

OLLSCOIL NA hÉIREANN, GAILLIMH
THE NATIONAL UNIVERSITY OF IRELAND, GALWAY

SEMESTER I EXAMINATIONS, 2000

B.E. DEGREE EXAMINATION (ELECTRONIC ENGINEERING)
B.E. DEGREE EXAMINATION (ELECTRONIC AND COMPUTER ENGINEERING)

COMMUNICATION SYSTEMS ENGINEERING II

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Duration of examination: *Two Hours*

Instructions: Answer any *Four* questions.

1. (a) Describe, with the aid of a diagram, the structure of the primary E1 TDM multiplex, which is used within the PSTN. Indicate clearly the structure and function of the various timeslots which make up the frame.
[7 marks]

(b) Signaling information relating to specific voice calls in the PSTN can be conveyed between exchanges over an E1 TDM link using any of the three techniques below:

- (i) Digitised in-band tones,
- (ii) TS16 based bit toggling,
- (iii) Multi-byte digital messages.

For each technique:

- (i) Explain, using a specific example, how precisely the signaling information is conveyed over the E1 TDM link,
- (ii) Clearly explain why the technique is either a CAS or CCS protocol,
- (iii) Indicate **one** advantage and **one** disadvantage of the technique.

[12 marks]

(c) A subscriber dials the number 091750511 on their telephone. Estimate the minimum time taken to signal this dialled information to the local exchange using:

- (i) Pulse dialling based on 10 pps signalling,
- (ii) DTMF dialling where the SLIC can detect a DTMF tone after 100 ms duration,
- (iii) A 128 byte CALL SETUP message transmitted over an ISDN basic rate interface.

You may assume a 100ms pause between individual digits being signaling where appropriate.

[6 marks]

2. (a) Explain the meaning of the terms **Integrated Services** and **Digital** in the context of the acronym ISDN.

[4 marks]

(b) Describe, with the aid of a diagram, the role of the Layer 1, 2 and 3 specifications for control and user information in an ISDN basic rate interface.

[7 marks]

(c) Describe the role of the following bits which are transmitted in the Layer 1 frame of an ISDN basic rate connection:

- (i) B bits,
- (ii) D bits,
- (iii) E bits,
- (iv) L bits.

[8 marks]

(d) Explain, stating specific examples, the meaning of **bearer services, supplementary services and tele-services** in the context of ISDN.

[6 marks]

3. (a) Explain TWO methods for calculating the traffic through a telecommunication device when traffic is measures in units of Erlangs, clearly indicating under what conditions each definition would be applicable.

[6 marks]

(b) A large business is currently using PSTN dial up lines to carry voice traffic between two sites. The busy hour traffic between the two sites is 40 calls with an average call holding time of 10 minutes. The company plans to install a 48kbps leased satellite link between the two sites, which is subdivided into timeslots of 4kbps. The first 4kbps in every frame is used for framing purposes and cannot be used. Additionally, voice traffic that is being carried over the satellite link is compressed to **8kbps** between the two sites.

A telecommunications engineer monitors the signalling traffic associated with the voice calls and determines that a reliable "worst case" estimate of the signalling traffic associated with EVERY call is 30000 bits.

- (i) Using this estimate of signalling traffic, determine how many 4kbps timeslots need to be allocated as common signalling channels in order to achieve a GOS of 0.1% for signalling traffic over the proposed satellite link. **Note:** If you fail to determine an answer for this part, you may assume that the answer is **4 timeslots** for use in part (ii).
- (ii) Determine the GOS, which would be achievable for the voice traffic over the links, after the framing and signalling timeslot capacity, determined in (i), have been allocated.
- (iii) Comment as to whether the GOS, as determined in (ii), would typically be deemed acceptable for voice traffic.

[15 marks]

(c) A business based in two sites currently uses PSTN dial up connections for all calls between the two sites. The annual bill for calls between the two sites is £40,0000. On analyzing the call patterns between the two sites, it was estimated that the busy hour traffic between the two sites was 100 calls per hour with an average call holding time of 10 minutes. Additionally, it was estimated that 1 in 100 call attempts made over the PSTN failed due to network congestion.

Determine if it would be cost effective for the company to utilize a lease line between the two sites, given a cost of £1,500 per channel on the leased line. You may wish to use figure 1, at the end of the paper, in completing this design.

[4 marks]

4. (a) Determine, from first principles, the optimum throughput and associated average number of attempts to achieve successful transmission of a satellite network, which has an access mechanism, based on a slotted ALOHA protocol. Clearly state any assumptions which you are making.

[10 marks]

(b) A slotted ALOHA system is operating such that 50% of slots contain collisions due to multiple earth stations attempting to transmit simultaneously. If all earth stations have a probability of transmitting during a timeslot of 0.05, determine:

- (i) The average number of frame transmission attempts in the timeslot period (to one decimal place),
- (ii) The number of earth stations in the system,
- (iii) The average number of attempts required to ensure successful transmission of a frame.

[7 marks]

(c) Discuss the role of **speech compression AND digital speech interpolation** technologies in increasing the capacity of a satellite link in carrying voice calls.

[8 marks]

5. (a) Explain the meaning of the following terms in the context of cellular telephony networks: **cells, frequency re-use and trunking.**

[6 marks]

(b) Explain why, in the GSM system, the Random Access Burst is substantially shorter than the Normal Burst generated by transmitters.

In the GSM specification, the bit rate transmitted on the radio carrier is 270 kbps. Given that a single GSM burst period has a duration of 156.25 bits. If it was desired that a GSM cell should only have a maximum radius of 50 km, determine the duration of Random Access Burst, which would have to be used in this system.

[6 marks]

(c) An incoming call is made from an external network to a mobile station in a GSM network. Describe the roles of the various devices within the network, which participate in routing this call to the required mobile station.

[7 marks]

(d) Describe the operation of any TWO techniques that provide security for the transmissions between a mobile station and base station.

[6 marks]

6. (a) Describe the role of the following terms, in the context of the GSM Air Interface:

- (i) Time Division Duplexing,
- (ii) Timing Advance,
- (iii) Adaptive Power Control,
- (iv) Discontinuous Transmission
- (v) Burst Transmission Mask.

[10 marks]

(b) Describe (i) the general type of information type carried on, and (ii) the physical transmission channel of the following logical channels in a GSM network.

- (i) Broadcast Control Channels,
- (ii) Common Control Channels,
- (iii) Associated Control Channels.

[9 marks]

(c) Describe the manner in which a GSM network supports unlimited terminal mobility while calls are in progress.

[6 marks]

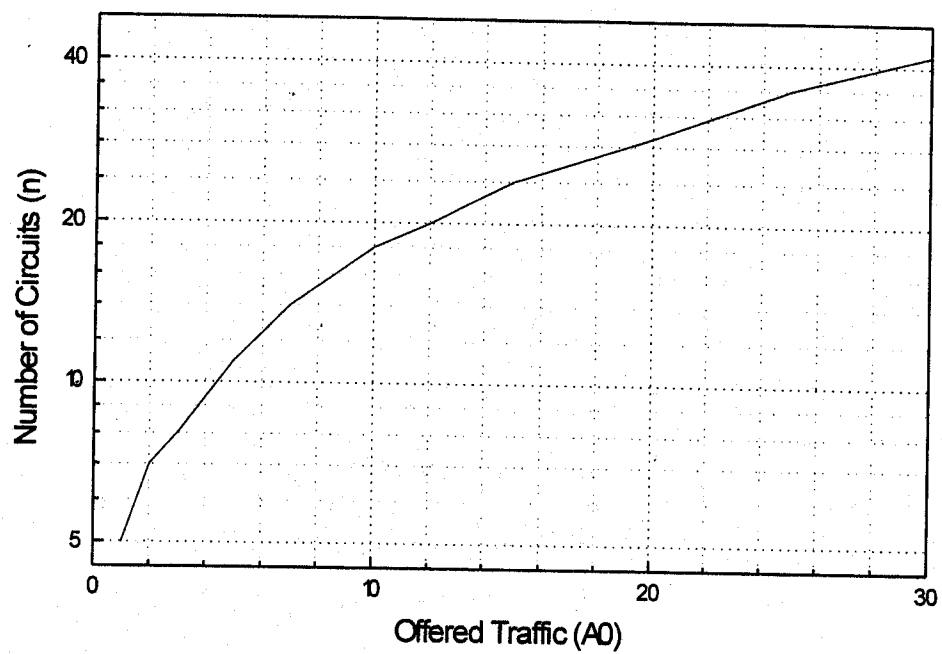


Figure 1 – Plot of Offered Traffic versus Number of Circuits for a Probability of Congestion of 0.01