CS4222/CS5422 Semester 2, 2022/2023

Tutorial for Week 10 (March 13th 2023)

Question 1: Is TDMA a good choice for IEEE 802.11 (or WiFi)?

Answer 1: The choice of medium access control (MAC) protocol depends on several factors. The most important ones are:

a) The characteristics of the dominant traffic type

b) The desired quality-of-service (QoS) for the traffic

Time division multiple access (TDMA) is a suitable MAC protocol for wireless traffic that is continuous or constantly active, and that requires predictable latency. For example, TDMA can be good for applications that involve voice communication.

However, most Wi-Fi devices want to transmit large amounts of data at high throughput, and they are not very sensitive to latency. Moreover, there can be many end-devices in a Wi-Fi network, but only a few of them may be active at any given time. Additionally, Wi-Fi devices should be able to join and leave the network easily.

Considering all of the above factors, it makes TDMA a poor choice for IEEE 802.11 or Wi-Fi.

Question 2: Four 802.11 stations share a single channel. The four stations have different link rates, namely 2Mbps, 20Mbps, 50Mbps and 100Mbps.

The standard 802.11 CSMA/CA MAC protocol with BEB is used.

a) What is the average throughput if all four stations always have packets to transmit?
b) What is the average throughput if the protocol used (not CSMA/CA) ensure that all stations are given same amount of time to transmit?
c)

Answer 2: Let us assume that the time required to transmit one packet at a data rate of 2 Mbps is one time unit.

Since all the stations have one packet to transmit, we can calculate the total time needed to transmit four packets as follows:

Total time = 1 + 1/10 + 1/25 + 1/50 = 1.16 time units

To find the normalized transmission rate (with respect to 2 Mbps), we divide the number of packets by the total time:

Normalized transmission rate = 4 / 1.16 = 3.448 packets per time unit

Finally, we can multiply the normalized transmission rate by the data rate to get the average throughput:

Average throughput = 2 * 3.448 = 6.897 Mbps

Question 3: 5 nodes (A, B, C, D and E) forms a straight line. The distance between the nodes are such that neighbouring can communicate but transmissions from nodes further away cannot be received. For example, A and B can communicate, but A and C cannot. Similarly, C and D can communicate, but B and D cannot. The nodes perform carrier sensing follow by RTS/CTS before data is transmitted.

- If node A is transmitting to node B, which other pair(s) of nodes can communicate at the same time?
- If node B is transmitting to node C, which other pair(s) of nodes can communicate at the same time?
- Assume that node A is sending data to station E through nodes B, C, and D. All transmissions rates are 11Mbps and RTS/CTS is used. What is maximum throughput achievable? Explain your answer

Answer 3:

a) D->E

(b) none

(c) 11/3

Question 4: Two mobile nodes (A and B) communicate using B-MAC. By default, a node performs preamble sampling every 1s for a 1ms interval. In addition, node A wakes up every 100s and sends a small packet to mote B. Assume that each node is equipped with a battery with lifetime of 2300mAHr. Transmission draws 20mA and receiving or idle listening draws a current of 10mA. You can assume that processing and sleeping do not consume energy.

- How long can node A run before the battery is completed depleted?
- How long can node B run before the battery is completed depleted?
- Consider the case where there is an additional node C and node A can transmit to either node B or node C (no change in A's transmission rate). Will the lifetimes computed (in parts a and b) for nodes A and B change? Explain your answer.

Answer 4:

We can calculate the average current drawn by each node in one second as follows:

Using the formula for battery duration, we can find the time until the battery is drained for each node:

Battery duration = Battery capacity / Average current

(a) For node A, average current = 0.01 * 20 + 0.99 * 0.001 * 10 = 0.2 + 0.0099 = 0.2099 mA

For node A, battery duration = 2300 / 0.2099 = 10958 hours, or about 457 days

(b) For node B, average current = 0.01 * 0.5 * 10 + 0.99 * 0.001 * 10 = 0.05 + 0.0099 = 0.0599 mA

For node B, battery duration = 2300 / 0.0599 = 38397 hours, or about 1600 days, or about 4.38 years

(c) For node C, average current = no change (or very small decrease in B)

(c)For node C, battery duration = no change (or very small decrease in B)

Question 5: For each of the following applications, explain what is the most appropriate MAC protocol that should be used. Explain your choice.

- Web browsing
- VoIP
- Low rate control traffic and carrier sensing is not performed.

Answer 5:

(a) CSMA/CA, high throughput for sharing among many users with bursty traffic.
(b) Polling/TDM/Reservation, requires low loss, short latency.
(c) Aloha/slotted Aloha, good for low data rate and does not perform carrier sensing.