Wireless Networking

Course code: CS4222/5422, Tutorial session: #1

<u>Brief Instructions regarding the tutorial session</u>
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: Is it permissible to transmit radio signals on any frequency band? What are the frequency bands typically used for wireless communication in IoT devices called? Can you identify these frequency bands in region of Europe, Singapore, and the United States?

Question 2: You are in charge of designing an IoT device. Considering the relationship between antenna size, frequency, and range, what type of antenna would you employ? What typical data rate can you expect, and what operating frequency would you choose?

Internet of Things Application	Description
Fire alarm	A fire alarm that keeps track of smoke and heat signature in home. When it encounters a fire, it generates a sound, and communicates the event to the owner of the house and other devices.
Vibration sensor	A sensor designed to keep track of vibrations of machine on a shop floor. The collected vibration data from several machines to an edge device for storage and analysis.
Agriculture sensor	An IoT device deployed on a farm to measure humidity, temperature and soil nutrients. The collected sensor data needs to be transmitted to a computer at center of farm for storage and analysis.

Question 3: There has been growing interest in connecting devices using a network of small satellites. For example, the SpaceX swarm is providing one such service. Most of these networks currently focus on providing downlink connectivity from the satellite to a ground device. Let's now consider the possibility of IoT devices communicating directly with an overhead satellite. The goal is to transmit small amounts of information from the IoT device to the satellite and vice versa. You can assume that the satellite is orbiting in a low earth orbit of 400 kilometres from the surface.

a) What frequency would you like to use for communication? What are the factors based on which you would decide the appropriate frequency to employ for the application?

b) If the sensitivity of the signal that can be received by the satellite is -96 dBm, and the transmit power of the IoT device is 24 dBm with a transmit antenna gain of 6 dBi, what would be the antenna gain required at the satellite for the chosen frequency?

c) What would be the link budget and antenna gain required if you instead employed a frequency of 13.56 MHz for communication? Why is this frequency not used for satellite communication between satellite and an IoT device? What are disadvantages?