BCS HIGHER EDUCATION QUALIFICATIONS
BCS Level 5 Diploma in IT

April 2011

EXAMINERS' REPORT

Computer Networks

General Comments

The responses to questions overall were slightly better this year as Section A questions are answered slightly better than those in Section B examinations. The border line pass category was less in numbers, and the number of passes and overall percentage of pass are also slightly better. There were some good answers particularly in Section A.
There were significantly lower numbers of blank answer books returned without any answers in them. But there were answer books with very few questions attempted as these students certainly did not prepare for the examination. A number of candidates did not pick up on various "keywords" in questions. Words such as *describe*, *define*, *explain*, *why*, all require candidates to express their answers in different ways. Some candidates therefore (for example), "described" an item rather than "explaining" how it worked and so on.

The instructions on the examination paper clearly tell candidates to answer section A questions in the section A answer book and section B answers in the section B answer book. A number of candidates did not obey these instructions, and as a result, answers for Section A questions appearing in the wrong answer book, and even in some cases a mix of Section A and Section B answers appearing in the same answer book are noticed.
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Again, it is worth repeating that these students need significantly better preparation based on good understanding of concepts to have realistic chance of good performance. It is also worth saying again that the students are strongly advised to read examiners reports such as this.

Section A

A1. This question is about physical layer transmission systems.

a) A digital transmission system uses a coding scheme that defines a symbol as a voltage that can have one of eight possible values. If the system operates at a transmission rate of 800 symbols per second, determine the data transmission rate measured in:

i) Baud

(2 marks)

ii) Bits per second

(4 marks)

b) A digital transmission system uses *zero bit insertion* (*bit stuffing*) to ensure that the flag sequence 01111110 can never occur within the transmitted data.

By considering the transmission of the following 5 data bytes show how zero bit insertion works.

01011010 11111001 11111010 01111110 01111000

(8 marks)

c) Identify three physical characteristics of fibre optic cable that make it more suitable for high speed digital transmission than copper cables.

(6 marks)

d) Describe what is meant by *wave division multiplexing* (WDM) and explain how it is able to deliver high rate data transmission over a fibre optic cable.

(5 marks)

Answer Pointers

a) 1 mark for Baud = 1 symbol per second, 1 mark for 800 baud, 2 marks for determining each symbol represents 3 bits and 2 marks for 2,400 bits per second.
b) 1 mark for knowing that zero bit insertion means adding logic 0s into the data stream; 1 mark for knowing that this must be done after 5 consecutive logic 1s; 2 marks for noting that a 0 needs to be inserted within byte 2; 2 marks for knowing that a 0 has to be inserted within byte 3 and 2 marks for byte 4.
c) 2 marks for each valid reason.
d) 2 marks for noting that different wavelengths of light are transmitted over the same fibre, 2 marks for noting that each wavelength carries its own data stream and 1 mark for noting that this is how it is able to carry higher data rates.

Examiners' Guidance Notes

This question was attempted by about 72% of the candidates of whom only a small proportion (35%) achieved a pass mark. The average mark was only 11 out of 25. The majority of candidates were familiar with Baud and bits per second. Again, many candidates were familiar with the definition of bit stuffing by the majority could not identify the extra bit added in the third byte. Parts c and d of the question were not correctly attempted by many of the candidates, indicating that the physical characteristics of fibre optic cables and wave division multiplexing were not well understood.

A2. This question is about Asynchronous Transfer Networks (ATM).

a) Show by means of a diagram the cell format used within an Asynchronous Transfer Mode (ATM) network. Clearly show on this diagram how many bits are assigned to each field.

(7 marks)

b) What is the difference between a Virtual Path and a Virtual Channel?

(5 marks)

c) When a connection is established over an ATM network a process called *Connection Admission Control* is used to ensure that the network is able to provide the required quality of service. Within this process, what is meant by a *traffic contract* and explain how a quality of service requirement is specified within a traffic contract.

(5 marks)

d) What is the difference in quality of service offered within an ATM network when using the Available Bit Rate (ABR) and Constant Bit Rate (CBR) services?

(8 marks)

Answer Pointers

a) 1 mark for header/payload main sections, 1 mark for a 5 octet header, 1 mark for 48 octet payload, 1 mark for Virtual Path identified, 1 mark for Virtual Channel identifier, 1 mark for Header Error Control, 1 mark for other fields.
b) 2 marks for the VC, 3 marks for the VP.
c) 2 marks for traffic contract defines the quality of service required, 1 mark for traffic contract defines the type of service and 2 marks for examples of typical traffic characteristic parameters.
d) ABR - 3 marks for allowing nodes to generate ATM cells up to available network capacity, 2 marks for knowing that the network provides feedback to regulate ABR traffic sources; CBR – 2 marks for providing fixed bandwidth with predictable response time, 1 mark for constant peak cell rate.

Examiners' Guidance Notes

This question was attempted by about 56% of the candidates of whom only a small proportion (29%) achieved a pass mark. The average mark was only 11 out of 25, while many of the candidates did not receive any marks at all. There is clear evidence that ATM was not understood by the majority of the candidates.

A3. This question is about protocol layers and the Open Systems Interconnection (OSI) Reference Model.

a) The OSI Reference Model defines seven protocol layers, each of which is responsible for a specific range of functions. By considering this model, explain the main functions performed by a protocol operating at:

i) The Physical layer
ii) The Network layer

iii) The Application layer

(9 marks = 3 x 3 marks)

b) Produce a diagram of the OSI seven layered model that clearly shows how data is transferred through the model's layers and that also illustrates what is meant by the term *peer to peer* protocol.

(10 marks)

c) In a small scale LAN, a computer is connected to a LAN switch, the LAN switch is then connected to a router and the router is connected to a second LAN switch. A server is then connected to this second switch. Determine which layers of the OSI Reference Model are used within:

i) The computer / server
ii) The LAN switches
iii) The router

(6 marks = 3 x 2 marks)

Answer Pointers

a) 3 marks for each layer, 1 mark per key point.
b) 2 marks for correctly identifying the seven layers in the correct order, 4 marks for showing that data travels vertically through the model, 4 marks for showing that a peer to peer protocol operates horizontally between two equivalent protocols layers.
c) 2 marks for each if all layers are correctly identified.

Examiners' Guidance Notes

This question was attempted by almost all the candidates (96%) with the majority (63%) achieving a pass mark and about 14% of them achieving a high grade. Many candidates did not understand the term of peer to peer protocol. Also, a majority of candidates missed a few marks by not identifying correctly all the participating layers within the OSI model used in computer/server and router.

Section B

B4. The question is about the provision of Quality of Service (QoS) within the Internet.

a) Briefly discuss the meaning of the term QoS as it is currently used in the context of traffic being moved within the Internet.

(5 marks)

b) What types of traffic gain benefit from being transmitted using QoS and why?

(5 marks)

c) Give an overall explanation of the differentiated services approach to the provision of QoS.

(15 marks)

Answer Pointers

a) The term QoS refers to the movement of traffic in the network such that some traffic is given different treatment than other traffic and thus experiences improved service (3). It is worth noting that QoS techniques might also be used to give some traffic treatment that is worse than best efforts (2).

b) In general, traffic related to inter-human applications such as videoconferencing (2) and telephony (2) gain benefit from QoS. It is worth noting that it might be appropriate to give some traffic (perhaps very bulky grid data traffic) a QoS worse than best efforts (1).

c) The differentiated services approach is about giving differentiated treatment to classes of traffic rather than to individual flows (3). The differentiated services approach defines a small set of per-hop behaviours (3). Traffic is then marked using a redefined TOS field in IP datagrams with appropriate code point values to match to each of the PHBs (2). This is then implemented by routers having multiple queues associated with each outbound interface (3) and traffic being placed into a particular queue depending on the DSCP present (2). The routers then process and transmit the traffic from the queues using some combination of priority queuing and weight round robin behaviour (2).

Examiners' Guidance Notes

This question was attempted by about 40% of the candidates of whom only a small proportion achieved a pass mark. It seems clear that the role of QoS within the Internet is not well understood. In addition, only a very small number of candidates had any knowledge of the Diff-Serv (differentiated services) approach to QoS, some talked about the (now rarely used) RSVP approach instead.

B5. This question is about the behaviour of routers within the Internet.

a) Briefly explain the difference between the two tasks of packet forwarding, and routing, which are conducted by routers.

(7 marks)

b) Routing within large networks operated by single administrations is often performed using link-state protocols.

i) Explain the general behaviour of link-state protocols.

(6 marks)

ii) Explain how the protocol OSPF has specific features to deal with its use in large networks.

(12 marks)

Answer Pointers

a) Packet forwarding is the task of examining every packet and deciding whether or not to forward it and to which interface (3). This must happen very rapidly. "Routing" is the process of constructing routing tables and will involve exchanging information with other routers and then analysing that data to create the best tables, this activity happens a lot less often than packet forwarding (4).

b) i) Link-state protocols announce the state of their directly connected links (2). The announcements get forwarded onto all routers in a network and thus every router then has full knowledge of the topology of the network and a common link-state database (2). The routers then calculate routing tables to be best from their own standpoint (2).

ii) OSPF operates as noted above. A network using OSPF is split into areas (2), one known as the backbone area (1). Routers with all interfaces within a single area are known as interior routers (2) and they only build full knowledge of that area. Routers with interfaces in multiple areas are known as area border routers (2). The area border routers carry summary knowledge of one area into another (2). A router with connections within this network and at least one connection in a network operated by another administration is known as an autonomous system boundary router and is responsible for transferring knowledge of the reachability of other networks into this network (3). Other relevant issues, such as the use of Designated Routers on multi-access network could also be discussed and marks would be awarded as appropriate.

Examiners' Guidance Notes

This question was attempted by about 56% of the candidates. Only about one quarter of those attempting the question achieved a pass mark. While some candidates gave a very clear answer to part a), others clearly do not understand the difference between the two tasks. For part b) i), some candidates gave clear answers, but others instead described distance vector protocols, or worse, presented an answer that was a confused combination of facts related to link-state and distance vector protocols. For part b) ii), a number of candidates gave very good, complete and comprehensive answers. Other answers were much less complete.

B6. Imagine you have been appointed to design the network to be deployed in two new buildings. The main building contains a dedicated computer room containing 10 high performance dedicated servers. The main building also contains a large coffee room and lounge area. The furniture in the coffee room/lounge is not fixed and is often moved around. A small secondary building contains an office where 12 workers use low performance desktop computers located on fixed desks. The two buildings are about 30 metres apart.

a) What type of network should be deployed in the dedicated computer room and what equipment should be installed?

(6 marks)

b) What type of network should be deployed in the coffee room/lounge and what equipment should be installed?

(6 marks)

c) What type of network should be deployed in the secondary building's office and what equipment should be installed?

(6 marks)

d) What type of network connections should be used between the rooms in the main building and what technology should be used to link from the main building to the secondary building?

(7 marks)

Answer Pointers

a) This should clearly have gigabit Ethernet (perhaps 10gigabit) installed (2). Copper cabling is probably appropriate, but fibre could also be proposed (2). It is clear that an appropriately sized switch should be installed (2).

b) This is clearly a location where a wireless LAN is appropriate (2) and it is clear that laptops and small mobile devices will be being used and these will need some form of wireless interface/adapter attached if they do not have built-in wireless capability (1). In terms of network, a wireless access point is required (2). Security is clearly a very important issue in wireless networks and some mention should thus be made about not deploying completely open wireless networks (1). Candidates may note the "large" remark and propose multiple access points. Candidates may mention the range to wireless standards that are available and the data rates they deliver. Any such extra material will have marks awarded as appropriate up to the maximum available for this part of the question.

c) This section clearly says "low performance" and "fixed desks". We would thus expect candidates to propose a cabled network, probably100Mbit/sec Ethernet but perhaps even 10 Mb/s (3). For equipment, again an Ethernet switch should be installed (3).

d) Inside the building, cabled Ethernet, probably gigabit, is clearly appropriate (3). Candidates may observe though that most wireless networks only operate up to around 104Mb/s and thus the link to the coffee room/lounge could perhaps be just 100Mb/s with no detriment. Between the main and secondary building, a fibre connection seems most appropriate. It is now accepted as general good practice that one does not normally run metallic network cabling between buildings (3). They could argue for 100Mb/s or 1000Mb/s (i.e. 1Gb/s) as the link to the second building (1).

Examiners' Guidance Notes

This question was the most popular question in section B, being attempted by about 76% of candidates. It was also the best answered question in section B with 56% of those attempting it achieving a pass mark. Part a) was generally answered fairly well. Some candidates proposed the provision of an Internet connection into the main server room and in some cases the deployment of a router. Such reasonable contributions were awarded appropriate remarks. However, several candidates proposed the installation of ADSL. ADSL is really NOT appropriate in such a circumstance. ADSL provides an "asymmetric" connection and is really appropriate for the Internet connection of individual, or very small groups. While it provides a high (in individual user terms) data rate from the Internet towards the customer, it provides a MUCH lower data rate in the direction from the customer to the Internet. For part b), almost all candidates proposed a wireless network. However, some

candidates proposed a solution they called a "WAN". That abbreviation is, almost always, used as an abbreviation for "wide area network", which is clearly not the correct solution. The abbreviation "WLAN" is more correct for "wireless local area network". Candidates should be very careful when they use abbreviations/acronyms, and are best advised to use the full name expansion as well. Many candidates failed to note the importance of considering security mechanisms if WLANs are being deployed. For part c), most answers were quite reasonable. For part d), candidates should note that it is now normally considered good practice to use fibre for data connections between buildings when LANs are being installed. Indeed, it is now very common practice to use fibre for longer connections within buildings too. Some candidates also falsely stated that fibre was still "very expensive". This is really not now true and indeed, fibre interfaces to switches and routers are now also very cheap from many manufacturers.