UNIVERSITY OF MORATUWA

FACULTY OF ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

MSc in Computer Science
2016 Intake Semester 1 Examination

CS5440 WIRELESS ACCESS NETWORKS

Time allowed: 2 Hours April 2016

ADDITIONAL MATERIAL: *None*

INSTRUCTIONS TO CANDIDATES:

1. This paper consists of **4** questions in **6** 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. Relevant equations and parameter values are given in Appendix (page **6**).
6. This examination accounts for 40% of the module assessment.
7. This is an **open book** examination.
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)

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 locate them while they are indoors. For example, GPS does not work in large multi-story car parks, department stores, hospitals, etc. 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 or location. *Active beacons* can also do 2-way communication with the smartphone (similar to a simple 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. [5]

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

(iii) What wireless technology would you recommend for the communication between beacons and smartphones? Justify your recommendation. [5]

(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. Gains of both beacon and device antennas are 1. For this environment, the reference distance is 10 m.

a) What will be the signal strength at 50 m from the beacon? [5]

b) Is the Signal to Noise Ratio (SNR) sufficient to localize the device at 50 m? Briefly explain.

Hint: Receiver antenna temperature is 300 K and receiver bandwidth is 31.5 KHz? [4]

(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 2 (25 marks)

(i) A wireless LAN is being designed for a branch office with 23 users. All 23 users have webmail access. However, only 12 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, e.g., file and printer sharing. Following traffic loads are given:

- Webmail access – 5 Kbps/user
- Web access – 25 Kbps/user
- ERP access – 50 Kbps/user
- LAN communication – 2 Mbps/user

a) Calculate the total Internet bandwidth requirement. [3]

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

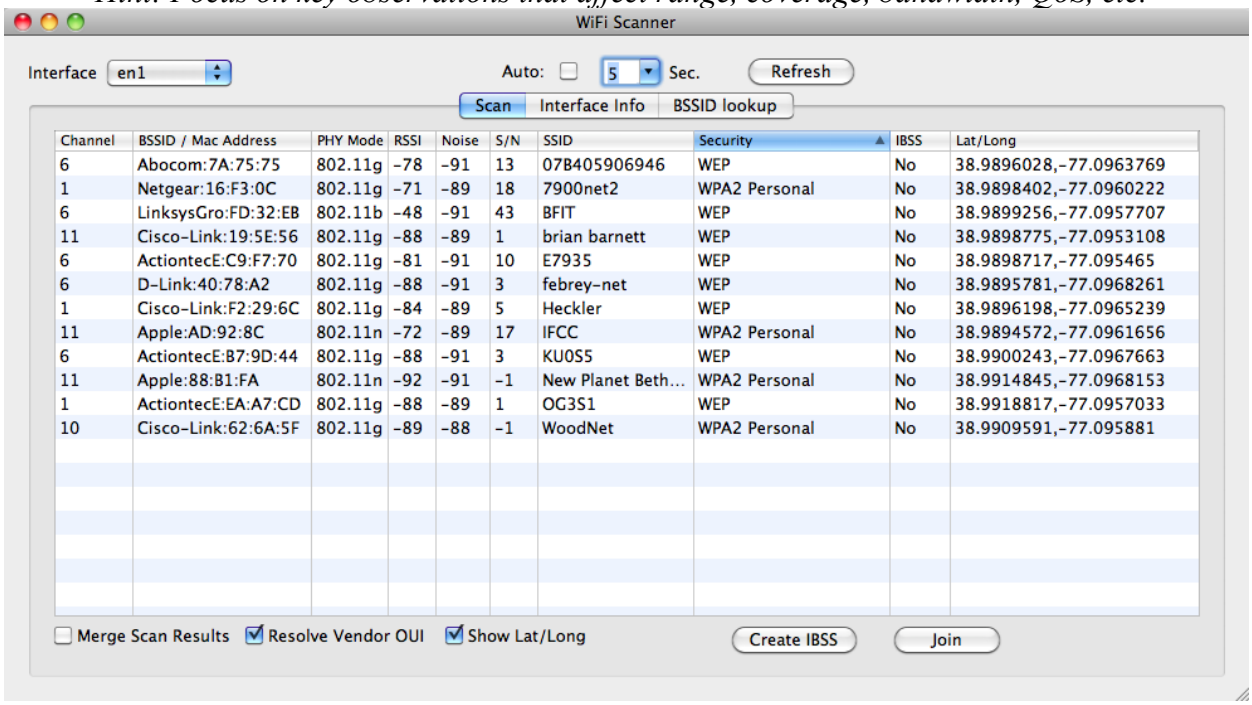
c) Would you recommend 802.11g network or an 802.11n network? Briefly explain. [4]

d) A vender has recommended to use a "4G Wireless router" 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]

(ii) How would you interpret the results of the following screenshot from a wireless scanner? Discuss. [7]

Hint: Focus on key observations that affect range, coverage, bandwidth, QoS, etc.

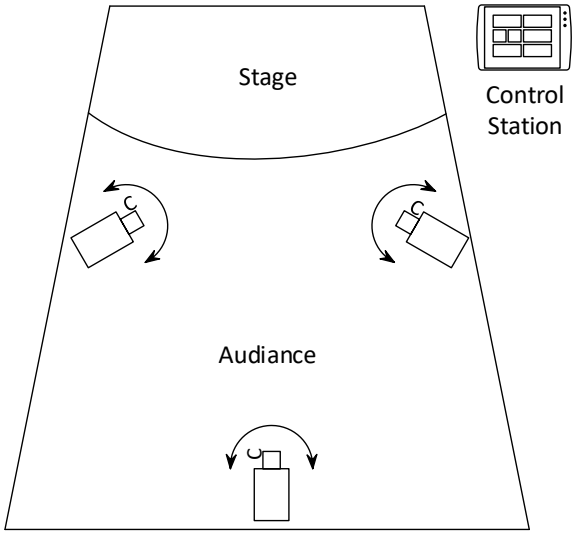


Channel	BSSID / Mac Address	PHY Mode	RSSI	Noise	S/N	SSID	Security	IBSS	Lat/Long
6	Abocom:7A:75:75	802.11g	-78	-91	13	07B405906946	WEP	No	38.9896028,-77.0963769
1	Netgear:16:F3:0C	802.11g	-71	-89	18	7900net2	WPA2 Personal	No	38.9898402,-77.0960222
6	LinksysGro:FD:32:EB	802.11b	-48	-91	43	BFIT	WEP	No	38.9899256,-77.0957707
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

Question 3 (25 marks)

A recording system is to be deployed at an auditorium. Three (3) cameras shown in the following figure are to be controlled via the control station on the right side of the stage.



Straight-line distance to each camera from the Control Station is 5m, 17m, and 33m, respectively. Each camera supports P/T/Z (i.e., camera can pan, tilt, and zoom) and valid range of values are as follows:

- Pan – 0 - 180^0
- Tilt – 0 - 60^0
- Zoom – 0 - 10x

Suppose you were invited to design a wireless controller to remotely control each of the cameras. The camera operator at the Control Station (Windows-based PC) controls and sets P/T/Z values for each camera. Those values need to be wirelessly communicate to the respective camera with minimum delay, as the camera operator may change the P/T/Z configuration while the recording is going on. You are also told that in the future the number of cameras may increase to 6.

(i) Would you recommend an infrastructure-based network or infrastructure-less network to control the 3 cameras? Explain. [3]

(ii) What type of a network topology would you recommend for this network? Justify your recommendation. [3]

(iii) What wireless technology (e.g., Bluetooth, ZigBee, WiFi, NFC, etc.) would you recommend to create these wireless controllers? Justify your recommendation. [4]

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

(v) What measures can you take to ensure only the authorized control station can control the cameras? [4]

(vi) Design a suitable message format to control the cameras from the Control Station. [8]

Question 4 (25 marks)

Internet of Things (IOT) combines sensors, connectivity, and people/processes to build smart systems such as smart cities.

(i) Outline how an IOT-based solution can be used to address one of the common problems faced by a city like traffic, air pollution, parking, and crimes.

Your solution needs to identify how sensors, connectivity, and people/processes are combined to provide a smart solution. Also, identify types of sensors to use, connectivity options, processes, and interfaces to interact with humans (e.g., visualization). [12]

(ii) Briefly explain 2 wireless security and privacy related challenges you may have to overcome while developing such a solution. [6]

(iii) What are the potential applications that NFC (Near Field Communication) can support in smart cities? Discuss. [7]

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 ----------