

Main Examination Period 2019

ECS702P Mobile and WLAN Technologies Duration: 2 hours 30 minutes

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INSTRUCTED TO DO SO BY AN INVIGILATOR**

<p>Answer ALL FOUR questions</p>

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 Maged Elkashlan

Question 1

a) Explain Rayleigh and Rician 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 0.03. 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 six 60 degree directional antennas are used?

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

[14 marks]

**Blocked-Calls-Cleared
(Erlang B)**

N	A, erlangs												
	B												
	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	3.39	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* = 4.
 - ii) *Number of cells per cluster* = 7.

[5 marks]

Question 2

a) Describe briefly the Physical layer specification in the IEEE802. 11a, 11b and 11g standards, respectively.

[6 marks]

b) Describe in detail the handoff process in IEEE802.11.

[7 marks]

c) Answer the following questions about WLAN.

i) What are hidden terminals in WLAN?

ii) Explain in detail how the hidden terminal problem is solved in the IEEE802.11 standard.

[5 marks]

d) Describe briefly the main improvements being made in IEEE802.11n standards.

[3 marks]

e) Describe the network topology in Bluetooth 2.0.

[4 marks]

Question 3

a) 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]

b) Considering the importance of power control in cellular networks, answer the following questions.

- i) Explain Open Loop Power Control used in the IS-95 system.
- ii) Why is Power Control so important in CDMA systems?

[7 marks]

c) Describe how the capacity of a single CDMA cell can be calculated and supply an example considering an SIR between 4dB and 10dB, a data transmission rate of 9600bps and the carrier bandwidth used in IS-95 (the channel bandwidth is 1.25MHz).

[5 marks]

d) The GPRS network is built on the GSM network to provide data services. Sketch the GPRS network architecture and name two key nodes.

[6 marks]

Question 4

- a) Figure 1 gives an overview of several types of handover in a combined UMTS/GSM network. Indicate what handover UE_i ($i=1 - 4$) is performing and describe this type of handover.

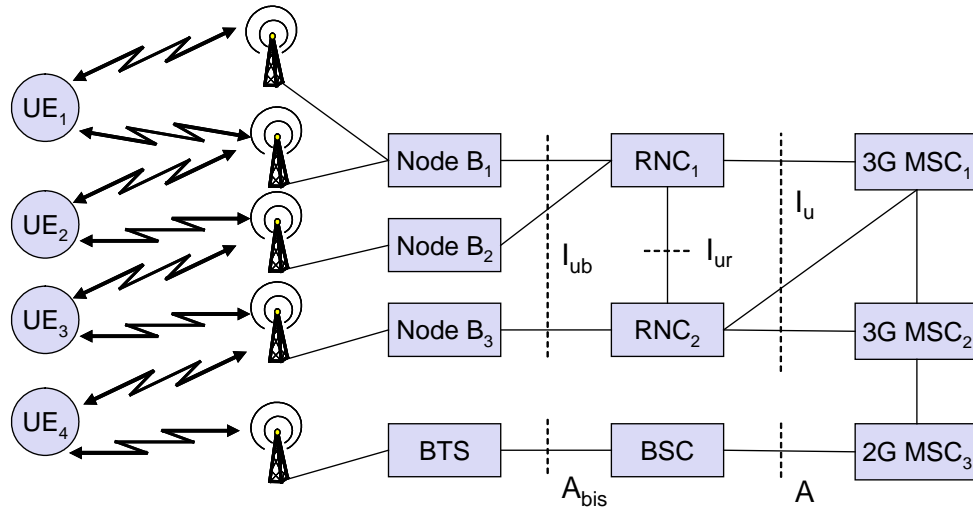
[14 marks]

Figure 1: Handovers in UMTS/GSM Network

- b) Answer the following questions about HSDPA:

- What does HSDPA stand for?
- Explain how the transmission latency is improved in HSDPA.
- What radio entity is modified mainly to cope with and control HSDPA channels?
- What is the improvement made on the transmission error control in HSDPA.

[6 marks]

- c) Explain in detail the Carrier Aggregation in the LTE-A standard.

[5 marks]