Computer Network(CSC 503)

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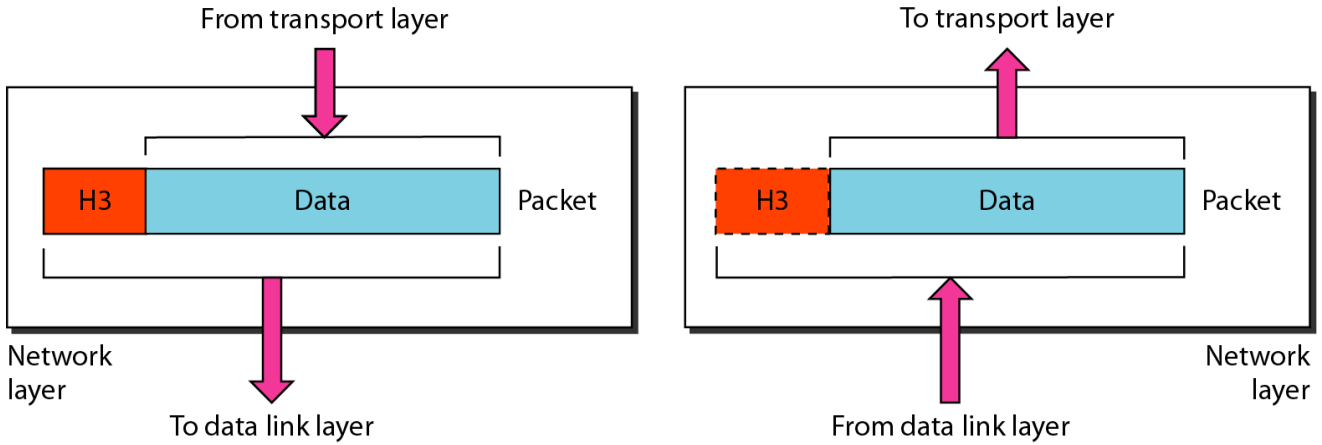
Lecture 24

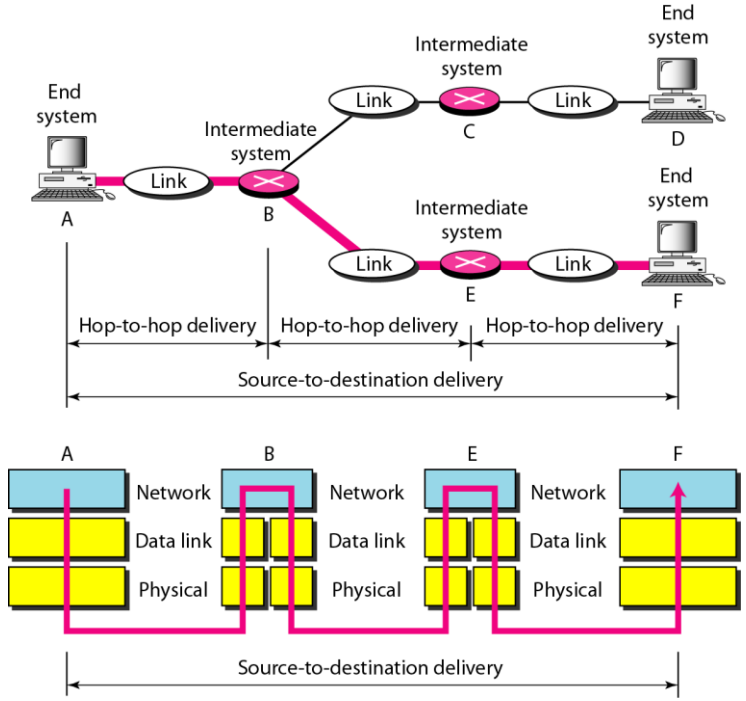
Module 4 **Network layer**

- 4.1 Network Layer design issues, Communication Primitives: Unicast, Multicast, Broadcast. IPv4 Addressing (classfull and classless), Subnetting, Supernetting design problems ,IPv4 Protocol, Network Address Translation (NAT), IPv6

Network Layer

- Network layer is the **third** layer of ISO OSI model
- Data in network layer is called as **packet**
- Network layer is needed when the **source and destination are in different networks**.
- Forwarding packet to the destination may require making many **hops** at **intermediate routers** along the way
- Network layer **protocols** exist in every host router. The router examines the **header fields** of all the IP packets that pass through it.





Network Layer Services

- **1. Packetizing**
- **2. Logical addressing**
- **3. Routing**
- **4. Forwarding**
- **Other services:** Following are the services which are also expected from the network layer
    (a) Error Control
    (b) Flow control
    (c) Congestion control
    (d) Quality of service
    (e) Security

Network Layer design issues

1. **Store-and-Forward Packet Switching**
2. **Services Provided to the Transport Layer**
3. **Implementation of Connectionless Service**
4. **Implementation of Connection-Oriented Service**
5. **Comparison of Virtual-Circuit and Datagram Networks**

1. Store-and-Forward Packet Switching

- The packet is stored at router and checksum is verified.
- Then it is forwarded to the next router along the path until it reaches the destination host

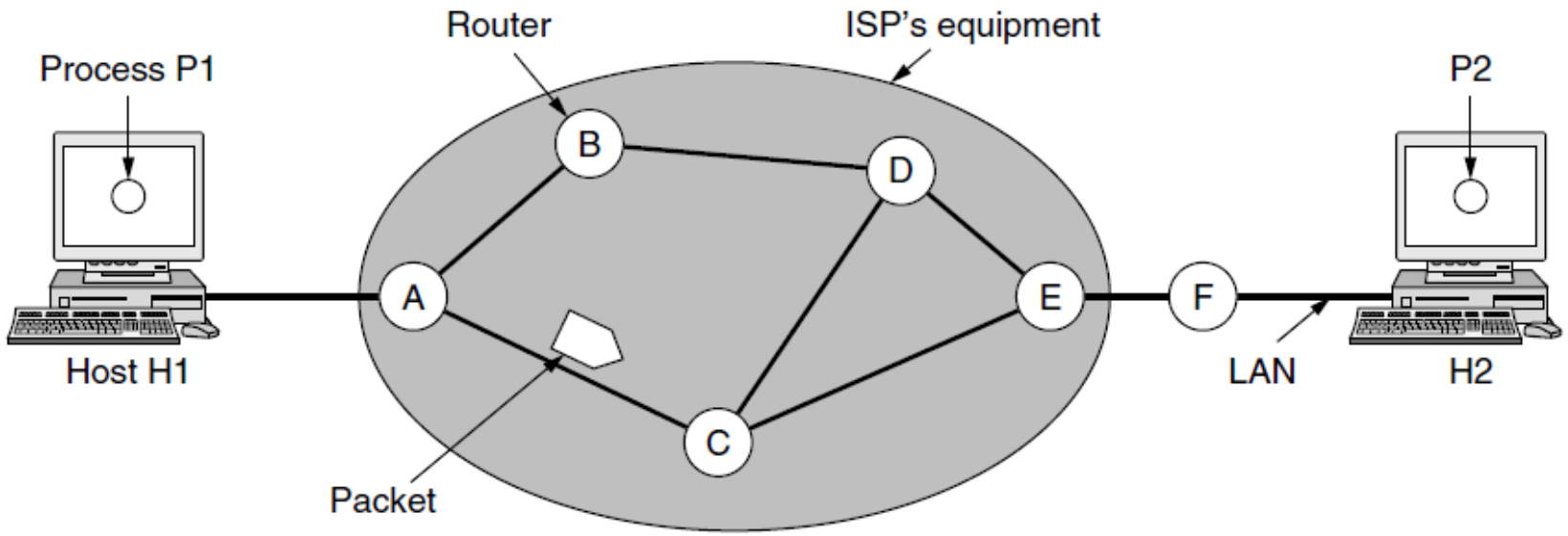


Fig. The environment of the network layer protocols.

2. Services Provided to the Transport Layer

1. The services should be independent of the router technology.
2. The transport layer should be shielded from the number, type, and topology of the routers present.
3. The network addresses made available to the transport layer should use a uniform numbering plan, even across LANs and WANs.

3. Implementation of Connectionless Service

- Packets are injected into the network individually and routed independently of each other.
- No advance setup is needed.
- The packets are frequently called **datagrams** (in analogy with telegrams)

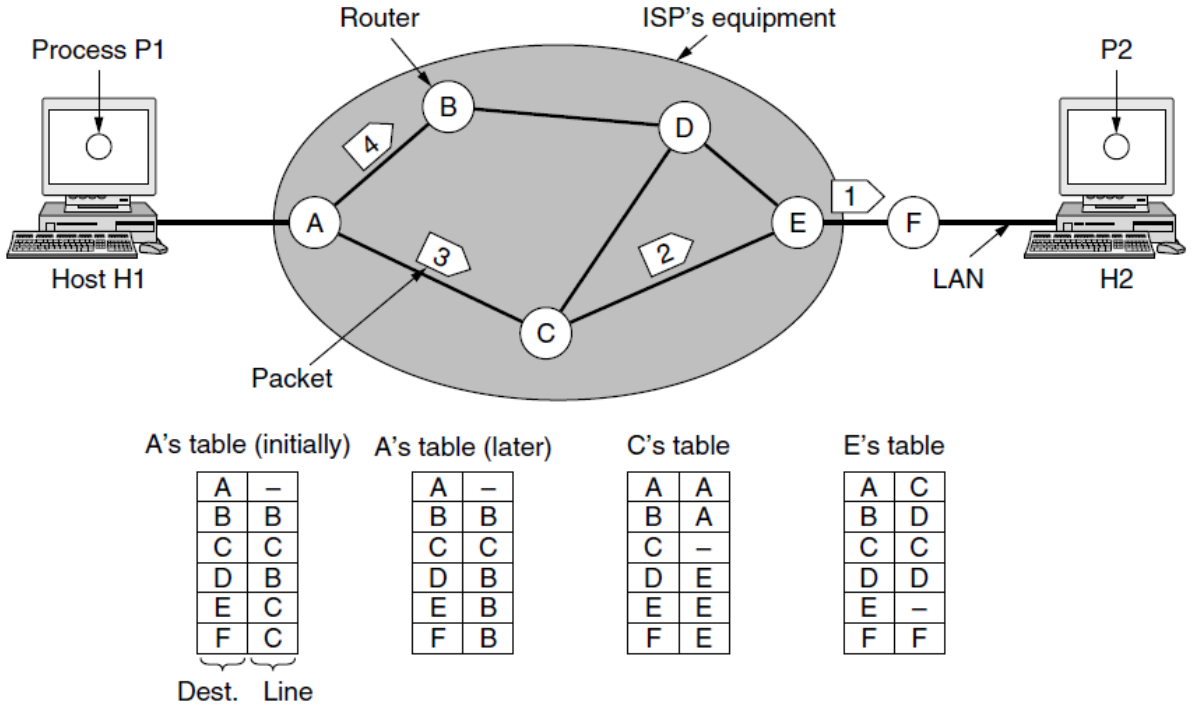


Fig: Routing within a datagram network.

4. Implementation of Connection-Oriented Service

- If connection-oriented service is used, a path from the source router all the way to the destination router must be established before any data packets can be sent.
- This connection is called a **VC** (**virtual circuit**), and the network is called a **virtual-circuit network**.

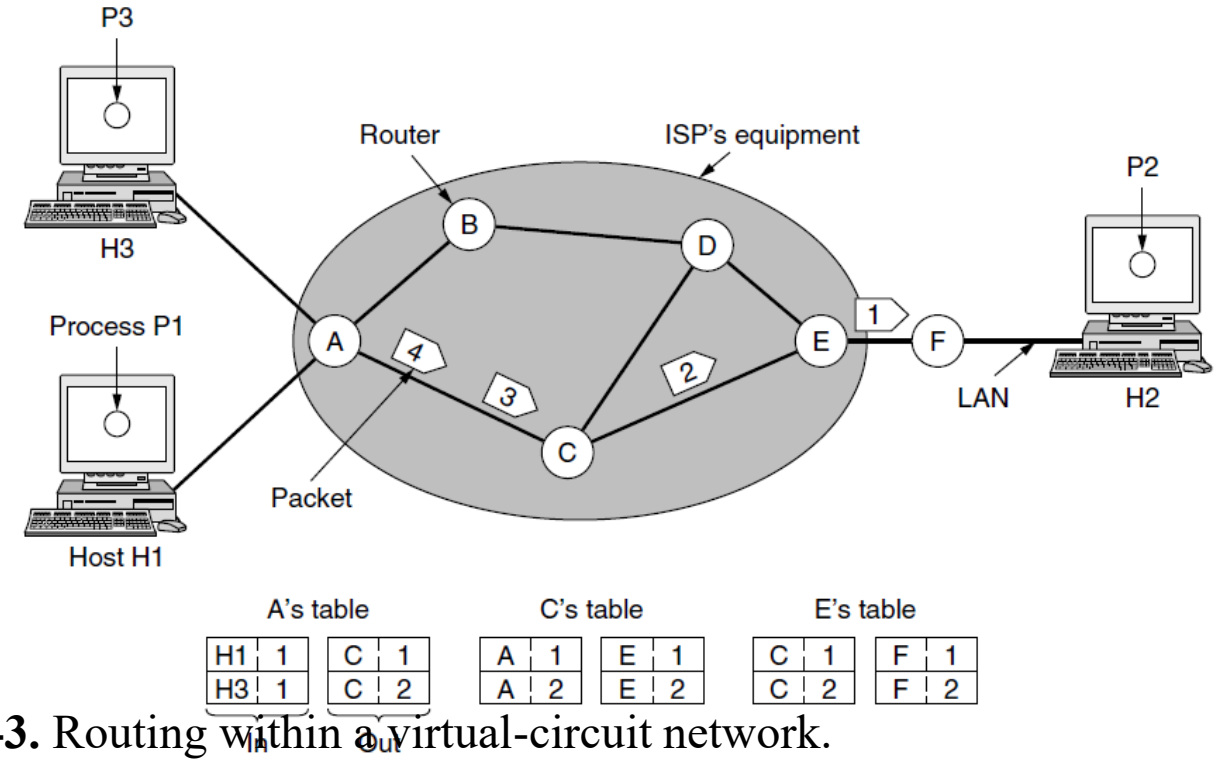
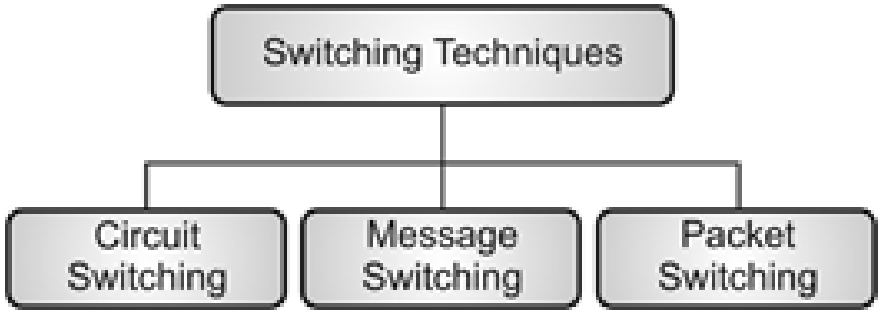


Figure 5-3. Routing within a virtual-circuit network.

Switching Techniques

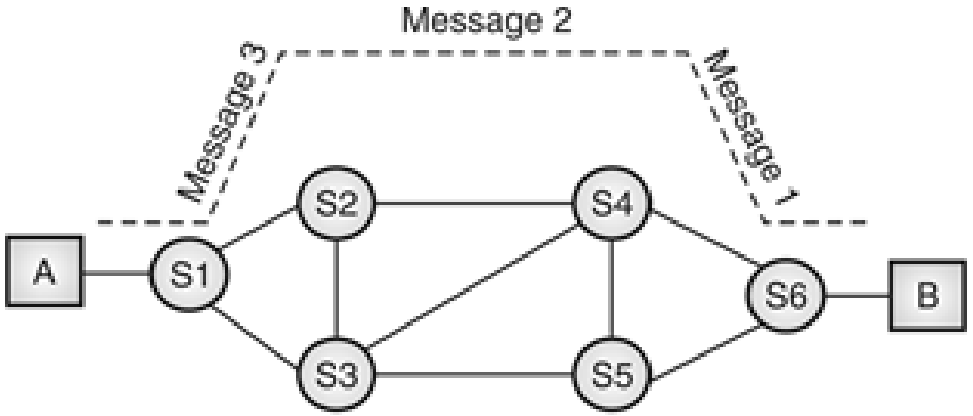


Circuit Switching

- In Circuit switching technique a **dedicated path** is established between sender and receiver

There are three phases of Communication through circuit switching :

- **i) Circuit establishment**
- **ii) Data transfer**
- **iii) Circuit Disconnect**

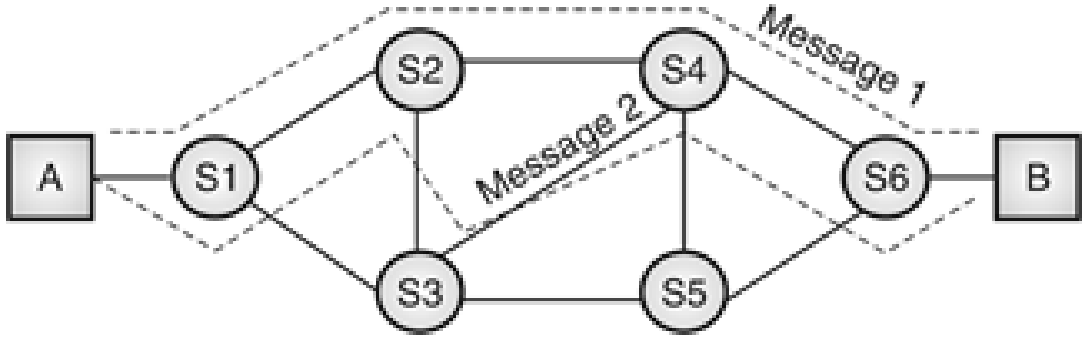


- **Data transfer is done through the dedicated path**
  Example: Telephone network

- The dedicated path will exists unless and until the connection is not terminated.

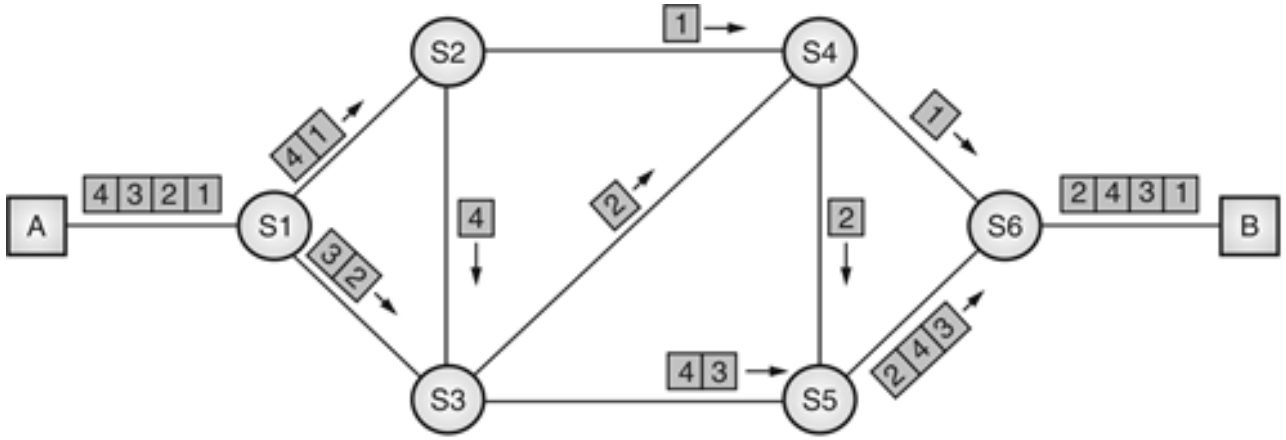
Message Switching

- Transferring of message is done as a complete unit and further it is routed through intermediate nodes where it is stored as well as forwarded
- Dedicated path is not established between the sender and receiver.
- Message Switching offers a **dynamic routing** as the message is routed through the intermediate nodes depending upon the data present in the message.
- Every message is treated as an independent entity by the Message switching.
- The entire message is stored by all of the nodes. Every node forwards it after storing it into itself(**Store and forward network)**



Packet Switching

- In this, the message is partitioned into tiny pieces and those pieces are independently transferred.
- The small pieces of message are called as packets.
- A unique number is assigned to every packet to identify their order at the receiving (destination) end.
- In the header of every packet there is information like source as well as destination address and sequence number
- If there is missing or corruption of any packet, then the message can be resented.



Two approaches of Packet switching

- 1. Datagram Packet switching
- 2. Virtual Circuit Switching

5. Comparison of Virtual-Circuit and Datagram Networks

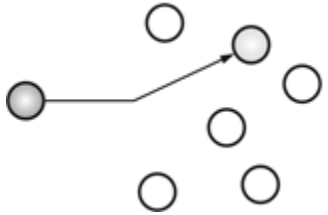
Issue	Datagram network	Virtual-circuit network
Circuit setup	Not needed	Required
Addressing	Each packet contains the full source and destination address	Each packet contains a short VC number
State information	Routers do not hold state information about connections	Each VC requires router table space per connection
Routing	Each packet is routed independently	Route chosen when VC is set up; all packets follow it
Effect of router failures	None, except for packets lost during the crash	All VCs that passed through the failed router are terminated
Quality of service	Difficult	Easy if enough resources can be allocated in advance for each VC
Congestion control	Difficult	Easy if enough resources can be allocated in advance for each VC

Communication Primitives: Unicast, Multicast, Broadcast.

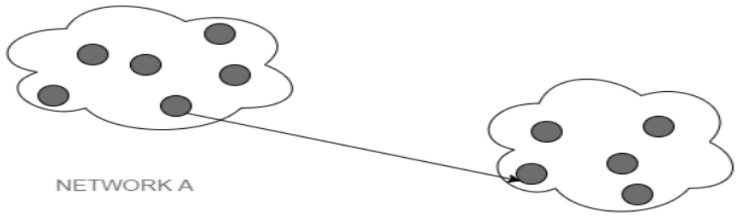
Following are the three simple methods used to transmit packets over a network.

- **1. Unicast**
- **2. Multicast**
- **3. Broadcast**

1.Unicast

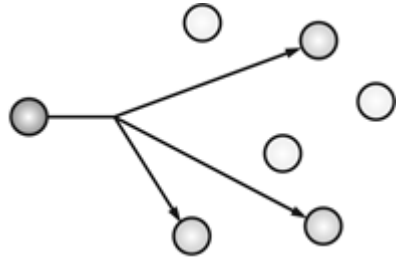


- One sender and one receiver.
- The most common method of information transfer which takes place on networks
- Multiple unicasting utilizes more bandwidth as compared to multicast.
- It does not scale well for streaming media.
- One-to-one mapping
- Ex: Web surfing, file transfer.
- This type of information transfer is useful when there is a participation of single sender and single recipient. Host 1 with address 192.168.24.56 wants to send data to Host2 with address 192.168.24.88.



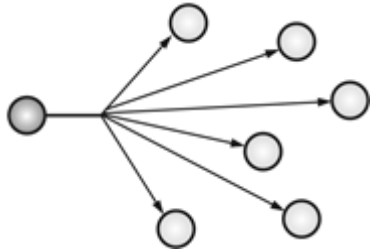
UNICAST EXAMPLE

2. Multicast

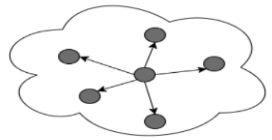


- One sender and multiple receivers: One-to-many Mapping
- Multicasting utilizes bandwidth efficiently.
- It’s an “on demand” system capable of catering for the likes of pay per view, or similar subscription-based services.
- These routers replicate data packets received at one input interface, then send the copied data out on multiple output interfaces.
- Example: News/sports/stock/weather updates, Distance learning ,Email distribution lists etc.
- IP multicast requires support of some other protocols like IGMP (Internet Group Management Protocol).
- In Classful IP addressing Class D is reserved for multicast groups. Multicast IP address range is from 224.0.0.0 – 239.255.255.255.

3. Broadcast



- A broadcast transmission simultaneously transmits the same information to all nodes on a network
- To ensure that the broadcast reaches all “corners”, the transmission may have to be refreshed or relayed at certain points.
- E.g. Television signals
- Broadcast information is sent from the source node only once – a copy of that data is then forwarded to all devices on the network.
- In LAN, Ethernet networks support broadcast transmission, in which case the Address Resolution Protocol (ARP)
- **i) Limited Broadcasting : When host1 wants to send packets to** to all the devices over the network. To achieve this it will append 255.255.255.255 (IPv4), called as Limited Broadcast



- **(ii) Direct Broadcasting :** This is useful when a device in one network wants to transfer packet stream to all the devices over the other network. This is achieved by translating all the Host ID part bits of the destination address to 1, referred as **Direct Broadcast Address** in the datagram header for information transfer.