UNIVERSITY OF MORATUWA

FACULTY OF ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

B.Sc. Engineering
2010 Intake Semester 7 Examination

CS4422 WIRELESS AND BROADBAND NETWORKING

Time allowed: 2 Hours September 2014

ADDITIONAL MATERIAL: *None*

INSTRUCTIONS TO CANDIDATES:

1. This paper consists of **5** questions in **5** pages.
2. Answer any **4** questions (out of 5).
3. Start answering each of the main questions on a new page.
4. The maximum attainable mark for each question is given in brackets.
5. This examination accounts for 50% of the module assessment.
6. This is an open book examination.
7. Key equations and design parameters are given in Appendix.
8. Only calculators approved by the Faculty of Engineering are permitted.
9. Assume reasonable values for any data not given in or with the examination paper. Clearly state such assumptions made on the script.
10. In case of any doubt as to the interpretation of the wording of a question, make suitable assumptions and clearly state them on the script.
11. This paper should be answered only in English.

Question 1 (25 marks)

(i) While reflection of wireless signals is usually considered as problematic, several wireless technologies consider reflection as a benefit. Using suitable examples explain how reflection can become an advantage in one wireless technology while it becomes a disadvantage in another. [6]

(ii) International Space Station (ISS) is positioned 400 km from the surface of the Earth. It uses a telephone system similar to satellite telephone. It transmits a 1.6 GHz wireless signal with a transmit power of 2 W. The transmitting antenna gain is 10 dB and receiver antenna gain is 3 dB.

a) Find the received power for the link from the ISS to a satellite phone on ISS-control-station on Earth. [6]

b) What is the Signal to Noise Ratio (SNR), if the receiver antenna temperature is 290 K and receiver bandwidth is 31.5 KHz? [4]

c) Is the SNR sufficient to operate the satellite phone at an acceptable voice quality? Briefly explain. [3]

d) What type of an antenna would you recommend for the satellite phone on ISS-control-station on Earth? Briefly explain. [3]

e) As the ISS is relatively close to the surface of the Earth, it rotates much faster than the surface of the Earth. Hence, a call cannot be directly connected to the same ISS-control-station for a long time. Would you recommend soft handoff or hard handoff when transferring a connection from one station to another? Briefly explain. [3]

Question 2 (25 marks)

A large department store (i.e., retail establishment with a building selling verity of items such as clothing, housewares, furniture, etc.) is interested in using electronic price tags. Each electronic price tag includes an LCD display, a microcontroller, and a radio receiver. These price tags enable the store to dynamically change the prices of products in a fraction of a second, while offering various discounts that are specific to a given day and a time.

Suppose a stationary transmitter is used to send the prices to respective electronic tags. The frequency of the transmitter is 914 MHz and the transmission power is 6.3 mW. Gains of both the transmitting and receiving antennas are 1.

(i) What wireless technology would you recommend for communicating with electronic tags? Justify your recommendation. [4]

(ii) What type of a network topology would you recommend for connecting the electronic tags and stationary transmitter? Justify your recommendation. [4]

(iii) List 4 wireless network related security issues that might arise in the proposed network. [4]

(iv) Briefly discuss what other factors you have to consider while developing this solution? [4]

(v) What is the received power at 10 m? [4]

(vi) Can the signals be received at an acceptable quality at a distance of 75 m? Assume the sensitivity level of the proposed receiver is -90 dBmW.

Hint: Based on empirical evidence, it has been found that it is more reasonable to model the received power in an indoor environment as a log-distance path-loss model. Assume the reference distance is 10 m. [5]

Question 3 (25 marks)

Mobile social networking is a form of social networking where users with similar interests converse and connect with one another through their mobile devices (e.g., smart phones and tablets). One such application is the sharing of "hot deals" and customer feedback within a large shopping mall with many shops. Customers can use such a network to share good bargains, e.g., discounted items and items on sale, with friends and other potential customers. They can also share their ratings about a particular product or a shop. Shop owners can also use the same network to advertise about the products that are on sale.

(i) Would you recommend an infrastructure-based network or infrastructure-less network to build such a mobile social network? Explain. [3]

(ii) What wireless technology (e.g., Bluetooth, ZigBee, WiFi, 3G, 4G, etc.) would you recommend to create this mobile social network? Justify your recommendation. [4]

(iii) What type of a network topology would you recommend for this network? Justify your recommendation. [4]

(iv) What type of a message routing scheme would you recommend? Justify your recommendation. [4]

(v) Design a suitable message format to share information about various types of messages. For example, there will be at least messages about discounts and customer ratings. [10]

Question 4 (25 marks)

(i) In practice IEEE 802.11b (i.e., Direct Sequence Spread Spectrum (DSSS) based WiFi) technology can use only channels 1, 6, and 11 simultaneously. Using a suitable diagram explain why other channels cannot be used simultaneously. [5]

(ii) "Evolved High-Speed Packet Access (HSPA+) is a better alternative than 4G Long Term Evolution (LTE)". Do you agree or disagree with this statement? Briefly explain. [4]

(iii) What are the major features of Digital Subscriber Line (DSL) technology? [4]

(iv) Recommend with justification a suitable wired/wireless broadband technology for each of the following cases:

a) To provide Internet access to a house on top of a tall mountain. [4]

b) To provide Internet access to a cargo ship that travels from Europe to Australia. [4]

c) To provide Triple-Play (i.e., voice, data, and TV) access to a home office (i.e., a small business that runs from home) in an urban neighbourhood. [4]

Question 5 (25 marks)

(i) "Guaranteed Time Slots in the IEEE 802.15.4 standard allows contention free communication between devices". Do you agree or disagree with this statement? Briefly explain. [4]

(ii) "4G networks are more vulnerable to external and internal attacks than 3G networks". Do you agree or disagree with this statement? Explain in detail. [6]

(iii) Among many applications of Inter-Vehicle Communication, safety applications are the most popular. One such safety application is to inform the cars/drivers that the car in front of them is applying the brakes. This can be achieved by sending a message from the car that applies braking to all the cars behind it. This message may indicate the location of the car and intensity of breaking, e.g., slow breaking vs. rapid breaking. When such a message is received, cars behind can automatically apply brakes with a suitable force/intensity. How much of a break force to apply can be determined by the gap between the two cars, current speed, and intensity of the brake applied by the car in front of them.

a) Briefly explain 3 challenges you may have to overcome while developing such a solution? [6]

b) Briefly explain how each of the challenges you mentioned in part (a) can be overcome with existing technologies. [6]

c) Explain why Data-Centric Routing is more suitable for this solution than TCP/IP. [3]

Appendix

Speed of light	3×10^{8} ms^{-1}
Boltzmann constant	1.3806488×10^{-23} m^2 kg s^{-2} K^{-1}
Speed equation	$v = f\lambda$
Friis free-space equation	$P_R(d) = \frac{P_T G_T G_R \lambda^2}{(4\pi)^2 d^2}$
Log-distance path-loss model	$P_R(d) = P_0(d_0) - 10n_p \log(d/d_0) + X_\sigma$
Thermal (white) noise	$P_{Thermal} = KTB$

Table 1 – Path-loss exponent and standard deviation in different buildings.

Building	Frequency (MHz)	Path-loss exponent, n	Standard deviation (dB)
Retail store	914	2.2	8.7
Grocery store	914	1.8	5.2
Office, hard partition	1500	3	7
Office, soft partition	900	2.4	9.6
Office, soft partition	1900	2.6	14.1
Factory, line of sight	1300	2	3
Suburban, indoor street	900	3	7
Factory, obstructed path	1300	3.3	6.8

Source: S. Rao, "Estimating the ZigBee transmission-range ISM band," EDN, May 2007, pp. 67-72.

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