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Chapter 6.2 Multiple Access Protocols

6.2.1 Multiple Access Links and Protocols

- There are two types of ”links”:
  - **Point-to-point** is used for dial-up access. It is a link between the Ethernet switch and the host.
  - **Broadcast** is used for old-fashioned Ethernet.
- **Multiple access protocols** use a single shared broadcast channel. There may be **interference** when two or more nodes transmit simultaneously. If a node receives two or more signals at the same time, there is **collision**.
- It is a distributed algorithm that determines how nodes share a channel (for example, determining when a node can transmit). Communication about channel sharing must be about the channel itself, meaning they can't try to coordinate with out-of-band channels.
- See an ideal multiple access protocol example on **slide 5-13**.

6.2.2 MAC Protocols: Taxonomy

6.2.2.1 Three Classes

- There are three broad classes:
  - **Channel partitioning** divides a channel into smaller pieces (time slots, frequency, code...) and allocates a piece to each node for exclusive use.
  - **Random access** does not divide channels and allows collisions, but it has procedures to ”recover” from collisions.
  - **”Taking turns”** allows nodes to take turns; however, nodes with more to send are permitted to take longer turns.

6.2.2.2 Channel Partitioning: TDMA

- **Time Division Multiple Access**
- Access to channels are provided in *”rounds”*.
- Each station gets a fixed length slot in each round. The $length = packet\ transmission\ time$.
- Unused slots go to idle.
- For example, in a 6-station LAN, if stations 1, 3, and 4 have packets, then slots 2, 5, and 6 are idle (**slide 5-15**).

6.2.2.3 Channel Partitioning: FDMA

- **Frequency Division Multiple Access**
- The channel is divided into *frequency bands*.
- Each station is assigned a fixed frequency band.
- Unised transmission time in frequency bands are left idle.
- For example, in a 6-station LAN, if stations 1, 3, and 4 have packets, then frequenc bands 2, 5, and 6 are idle (**slide 5-16**).

6.2.2.4 Random Access Protocols

- When a node has a packet to send, it will be transmitted at the full channel data rate, R.
- There is no prior coordination between nodes at all.
- If two or more nodes are transmitting at the same time, a *collision* occurs.
- **Random access MAC protocol** specifies both how to detect collisions and how to recover from them (such as using delayed retransmissions).
- Examples of random access MAC protocols are: *slotted ALOHA, ALOHA, CSMA, CSMA/CD, CSMA/CA*.

6.2.2.5 Carrier Sense Multiple Access (CSMA)

- CSMA listens before transmission. If it senses that the *channel is idle*, then the entire frame is transmitted. If the *channel is busy*, then the transmission is deferred to a later time.
- Note that collisions can still occur if two nodes do not hear each other's transmission. In such a case, the entire packet transission time is wasted.

6.2.2.6 CSMA/CD (Collision Detection

- The carrier sensing and deferral work exactly as in CSMA.
- Collisions are detected within a shrot time, and colliding transmissions are aborted so the channel isn't wasted as much.
- Collision detection works differently in wired and wireless LANs:
  - It is easy in wired LANs. The signal strength is measured and compared to the transmitted and received signals.
  - It is much harder in wireless LANS. Received signal strength is overwhelmed by local transmission strength.
- See CSMA/CD algorithm on **slide 5-22**.
- CSMA/CD has an efficiency of: $\frac{1}{1+5t_{prop}/t_{trans}}$. t_{prop} is the max prop delay between 2 nodes in LAN, and t_{trans} is the time to transmit max-size frame.

6.2.2.7 CSMA/CA (Collision Avoidance)

- This protocol method tries to avoid collisions that occur when two or more nodes transmit at the same time.
- Collision detection dos not exist in 802.11 because it is difficult to sense collisions when transmitting due to weak received signals that fade (since collision sensing is received).

6.2.2.8 ”Taking Turns”

- The taking turns protocol has two variations.
- In a **polling protocol**, a designated master node ”invites” slave nodes to transmit turn-by-turn.
  - This is usually used with ”dumb” slave devices. They are told the max number of frames they are permitted to transmit.
  - The master node detects that the slaves are done by a lack of activity. They will then cycle to the next node.
  - There are concerns with *polling overhead*, *latency*, and *a single point of failure at the master node*.
- Another **token passing** protocol has no master node, but rather tokens being exchanged between nodes.
  - Tokens are always exchanged between nodes in a fixed order.
  - A node holds a token while transmitting up to a maximum number of frames or until it has nothing left to transmit. Then it will pass the token to the next node.
  - It has the similar concerns as polling: *token overhead*, *latency*, and *a single point of failure at the node holding a token*.

6.2.2.9 Comparison

- **Channel partitioning MAC protocols** share channels efficiently and fairly, even at high loads, but it is not very efficient at low load since there is delay in channel access. I/N bandwidth is allocated even if there is only 1 active node. There is *Time Division* and *Frequency Division*.
- **Random access MAC protocols** are efficient at low load. A single node can fully utilize a channel, but at high load, there is a high risk of collision overhead. *CSMA/CD* is used in Ethernet while *CSMA/CA* is used in 802.11.
- The **”taking turns” protocol** looks for the best of both worlds. It could use *polling* from a central site, or *token passing*. Bluetooth, FDDI, and token rings use this protocol method.