KOM Questions – Lecture 5a

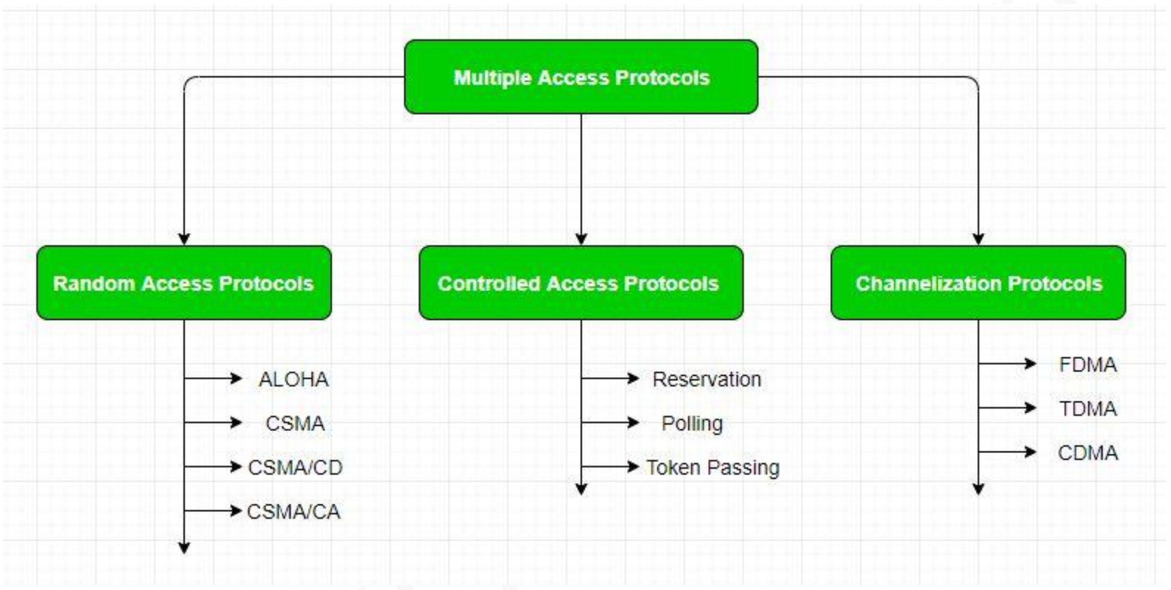
Data Communications and Networking (Fourth Edition)

Media Access Control

1.1 What is multiple access control (MAC) and why is it necessary?

Nodes may be connected to common link (multipoint), where the medium (channel) needs to be shared by multiple nodes and therefore requires a protocol to manage multiple-access.

1.2 Briefly describe the three types of methods for media access control.



Random Access	Controlled Access	Channelization
All stations have same superiority, i.e., no station has more priority than another station. Each station can transmit when it desires on the condition that it follows the protocol, including testing the state of the medium.	The data is sent by that station which is approved by all other stations. The stations seek information from one another to determine which station has the right to send. Only one node sends at a time.	The available bandwidth of the link is shared in time, frequency or code amongst different stations, which allows multiple stations to access the shared channel simultaneously.

1.3 Stations in a pure Aloha network send frames of size 1000 bits at the rate of 1 Mbps. What is the vulnerable time for this network?

First, the average frame transmission time T_{fr} is

$$T_{fr} = \frac{1000 \text{ bits}}{1 \text{ Mbps}} = 1 \text{ ms}$$

The vulnerable time is then

$$2 \times T_{fr} \rightarrow 2 \times 1 \text{ ms} = 2 \text{ ms}$$

Meaning that no station should send later than 1 ms before this station starts transmission and no station should start sending during the period (1 ms) that this station is sending.

1.4 What is the general idea behind CSMA methods?

Carrier sense multiple access (CSMA) requires that each station first listens to the medium before sending, which can decrease the risk of collisions. In other words, CSMA is based on the principle "sense before transmit" or "listen before talk."

1.5 Briefly describe the persistence methods for CSMA. What are they used for?

Persistence methods define how a station acts in case a channel is busy.

1-Persistent	**Non-persistent**	**p-persistent**
After the station finds the line idle, it sends its frame immediately (with probability of 1).	If the line is idle, a station sends a frame immediately. If the line is not idle, it waits a random amount of time and then senses the line again.	Used in time-slotted protocols. If the line is idle, with probability p, the station sends its frame; otherwise $(q = 1 - p)$, the station waits a slot and sense the channel again.

1.6 Can collisions be detected in wireless networks? Why/why not?

In a wireless system, much of the energy is lost in the transmission itself. Therefore, a collision may add only 5-10% extra energy. This provides no effective way to detect collisions.

1.7 How can channels be divided (for channelization methods)?

Frequency	**Time**	**Coding**
The Frequency Division Multiple Access method divides the bandwidth into multiple frequency bands, allocating a band per node.	The Time Division Multiple Access method divides the entire bandwidth into multiple time segments, allocating a segment per node.	The Code Division Multiple Access uses a shared communication channel by encoding the data to be transmitted.

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1.8 What is the idea behind CDMA? How are codes generated?

The **Code Division Multiple Access** doesn't physically divide the medium, but uses the channel as a shared communication channel. This is achieved by encoding the data to be transmitted, where each node uses a designated code (chip) for encoding. The transmission must occur synchronously, sending the encoded data bit by bit, where the data on the channel is the sum of all the signal elements.

The codes, specifically named chip sequences, are generated using **Walsh table** so that they oblige the required properties. A Walsh table for $s = 2$ nodes is a 2×2 matrix, where each row corresponds to the code for a particular node.

1.9 Alice and Bob are experimenting with CDMA using a $\mathbf{W_2}$ Walsh table. Alice uses the code $\boldsymbol{C_1} = [+\mathbf{1}, +\mathbf{1}]$ and Bob uses the code $\boldsymbol{C_2} = [+\mathbf{1}, -\mathbf{1}]$. Assume that they simultaneously send a hexadecimal digit to each other. Alice sends $\mathbf{6_{16}}$ and Bob sends $\mathrm{\mathbf{B}}_{\mathbf{16}}$. Show how they can detect what the other person has sent (with computations for all "steps" for a single bit).

First, for Alice and Bob, the bit-sequences are encoded

$$6_{16} = 0110_2 \quad \rightarrow \quad -1 \quad +1 \quad +1 \quad -1 \quad , \quad \mathrm{B}_{16} = 1011_2 \quad \rightarrow \quad +1 \quad -1 \quad +1 \quad +1$$

To transmit the first bit (most significant bit) of the encoded sequences, the encoded bits are converted

$$\underbrace{-1}_{d_1} \cdot \underbrace{[+1, +1]}_{C_1} = [-1, -1] \quad , \quad \underbrace{+1}_{d_2} \cdot \underbrace{[+1, -1]}_{C_2} = [+1, -1]$$

The shared data sequence is then

$$d_s = [-1, -1] + [+1, -1] = [0, -2]$$

Given the shared data sequence d_s and $s = 2$, Bob can decode Alice's bit, as

$$d_1 = \frac{[0, -2] \cdot [+1, +1]}{2} = \frac{0 - 2}{2} = -1 = 0_2$$

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