UNIVERSITY OF MORATUWA

FACULTY OF ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

B.Sc. Engineering
2013 Intake Semester 7 Examination

CS4492 WIRELESS AND BROADBAND NETWORKING

Time allowed: 2 Hours June/July 2017

ADDITIONAL MATERIAL: *None*

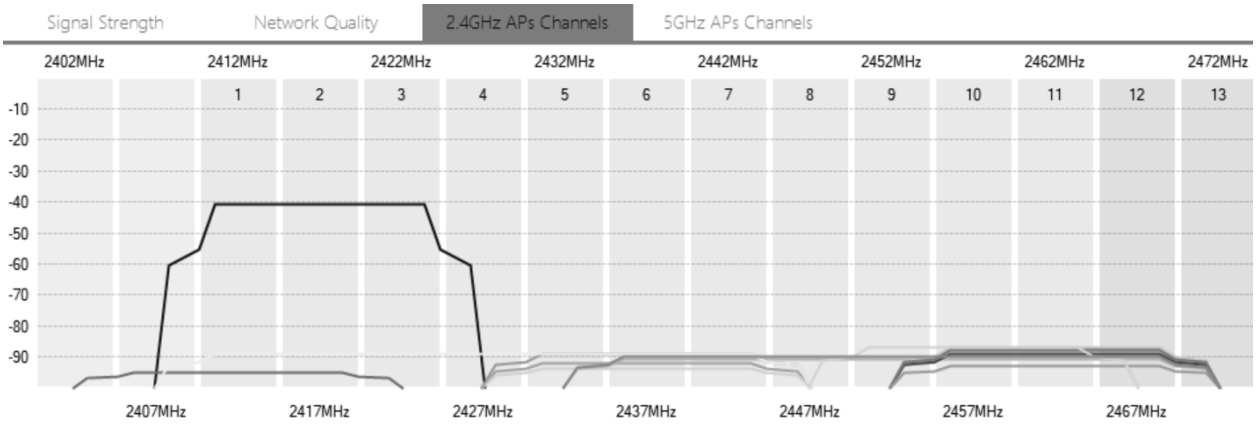
INSTRUCTIONS TO CANDIDATES:

1. This paper consists of **4** questions in **5** pages.
2. Answer **All** questions.
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) A wireless scanner detected the following WiFi networks around Park Street, Colombo 2.

SSID	MAC Address	RSSI	Chan	802.11	Max Speed	WEP	WPA	WPA2	WPS	Vendor
Guest_Wifi	58:97:1E:E8:33:C2	-86	11	b, g, n	144.4 Mbps	Open				Cisco Systems. Inc
[Hidden]	18:A6:F7:7E:30:10	-45	2	b, g, n	144.4 Mbps		PSK-(TKIP|CCMP)	PSK-(TKIP|CCMP)		TP-LINK TECHNOLOGIE
Mobitel_EB	54:4A:00:4B:3C:F2	-88	6	b, g, n	144.4 Mbps		PSK-CCMP	PSK-CCMP		Cisco Systems. Inc
Mobitel_Open	54:4A:00:4B:3C:F0	-95	6	b, g, n	144.4 Mbps	Open				Cisco Systems. Inc
Mobitel_EAP	54:4A:00:4B:3C:F1	-93	6	b, g, n	144.4 Mbps			MGT-(TKIP|CCMP)		Cisco Systems. Inc
Ravidu	F2:4F:7E:BA:46:E1	-91	1	b, g, n	72.2 Mbps			PSK-CCMP		
[Hidden]	FA:8F:CA:8C:AF:E3	-92	1	b, g, n	72.2 Mbps	Open				
NVR639904553	BC:AD:28:EF:22:21	-92	11+7	b, g, n	300 Mbps			PSK-CCMP	1.0	Hangzhou Hikvision Dig
WIFI_SAP	58:97:1E:E8:33:C5	-85	11	b, g, n	144.4 Mbps			PSK-CCMP		Cisco Systems. Inc
Test_AD	58:97:1E:E8:33:C3	-86	11	b, g, n	144.4 Mbps			MGT-CCMP		Cisco Systems. Inc
HEMASEXT	58:97:1E:E8:33:C1	-89	11	b, g, n	144.4 Mbps			PSK-CCMP		Cisco Systems. Inc
HEMAS	58:97:1E:E8:33:C0	-86	11	b, g, n	144.4 Mbps			PSK-CCMP		Cisco Systems. Inc
AndroidAP	94:B1:0A:87:2F:CD	-93	6	b, g, n	72.2 Mbps	Open				Samsung Electronics Co.
[Hidden]	58:97:1E:E8:33:C4	-85	11	b, g, n	144.4 Mbps			PSK-CCMP		Cisco Systems. Inc
SkyCargoCMB	90:61:0C:30:FF:75	-92	2+6	b, g, n	300 Mbps		PSK-CCMP	PSK-CCMP	1.0	Fida International (S) Pte
Harsha Mac	6C:40:08:9E:7E:16	-93	11	b, g, n	216.7 Mbps			PSK-CCMP		Apple. Inc.
20A2sam	F4:83:CD:F1:BD:C3	-94	1+5	b, g, n	450 Mbps		PSK-CCMP	PSK-CCMP		TP-LINK TECHNOLOGIE
NARAWIFI	DC:09:4C:A3:31:A0	-87	10	b, g, n	144.4 Mbps		PSK-(TKIP|CCMP)	PSK-(TKIP|CCMP)		HUAWEI TECHNOLOGIE
LTL1	98:DE:D0:65:B6:48	-93	1	b, g, n	300 Mbps		PSK-(TKIP|CCMP)	PSK-(TKIP|CCMP)		TP-LINK TECHNOLOGIE
Dialog 4G	44:6E:E5:6A:9A:5C	-95	10	b, g, n	144.4 Mbps		PSK-(TKIP|CCMP)	PSK-(TKIP|CCMP)		HUAWEI TECHNOLOGIE
Mobitel_EB	54:4A:00:4B:3C:FD	-95	36	a, n	144.4 Mbps		PSK-CCMP	PSK-CCMP		Cisco Systems. Inc
Mobitel_EAP	54:4A:00:4B:3C:FE	-94	36	a, n	144.4 Mbps			MGT-(TKIP|CCMP)		Cisco Systems. Inc
[Hidden]	42:AD:28:EF:22:21	-93	11+7	b, g, n	300 Mbps	Open				



a) What can you conclude from the observations?

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

b) How secure are these networks? [3]

c) List 3 suggestions to improve the wireless communication environment? [3]

d) It can be seen that access points operating on the same channel have different throughputs such as 72.2, 144, and 300 Mbps. How is this possible? [3]

(ii) Suppose one of the above access points has a channel width of 20 MHz and operates on channel 6 (i.e., frequency 2,437 MHz) with an output power of -28 dBm.

a) What will be the signal strength at 50 m from the access point. Assume the reference distance is 5 m and the path loss exponent is 2.2. Transmission and receiver antenna gains are 2 and 1, respectively. [7]

b) Is the signal strength sufficient, if the receiver sensitivity is -95 dBm? Discuss. [3]

Question 2 (25 marks)

A smart meter is an electronic device that records the consumption of electric energy in intervals of an hour or less and communicates that data at least daily back to the utility office for monitoring and billing. Some smart meters also come with in-home displays, so you can better understand your energy usage. Smart meters are expected to be installed in every house or place of business within the next couple of years.

(i) What wireless technology would you recommend for the communication between a smart meter and the utility office? Justify. [5]

(ii) What network topology would you recommend for the communication between a smart meter and the utility office? Justify. [5]

(iii) What type of a message routing scheme would you recommend for the communication between a smart meter and the utility office? Justify. [4]

(iv) Design a suitable message format for the messages sent by the smart meter. Clearly state any assumptions. [6]

(v) "*I recommend having two-way communication between smart meter and the utility office, as well as among smart meters*"

Do you agree or disagree with this statement? Discuss. [5]

Question 3 (25 marks)

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

a) To provide Internet access to a school in a rural area. [5]

b) Automatic payment solution for frequent users of highways. [5]

c) To provide HD quality IPTV services within a city. [5]

(ii) Bring Your Own Device (BYOD) is becoming popular where users can use their personal devices for office work. While this brings in many advantages, it also creates several technical and security issues.

a) Using an example, describe how a user's BYOD device can be located regardless of its location (i.e., home, office, or on the go). [6]

b) Describe 2 techniques to minimize potential security issues while using BYOD devices? [4]

Question 4 (25 marks)

(i) A wireless LAN is being designed for a large warehouse with 12 computer users. All users have web access (including webmail) and access to a cloud-based stock management system. These users also connect to a file and print server at the warehouse. Warehouse consists of 4 CCTV cameras and the video streams from the cameras are sent to the head office for viewing and archiving. A set of wireless sensors are also used to monitor micro-climate and doors of the warehouse from the head office. The following traffic loads are given:

- Web Access – 30 Kbps/user
- CCTV – 500 Kbps per camera
- All Sensors – 10 Kbps
- Stock management system – 50 Kbps/user
- File and Print services – 1 Mbps/user

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

b) Calculate the total capacity requirement within the wireless LAN. [4]

c) An ISP has recommended to use a "4G Wireless router based on LTE-Advanced technology" to provide the connectivity to the warehouse.

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

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

e) Owner of the warehouse has realized that the storage facilities are not optimally utilized and items are not stored and dispatched on time. Moreover, some of the food items tend to go bad much earlier than their expiration date, as the micro-climate of the warehouse is not properly maintained. Furthermore, the owner has realized inconsistencies in the actual stock and stock management system.

Propose an IoT-based solution to overcome the issues. Your solution should consider sensors, connectivity, and people & processes in an IoT environment. [9]

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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