

Computer Networks

Homework 5

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9.5.2023

Problem 1:

N stations share a 10Mbps pure ALOHA channel. Each station outputs on average one new 20000b frame every 20s. In case of maximum utilization by pure ALOHA:

- What is the maximum N such that the real data rate is sufficient for all the stations?
- What is the vulnerable time?
- What is the average total number G of all generated frames per frame transmission time? Which frames, apart from the new ones, are included in this number?
- What would the vulnerable time be if slotted ALOHA was used?

$$\text{data rate} = 10 * 10^6 \text{ bps}$$

$$\text{data}_F = 20 * 10^3 \text{ b}$$

$$N_{\text{nfps}} = 1/20\text{s}$$

$$G_{\text{max}} = 1/2$$

$$S_{\text{max}} = 0.184$$

- $d. r._{\text{ALOHA}} = S_{\text{max}} * \text{data rate} = 0.184 * 10 * 10^6 \text{ bps} = 1\,840\,000 \text{ bps}$
req. $d. r. = d. r._{\text{ALOHA}} = \text{data}_F * N_s * N_{\text{nfps}}$
 $N_s = d. r._{\text{ALOHA}} / (\text{data}_F * N_{\text{nfps}}) = 1\,840\,000 \text{ bps} / (20 * 10^3 \text{ b} * 1/20\text{s}) = 1\,840$
Answer: The maximum number of stations such that the data rate is sufficient is 1 840.
- $T_{\text{Fr}} = \text{data}_F / \text{data rate} = 20 * 10^3 \text{ b} / (10 * 10^6 \text{ bps}) = 2 \text{ ms}$
 $T_V = 2 * T_{\text{Fr}} = 2 * 2 \text{ ms} = 4 \text{ ms}$
Answer: The vulnerable time is 4 ms.
- Answer:** Because we assume a case of maximum utilization the average total number G is 1/2. The retransmission frames are also included in this number.
- $T_V = T_{\text{Fr}} = 2 \text{ ms}$
Answer: The vulnerable time would be 2 ms if slotted ALOHA was used.

Problem 2:

Protocol families such as ALOHA, CSMA, etc. allow multiple devices to access a shared communication channel. Which of the following data-link protocol families require such access:

- a) Wi-Fi,
- b) "Classic" Ethernet,
- c) "Switched" Ethernet with full duplex transmission?

Shortly justify the answer for each point (descriptions of the two Ethernets can be found in "Computer Networks (5th Edition)" by Tanenbaum).

a) Wi-Fi requires multiple devices to access a shared communication channel. It uses the CSMA/CA protocol, which allows devices to sense the channel and avoid collisions by using a contention-based access method. Devices wait for a clear channel before transmitting data, and collisions are minimized using virtual carrier sensing and acknowledgement mechanisms.

b) "Classic" Ethernet also requires multiple devices to access a shared communication channel. It uses the CSMA/CD protocol. Devices listen to the channel before transmitting, and if a collision is detected, they wait for a random backoff period before retransmitting. CSMA/CD allows devices to contend for access to the channel, ensuring fairness among multiple devices.

c) "Switched" Ethernet with full duplex transmission does not require devices to access a shared communication channel. In full-duplex mode, each device has a dedicated and separate transmit and receive path, allowing simultaneous bi-directional communication. Collisions are eliminated, as each device can transmit and receive data independently.