NATIONAL UNIVERSITY OF SINGAPORE

CS4222: Wireless Networking

(SEMESTER 2: AY 2018/2019)

Final Assessment

Time Allowed: 2 Hours

INSTRUCTIONS TO STUDENTS

1. Please write your Student Number only. Do not write your name.
2. This assessment paper contains SIX (6) questions and comprises TEN (10) printed pages.
3. Students are required to answer ALL questions.
4. Answer **ALL** questions within the box in this booklet.
5. This is an OPEN BOOK assessment.

STUDENT NUMBER: _____

This portion is for examiner's use only

Question	Score	Marks	Question	Score	Marks
(1)		12	(4)		8
(2)		12	(5)		8
(3)		8	(6)		12
Total	/ 60				

Q1: Short Questions (12pt)

(a) (2pt) Why is mobile phone reception inside the elevator bad?

(b) (2pt) In Mobile IP, who keeps track of the current location of the mobile node?

(c) (2pt) Consider an antenna transmitting at a power of 5W at 900MHz, calculate the received power (in Watt) at a distance of 2km if propagation is taking place in free space. Let the total antenna gain be 10^5 and $c = 3*10^8$ m/s.

(d) (2pt) What is millimeter wave and how is its use changing the wireless transmission spectrum available?

(e) (2pt) In addition to differences in the bit rate supported, name one other difference between 3G and 4G cellular networks.

(f) (2pt) Explain why CTP does not perform periodic link quality measurement.

Q2 (12pt) Energy Efficient MAC Protocols

Consider a node running B-MAC. It wakes up periodically every 200ms to sample the channel for 2ms. If there is no channel activity, it goes back to sleep. The transmission and reception/listening states draw 10mA. The sleeping state draws 0.1mA.

(a) (2pt) Consider the scenario whereby there is no transmission. What is the average current consumption of a node?

(b) (4pt) Consider a scenario with sensor node A transmitting a very small packet to node B every 2s and both nodes use B-MAC. Calculate the average current consumption of nodes A and B.

Consider a node running R-MAC. In R-MAC, a node wakes up periodically every 200ms to transmit a small probe to check for active sender. If no sender is detected, it goes back to sleep. The entire period of probe transmission and sender's transmission detection is 2ms. The transmission, reception and listening states draw 10mA. The sleeping state draws 0.1mA.

(2pt) Consider the scenario whereby there is no transmission. What is the average current consumption of a node?

(c) (4pt) Consider a scenario with sensor node A transmitting a very small packet to node B every 2s and both nodes use R-MAC. Calculate the average current consumption of nodes A and B.

Q3: (8pt) Neighbor Discovery

(a) (3pt) Assume that time is divided into slots of duration 200ms. In each time slot, a node wakes up with a probability of 0.1. What is the average time taken for two such nodes to select a common slot to wake up?

(b) (3pt) Consider an asynchronous quorum based neighbor discovery scheme [1], with time slots organized into a n by n grid. What is the smallest value of n needed to obtain a duty cycle of less than 5%?

(c) (2pt) Consider an asynchronous quorum based neighbor discovery scheme [1], with time slots of 200ms organized into a 10 by 10 grid. What is the maximum time needed for two nodes to discover each other by waking up at the same timeslot?

[1] Yu-Chee Tseng, Chih-Shun Hsu, and Ten-Yueng Hsieh. Power-saving protocols for IEEE 802.11-based multi-hop ad hoc networks. In INFOCOM, 2002.

Q4: (8pt) Multi-Channel Protocols

(4pt) Explain why the use of multi-channel can improve wireless transmission reliability.

(4pt) One of the challenge of using multiple-channel for communication is that different nodes may be transmitting or listening on different channels. When nodes are not sending/receiving on the same channel, communication is not possible. Propose an approach whereby nodes can coordinate their channel switching behavior so that nodes can communicate on the same channel.

Q5: (8pt) Cell Planning

A city has an area of 700km^2 and is covered by a cellular system using a reuse factor of 3. Each cell has a radius of 1 km and the system is allocated 30MHz of spectrum. Assume that each duplex channel has a bandwidth of 30KHz and each cell needs to have 5 interference-free control channels.

(a) (2pt) What is the number of cells in the service area?

(b) (3pt) What is the total number of data channels that can be supported in the system at the same time?

(c) (3pt) The total number of data channels has to be doubled by making the cell size smaller. Assume that the number of control channels per cell remain the same at 5 and the same reuse factor of 3 can be used. What is the largest cell radius possible?

Q6: (12pt) Network Design

You are tasked to work on the design of a low power wireless network for IoT devices. IoT devices run on battery and communicate with a base station that may be placed up to a few kilometers away. The base station is active all the time. On the other hand, in order to reduce power consumption, the IoT device should be sleeping most of the time. Two classes of devices should be supported.

Class A device: The device uses the ALOHA MAC protocol. To conserve power, the device will only wake up to communicate when it has data to send and sleeps when it is not communicating.

(a) (3pt) What is/are the advantage(s) of using the ALOHA protocol for Class A device?

(b) (3pt) Since the device is sleeping when it is not communicating, how can the base station communicates with the IoT device?

(c) (4pt) Class B device is supposed to support more frequent 2-way communication between the station base and device. Propose a MAC protocol that can be used by Class B device that is energy efficient. Explain how it works.

(d) (2pt) This network is to run in the ISM band. Which ISM band would you select? Justify your choice.

End-of-Paper