Queen Mary
University of London

Main Examination Period 2018

ECS702P Mobile and WLAN Technologies Duration: 2 hours 30 minutes

YOU ARE NOT PERMITTED TO READ THE CONTENTS OF THIS QUESTION PAPER UNTIL INSTRUCTED TO DO SO BY AN INVIGILATOR

Answer FOUR questions

If you answer more questions than specified, only the first answers (up to the specified number) will be marked. Cross out any answers that you do not wish to be marked

Calculators are permitted in this examination. Please state on your answer book the name and type of machine used.

Complete all rough workings in the answer book and cross through any work that is not to be assessed.

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Examiners: Prof Xiaodong Chen and Dr Eliane L. Bodanese

Question 1

a) Explain Flat fading and frequency selective fading. Describe their impact on the wireless channel, with the help of a sketch of BER vs E_b/N_0 curves.

[6 marks]

b) Assume a cell receives on average 360 calls per hour, the mean holding time of a call is 120 seconds and the grade of service is 0.02. Considering Table 1, answer the following questions.

i) Calculate the offered traffic in the cell.

ii) How many channels are needed in this cell if an omnidirectional antenna is used?

iii) Considering the offered traffic is uniformly distributed inside the cell, how many channels does the cell need if three 120 degree directional antennas are used?

iv) Compare the channel utilisation efficiency in sub-questions ii and iii.

[14 marks]

Blocked-Calls-Cleared (Erlang *B*)

	A, erlangs												
	B												
N	1.0%	1.2%	1.5%	2%	3%	5%	7%	10%	15%	20%	30%	40%	50%
1	.0101	.0121	.0152	.0204	.0309	.0526	.0753	.111	.176	.250	.429	.667	1.00
2	.153	.168	.190	.223	.282	.381	.470	.595	.796	1.00	1.45	2.00	2.73
3	.455	.489	.535	.602	.715	.899	1.06	1.27	1.60	1.93	2.63	3.48	4.59
4	.869	.922	.992	1.09	1.26	1.52	1.75	2.05	2.50	2.95	3.89	5.02	6.50
5	1.36	1.43	1.52	1.66	1.88	2.22	2.50	2.88	3.45	4.01	5.19	6.60	8.44
6	1.91	2.00	2.11	2.28	2.54	2.96	3.30	3.76	4.44	5.11	6.51	8.19	10.4
7	2.50	2.60	2.74	2.94	3.25	3.74	4.14	4.67	5.46	6.23	7.86	9.80	12.4
8	3.13	3.25	3.40	3.63	3.99	4.54	5.00	5.60	6.50	7.37	9.21	11.4	14.3
9	3.78	3.92	4.09	4.34	4.75	5.37	5.88	6.55	7.55	8.52	10.6	13.0	16.3
10	4.46	4.61	4.81	5.08	5.53	6.22	6.78	7.51	8.62	9.68	12.0	14.7	18.3
11	5.16	5.32	5.54	5.84	6.33	7.08	7.69	8.49	9.69	10.9	13.3	16.3	20.3
12	5.88	6.05	6.29	6.61	7.14	7.95	8.61	9.47	10.8	12.0	14.7	18.0	22.2
13	6.61	6.80	7.05	7.40	7.97	8.83	9.54	10.5	11.9	13.2	16.1	19.6	24.2
14	7.35	7.56	7.82	8.20	8.80	9.73	10.5	11.5	13.0	14.4	17.5	21.2	26.2
15	8.11	8.33	8.61	9.01	9.65	10.6	11.4	12.5	14.1	15.6	18.9	22.9	28.2
16	8.88	9.11	9.41	9.83	10.5	11.5	12.4	13.5	15.2	16.8	20.3	24.5	30.2
17	9.65	9.89	10.2	10.7	11.4	12.5	13.4	14.5	16.3	18.0	21.7	26.2	32.2
18	10.4	10.7	11.0	11.5	12.2	13.4	14.3	15.5	17.4	19.2	23.1	27.8	34.2
19	11.2	11.5	11.8	12.3	13.1	14.3	15.3	16.6	18.5	20.4	24.5	29.5	36.2
20	12.0	12.3	12.7	13.2	14.0	15.2	16.3	17.6	19.6	21.6	25.9	31.2	38.2

Table 1: Erlang B table

Continues on next page…

c) Given the following *number of cells per cluster*, find the respective ***cochannel reuse ratio***.

i) *Number of cells per cluster* = 3.

ii) *Number of cells per cluster* = 12.

[5 marks]

Question 2

a) Explain how OFDM works, with the help of diagrams if necessary.

[6 marks]

b) Describe briefly three options of the Physical layer in the IEEE802.11 standard.

[6 marks]

c) Describe the main features in the IEEE802.11ac proposal.

[4 marks]

d) Explain how the WLAN security is improved in WPA2.

[5 marks]

e) Explain what hidden terminals are, with the help of a diagram if necessary.

[4 marks]

Question 3

a) Describe the Radio Specification of Bluetooth 2.0.

[6 marks]

b) With the help of a diagram, explain how the data transaction is done in Bluetooth Low Energy standard (4.0).

[5 marks]

c) Briefly describe the security improvement made in Bluetooth 2.1.

[4 marks]

d) With the help of diagrams, explain how the Frequency Hopping Spread Spectrum (FHSS) works.

[6 marks]

e) Explain the network topology and access methods in Bluetooth.

[4 marks]

Question 4

a) Answer the following questions in the GSM system.

i) How many time slots are used in a TDMA frame?

ii) How many cells are adopted in a cluster? How many sectors are divided in a cell?

iii) What are the HLR and VLR?

iv) What kind of random access method is used when a Mobile Station wants to access to GSM system?

v) Explain what kind of power control is used in the GSM system.

[8 marks]

b) Answer the following questions related to Short Messaging Services (SMS) in GSM:

i) Explain briefly the architecture of ***Short Messaging Service*** (SMS) in GSM;

ii) Describe the operation of a Mobile Terminated SMS in GSM.

[7 marks]

c) Describe the functionality of the Rake receiver in CDMA systems.

[5 marks]

d) Describe how the capacity of a single CDMA cell can be calculated and supply an example considering an SIR between 3dB and 9dB, a data transmission rate of 9600bps and the carrier bandwidth used in IS-95 (the channel bandwidth is 1.25MHz).

[5 marks]

Question 5

a) Supply the appropriate words to fill the blanks in the following sentences about the UMTS system (**Note: write your answer in the answer book and NOT on this page**):

UMTS system uses W-CDMA as its multiple access technique. _____(1) power control is a very important aspect in UMTS, in particular in the uplink, because of the near-far problem. _____ _____ (2) power control mechanisms make a rough estimate of path loss by means of a downlink beacon signal. In _____ _____(3) power control, the BS performs frequent estimates of the received Signal-to-Interference Ratio (SIR) in the _____ (4) and compares it to a target SIR. If the measured SIR is higher than the target SIR, the BS will command the MS to lower the power; if it is too low it will command the MS to increase its power. _____ _____ (5) power control adjusts the target SIR in the BS according to the needs of the individual radio link.

[5 marks]

b) With the help of a diagram, explain how the soft-handover works in UMTS.

[6 marks]

c) Figure 1 gives an overview of several types of handover in a combined UMTS/GSM network. Indicate what handover UE_3 is performing and describe this type of handover.

[6 marks]

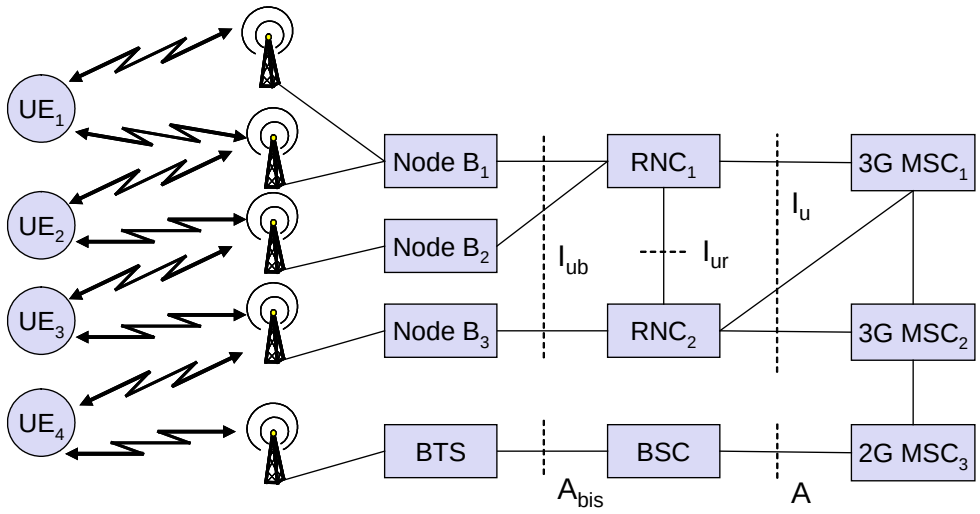

Figure 1: Handovers in UMTS

d) The GPRS network is built on the GSM network to provide data services.

i) Sketch the GPRS network architecture and name two key nodes;

ii) Describe the functions of two GPRS supporting nodes.

[8 marks]

Question 6

a) Describe the general functionality of HSUPA.

[4 marks]

b) Answer the following questions about HSDPA:

i) What does HSDPA stand for?

ii) Describe the means used by HSDPA to increase downlink data throughput.

iii) What radio entity was modified mainly to cope with and control HSDPA channels?

iv) Cite two important features of UMTS channels that are disabled in HSDPA channels.

[6 marks]

c) With the help of diagrams, explain how the OFDMA works in LTE downlinks.

[8 marks]

d) With the help of diagrams, describe the handover procedure in the LTE-A standard.

[7 marks]

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