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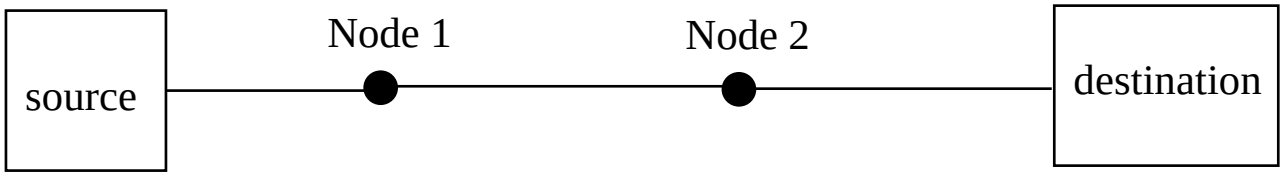
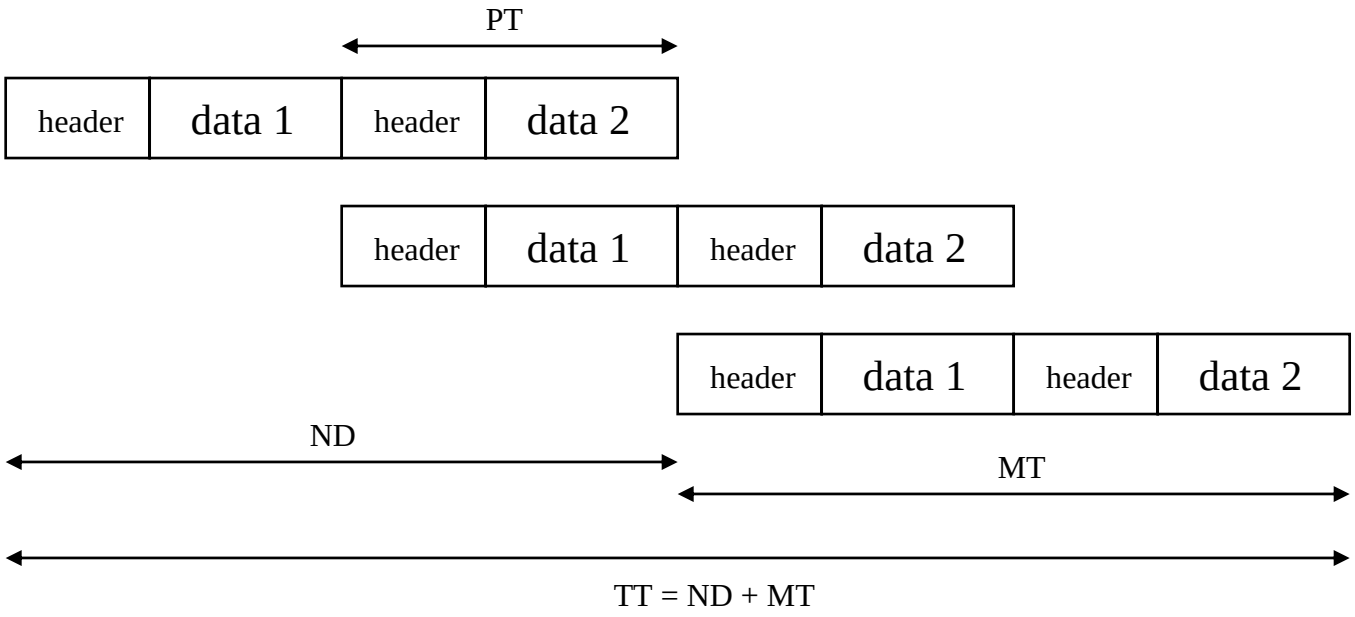
Question 1(a)

Store and forward network with 2 intermediate nodes:



If a message is broken into 2 packets the transfer vs. time is as follows:



Ignoring propagation delay and assuming all the delays are due to holding time gives:

PT: Packet Time = Time to send/receive one packet = No of bits in packet/Bit rate
ND: Network Delay = Number of intermediate nodes x Packet Time
MT: Message time = Time to send all packets in message = No. of packets x PT
TT: Total time for message to be received = ND + MT

12 marks

1(b)

Total message size = 2000 bits, header = 200 bits, data rate = 2 Mbps

No .of packets	Packet Size	PT	ND	MT	TT	
1	2200	1.1ms	2.2ms	1.1ms	3.3ms	2 marks
5	600	0.3ms	0.6ms	1.5ms	2.1ms	2 marks
10	400	0.2ms	0.4ms	2.0ms	2.4ms	2 marks

As the message is broken into smaller packets the total transfer time decreases first but eventually increases again because of the fixed header size.

2 marks

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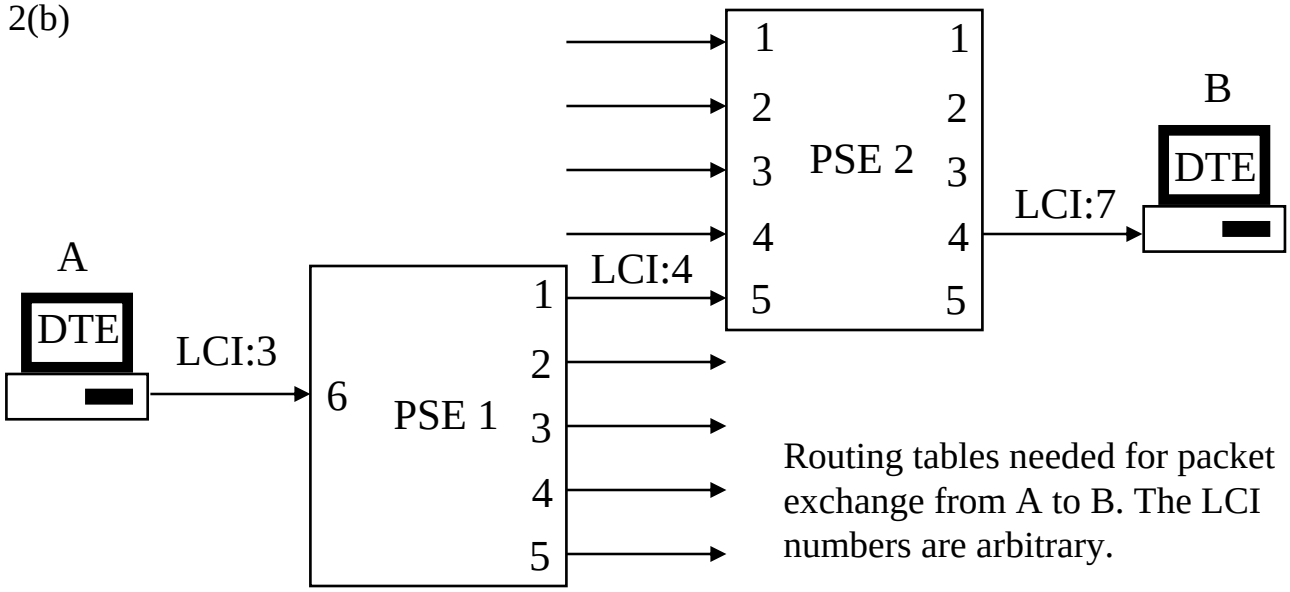
Question 2(a)

In an X.25 data network, each end user is given a unique network address known as a Network User Address (NUA). If a message is to be sent from one user to another, the initiating node first submits a Call Request Packet to the network containing its NUA number and the destinations' NUA number and some control information including a Logical Channel Identifier (LCI) which it wants to use to label the data transmission. If the request is accepted by the destination then the initiating node can send its set of packets into the network using only its LCI as a label. Each packet switching exchange (PSE) in the network through which the message passes will label the transmission with its own LCI number and therefore each PSE will have to build up a routing table to indicate how data streams at its input ports should be routed an labelled through its output ports.
In an X.25 system each physical link can be used for up to 4094 logical channels as Indicated by the LCI number. This allows the physical links to be shared or multiplexed between different applications and users so allowing the network resources to be shared.

7 marks

2(b)



Routing tables needed for packet exchange from A to B. The LCI numbers are arbitrary.

PSE 1 Routing Table			
Input		Output	
Link No.	LCI No.	Link No.	LCI No.
6	3	1	4

PSE 2 Routing Table			
Input		Output	
Link No.	LCI No.	Link No.	LCI No.
5	4	4	7

4 marks

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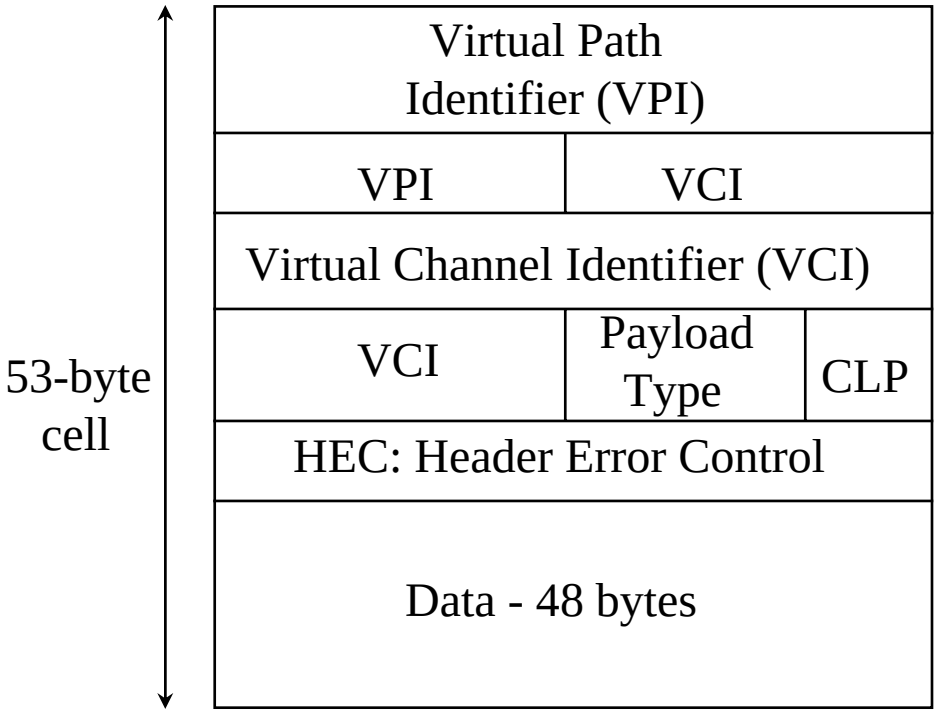
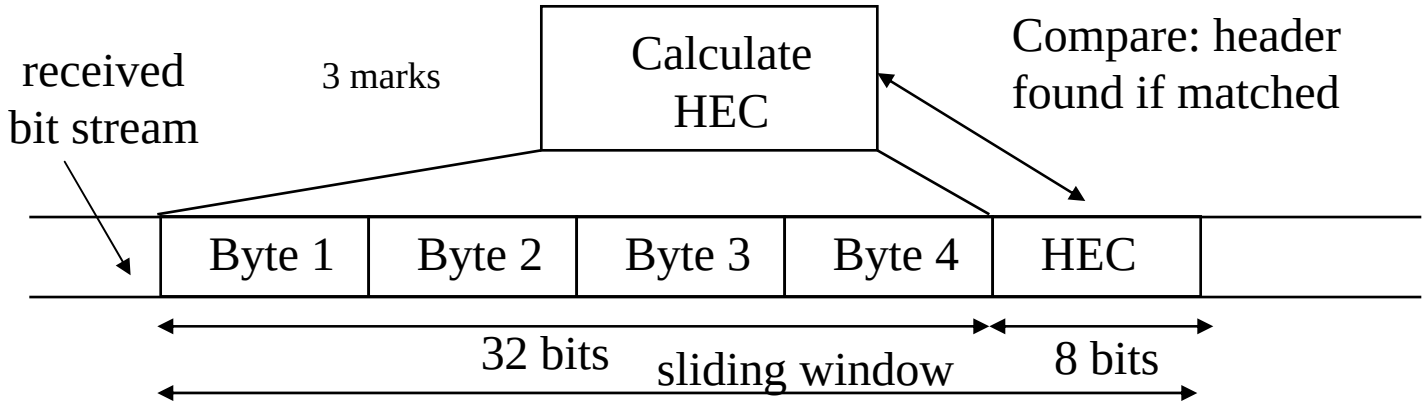
Question 2(c)(i) Format of ATM cell (network –network interface)



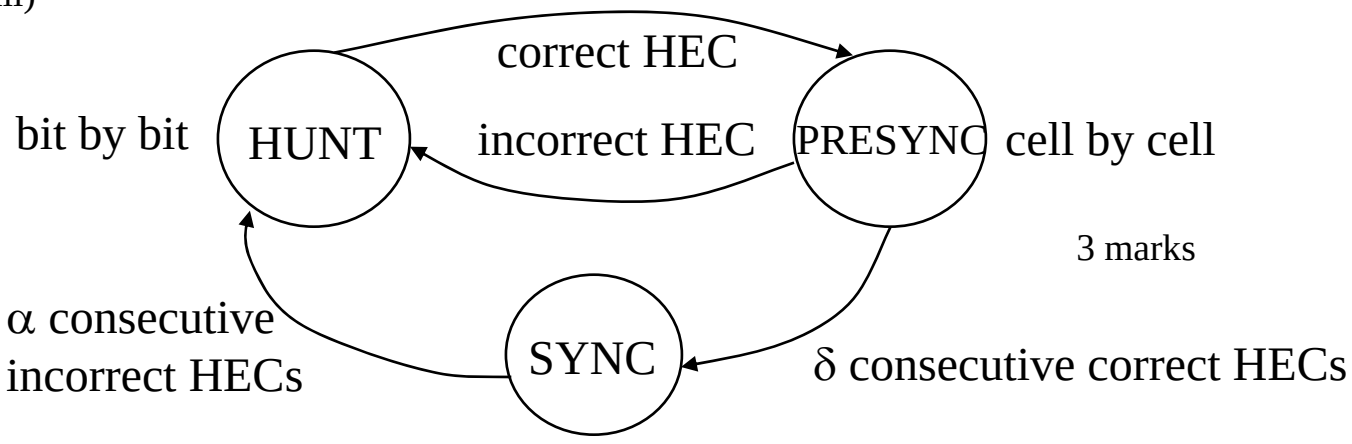
3 marks

(ii) The cell boundaries in an ATM system are identified by reading the data in a sliding window scheme and comparing a locally calculated HEC with the received one. If these match, the start of the cell is considered to be successfully located.



3 marks

(iii)



3 marks

α and δ are numbers chosen to give the best performance – usually less than 10.

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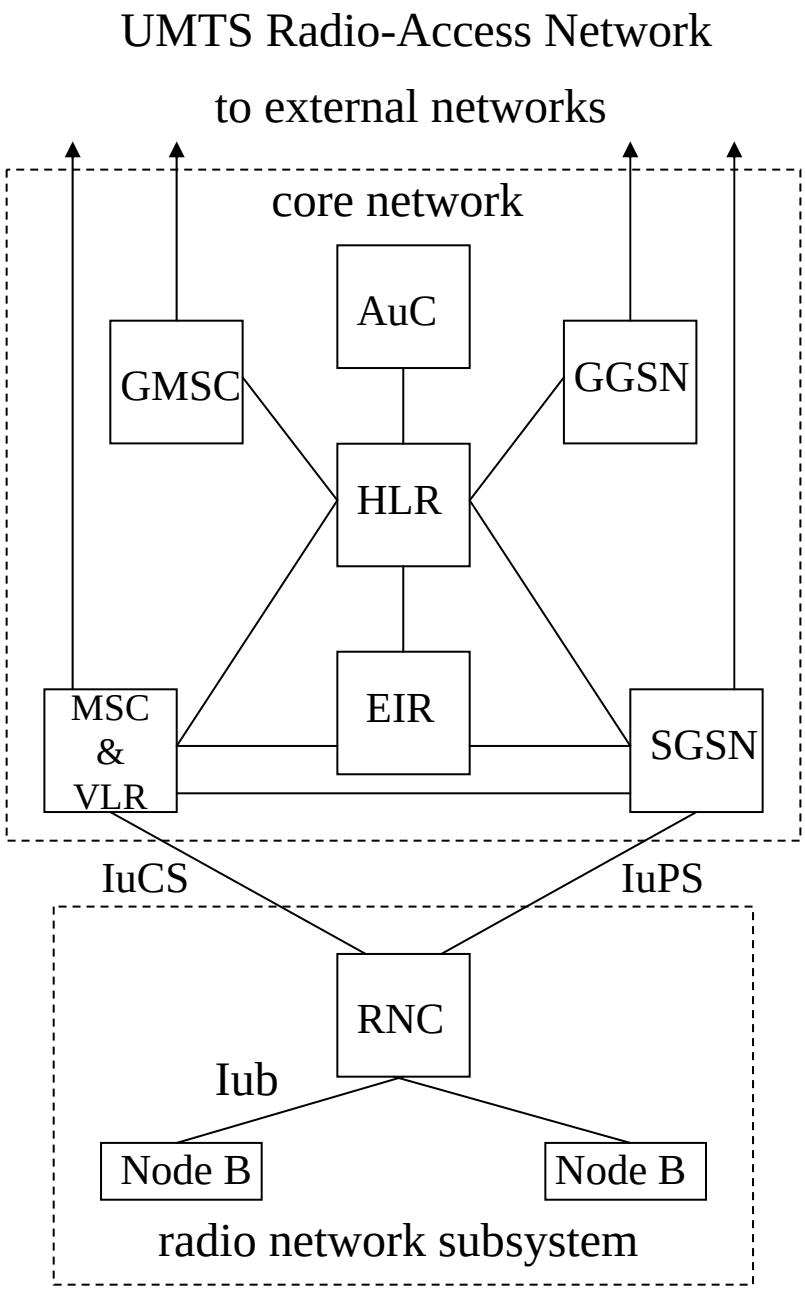
Question 3(a)



The mobile terminals (Node B) communicate with the Radio Network Controller (RNC). The RNC connects to the core network which is divided into circuit switched and packet switched elements. The circuit switched elements include the mobile services switching centre (MSC) and the gateway MSC (GMSC). The packet switched elements include the serving GPRS support node (SGSN) and the gateway GPRS support node (GGSN). Some elements such as the equipment identity register (EIR), the home location register (HLR), the visitor location register (VLR), and the authentication centre (AuC) are shared by both domains.

8 marks

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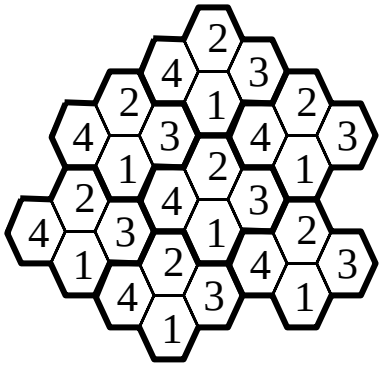
Question 3(b)

(i) Cell organization and frequency re-use

Cell pattern for N=4



Cellular systems divide up the geographical area into non-overlapping sub-regions or cells, typically hexagonal in shape. The same set of frequencies can be reused at different locations because of the attenuation of the high frequency radio signals. Each cell is assigned a set of channels which can be re-used again some distance away. The diagram shows a frequency reuse pattern for a grouping of 4 cells.

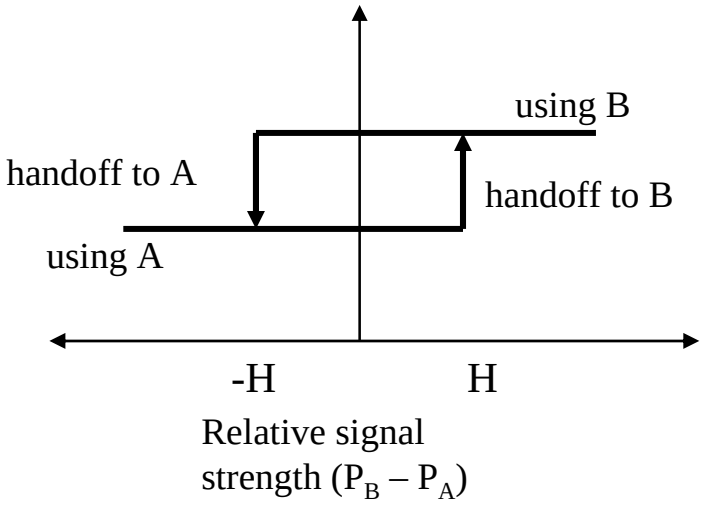
4 marks

(ii) The power control algorithms

These control the transmit power of the UEs so that their signals reach Node B with the strength. Two power control algorithms are used – open loop and closed loop. Open loop is used during initial access and uses the received signal strength to estimate path losses and determine the transmit strength. Once the system is accessed, signal power is measured in each timeslot and a control bit is used to either increase or decrease power. The closed-loop power control commands occurs much more frequently in WCDMA than in GSM (1500 times per second vs. ~2 per second.)

4 marks

(iii) Hand-off algorithms



As the user moves away from one cell into another the call will have to be handed over from one base-station to another. This is initiated by the BS when the received signal strength from the mobile drops below a certain threshold level and is coordinated by the MSC. A hysteresis decision making condition is usually used to prevent the mobile unit from being bounced back and forth between two base stations when the signal strengths reaching them are approximately the same.

4 marks