THE BCS PROFESSIONAL EXAMINATION
Diploma

April 2000

EXAMINERS' REPORT

Computer Networks

Of the 163 candidates who sat the examination 84% were successful, the average mark for the paper being 51%. There was an even distribution of attempts across all questions. Question 5 was the most popular question with 138 attempts. The examiner's comments on each question are as follows.

QUESTION ONE

The bookwork in part *a)* was reasonably well done, too well done in many respects, as many candidates were too verbose. Parts *b)* and *c)* were badly answered, generally there were not too many problem-solvers in evidence.

Answer Pointers

a) CSMA/CD
When a host wishes to send a frame, it first listens to the ether to see if it is already being used (Carrier Sense). If it is, the host waits until the current transmission finishes; if not, the host begins transmitting immediately. But since all hosts can transmit at any time (multiple access), it is possible that another host could begin transmitting at exactly the same time, causing both transmissions to become garbled. Analog circuitry in the network interface monitors the ether to see if it conforms with the signal being transmitted (collision detection). Recovering from a collision consists of aborting the current transmission, broadcasting a noise burst to make sure that all the other hosts detect that a collision has occurred, waiting a random length of time and then trying again.
Token passing
On receipt of a valid token, a host may transmit any frames it has waiting for a certain amount of time. It then passes the token to its successor. If a host has no frames waiting when it receives the token, it passes it on immediately.
Deterministic, guarantees access to medium. Supports priority. Efficient at high load.
(7 **Marks)**

b) Any changes in the character impedance of the cable will result in a reflection. What we see here is a sudden increase in the impedance, probably due to a break in the wire. We know it's a break (rather than a short) because of the type of reflection. The distance to the fault can be determined by recognising that the signal has to travel twice the distance before it affects the driver. Some simple maths gives us the round trip distance of 200m, indicating that the fault is 100m in. (**9 Marks)**

c) The frequency response of the channel acts as a filter. At 3000 bps harmonics are generated at 375Hz, 750Hz, 1,500Hz etc. By doubling the fundamental frequency, we are losing one of the higher frequency harmonics. It looks like this is a particularly powerful harmonic. To determine the band width of the channel we will need to know which harmonic is so

significant. From this we can calculate the frequency and thus the bandwidth of the channel.
(**9 Marks)**

QUESTION TWO

Almost all the candidates were able to handle part *a)*, part *b)* was reasonably well done but only a few good answers were presented for part *c)*.

Answer Pointers

a) Application: Network services to support applications
Presentation: Representation of data
Session: Accounting, checkpoints
Transport: Max message length, multiplexing
Network: Routing
Data Link: Framing, error detection/correction
Physical: Media, signals, coding
(**7 Marks)**

b) Bridge
Traffic-isolation repeaters. Operate at ISO Data Link Layer. Conditionally forward packets from one network to another. Use store-and-forward, so longer processing delay than with repeater.

- Transparent Bridge (802.3)
- Source Route Bridge (802.5)
- Combination/mixed media Bridge (connects dissimilar types of LAN)
- Remote Bridge (connects distributed LANs via a point-to-point line)

Router
Operates at ISO Network Layer. Separates LANs into distinct networks, providing a much larger degree of management and traffic isolation. Routers verify and, in many protocols, modify the packets they forward and recalculate checksums. Routers are not end-node transparent. If an end-node needs to send a packet to a node on some other LAN through a router, the packet must be addressed to the router's hardware address. Therefore, end nodes must have some procedure for obtaining that address. **(8 Marks)**

c) Non-Adaptive routing
Fixed (Directory)
Flooding
Random
Adaptive Routing
In virtually all packet-switching networks, some form of adaptive routing strategy is used. I.e. routing decisions change (adapt) as conditions on the network change – node failure, congestion. To achieve this, information must be exchanged between the nodes.
Hot potato
Shortest Path Routing
Local Adaptive
Global Adaptive
Adaptive Neighbours
Even with an adaptive routing protocol, still need to use non-adaptive (e.g. flooding) to initially locate all the nodes on the network. (**10 Marks)**

QUESTION THREE

The marks were weighted 3/5/2 across the three components of part *a).* Apart from the code efficiency question, the Hamming code work in part *b)* was confidently tackled. Despite weighting in favour of the easier material (3/2/2) for the three sections, few candidates got good marks in part *c).*

Answer Pointers

a) i) The transmitter must delay sending the current packet until it has received an acknowledgement of the previous packet before sending the current one.

ii) The window partitions the sequence of packets into three. Those that have been successfully transmitted and acknowledged, those that have been unsuccessfully received and those that have been received but where the acknowledgement has failed. A well-tuned sliding window protocol keeps the network completely saturated with packets. **(10 Marks)**

b) The hamming code check will identify bit 7 as being in error.
Correcting and extracting the 8 data bits (determined by examination) reveals the original message to be 01101101
The code efficiency is 8/12 **(8 Marks)**

c) N bit burst error has at least n good bits either side of it.

Single bit errors are caught if the polynomial has more than one term.
Double bit errors are caught if the polynomial does not have a $X^k - 1$ factor.

All burst errors less than or equal to R will be caught. Probability of missing an R+1 burst error is $(1/2)^{r-1}$ **(7 Marks)**

QUESTION FOUR

The bookwork in *a)* and *b)* was reasonably well done, but a number of candidates were inclined to re-use their answers to *b)* in tackling part *c).*

Answer Pointers

a) Connectionless: Frames may take different routes through the network. The frames may arrive out of order and so the receiver needs to buffer them and reorder. Can be useful if routes breakdown or become congested. Full destination address must be specified and route must be found each time, this can be wasteful.
Connection oriented: Once a route has been established, all subsequent frames follow the same path. Frames will arrive in order, reducing the buffering and processing required at the receiver. The mechanism is sensitive to failure of a node or congestion. The next time the route is established it does not necessarily go the same way. **(8 Marks)**

b) TCP (Transmission Control Protocol) provides a reliable byte-stream transfer service between two endpoints on an Internet. TCP depends on IP to move packets around the network on its behalf. IP is inherently unreliable, so TCP protects against data loss, data corruption, packet re-ordering and data duplication by adding checksums and sequence numbers to transmitted data and, on the receiving side, sending back packets that acknowledge the receipt of data. Before sending data across the network, TCP establishes a

connection with the destination via an exchange of management packets. The connection is destroyed, again via an exchange of management packets, when the application that was using TCP indicates that no more data will be transferred.
UDP (User Datagram Protocol) provides an unreliable packetized data transfer service between endpoints on an Internet. UDP depends on IP to move packets around the network on its behalf. UDP does not guarantee delivery, order and even has the potential for duplicate packets. UDP does guarantee data integrity by adding a checksum. (**9 Marks)**

There is an overhead incurred for the reliability and sequencing that TCP provides. Not all applications require that a datagram arrive in order, or even at all.
A low-probability mishap that causes some data to be lost or corrupted might only cause a 1/10 second error in a displayed image, or a small crackle in the sound. But recovering that data would involve retransmitting it. By the time the retransmitted data arrives it is probably too late to do anything with it in a real-time application like video or sound. In such situations, applications are often better off just continuing with the next frame or soundbyte rather than pausing while informing the remote end that something wrong has occurred and asking it to retransmit. Similarly, an application might implement another way to recover from an error that is more efficient than TCP's timeout-and-retransmit mechanism (such as transmitting an error-correcting code with the data).
One pitfall to using UDP: some designers hear that it has lower overhead than TCP and may struggle to use it in an inappropriate application. This may result in them simply reinventing TCP – probably crudely – now floating on the additional layer of UDP. For many applications, using TCP is likely to allow them to run faster than having to impose reliability and sequencing on top of UDP. (Compare TFTP and FTP). (**8 Marks)**

QUESTION FIVE

Again the terms were pretty well understood in *a)*, but not many candidates knew about routing algorithms. Coverage of encryption algorithms was not satisfactory.

Answer Pointers

a) The terms circuit switching and packet switching differ in the techniques used to transfer data from one link to another between source and destination. Circuit switching implies that a dedicated physical connection is established between two nodes prior to the data transfer. This method is relatively inefficient in the deployment of the available bandwidth. An application area would be associated with real time control systems. Candidates would be expected to describe such a system with which they are familiar.
Packet switching involves the transmission of messages in small packets so as to ensure that total messages can be reconstructed in the event of one or more packets being corrupted due to noise on the circuit. Packets are transmitted as and when a time slot on the network becomes available thus improving the channel utilisation. Advantages include data rate conversion, the ability to handle heavy traffic plus the ability to prioritise packets.
(12 marks)

b) Discussion of two routing algorithms e.g. shortest path in which packets are delivered on a hop by hop basis
Dedicated predetermined paths based on historical traffic analysis
There are a few other techniques which are equally valid in responding to this part of the question. (**13 marks)**

QUESTION SIX

Whilst answers to part *a)* demonstrated understanding, answers to part *b)* needed good competence in written English, something not possessed by quite a number of candidates. Those that had covered data compression were able to gain marks in part *c)*.

Answer Pointers

a) Description and waveform diagrams for the three types of modulation
(**2 marks each)**

b) Definition required i.e. the number of binary signals which can be transmitted in one second for a given bandwidth plus the derivation of a formulae linking Capacity, Bandwidth and Signal to Noise ratio.

C = W Log 2(1+SN) (**10 marks)**

c) Candidates should describe the operation of a data compression algorithm used in the manipulation of graphical images e.g. Modified Huffman encoding, Run length encoding, Delta encoding (**9 marks)**