

MAC Protocols

Multiple Access Protocols

- **Multiple Access Protocols**—by which nodes regulate their transmission into the shared broadcast channel.
- Multiple Access Protocols are needed in a wide variety of network settings, including both wired and wireless access networks, and satellite networks.

Multiple Access Protocols

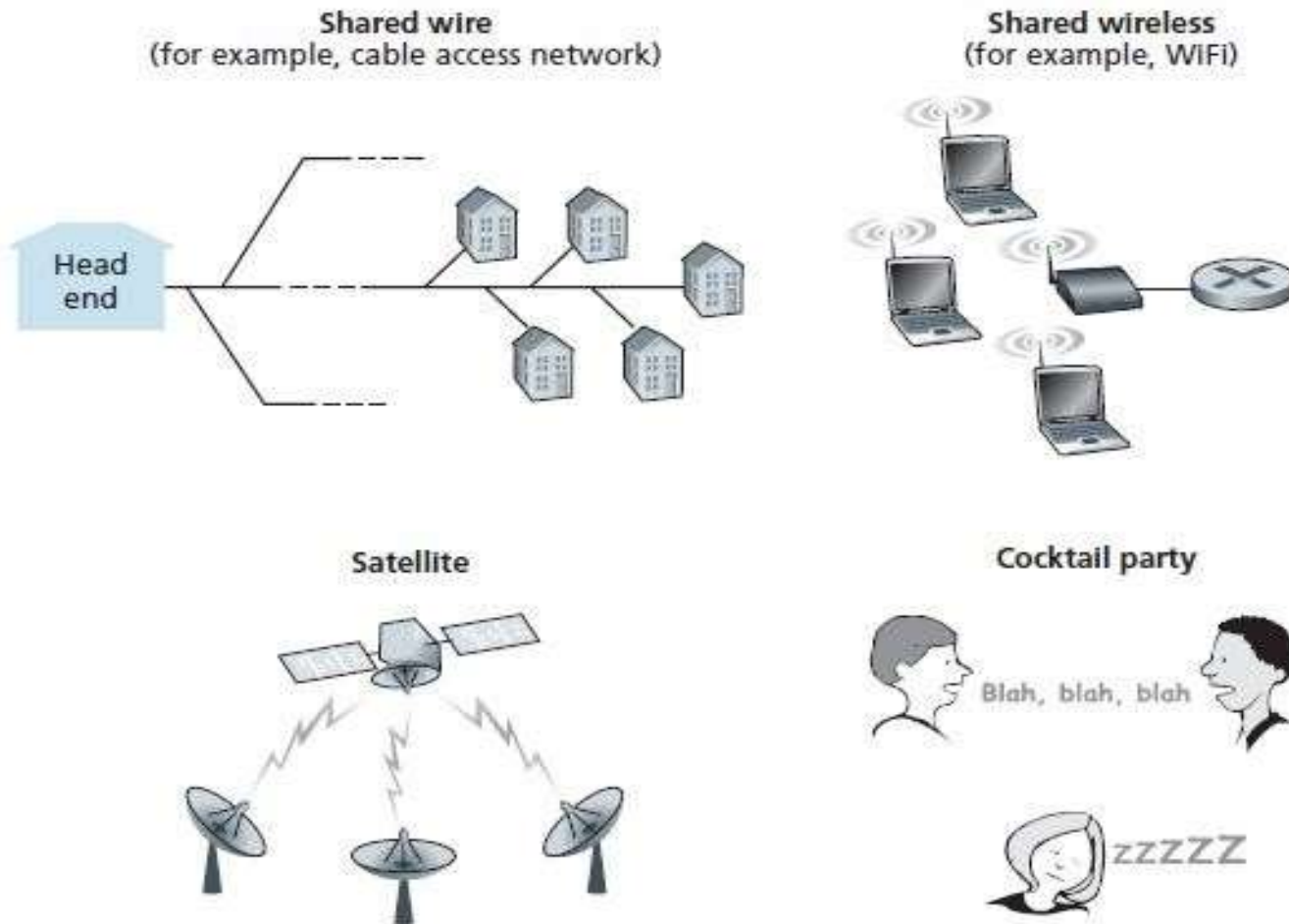


Figure 5.8 ♦ Various multiple access channels

Multiple Access Protocols

- A multiple access protocol for a broadcast channel of rate R bits per second should have the following desirable characteristics:
 - 1. When only one node has data to send, that node has a throughput of R bps.
 - 2. When M nodes have data to send, each of these nodes has a throughput of R/M bps. This need not necessarily imply that each of the M nodes always has an instantaneous rate of R/M , but rather that each node should have an average transmission rate of R/M over some suitably defined interval of time.

Multiple Access Protocols

- 3. The protocol is decentralized; that is, there is no master node that represents a single point of failure for the network.
- 4. The protocol is simple, so that it is inexpensive to implement.

Multiple Access Protocols

- There are three categories:
 - **Channel partitioning protocols,**
 - **Random access protocols, and**
 - **Taking-turns protocols.**

Channel Partitioning Protocols

- There are two techniques that can be used to partition a broadcast channel's bandwidth among all nodes sharing that channel.
 - Time-Division Multiplexing (TDM) and
 - Frequency-Division Multiplexing (FDM)
- In **TDM**:
 - Suppose the channel supports N nodes and that the transmission rate of the channel is R bps.
 - TDM divides time into **time frames** and further divides each time frame into N **time slots**.

Channel Partitioning Protocols

- Each time slot is then assigned to one of the N nodes. Whenever a node has a packet to send, it transmits the packet's bits during its assigned time slot in the revolving TDM frame.
- Typically, slot sizes are chosen so that a single packet can be transmitted during a slot time.
- In **FDM**:
 - FDM divides the R bps channel into different frequencies (each with a bandwidth of R/N) and assigns each frequency to one of the N nodes.
 - FDM thus creates N smaller channels of R/N bps out of the single, larger R bps channel.

Channel Partitioning Protocols

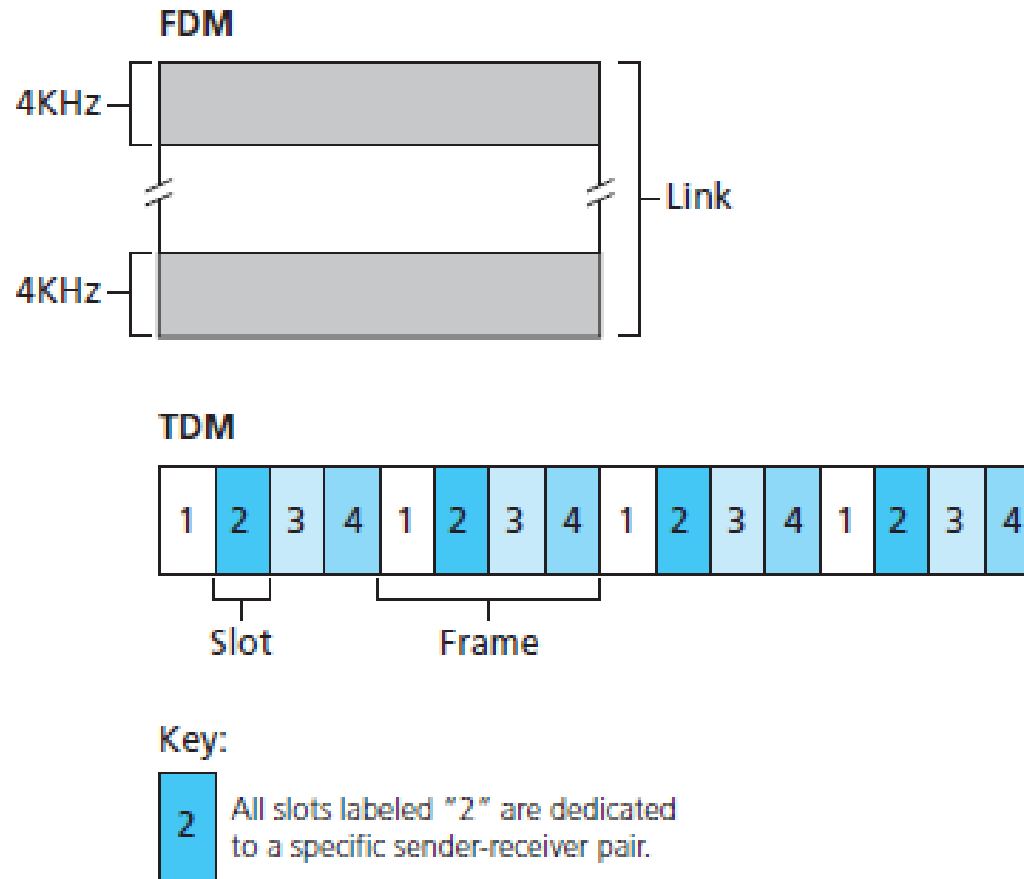


Figure 5.9 ♦ A four-node TDM and FDM example

Channel Partitioning Protocols

- **code division multiple access (CDMA):**
- While TDM and FDM assign time slots and frequencies, respectively, to the nodes, CDMA assigns a different *code* to each node.
- Each node then uses its unique code to encode the data bits it sends.
- CDMA networks have the wonderful property that different nodes can transmit *simultaneously*.

Random access protocols

- In a random access protocol, a transmitting node always transmits at the full rate of the channel, namely, R bps.
- When there is a collision, each node involved in the collision repeatedly retransmits its frame (that is, packet) until its frame gets through without a collision.
- But when a node experiences a collision, it doesn't necessarily retransmit the frame right away.
- *Instead it waits a random delay before retransmitting the frame.*

Random access protocols

- The ALOHA protocols:
 - **ALOHA**
 - **Slotted ALOHA**
- The carrier sense multiple access (CSMA) protocols:
 - **CSMA with collision detection (CSMA/CD)** protocols.
 - **CSMA with collision avoidance (CSMA/CA)** protocols.
- **Details:-**
 - Data Communications and Networking
 - By- B. A. Forouzan.
 - 3rd Edition, Chap-13th , Page: 311

Taking-Turns Protocols

- The **polling protocol**:
 - The polling protocol requires one of the nodes to be designated as a master node.
 - The master node **polls** each of the nodes in a round-robin fashion.
 - In particular, the master node first sends a message to node 1, saying that it (node 1) can transmit up to some maximum number of frames.
 - After node 1 transmits some frames, the master node tells node 2 it (node 2) can transmit up to the maximum number of frames.
 - The procedure continues in this manner, with the master node polling each of the nodes in a cyclic manner.

Taking-Turns Protocols

- The **token-passing protocol**:
 - A small, special-purpose frame known as a **token** is exchanged among the nodes in some fixed order.
 - For example, node 1 might always send the token to node 2, node 2 might always send the token to node 3, and node N might always send the token to node 1.
 - When a node receives a token, it holds onto the token only if it has some frames to transmit; otherwise, it immediately forwards the token to the next node.

Address Resolution Protocol (ARP)

- Internet IP addresses and link-layer addresses (MAC addresses) both are network-layer addresses and there is a need to translate between them. For the Internet, this is the job of the **Address Resolution Protocol (ARP)**
- **Details:-**
 - Data Communications and Networking
 - By- B. A. Forouzan
 - 3rd Edition, Page: 514

Address Resolution Protocol (ARP)

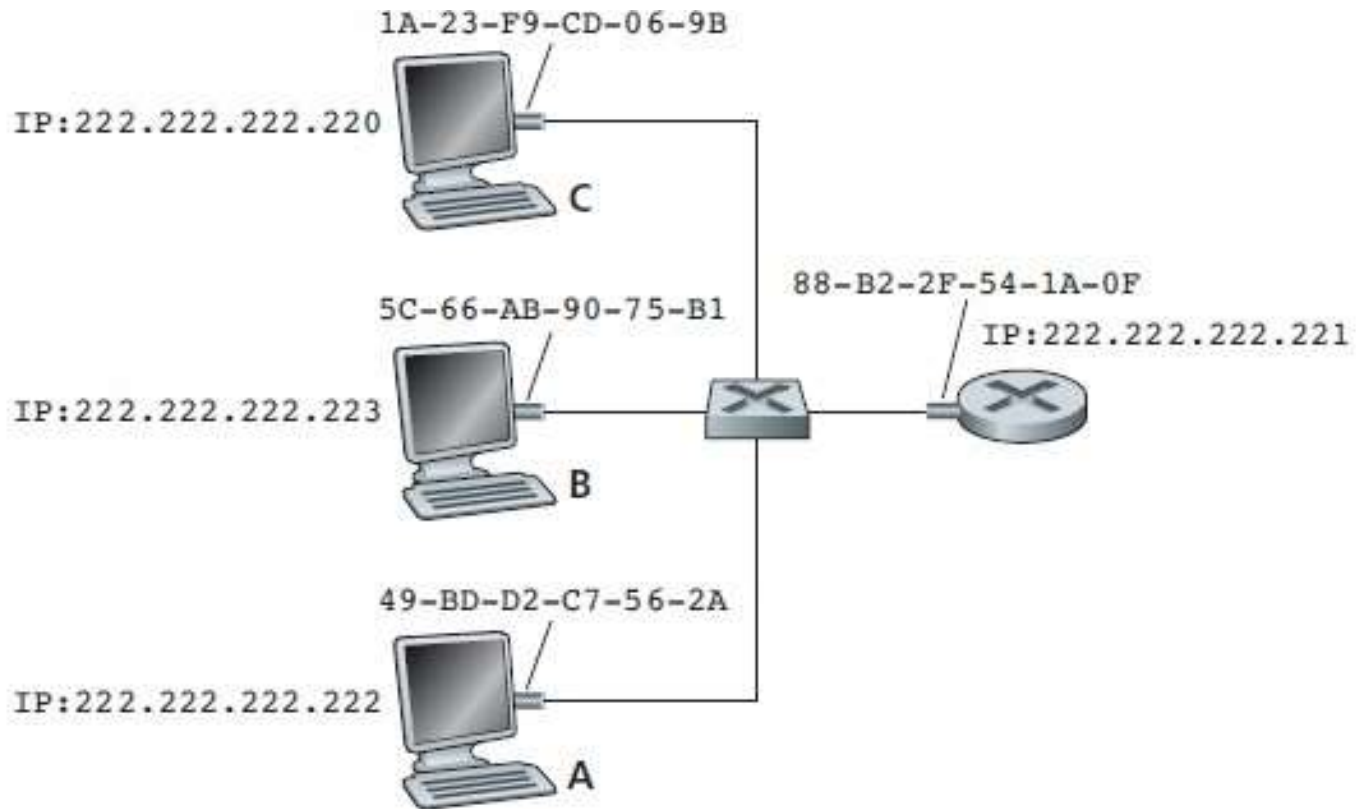


Figure 5.17 ♦ Each interface on a LAN has an IP address and a MAC address

Address Resolution Protocol (ARP)

IP Address	MAC Address	TTL
222.222.222.221	88-B2-2F-54-1A-0F	13:45:00
222.222.222.223	5C-66-AB-90-75-B1	13:52:00

Figure 5.18 ♦ A possible ARP table in 222.222.222.220

END