Wireless Networking

Course code: CS4222/5422, Tutorial session: #7

Brief Instructions regarding the tutorial session

1. The attendance to tutorial sessions would contribute towards the determination of final grade
2. Please review the questions before coming to the tutorial session
3. Make an effort to solve the questions before attending tutorial. The teaching assistants will help in case of issues
4. The designated time for the tutorial session is one hour. Please contact the teaching assistants or the instructor if you need any further clarification regarding the tutorials outside the allocated period. Please send them an email.

Question 1: Over the past several years, we have seen a growing interest in utilizing satellites to provide wireless connectivity to Internet of Things (IoT) devices. These satellites usually operate at altitudes of 400 to 500 kilometers from the Earth's surface. However, this deployment of satellites has led to concerns regarding orbital congestion and pollution. As an alternative, high-altitude balloons are being explored to provide network connectivity to Internet of things devices. These balloons fly at much lower altitudes of around 20 kilometers from earth's surface and they offer a very cost-effective solution to satellite launches.
Based on the above-mentioned scenario if you are using low-altitude balloons to provide connectivity to ground based IoT devices. Please answer the following questions:

a) Which frequency bands are suitable for communication between balloon and IoT device? Provide appropriate rationale for your choice.

b) Given that the IoT device is equipped with a radio with a receive sensitivity of -100 dBm and an antenna gain of 2 dBi. There is an estimated distance of 20 kilometers between the balloon and the IoT device, and the balloon is equipped with 8 dBi antenna. Please calculate the transmit power required at the balloon to ensure successful packet reception at IoT device. Use the frequency selected in part (a) for your calculations. The path loss exponent is 2.

Question 2: The ALOHA and slotted ALOHA protocols have a maximum channel utilization of 18% and 36%, respectively. However, the CSMA/CA protocol can achieve much higher utilization. How does CSMA/CA do this? Explain the main difference between CSMA/CA and ALOHA protocols and how it affects the channel efficiency.

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.

a) If node A is transmitting to node B, which other pair(s) of nodes can communicate at the same time?
b) If node B is transmitting to node C, which other pair(s) of nodes can communicate at the same time?
c) 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.

Question 4: Is TDMA a good choice for IEEE 802.11 (or WiFi)?