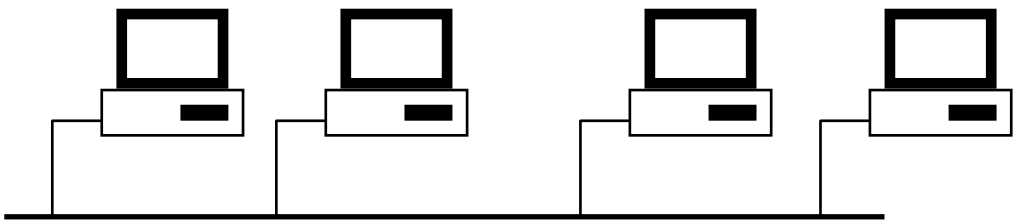
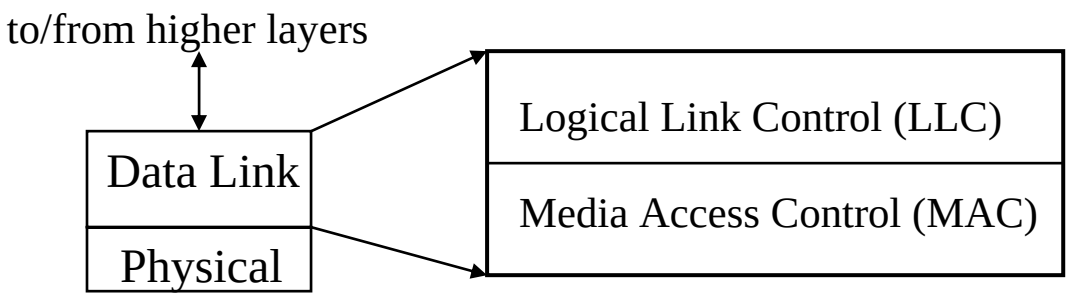
EE4004 Telecommunications Summer 2007
Question 2(a)

Logical connections using a passive bus architecture



Subdivision of the Data Link Layer



The MAC layer implements the basic protocols for sending data on a shared medium (avoiding interference and performing addressing) while the LLC adds error detection and possibly correction.

4 marks

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Question 2(b)

If a node in a CSMA/CD system wants to transmit a message the following sequence of events occur:

1. Listen to the signal on the medium (carrier sense).
2. If there is another node already transmitting then wait until this stops.
3. When the medium is free begin transmitting the frame.
4. While transmitting continue to monitor the medium to determine if another node has started a transmission or has detected a collision.
5. If no collision has occurred continue to transmit the frame and monitor the medium.
6. If a collision has occurred discontinue the transmission and wait a certain time before trying again.

6 marks

Question 2(d)

For proper operation of the CSMA/CD protocol the holding time must be greater than the maximum round trip delay time on the bus. Therefore:

$$H > \frac{2L}{v} \Rightarrow L < \frac{(\text{Holding Time}) \times (\text{Propagation Velocity})}{2}$$

$$\Rightarrow L < \frac{(\text{Frame Length}) \times (\text{Propagation Velocity})}{2 \times (\text{Line Data Rate})}$$

$$\Rightarrow L < \frac{100 \times 8 \times 2.3 \times 10^8}{2 \times 1 \times 10^9} = 92m$$

4 marks

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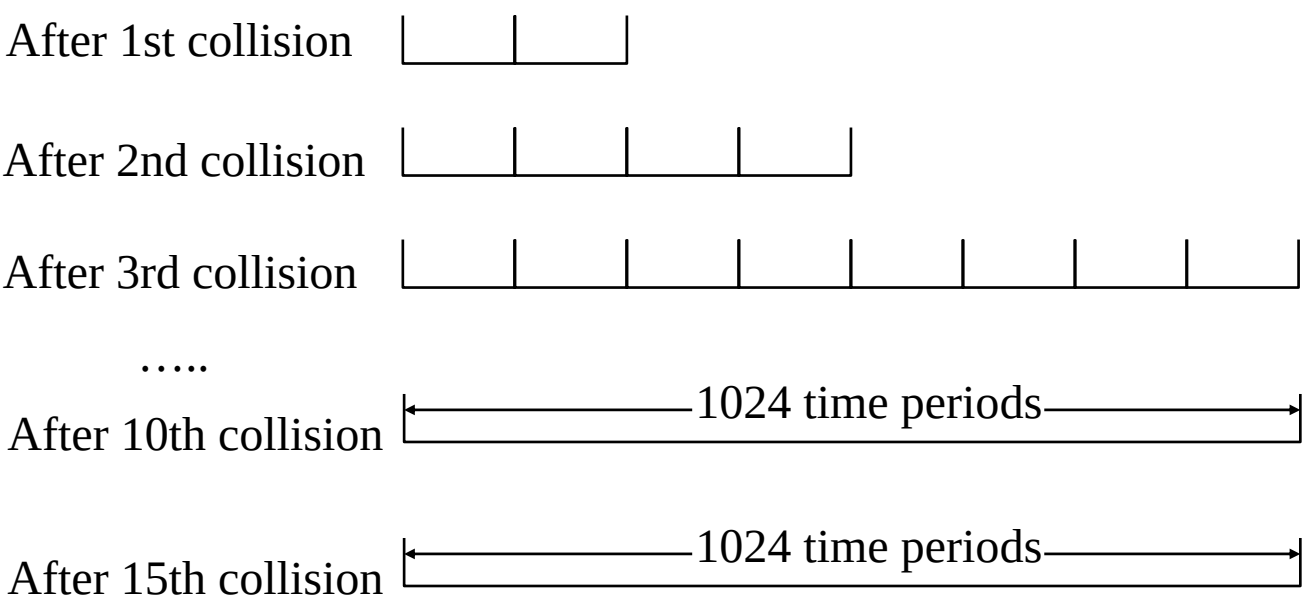
Question 2(c)

Truncated Binary Exponential Back-Off Algorithm

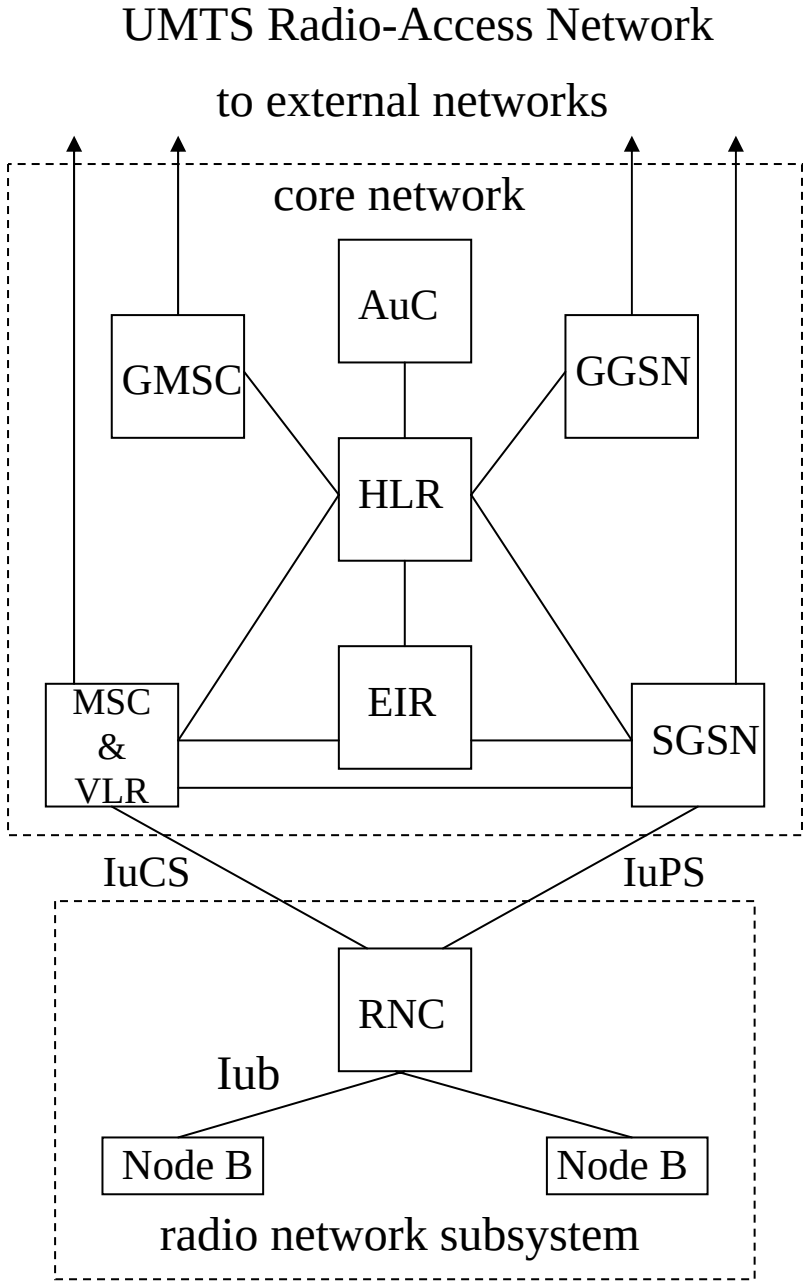
Any node which is transmitting data continuously monitors the bus and compares the data on the bus with the data that it is transmitting. If these do not match then the data is being corrupted by a collision. In this case the node transmits a 4-byte jamming signal to warn the other nodes that an error condition is present. The node then stops transmitting and waits a period of time before trying again.

The first time a collision occurs, the node will wait either zero or one 512-bit periods before trying again - thus there is a 50% chance of a collision occurring again for two nodes competing for access. If a collision occurs again then the node will stop and wait 0,1,2 or 3 512-bit periods before trying again giving a 25% chance of a further collision. After 10 collisions there will be 1024 choices of time-periods to wait. This isn't increased any further and after the 15th attempt the node gives up.



6 marks

EE4004 Telecommunications Summer 2007
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) Frequency Allocation and Downstream Data Rates

The main data rate categories are
(a) 384 kbits/s for regular urban outdoor use
(b) 144 kbits/s for satellite and rural outdoor
(c) 2.048 Mbits/s for indoor and low range outdoor (where supported)

The frequency allocations in Ireland are 1920 to 1980 MHz for the WCDMA downlink and 2110 MHz to 2170 MHz for the WCDMA uplink.

4 marks

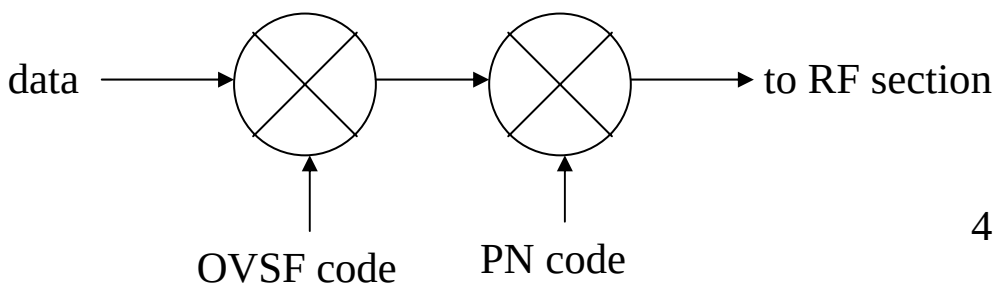
(ii) The power control algorithms

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) Spreading codes

Data to be transmitted is encoded using a spreading code particular to a given user. These codes are orthogonal and known as Orthogonal Variable Spreading Factor (OVSF) codes. The OVSF codes identify the user services in the uplink and the user channels in the downlink. A second stage of scrambling uses a pseudorandom number (PN) and is used to identify the individual Node B or UE.



4 marks