UNIVERSITY OF MORATUWA

FACULTY OF ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

B.Sc. Engineering
2012 Intake Semester 7 Examination

CS4492 WIRELESS AND BROADBAND NETWORKING

Time allowed: 2 Hours October/November 2016

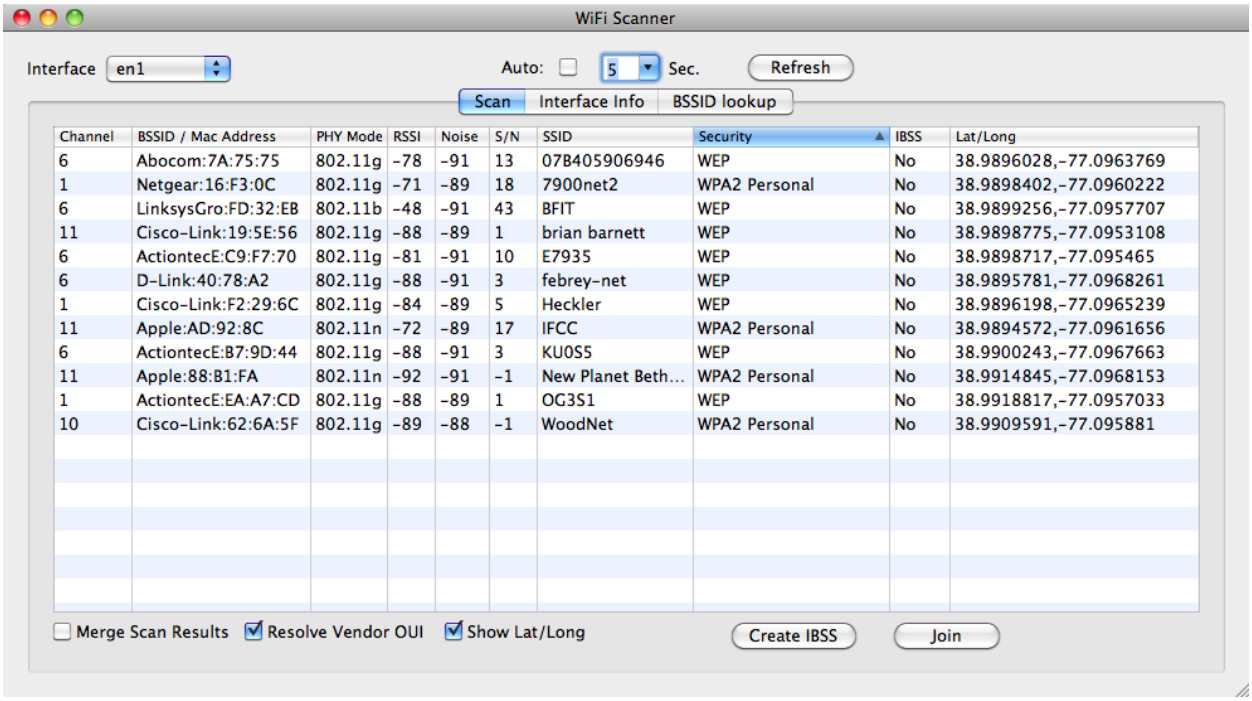
ADDITIONAL MATERIAL: *None*

INSTRUCTIONS TO CANDIDATES:

1. This paper consists of **5** questions in **6** 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) Following is a screenshot from a wireless scanner.



Channel	BSSID / Mac Address	PHY Mode	RSSI	Noise	S/N	SSID	Security	IBSS	Lat/Long
6	Abocom:7A:75:75	802.11g	-78	-91	13	07B405906946	WEP	No	38.9896028,-77.0963769
1	Netgear:16:F3:0C	802.11g	-71	-89	18	7900net2	WPA2 Personal	No	38.9898402,-77.0960222
6	LinksysGro:FD:32:EB	802.11b	-48	-91	43	BFIT	WEP	No	38.9899256,-77.0957707
11	Cisco-Link:19:5E:56	802.11g	-88	-89	1	brian barnett	WEP	No	38.9898775,-77.0953108
6	ActiontecE:C9:F7:70	802.11g	-81	-91	10	E7935	WEP	No	38.9898717,-77.095465
6	D-Link:40:78:A2	802.11g	-88	-91	3	febrey-net	WEP	No	38.9895781,-77.0968261
1	Cisco-Link:F2:29:6C	802.11g	-84	-89	5	Heckler	WEP	No	38.9896198,-77.0965239
11	Apple:AD:92:8C	802.11n	-72	-89	17	IFCC	WPA2 Personal	No	38.9894572,-77.0961656
6	ActiontecE:B7:9D:44	802.11g	-88	-91	3	KU0S5	WEP	No	38.9900243,-77.0967663
11	Apple:88:B1:FA	802.11n	-92	-91	-1	New Planet Beth...	WPA2 Personal	No	38.9914845,-77.0968153
1	ActiontecE:EA:A7:CD	802.11g	-88	-89	1	OG3S1	WEP	No	38.9918817,-77.0957033
10	Cisco-Link:62:6A:5F	802.11g	-89	-88	-1	WoodNet	WPA2 Personal	No	38.9909591,-77.095881

Source: http://wlanbook.com

a) What can you conclude from the observations?

Hint: Focus on the key observations that affect range, coverage, bandwidth, QoS, etc. [6]

b) What are your suggestions to improve the wireless communication environment? [4]

(ii) IEEE 802.15.4 superframe structure supports Guaranteed Time Slots.

a) Using a suitable example, explain the benefits of having a Contention Free Period. [4]

b) To improve throughput should we increase or decrease the Contention Free Period, compared to the Contention Access Period? Discuss. [4]

(iii) Using a suitable diagram explain the Triangular Routing Problem in Mobile IP, and how it can be corrected. [7]

Question 2 (25 marks)

While the number of smartphone owners is growing rapidly, the owners of these devices spend most of their time indoors. Hence, it is very difficult to localize them while they are indoors. For example, GPS does not work in large multi-story car parks, department stores and hospitals.

Wireless Beacons are the solution. Beacons are relatively cheap hardware that are mounted on different know locations of a building and emit radio waves. *Passive beacons* periodically send a predefined signal to indicate the device ID, location, or URL. *Active beacons* can also perform 2-way communication with the smartphone (similar to a Wireless Access Point). Beacons are expected to transform how retailers, event organizers, transportation systems, enterprises, and universities communicate with people indoors.

Answer the following questions in the context of beacons.

(i) What types of attenuations are applicable for wireless signals generated from indoor beacons? Briefly discuss. [6]

(ii) How will those attenuations discussed in (i) affect the localization accuracy (i.e., ability to identify the location of a smartphone accurately)? [3]

(iii) What wireless technology would you recommend for the communication between beacons and smartphones? Justify your recommendation. [4]

(iv) A beacons-based solution is proposed for a suburban indoor street, where a proprietary device will be given to tourists to identify their location. The device emits a transmission power of 6 mW at 900 MHz. Gain of the beacon antenna is 2 while device antenna is 1.

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 for this environment is 5 m.

a) What will be the signal strength at 30 m from the beacon? [6]

b) Is the Signal to Noise Ratio (SNR) sufficient to localize the device at 30 m? Briefly explain.

Hint: Receiver antenna temperature is 300 K and receiver bandwidth is 31.5 KHz? [3]

(v) Passive beacons are expected to work without human intervention. Hence, what power harnessing technique(s) would you recommend to enhance their lifetime? [3]

Question 3 (25 marks)

Suppose your friend Kamal came to you with a broken quadcopter (i.e., a multirotor helicopter that is lifted and propelled by four rotors). Kamal says he is unable to control the quadcopter using the remote controller. He wants you to fix it.

After a bit of diagnostic you realized that the problem is with the transmitter of the remote controller. However, as the transmitter is a proprietary design you are unable to fix it. Instead, you decide to replace the transmitter on the remote controller and receiver on the quadcopter with your own design, as rest of the components seems to be working correctly.

Remote controller had the following configuration:

Source: http://norunway.com/wp/rc-drone-transmitter/

You need to be able to send Rudder, Throttle, Pitch, and Roll values/signals to the quadcopter. Moreover, you need to support 4 on/off switches (on top of the controller), which are used to send various configuration options to the quadcopter. The quadcopter is designed for a flying range of 100 m.

(i) What wireless technology would you recommend to communicate between your transmitter and receiver? Justify your recommendation. [4]

(ii) What type of a message routing scheme would you recommend? Justify your recommendation. [3]

(iii) Design a suitable message format to control the quadcopter. Clearly state any assumptions. [12]

(iv) If the chosen receiver has a receive sensitivity of -95 dBm, can you expect to reach the flying range of 100 m?

Assume chosen transmitter emits a transmission power of 10 mW at 2.4 GHz, and gains of the transmitting and receiving antenna are 1. [6]

Question 4 (25 marks)

(i) "*IP TV over FTTx is a better alternative compared to satellite TV*".

Do you agree or disagree with this statement. Discuss. [6]

(ii) A wireless LAN is being designed for an office with 25 users. All 25 users have webmail access. However, only 15 users have access to other websites inducing online productivity tools like Google Docs and Office 365 (other than webmail). 5 users access a cloud-based Enterprise Resource Planning (ERP) system. It is also important to allow LAN communication among the PCs and laptops in the branch. Following traffic loads are given:

- Webmail access – 6 Kbps/user
- ERP access – 50 Kbps/user
- Web access – 25 Kbps/user
- LAN communication – 2.5 Mbps/user

a) Calculate the total Internet bandwidth requirement. [4]

b) Calculate the total capacity requirement within the wireless LAN. [3]

c) Would you recommend 802.11g network or an 802.11n network? Briefly explain. [4]

d) A vender has recommended to use a "4G Wireless router based on LTE-Advanced technology" to provide the connectivity to the branch office.

Do you agree or disagree with this recommendation? Justify. [4]

e) What non-technical factors should be considered while deploying the proposed wireless network? Briefly discuss. [4]

Question 5 (25 marks)

(i) Recommend with justification a suitable wired/wireless technology for following cases:

a) To provide Internet access to an apartment in an apartment complex at a major city. [5]

b) To connect a 500 hectare tea estate in Nuwara Eliya to the head office in Colombo. [5]

c) To automatically configure smart lights with an IoT gateway/controller at a house. [5]

(ii) Recent Distributed Denial of Service (DDoS) attack on Dyn DNS servers initiated by Internet of Things (IOT) devices prevented the access to some of the popular websites like Twitter and GitHub for hours. Surprisingly, this attack was initiated by millions of IoT devices such as IP cameras, DVRs, and home Wi-Fi access points, which were compromised by attackers to be bots. With this incident, privacy and security advocates of IoT are emphasizing the disruptive power of IoT and need for regulation.

a) What characteristics of the implementation of IoT devices make them vulnerable to such attacks? [4]

b) Briefly explain 2 solutions we could adopt to overcome such vulnerabilities. [6]

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.

---------- END OF THE PAPER ----------