CS4222/CS5422

Final Assessment

May 6, 2020

Total Marks: 60 (4 Parts, 8 Questions)

Time: 2hrs

NUS Code of Student Conduct

(A) Academic, Professional and Personal Integrity

http://nus.edu.sg/osa/resources/code-of-student-conduct

- The University is committed to nurturing an environment conducive for the exchange of ideas, advancement of knowledge and intellectual development. Academic honesty and integrity are essential conditions for the pursuit and acquisition of knowledge, and the University expects each student to maintain and uphold the highest standards of integrity and academic honesty at all times.

- The University takes a strict view of cheating in any form, deceptive fabrication, plagiarism and violation of intellectual property and copyright laws. Any student who is found to have engaged in such misconduct will be subject to disciplinary action by the University.

- It is important to note that all students share the responsibility of protecting the academic standards and reputation of the University. This responsibility can extend beyond each student's own conduct, and can include reporting incidents of suspected academic dishonesty through the appropriate channels. Students who have reasonable grounds to suspect academic dishonesty should raise their concerns directly to the relevant Head of Department, Dean of Faculty, Registrar, Vice Provost or Provost.

By uploading this file to LumiNUS, I declare that I have read and understood the above NUS Code of Student Conduct pertaining to Academic, Professional and Personal Integrity.

Part 1 (10pt) 3 Short Questions

Duration: 18 minutes

Your answer should not exceed 1 page for all 3 questions.

Submission: LumiNUS, final-assessment-Part1.

Name of File: StudentNumber-Part1

Note: If you submit more than once, please delete the previous submission(s). If there are multiple submissions in the folder, only the last submission will be graded.

Q1) (3pt) Using the Free Space Propagation Model, in terms of the received power, what happens when the frequency spectrum for wireless transmission changes from 5GHz to 35GHz? You can assume that all other parameters remain the same and the path loss component is 2.

Q2) (3pt) Using the Free Space Propagation Model, what is the change in communication range if the centre frequency is reduced from 5.6GHz to 800MHz and the received power remains the same? You can assume that all other parameters remain the same and the path loss component is 3. Show your working.

Q3) (4pt) Why does the Collection Tree Protocol not use periodic beaconing to measure link quality?

Part 2 (16pt) 2 Questions

Duration: 32 minutes

Your answer to each question should not exceed 1 page. Each question should be answered on a separate page.

Submission: LumiNUS, final-assessment-Part2

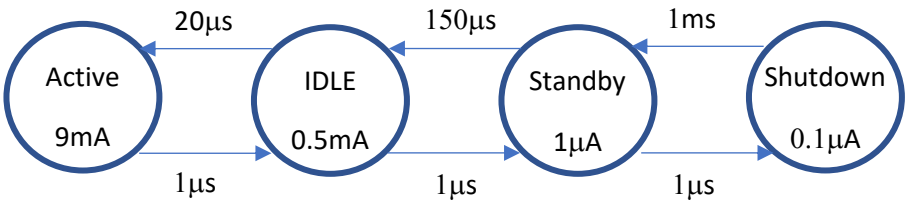
Name of File: StudentNumber-Part2-Q4, StudentNumber-Part2-Q5

Note: If you submit more than once, please delete the previous submission(s). If there are multiple submissions in the folder, only the last submission will be graded.

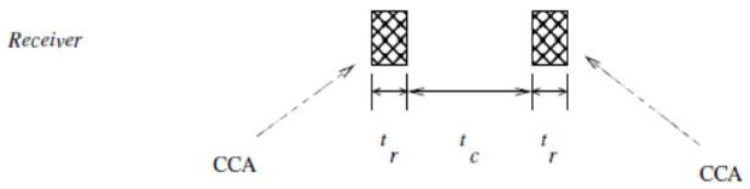
Q4) (6pt) In many mobile applications, both the GPS sensor and the accelerometer sensor are used to track the (outdoor) location and context of the mobile device. Let the accelerometer consumes 5mW and the GPS consumes 400mW. You are tasked to design an app that tracks the user's location using GPS. It is known that the user is stationary most of the time. Outline an approach that can (roughly) track the user's (outdoor) location using as little energy as possible. You need to explain why your approach is energy efficient and yet provide sufficient accuracy.

Q5) (10pt) The figure below shows the radio states of a transceiver that are used to implement the carrier sensing performed by the receiver using Contiki MAC. Assume that there is no data transmission and the receiver wake up 8 times a second to sample the channel. The current drawn during transition is the current drawn from the initial state. Hence, when the device moves from "Shutdown" to "Standby", the current drawn in the 1ms transition time is 0.1µA.

If the total current drawn by the radio is to be minimized, what is the amount of time the radio spends in the 4 different states (Active, Idle, Standby, Shutdown) in a 1s interval?



The device can transmit, receive and sense carrier only in the active state.



Carrier sensing performed by Contiki MAC Receiver: t_r = 0.2µs, t_c = 0.5ms,

Part 3 (16pt) 1 Question

Duration: 35 minutes

Your answer should not exceed 2 pages for Part 3.

Submission: LumiNUS, final-assessment-Part3

Name of File: StudentNumber-Part3-Page1 (and if needed StudentNumber-Part3-Page2)

Note: If you submit more than once, please delete the previous submission(s). If there are multiple submissions in the folder, only the last submission will be graded.

Q6) There are 3 sensor nodes. Every 1s, Node A transmits a very small packet to node B. Node C does not send or receive any data. Assume that B-MAC is used. A receiver wakes up every 250ms to sample the channel for 5ms. The transmission/reception/listening and sleep states draw 10mA and 0.1mA respectively. **You can ignore the energy consumed by the transmission/reception of the data and ACK packets.**

(a) (6pt) Calculate the average current drawn (in mA) by nodes A, B and C.

(b) (10pt) Let X-MAC be used instead of B-MAC. In this X-MAC implementation, the duration of a probe packet send by the transmitter is 6ms and the interval between probe packets is 4ms. A node wakes up every 250ms to sample the channel for 5ms. For the receiver to decode the probe packet correctly, it must wakeup before the start of the probe packet. Hence, if it detects channel activity but cannot decode the probe packet correctly, it has to stay awake to receive the next probe packet. Calculate the average current drawn (in mA) by nodes A, B and C.

Part 4 (18pt) 2 Questions

Duration: 35 minutes

Your answer to each question should not exceed 1 page. Each question should be answered on a separate page.

Submission: LumiNUS, final-assessment-Part4

Name of File: StudentNumber-Part4-Q7, StudentNumber-Part4-Q8

Note: If you submit more than once, please delete the previous submission(s). If there are multiple submissions in the folder, only the last submission will be graded.

Q7) (12pt) Someone has proposed a design for a sensor network for construction monitoring of a high-rise building. The objective is to collect structural data every 2 hrs to a central gateway. The construction site includes basements and underground tunnels. Many locations are not easily accessible, making it difficult to place sensing and communication nodes. The proposed design consists of using the 5GHz ISM band, null MAC with no duty cycling and data centric routing.

Explain the drawbacks of this design. Propose how you would modify the design in terms of choice of frequency spectrum used, MAC protocol, duty cycling and routing protocol. There is no single right answer. However, your design has to be "coherent" and you can include any other design choices and components that you would like to include in the system.

Q8) (6pt) TraceTogether is a smartphone app released by the Singaporean Government that allows for contact tracing using the BLE radio. You are tasked to design a similar tracing application to run on the TI SensorTag using the IEEE 802.15.4 radio.

You can assume the following:

- In an actual deployment, you will configure the transmission power and set a threshold for the link quality to determine if two devices are sufficiently (physically) close. For this question, you can assume that two devices are "in contact" if they can hear each other's radio beacons.
- You only need to detect devices that are "in contact" for more than 30 seconds.

Your system needs to:

- discover pair of devices with contact times of 30s or more with high probability.
- reduce power consumption as much as possible.

Outline your design, and justify your design decisions.

End-of-Assessment