

City University of Hong Kong
Department of Electrical Engineering

EE4316 Mobile Data Networks

Test 2

22 April 2020

Duration: 60 minutes

Total marks: 60

Remarks: This is an open-book test

Declaration:

I pledge that the answers in this exam/quiz are my own and that I will not seek or obtain an unfair advantage in producing these answers. Specifically,

- o I will not plagiarize (copy without citation) from any source;*
- o I will not communicate or attempt to communicate with any other person during the exam/quiz; neither will I give or attempt to give assistance to another student taking the exam/quiz; and*
- o I will use only approved devices (e.g., calculators) and/or approved device models.*

I understand that any act of academic dishonesty can lead to disciplinary action.

Name:

Signature:

Student ID:

1. Describe the frequency planning procedure in UMTS networks.

[2 marks]

2. What handover technique is used in UMTS networks?

[1 mark]

3. When GSM is upgraded to UMTS, the Base Station Subsystem (BSS) is completely re-designed and becomes UMTS Terrestrial Radio Access Network (UTRAN). Name the two elements in UTRAN.

[2 marks]

4. A cellular network has the following data which can be used to evaluate the impact of location updates on the radio resource:

Density of MS in the cell = 10,000 MS/km²
 Cell radius = 500 m
 Average moving velocity of an MS = 10 km/hour
 Number of cells per LA = 10

- a. Calculate the rate of location update in a cell.

[5 marks]

- b. Out of 120 location updates, the distribution and duration of each type is given by the following table:

Type	Number	Duration
Intra-VLR LU	20	600 ms
Inter-VLR LU with TMSI	40	3000 ms
Inter-VLR LU with IMSI	60	5000 ms

Determine the number of channels required to achieve 1% of blocking of location updates.

[10 marks]

5. GPRS extends data capabilities of GSM and provides connections to external packet data networks.

- a. What are the new elements added to the GSM infrastructure to support GPRS? Describe their functions.

[6 marks]

- b. Consider a base station with C channels for the voice call and GPRS packet sharing in a homogeneous GSM/GPRS network. A voice call requires 1 channel and a GPRS call requires M channels. Upon a GPRS data arrival, if the number of idle channels $C_{idle} \geq M$, M channels are allocated to the GPRS call. If $0 < C_{idle} < M$, C_{idle} channels are allocated. Otherwise, i.e. $C_{idle} = 0$, the GPRS call is blocked. The GPRS packet using m ($m=1, 2, \dots, M$) channels is referred as a *type- m GPRS call*. We assume that the aggregated voice calls (new calls and handoff calls) and GPRS packets follow the Poisson process with the arrival rate λ_v and λ_g , respectively. The channel holding time of voice call is exponentially distributed with mean $1/\mu_v$. The service time of each GPRS packet with one channel is exponentially distributed with mean $1/\mu_g$. This system can be modeled as a Markov chain, from which the blocking probabilities of voice and GPRS calls can be obtained. Let each state of the Markov chain be denoted as $\mathbf{x} = (i, j_1, j_2 \dots j_M)$ with i representing the number of voice call in service, j_m ($m \in M \equiv \{1, 2 \dots M\}$) the number of type- m ongoing GPRS call. Draw the Markov chain of this system for $C=3, M=2$.

[15 marks]

6. When a GSM mobile desires to originate a call, it sends an access burst on the Random Access CHannel (RACH) randomly among one of the slots in the range of $[0, TX_INTEGER-1]$. Assume that, in case of collisions, the maximum number of retransmission of access request is limited by $MAX_RETRANS$. Given that $TX_INTEGER=8$, and $MAX_RETRANS=5$, two mobiles are trying to access a particular RACH.
- a. What is the probability that both mobiles can access the RACH without collision?
[3 marks]
 - b. What is the mean number of attempts needed for a mobile to successfully access the RACH?
[12 marks]
7. What is the issue in supporting high data rate in 4G networks if single carrier frequency is used? How does OFDM address the issue?
[4 marks]

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