Wireless Networking

Course code: CS4222/5422, Tutorial session: #6

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: You are tasked with designing an application that utilizes GPS to track the user's location. Notably, the GPS sensor has an energy consumption rate of 400mW, whereas the accelerometer sensor consumes a mere 5mW. Given that users are predominantly stationary while engaging with the app, how can you devise an app that is both energy-efficient and accurate in tracking the user's outdoor location? Please describe your strategy and highlight its benefits.

Question 2: Please find the specifications of the radio transceivers for various communication technologies.

Specification	Bluetooth	ZigBee	Wi-Fi	LoRa	Backscatter	Judo
Voltage (V)	1.8	3	3.3	3.3	2	0.12
Transmit current (mA)	60	30	220	28	0.035	0.7
Receive current (mA)	50	25	210	13.8	N.A	N.A
Bitrate (Mb/s)	1.2	0.25	54	0.027	0.003	0.1

Please calculate the following based on the above specification.

- Calculate the energy milli-joules (mJ)) require to transmit 1 bit for different technologies
- Let us assume you are transmitting 1000 bytes of information. Please calculate the total energy used for the transmissions employing various radio technologies?
- If the bit error rate for bluetooth, ZigBee, LoRa, Backscatter are, 30%, 5%, 1%, 40%. How much energy is spent to successfully transmit 1000 bytes of information?
- Would you always select technology with the lowest energy per bit? What other criteria would you need to consider when making a selection for the particular technology to be used for an application scenario?
- Give specific examples of applications where you may want to use WiFi versus ZigBee?
- Give specific example where you may want to use backscatter over bluetooth?

Question 3: You are using a radio transceiver for an application with the following specification; a bitrate of 100 kilobits per second. Its power consumption varies according to its operational mode: it utilizes 10 microamperes in sleep mode, 10 milliamperes when receiving packets, and 5 milliamperes in idle state. Moreover, the transceiver's current consumption escalates with increased transmit power, affecting its operational efficiency at different radiated power levels.

Radio Transmit Power	Current Consumption
-10 dBm	10 milliamperes
0 dBm	15 milliamperes
5 dBm	20 milliamperes
15 dBm	30 milliamperes

This transceiver will be integrated into an application where a consistently active microcontroller, drawing 2 milliamperes of current, periodically awakens the radio from its low-power sleep mode. This occurs every second for a duration of 50 milliseconds, allowing the transceiver to receive transmissions. Subsequently, at the conclusion of this interval, the transceiver sends a 50-byte data packet to a receiver located at distances of 100 meters and 500 meters, respectively. The system is energized by a 3-volt battery with a 120 mAH capacity.

Could you please calculate:

a) The appropriate transmit power for communication over the specified distances,
b) The power consumption in the various operational states of the device,
c) The estimated battery life for supporting this specific application?