

Principles of Data Communications

Reference Book: Data Communications and Networking by Behrouz A. Forouzan

DATA LINK LAYER

- A packet at the data-link layer is normally called a frame.
- Flow Control - data link layer, transport layer.
- Error Control

Flow Control

- Whenever we have a producer and a consumer, we need to think about flow control.
- If the producer produces items that cannot be consumed, accumulation of items occurs.
- The sending data-link layer at the end of a link is a producer of frames; the receiving data-link layer at the other end of a link is a consumer.
- If the rate of produced frames is higher than the rate of consumed frames, frames at the receiving end need to be buffered while waiting to be consumed (processed).
- Definitely, we cannot have an unlimited buffer size at the receiving side. We have two choices.
 - The first choice is to let the receiving data-link layer drop the frames if its buffer is full.
 - The second choice is to let the receiving data-link layer send a feedback to the sending data-link layer to ask it to stop or slow down.

- Different data-link-layer protocols use different strategies for flow control.
- Flow control also occurs at the transport layer.

- At the sending node, a frame in a data-link layer needs to be changed to bits, transformed to electromagnetic signals, and transmitted through the transmission media.
- At the receiving node, electromagnetic signals are received, transformed to bits, and put together to create a frame.
- Since electromagnetic signals are susceptible to error, a frame is susceptible to error. The error needs first to be detected.
- After detection, it needs to be either corrected at the receiver node or discarded and retransmitted by the sending node.

Congestion Control

- Although a link may be congested with frames, which may result in frame loss, most data-link-layer protocols do not directly use a congestion control to alleviate congestion, although some wide-area networks do.
- In general, congestion control is considered an issue in the network layer or the transport layer because of its end-to-end nature.

Two Sublayers

- To better understand the functionality and the services provided by the link layer, we can divide the data-link layer into two sublayers:
 - Data Link Control (DLC)
 - Media Access Control (MAC)

LINK-LAYER ADDRESSING

- A link-layer address is sometimes called a link address, sometimes a physical address, and sometimes a MAC address.
- When a datagram passes from the network layer to the data-link layer, the datagram will be encapsulated in a frame and two data-link addresses are added to the frame header.

- How are the source and destination IP addresses in a packet determined?
 - The answer is that the host should know its own IP address, which becomes the source IP address in the packet. The application layer uses the services of DNS to find the destination address of the packet and passes it to the network layer to be inserted in the packet.
 - google(name)-IP address

- How are the source and destination link-layer addresses determined for each link?
 - Again, each hop (router or host) should know its own link-layer address
 - The destination link-layer address is determined by using the Address Resolution Protocol (ARP)

Three Types of Addresses

- Unicast Address
 - Unicasting means one-to-one communication.
 - A frame with a unicast address destination is destined only for one entity in the link.

Three Types of Addresses

- Multicast Address
 - Multicasting means one-to-many communication. However, the jurisdiction is local (inside the link).

Three Types of Addresses

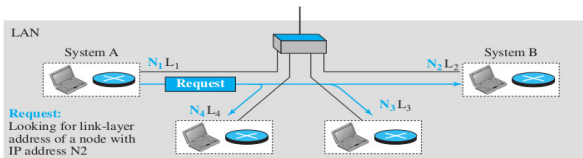
- Broadcast Address

- Some link-layer protocols define a broadcast address.
- Broadcasting means one-to-all communication.
- A frame with a destination broadcast address is sent to all entities in the link.
- The broadcast link-layer addresses in the most common LAN, Ethernet, are 48 bits, all 1s, that are presented as 12 hexadecimal digits separated by colons. The following shows a broadcast address: FF:FF:FF:FF:FF:FF

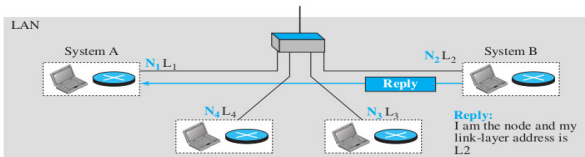
Address Resolution Protocol (ARP)

- The ARP protocol is one of the auxiliary protocols defined in the network layer.
- It belongs to the network layer (layer3), but we discuss it here because it maps an IP address to a logical-link address - (Hence Layer 2 protocol).
- ARP accepts an IP address from the IP protocol, maps the address to the corresponding link-layer address, and passes it to the data-link layer.
- IP address- MAC address - LAN

Address Resolution Protocol (ARP)



a. ARP request is broadcast



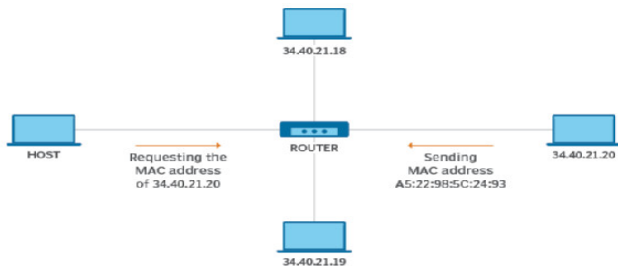
b. ARP reply is unicast

- Anytime a host or a router needs to find the link-layer address of another host or router in its network, it sends an ARP request packet.
- The packet includes the link-layer and IP addresses of the sender and the IP address of the receiver.
- Because the sender does not know the link-layer address of the receiver, the query is broadcast over the link using the link-layer broadcast address (see Figure).

- Every host or router on the network receives and processes the ARP request packet, but only the intended recipient recognizes its IP address and sends back an ARP response packet.
- The response packet contains the recipients IP and link-layer addresses.
- The packet is unicast directly to the node that sent the request packet.
- In Figure a, the system on the left (A) has a packet that needs to be delivered to another system (B) with IP address N2. System A needs to pass the packet to its data-link layer for the actual delivery, but it does not know the physical address of the recipient.

- It uses the services of ARP by asking the ARP protocol to send a broadcast ARP request packet to ask for the physical address of a system with an IP address of N2.
- This packet is received by every system on the physical network, but only system B will answer it, as shown in Figure b.
- System B sends an ARP reply packet that includes its physical address.
- Now system A can send all the packets it has for this destination using the physical address it received.

How address resolution protocol (ARP) works



- Flow Control
- Error Control
- Addressing
- ARP

THANK YOU