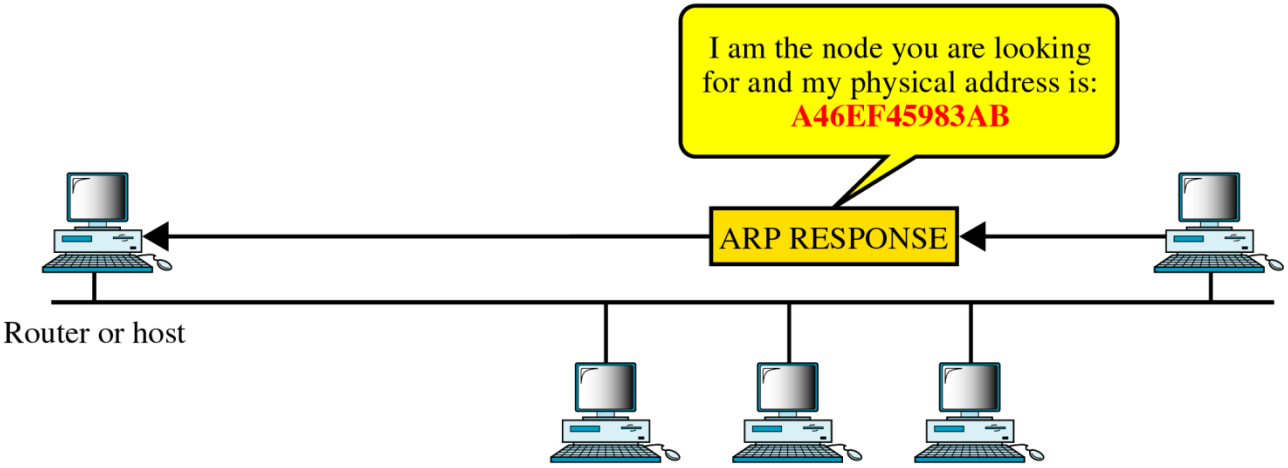
- ARP takes the IP address of a host as i/p and gives its corresponding physical address as the output.



ARP



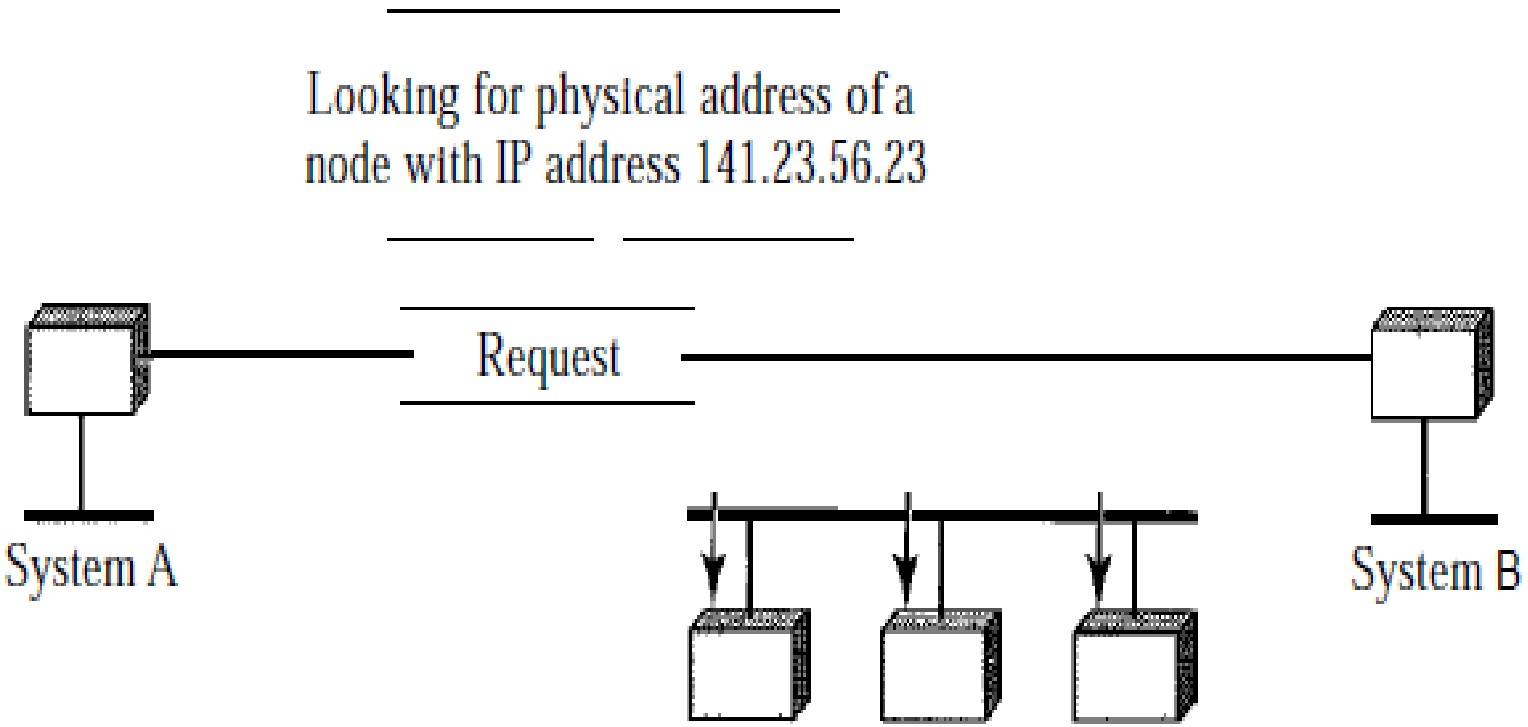
a. ARP request

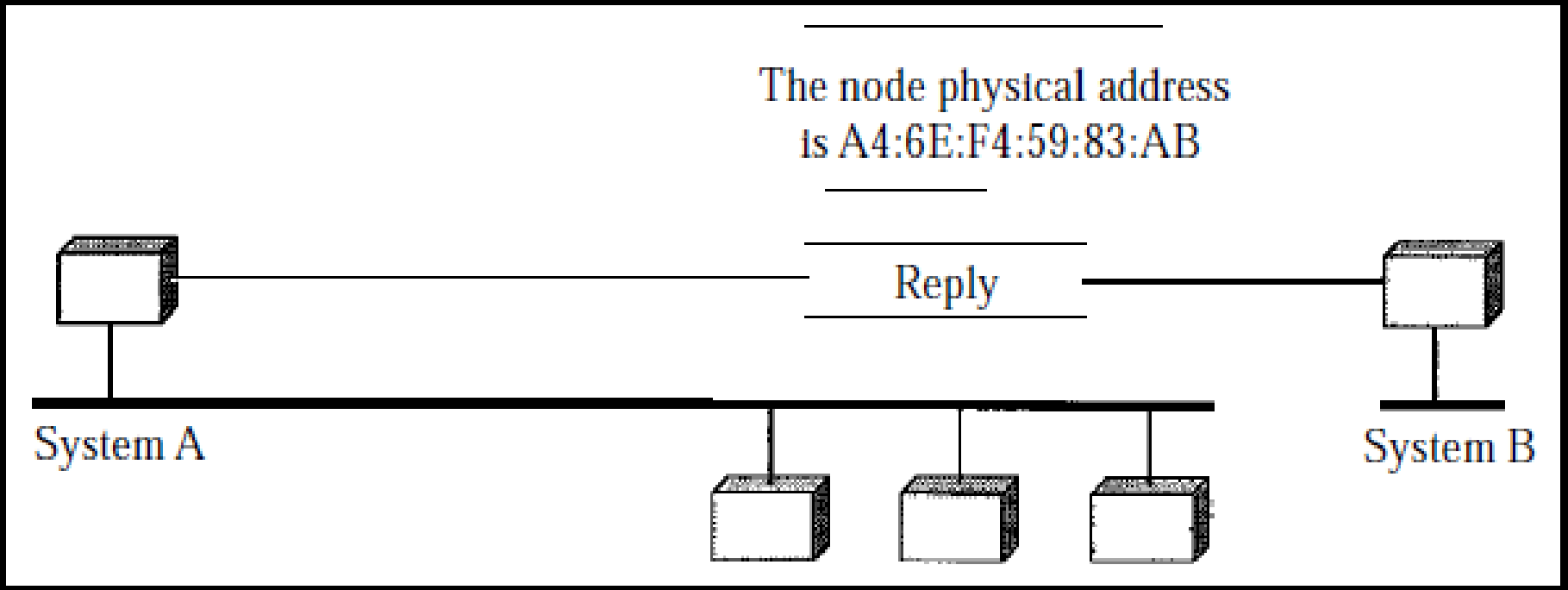


b. ARP response

ARP

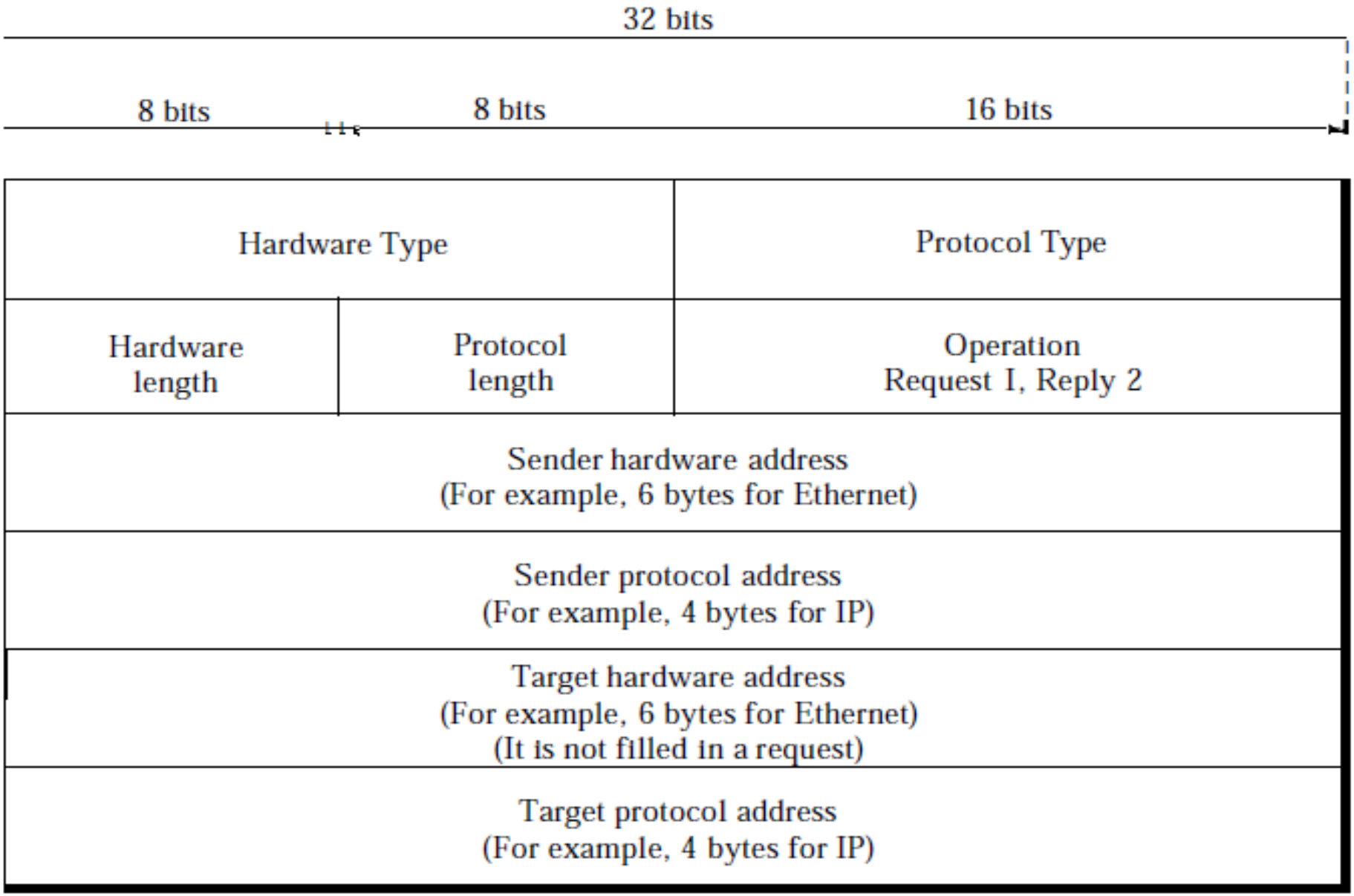
- **How to find MAC address:-** The router or host A who want to find the MAC address of some other router , sends a ARP request packet . packet consists of **IP and MAC address of sender** and **IP address of receiver** (B). This packet is broadcast over the n/w.





Every host and router on the n/w receives and process the ARP request packet . But only B recognizes its IP address and send back ARP response packet. Which contains the IP and physical address of receiver(B) .this packet delivered only to A using A's physical address in ARP request packet.

ARP packet format



ARP packet format

- **Hardware type**. This is a 16-bit field defining the type of the network on which ARP is running. Each LAN has been assigned an integer based on its type. ARP can be used on any physical network.
- **Protocol type**. This is a 16-bit field defining the protocol. For example, the value of this field for the IPv4 protocol is 080016, ARP can be used with any higher-level protocol.
- **Hardware length**. This is an 8-bit field defining the length of the physical address in bytes. for Ethernet the value is 6.
- **Protocol length**. This is an 8-bit field defining the length of the logical address in bytes. for the IPv4 protocol the value is 4.
- **Operation**. This is a 16-bit field defining the type of packet. Two packet types are defined: ARP request (1) and ARP reply (2).

Operations of ARP on internet

These are the steps involved in an ARP process:

1. The sender knows the IP address of the target.
2. IP asks ARP to create an ARP request message, filling in the sender physical address, the sender IP address, and the target IP address. The target physical address field is filled with O's.
3. The message is passed to the data link layer where it is encapsulated in a frame by using the physical address of the sender as the source address and the physical broadcast address as the destination address.

Operations of ARP on internet

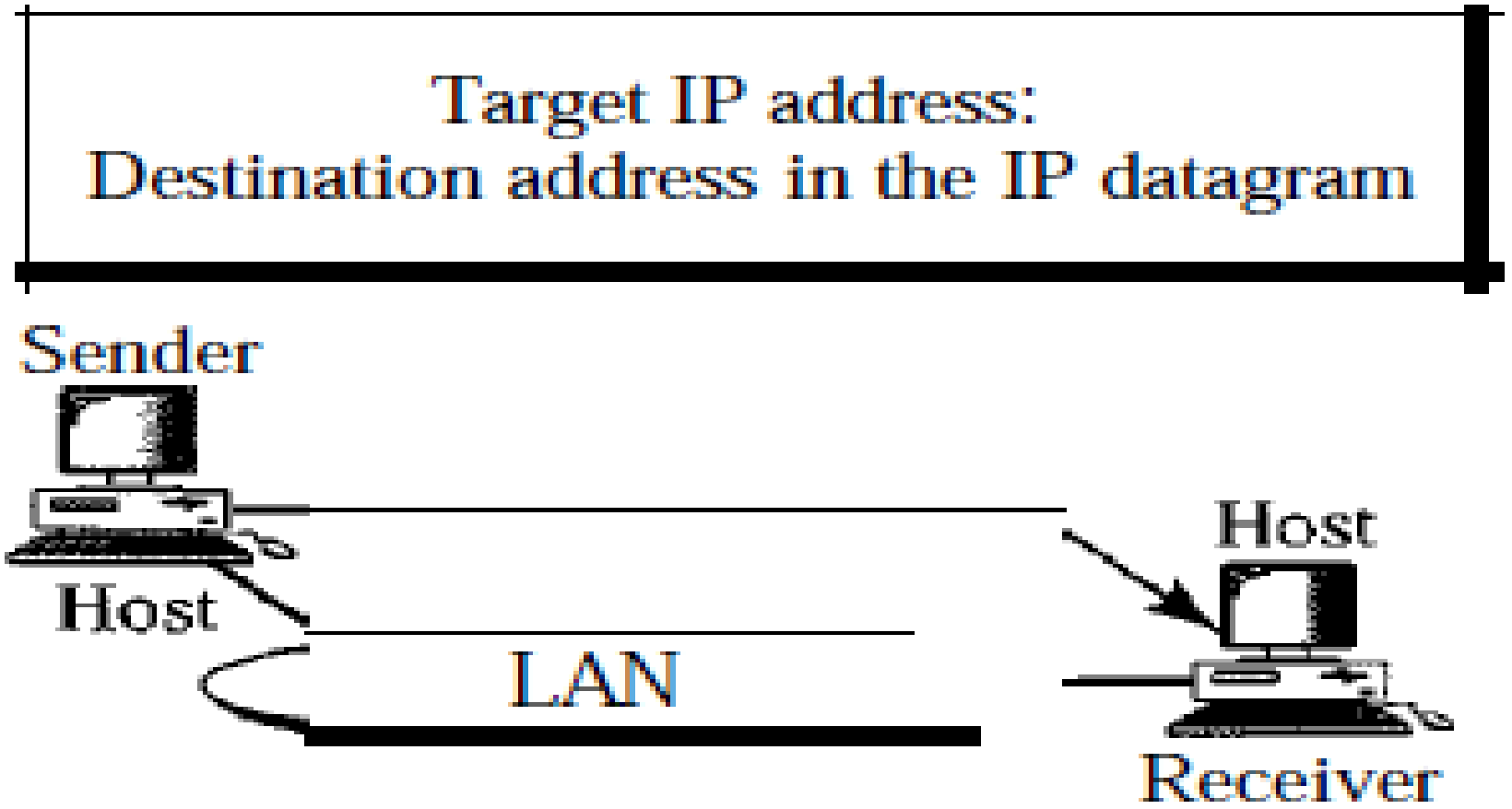
4. Every host or router receives the frame. Because the frame contains a broadcast destination address, all stations remove the message and pass it to ARP.
5. All machines except the one targeted drop the packet. The target machine recognizes its IP address.
6. The target machine replies with an ARP reply message that contains its physical address. The message is unicast.

Operations of ARP on internet

7. The sender receives the reply message. It now knows the physical address of the target machine.
8. The IP datagram, which carries data for the target machine, is now encapsulated in a frame and is unicast to the destination.

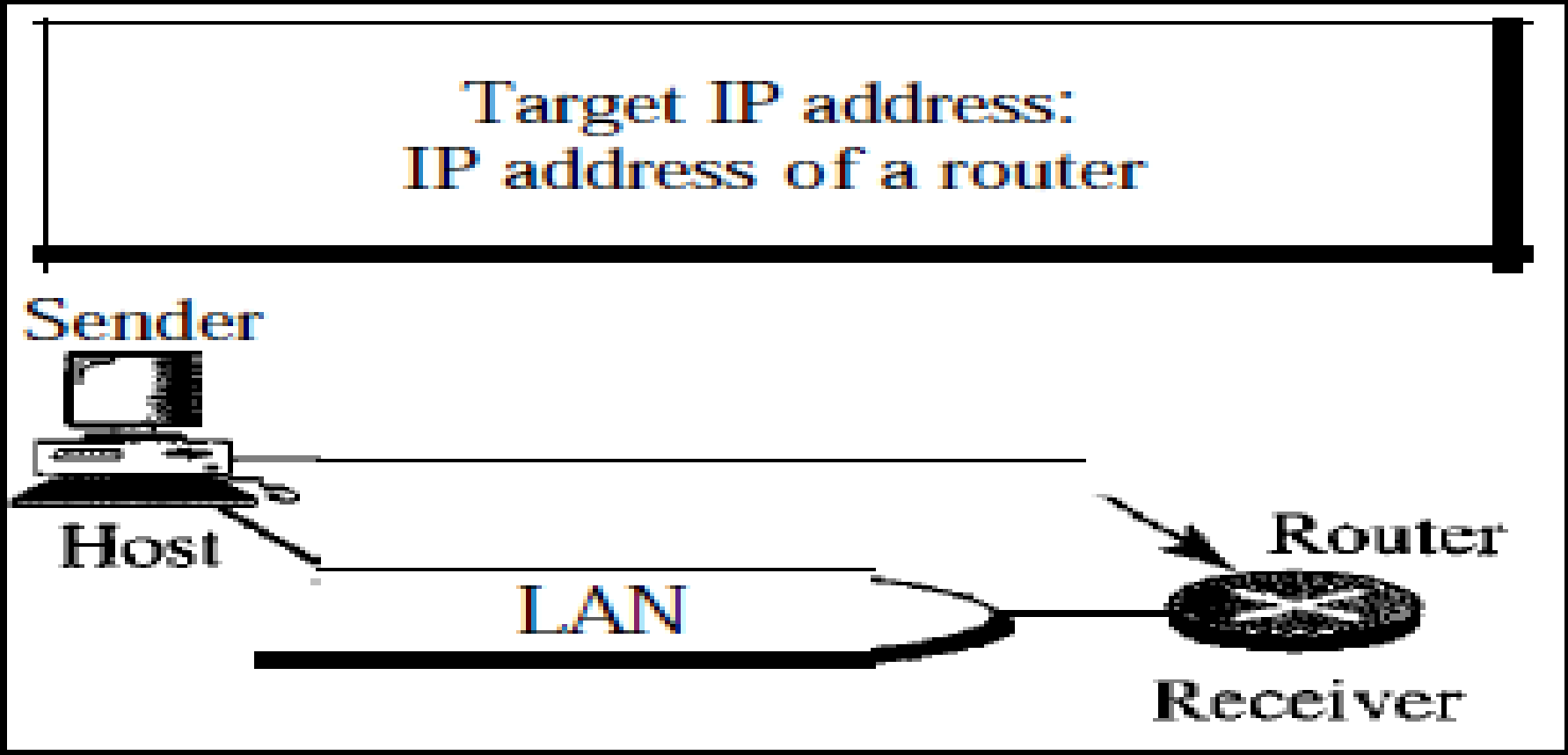
The following are four different cases in which the services of ARP can be used :-

Case 1. A host has a packet to send to another host on the same network.



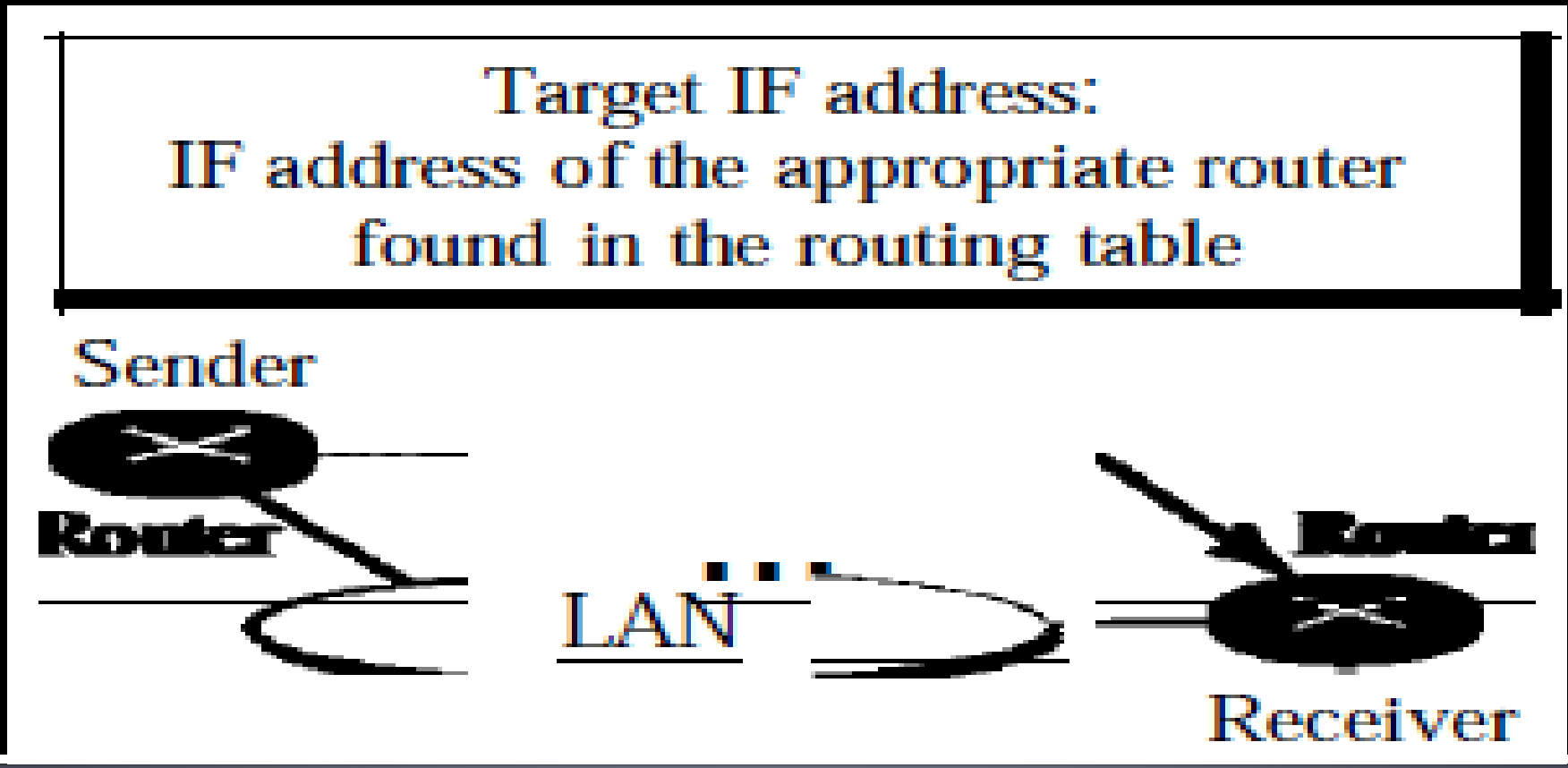
In this case, the logical address that must be mapped to a physical address is the destination IP address in the datagram header.

Case 2. A host wants to send a packet to another host on another network.



In this case, the host looks at its routing table and finds the IP address of the next hop (router) for this destination. If it does not have a routing table, it looks for the IP address of the default router. The IP address of the router becomes the logical address that must be mapped to a physical address

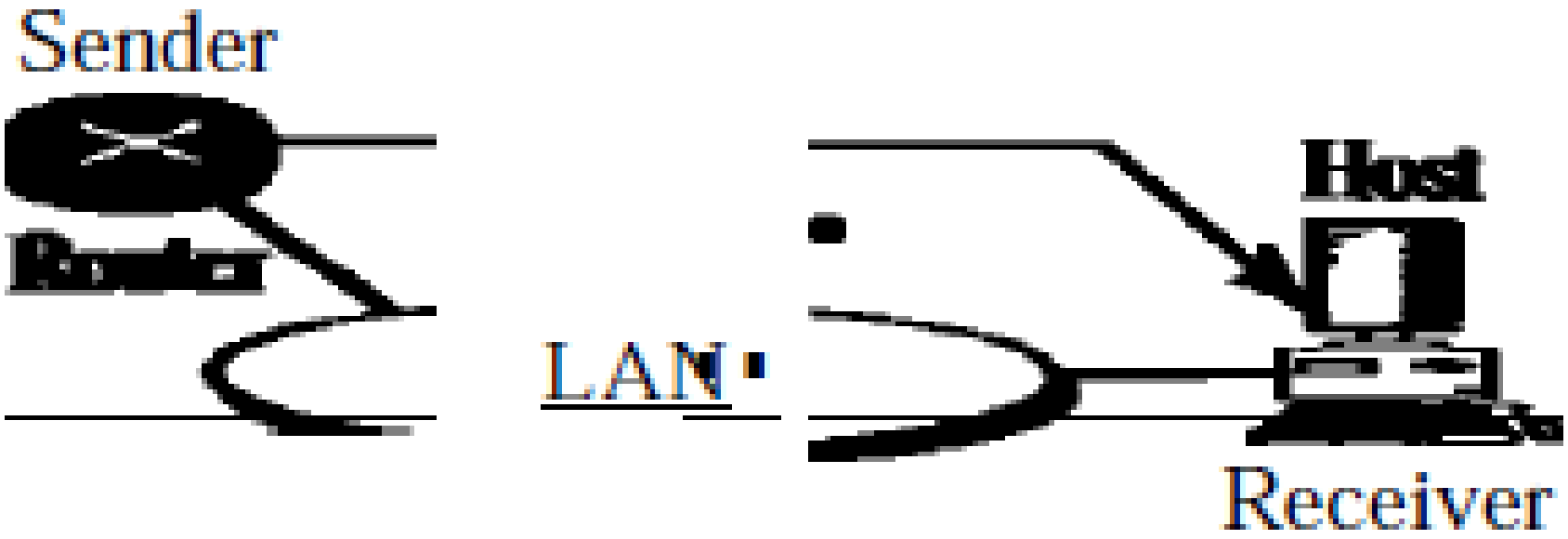
Case 3. A router receives a packet to be sent to a host on another network.



The sender is a router that has received a datagram destined for a host on another network. It checks its routing table and finds the IP address of the next router. The IP address of the next router becomes the logical address that must be mapped to a physical address

Case 4. A router receives a packet to be sent to a host on the same network.

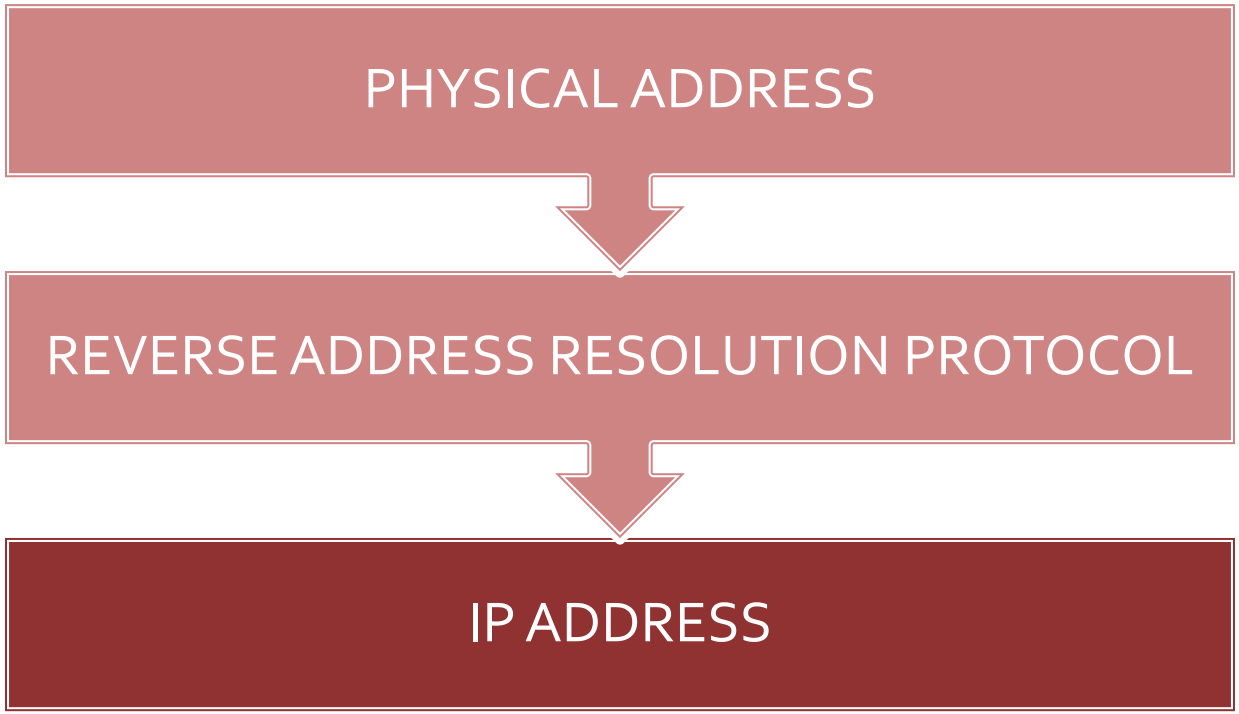
Target IP address:
Destination address in the IP datagram



The sender is a router that has received a datagram destined for a host on the same network. The destination IP address of the datagram becomes the logical address that must be mapped to a physical address.

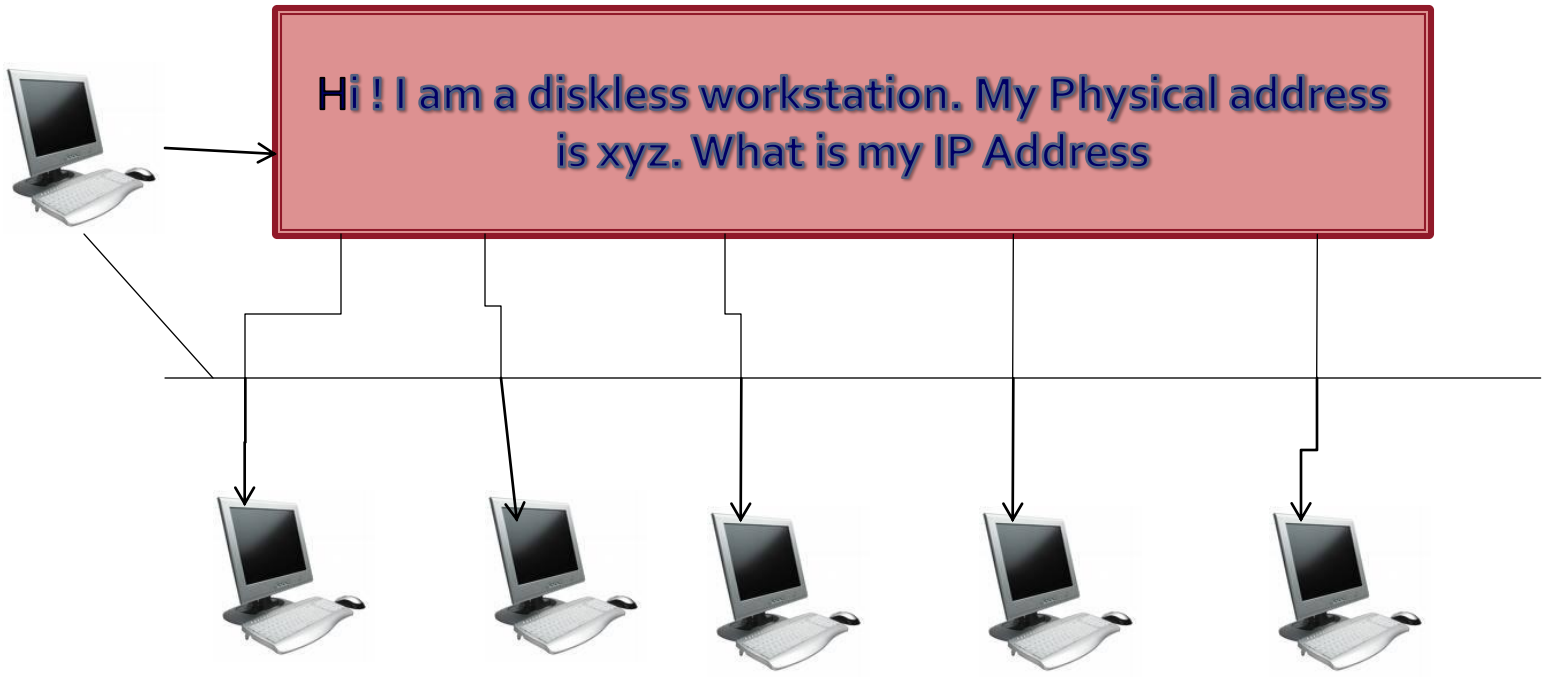
Reverse Address Resolution Protocol (RARP)

The RARP is used to obtained the IP, address of a host based on its physical address. That is, it perform a job that is exactly opposite to that of the ARP. A host should have the IP address stored on its hard disk.

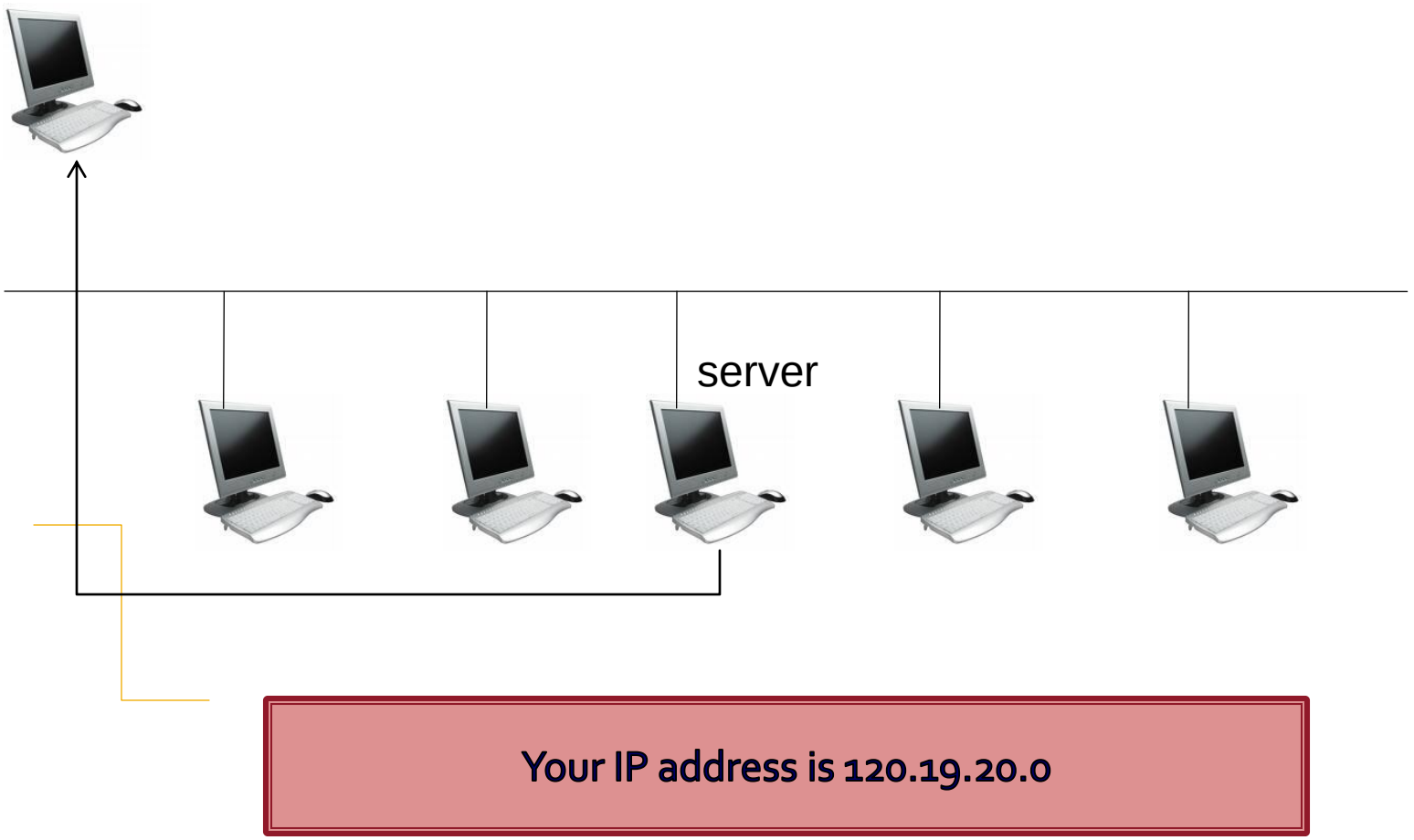


RARP

- RARP works in a very similar way to ARP, but in the exactly opposite direction.
- In RARP, the host interested in knowing its IP address broadcast on RARP query datagram. This datagram contains its physical address. Every other computer on the network receive the datagram.
- All the computers except a centralized computer (the server computer) ignore this datagram.
- However, the server recognizes this special kind of datagram and send the broadcasting computer its IP address.
- The server contains a list of the physical addresses and their corresponding IP addresses for all diskless station.



A host sends an RARP query datagram



Server sends an RARP response

Only server replies back and sends the diskless host's IP address

ICMP

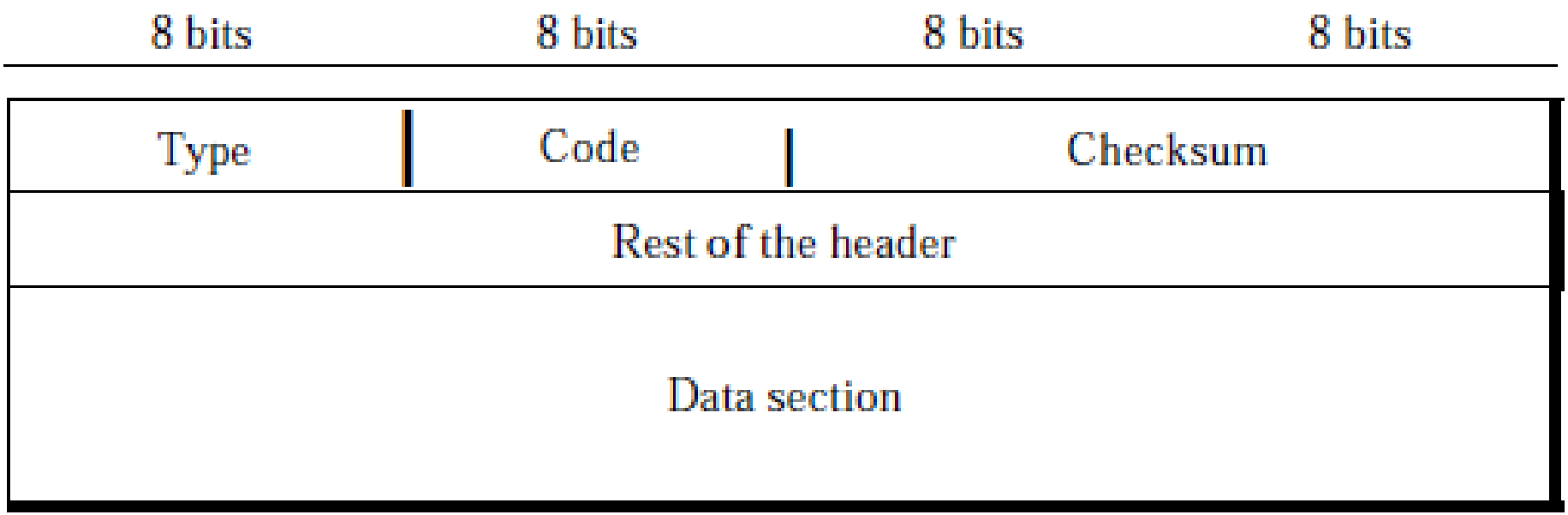
The IP protocol is a best-effort delivery service that delivers a datagram from its original source to its final destination. The IP protocol has no error-reporting or error-correcting mechanism. ICMP has been designed to compensate for the above two deficiencies.

Types of Messages

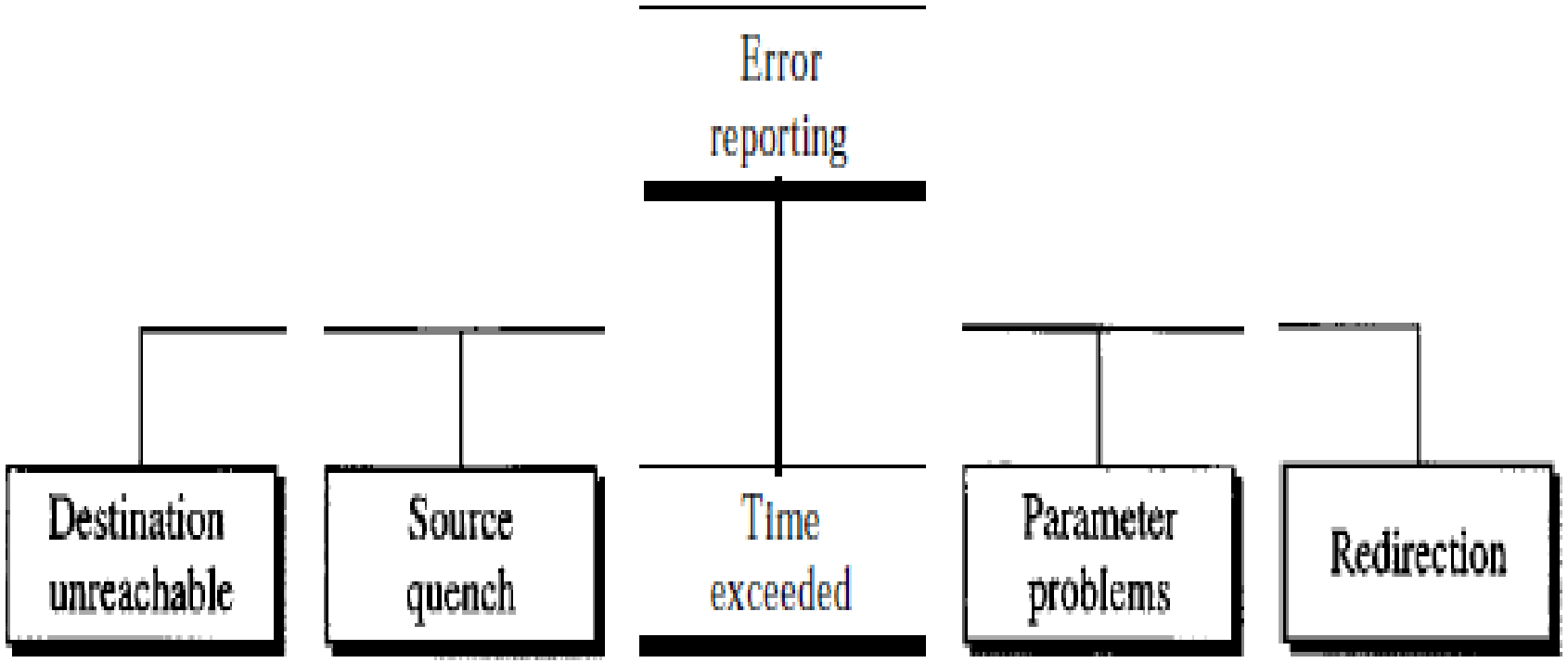
- **The error-reporting messages** report problems that a router or a host (destination) may encounter when it processes an IP packet.
- **The query messages**, help a host or a network manager get specific information from a router or another host. For example, nodes can discover their neighbors. Also, hosts can discover and learn about routers on their network, and routers can help a node redirect its messages.

Message Format

An ICMP message has an 8-byte header and a variable-size data section.



Error Reporting



Destination Unreachable

- When a router can’t forward or deliver an IP packet it sends destination unreachable ICMP message back to the source.

Time Exceeded

- Each datagram contains a field called **time to live** that controls visiting a series of routers endlessly situation .
- When a datagram visits a router, the value of time to live field is decremented by 1.
- When the time-to-live value reaches 0, after decrementing, the router discards the datagram , and a time-exceeded message must be sent by the router to the original source.
- Second, a time-exceeded message is also generated when not all fragments that make up a message arrive at the destination host within a certain time limit.

Source Quench message

- It is used to report congestion to the source and request it to reduce the current rate of packet transmission . there is no flow and congestion control in IP. So ICMP is designed to add a kind of flow control and congestion control to IP. This message serves two purposes
- Tells the source that the datagram is discarded
- Gives warning to the source that source should slow down transmission b'z congestion has taken place.

Query

- Echo request and reply
- Time Stamp request and reply
- Address mask request and reply
- Router solicitation and advertisement

IGMP

The IP protocol can be involved in two types of communication: **unicasting and multicasting** .

- **Unicasting** is the communication between one sender and one receiver. It is a one-to-one communication.
- **multicasting** some processes sometimes need to send the same message to a large number of receivers simultaneously this is called multicasting, applications Like multiple stockbrokers can simultaneously be informed of changes in a stock price , or travel agents can be informed of a plane cancellation. Some other applications include distance learning and video-on-demand .

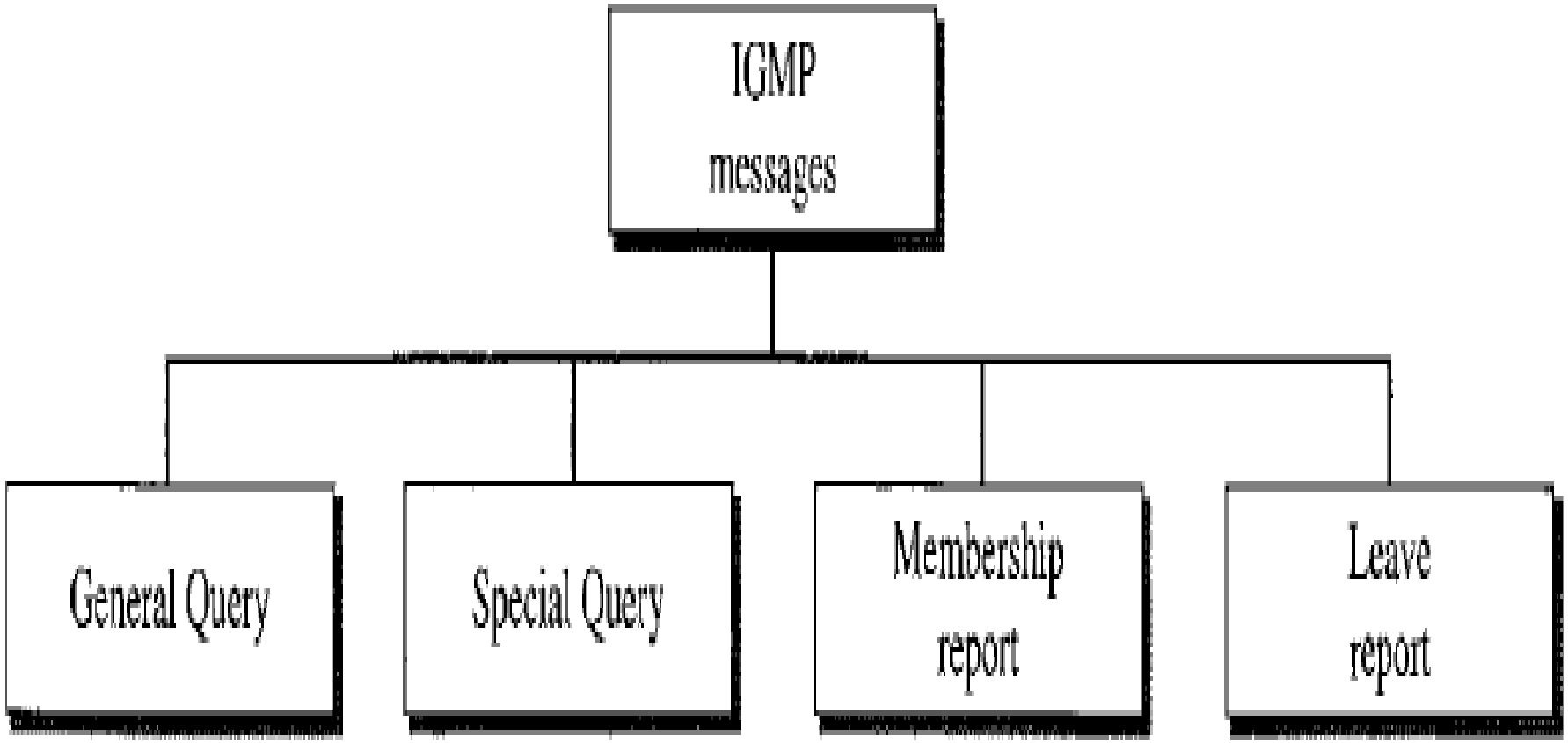
Group Management

- For multicasting in the Internet we need routers that are able to route multicast packets . The routing tables of these routers must be updated by using one of the multicasting routing protocol.
- **IGMP is not a multicasting routing protocol; it is a protocol that manages group membership. It helps a multicast router create and update a list of loyal members related to each router interface.**
- The IGMP protocol gives the multicast routers information about the membership status of hosts (routers) connected to the network.

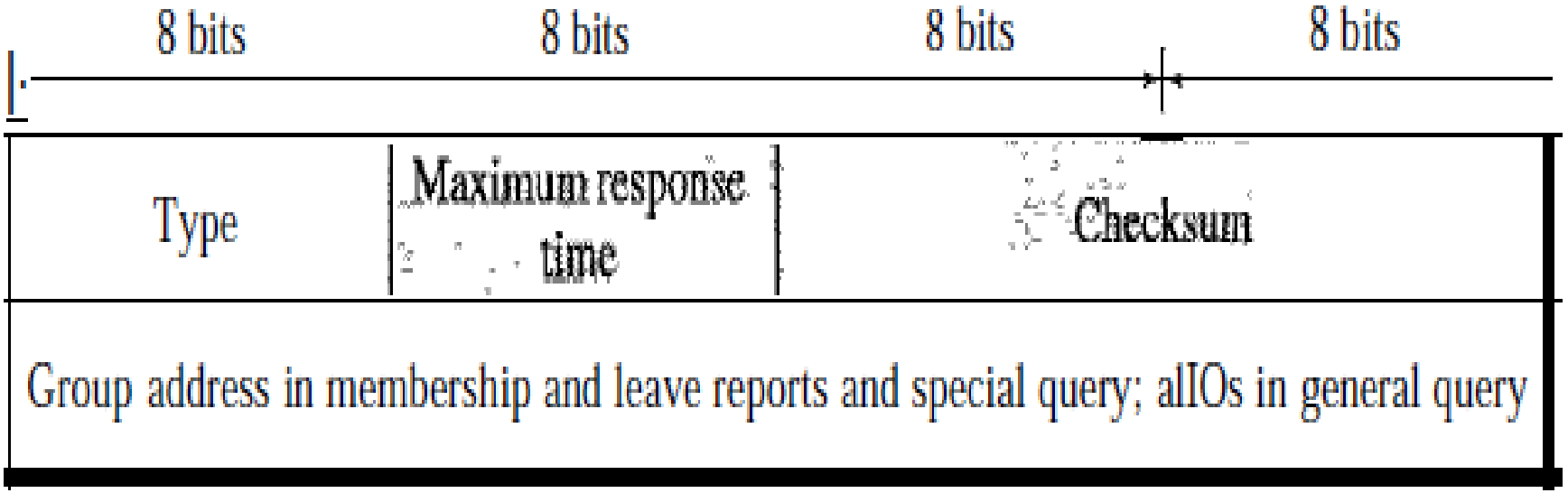
Group Management

- 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 these packets. This creates a lot of traffic and consumes bandwidth.
- **A better solution is to 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



Message Format



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, sends request to the host. host adds the name of the process and the name of the requested group to its list. And , host sends a membership report message. membership report be sent twice, one after the other within a few seconds. 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 router sees that none of the networks connected to its interfaces is interested in a specific group, it sends a leave report about that group.

IGMP Operation

- **Monitoring Membership**
- Consider the situation in which host is shut down or removed from the system and one host interested in joining a group, The multicast router is responsible for monitoring all the hosts or routers in a LAN to see if they want to continue their membership in a group.

IGMP Operation

- **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.

IGMP Operation

- **Query Router**
- Query messages may create a lot of responses. To prevent unnecessary traffic, IGMP
- designates one router as the query router for each network. Only this designated router sends the query message, and the other routers are passive.

Applications

- These protocols work along with IP protocol to support different tasks of IP protocol like address resolution and group management

Scope of Research

- Changes in ARP and RARP protocols for the next version of IP Protocol
- IP protocols in wireless domian
- IP protocols in mobile networks