

BCS HIGHER EDUCATION QUALIFICATIONS

BCS Level 5 Diploma in IT

October 2011

EXAMINERS' REPORT

Computer Networks

General Comments

The performance overall is similar to April 2011 sitting, and as has been stressed before, students will benefit by reading examiners' reports such as this. There is no short cut to good performance except serious preparation working through the recommended texts, and looking at the past examination papers as guidance.

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. However, a number of candidates did not follow these instructions, answering questions in the wrong answer books thus causing inconvenience to orderly marking. 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. Candidates were expected to answer any four questions from the two sections. However, eight per cent of the candidates attempted more than four questions.

Candidates are strongly recommended to familiarise themselves ahead the keywords as explained by looking through past examination papers. No advantage is gained by answering more than 4 questions. On the other hand in doing so, precious time is lost in not focusing on answering the required 4 questions.

Section A

A1. This question is about broadband Internet access.

- a. Many people now access the Internet from home using a broadband connection. The most common form of broadband connection is that based upon the Asymmetrical Digital Subscriber Line (ADSL) technology. How does ADSL ensure that both data and telephone calls can be carried over the same twisted pair cable which connects a house to a local exchange?

(8 marks)

- b. Imagine that you are browsing the web using a laptop computer at home which is connected to the Internet via a WiFi network in your house and

an ADSL router connection to the Internet. When accessing a website you feel that the response of the site is very slow. By considering the whole network from your laptop to the server that is hosting the website you are accessing, explain how the following may be contributing to the problem:

- i. your laptop and local WiFi network
- ii. the ADSL network
- iii. the Internet
- iv. the website you are accessing

(Marks = 4 x 3 marks)

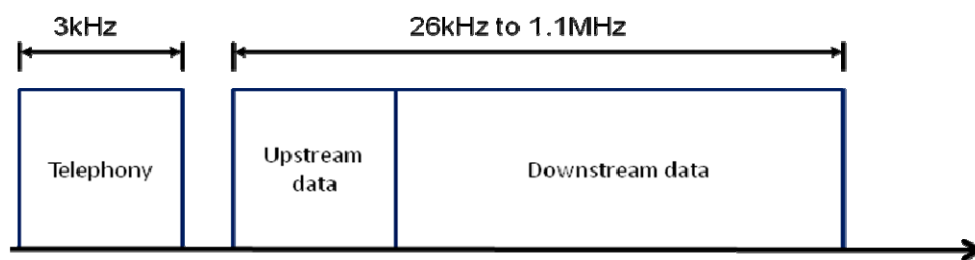
- c. Many countries are now upgrading broadband access networks to offer customers high speed Internet access. One such technology is called fibre to the cabinet (FTTC). Briefly explain how this technology differs from ADSL and hence, is able to offer higher bandwidths than ADSL.

(5 marks)

Answer Pointers

a)

ADSL delivers data and telephony over the same twisted pair by using higher frequencies for the data services. Telephony occupies the first 3kHz of a line's bandwidth and ADSL uses frequencies in the range 26kHz to 1.1MHz for data. This bandwidth is then divided into 256 channels, each of 4.3kHz and within these 256 channels, adaptive coding is used (QPSK, QAM) to encode up to 64 kbps per channel. However, within the data frequency bands, a different capacity is provided for upstream and downstream communications hence, the term asymmetric. Within a home it is important to keep data and telephony separate which requires the installation of micro-filters to achieve this.



(Marking scheme: 2 marks for telephony being within 3kHz band; 2 marks for ADSL using higher frequencies for data; 2 marks for recognising that upstream and downstream are given different data rates; 1 mark for appreciating that adaptive coding is used and 1 mark for the need to local micro-filters)

Answer Pointers

b)

(i)

Problems could arise because of the speed/performance of your laptop, the number of simultaneous software applications that are running on the laptop, the capacity of your WiFi network and the number of other devices that are presently connected to your WiFi network

(Marking schemes: key points are laptop capacity (1), number of software applications running (1), WiFi users (1))

(ii)

The capacity of your ADSL network might be restricted because of the quality of the copper wire connecting your home or the distance of your home from the local exchange. In addition, domestic ADSL services are based on a contention ratio which means that capacity is shared amongst homes attached to the same exchange. Therefore, if several people are using the ADSL network, capacity will be reduced.

(Marking scheme: key points are capacity of ADSL network based on distance from exchange (1) and contention ratio (2))

(iii)

The Internet is a global network that offers a best effort service. Therefore, congestion can occur on the Internet when traffic levels are high. If accessing the website you are viewing requires data to be routed through a congested area then delays will be experienced which in turn, could lead to a poor response rate from the site.

(Marking scheme: key points are best effort service (1), traffic congestion (1), delays caused by data passing through congested areas (1))

(iv)

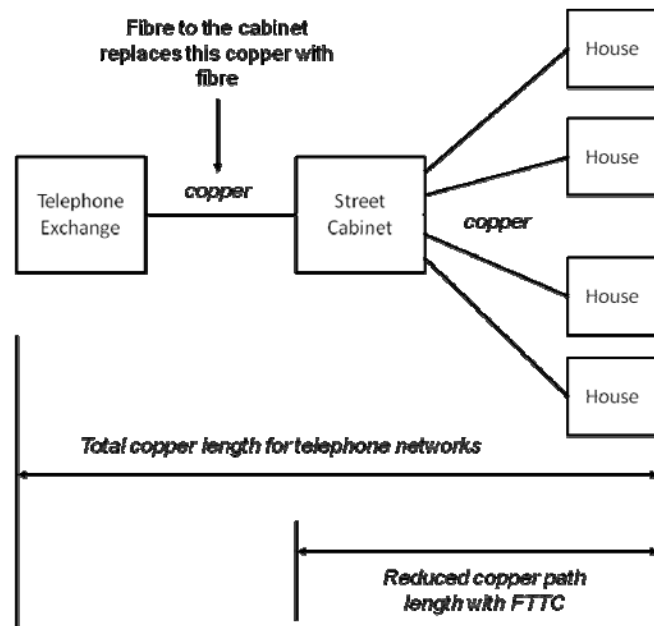
The performance of the website and the server on which it is hosted might also be a problem if for example, the server is unable to handle a large number of simultaneous users because of storage or performance limitations. Equally, the design of the site's code itself might lead to performance problems if it has not been optimised.

(Marking scheme: key points are server performance (1), in ability to handle volume of users (1), general efficiency of the site design (1))

Answer Pointers

c)

Existing telephony networks provide copper cable from the exchange to the roadside cabinet and then onwards from there to each home. The copper path is therefore from the home to the exchange. There are two key problems which limit bandwidth, the length of the copper path and cross-talk caused from the interference from each copper pair when placed in close proximity to each other. Fibre to the cabinet replaces the copper path from the exchange to the cabinet but leaves the copper from the cabinet to homes. However, this does mean that higher capacity data can be delivered to the cabinet and since the copper path has been reduced, increased capacity can also be achieved over the remaining copper from the cabinet to the home.



(Marking scheme: 1 mark for knowing that the copper path extends from the exchange to the home; 1 mark for understanding the performance limits of this; 1 mark for knowing that fibre will replace copper from the exchange to the cabinet; 2 marks for performance improvement due to reduced copper path length and higher capacity to cabinet through fibre)

Examiners' Guidance Notes

This question was attempted by 83% of the candidates of whom only a small number (23%) achieved a pass mark. Although it was the second most answered question of the exam, most of the candidates were familiar with the definition of ADSL but they failed to explain how ADSL delivers both data and telephony over the same medium. Some candidates mentioned the importance of using micro-filters but again they didn't explain the reasons. The responses about FTTC were very weak indicating that the candidates lacked of any knowledge about this topic.

A2. This question is about virtual circuits and TCP/UDP.

- What is meant by the term *virtual circuit*?
(2 marks)
- What is the difference between a *connection orientated* and a *connectionless protocol*?
(8 marks)
- Explain how a connection orientated virtual circuit is established by the Transmission Control Protocol (TCP).
(9 marks)
- In contrast to TCP, the User Datagram Protocol (UDP) is a connectionless data transfer protocol. What function is provided by port numbers within a UDP protocol datagram?
(5 marks)

Answer Pointers

a)

A virtual circuit is a means of establishing a connection between two points on a packet switched network. It is virtual in the sense that it appears as though there is a dedicated link between these two points.

(Marking scheme: 1 mark for it being a connection and 1 mark for the appearance of a dedicated link)

Answer Pointers

b)

A connection orientated protocol has an initial phase in which a virtual circuit is established between communicating devices before any data is transferred between them. Similarly once all data has been transferred, the connection is formally closed with another protocol exchange. Data transferred by a connection orientated protocol is also normally acknowledged with its rate of transfer being managed with a flow control process.

A connectionless protocol, in contrast, simply packages data ready for transmission and sends it to the destination without first establishing a connection. Data transferred is also not acknowledged thereby removing any guarantee of delivery.

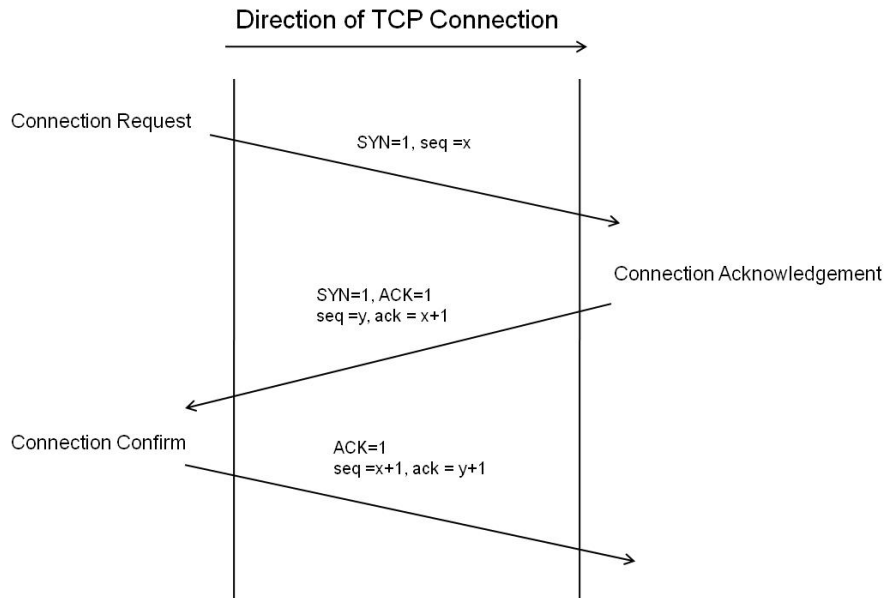
(marking scheme: 2 for connection establishment, 2 marks for connection termination; 1 mark for acknowledgement; 2 marks for data being sent without any connection; 1 mark for unreliable.)

Answer Pointers

c)

A TCP connection is uni-directional which means that for two way communications, a connection must be established from the user to the server and separately from the server to the user. Each process does however, follow the same three way handshake procedure.

The user will issue a TCP segment with the SYN flag set and the sequence number equal to some initial value – say x . The server – if it wants to accept the connection request – will return a TCP segment with both the SYN and ACK flags set. It will also choose a sequence number starting value – say y . The acknowledgement field of this segment will be set to $x+1$ to acknowledge receipt of the connection request segment. When the user receives this response it will issue one further TCP segment with the ACK field set. The acknowledgement in this segment will be $y+1$ and the sequence number will be $x+1$



(Marking scheme: 2 marks for a need for two uni-directional connections; 3 marks for the connection request (SYN=1); 3 marks for the connection acknowledgement (SYN=ACK=1) and 2 marks for the connection confirm.)

Answer Pointers

c)

Port numbers are 16 bits in length and each UDP datagram contains a destination and source port. They are used to differentiate the higher layer protocols which are using the services provided by UDP. Each port number identifies the particular higher layer protocol to which a given data stream belongs. Hence, through the use of port numbers, several higher layer protocols can be multiplexed over the same UDP data stream.

(Marking scheme: 1 mark for 16 bits in length; 2 marks for source and destination port included and 2 marks for identifying higher layer protocols)

Examiners' Guidance Notes

Question 2 was the most answered question of the exam and was attempted by 207 (91%) candidates of whom a little over half of them (56%) achieved a pass mark. It was clear that virtual circuit was well understood by the candidates. The candidates gave clear responses describing the difference between connection orientated and connection-less protocol. But there was some confusion in the responses in parts 2.c and 2.d. Many candidates didn't understand UDP. Overall, this question overall attracted good responses.

3. This question is about global network services.

- a. International companies require a global data communications network to interconnect IT systems in their offices around the world. This in turn,

requires data links between sites and ideally, these links should provide a guaranteed bandwidth. What are the problems with using the Internet to provide such connectivity?

(6 marks)

- b. Many global telecommunication companies now provide data connections using multiprotocol label switching (MPLS) technology. Briefly describe the basic principles of MPLS and explain the advantages it offers over using the Internet.**

(12 marks)

- c. Organisations who manage their own global data network wish to ensure that data being transmitted over the network is secure. Explain how a Virtual Private Network (VPN) could provide secure communications.**

(7 marks)

Answer Pointers

a)

Problems with the Internet which would not make it a suitable choice for providing these links are:

- The Internet is a best effort service which means that there is no guarantee that data will be delivered and if it is delivered, there is no way of predicting how long it will take.
- No prioritisation – all traffic types handled equally which means that you cannot differentiate time critical applications from non time critical ones.
- There is no inherent security which means that data can be read by others.
- The volume of traffic on the Internet cannot be predicted which means that the bandwidth being delivered for a service cannot be predicted either.

(Marking scheme: 2 marks for each of the following valid reasons – no delivery guarantee, no traffic differentiation, no security and no bandwidth guarantee - up to a maximum of 6.)

Answer Pointers

b)

An MPLS network comprises a series of 'label' switching routers. When traffic arrives at the first switch of an MPLS network (Label Edge Router), a connection is established through the MPLS network using the resource reservation protocol (RSVP). Using RSVP ensures that all routers along the connection path are able to support the quality of service required by the connection. In this way, different grades of service can be offered to different traffic types. Only if the quality of service required by a data flow can be guaranteed along the full length of the connection will it be accepted.

All intermediate routers are termed label switching routers. Once the connection is established, it will be assigned a 'label' which is typically a 32 bit number. Information about which label identifiers have been assigned to which data flow is exchanged between routers using a Label Distribution Protocol. All data belonging to a particular connection is formatted

into a packet with the label identifier added. Each label switching router then routes this data based on its label only. On reaching the far end of the connection, the final or egress router, removes the label.

The advantage of MPLS over the Internet is that MPLS is able to guarantee a given quality of service and ensure that services can be differentiated to prioritise, for example, time critical applications like voice.

(Marking scheme: 2 marks for identifying Label Edge and Label Switching Routers, 2 marks for the use of RSVP in the connection establishment phase, 2 marks for noting that services can be differentiated through the quality of service provided, 2 marks for the assignment of the label to identify the connection, 2 marks for the exchange of label information using the label distribution protocol and 2 marks for comparing MPLS with the Internet)

Answer Pointers

c)

A Virtual Private Network is a means of providing a private network connection over an open or public network. This is achieved through the establishment of virtual circuits or 'tunnels' through the public network. In effect the VPN encapsulates a user's data within a large packet structure; the header of which provides identification. Networks which support VPNs can then use this VPN header to route the packets.

A VPN is established over an existing virtual circuit through a security protocol such as IPsec. In this way data is encrypted as it passes over the virtual circuit with only the two end routers knowing the encryption keys.

(Marking scheme: 2 marks for providing VPN providing a private connection through a public network, 2 marks for VPN packet encapsulation, 2 marks for the use of a shared security protocol between end points, 1 mark for data encryption.)

Examiners' Guidance Notes

This question was the least popular in section A but still was attempted by 67% of the candidates. However, 60% of these candidates achieved a pass mark which was the highest pass mark in both sections A and B. The candidates provided good responses for part 3.a showing a good level of understanding. But the responses for part 3.b were not very good, indicating that the majority of candidates did not grasp an understanding for MPLS. Responses for part 3.c were varied. Some candidates provided very good responses while others didn't.

Section B

B4. This question is about error control in communications systems.

- a. **Explain the circumstances under which the use of parity bits is appropriate for error control.**

(3 marks)

- b. Explain how the combination of longitudinal parity and horizontal parity can be used as an error correction technique in some circumstances. (7 marks)
- c. Outline how the CRC method functions. (12 marks)
- d. Under what circumstances is the use of cyclic redundancy counts (CRC) an appropriate error control technique? (3 marks)

Answer Pointers

a)

Parity bit usage is most appropriate in situations where only isolated bit errors are expected (3).

b)

The candidates will explain what they mean by horizontal and vertical parity (2) and then produce the standard example whereby a small block of characters is transmitted with a parity bit per character (1) and then a parity bit per column of bits (1) and will then explain how, assuming only a single bit is in error, then that can be located and corrected (3).

c)

CRC operates by adding error control to sequences of data (3). The original data is essentially divided by a pre-agreed divisor (3) and the remainder created is then added on to the end of the data transmitted (3). The receiver then divides by the same divisor and if all is o.k. there should then be no remainder (3). There are alternative ways to describe this and all will be awarded marks as appropriate.

d)

CRC is appropriate if burst errors are expected (3).

Examiners' Guidance Notes

This question was attempted by about 47% of the candidates of whom about proportion 40% achieved a pass mark. The average mark was only 11 out of 25.

Some candidates gave a very good answer to part d) but a large number did not.

B5. This question is concerned with multicast IP.

- e. Briefly discuss the meaning of the term *multicast transmission* and how this differs from both unicast and broadcast transmission. (9 marks)
- f. What types of application gain benefit from using multicast as opposed to unicast transmission? (6 marks)

- g. Explain the way that the protocol Internet Group Management Protocol (IGMP) is used within a LAN to control multicast traffic. Discuss the difference in features between IGMPv1, IGMPv2 and IGMPv3 as part of your answer.**

(10 marks)

Answer Pointers

a)

Unicast is the transmission from one source to a single destination (3), broadcast is from one source to all destinations (3), multicast is the transmission from a single source (or perhaps several) to a set of destinations (which could be anywhere on the multicast-enabled internet) that have indicated that they wish to receive the multicast address specified (3).

b)

Multicast transmission can be very useful for some types of multi-site video conference (3); it is also useful to support transmission from “TV studios” to large sets of receivers or similar (3). Another good example of an application is a disk duplication utility which needs to clone the disks of a set of computers (3). All other relevant suggestions rewarded appropriately with the final mark capped to 6.

c)

IGMPv1 contains messages to allow potential receivers to express their interest in traffic (2) and allows routers to query such receivers (2). IGMPv2 introduced several updates, in particular, the existence of LEAVE messages (2) and also the use of multicast for message transmission (2). IGMPv3 introduces support for source specific multicast (2) and removes some earlier use of report suppression (2). Final mark capped to 10.

Examiners' Guidance Notes

This question was attempted by about 53% of the candidates of whom only a very small proportion (15%) achieved a pass mark.

Multicast IP plays an important role for many applications. Only a small number of candidates had full and complete knowledge of this topic. Some candidates seemed to falsely describe IP multicast as taking at a level that was not the IP level. Some candidates did not realise that Access Points do NOT have to include a router capability. Many candidates appeared to be (falsely) that the term MAC only referred to a single aspect of medium access control, namely that of a MAC address. Candidates should be aware that the MAC layer contains a lot more functionality as indicated in the answer pointers given above.

B6. This question is about wireless LANs using the IEEE 802.11 family of standards.

- a. Briefly explain the meaning of each of the technical terms**
- i. Access Point**
 - ii. Basic Service Set**
 - iii. Coordination Function**

(3 marks each, 9 in total)

- b. Explain the role of the Request to Send (RTS) and Clear to Send (CTS) frames within an 802.11 WLAN.**

(6 marks)

- c. WLANs can have higher bit error rates than wired networks.**
- i. Explain why this can be true?**
 - ii. Explain what the MAC does to frames to help reduce this problem.**

(5 marks each, 10 in total)

Answer Pointers

a)

An access point is an entity with station functionality but which also acts as the centre point in a deployed WLAN (3).

The term Basic Service Set (BSS) refers a single set of stations operating in a group and sharing a single coordination function (3). The area covered by a single BSS is called the Basic Service Area or BSA.

The term coordination function refers to the function that determines when each station in a BSS may be allowed to transmit (3).

b)

RTS and CTS are used to request access to the transmission channel (2) and then confirm that access (2) and area used to assist with reliable data delivery (2). The exchange is normally between an end station and an access point.

c)

The higher data rate is an inevitable result of wireless transmission (1). In particular the frequencies used by WLANs are the same as those being used for other purposes such as microwave ovens! (2) Also, wireless LAN layout can lead to hidden nodes causing interference as they falsely believe that the medium may be free (2).

The key thing done is that at the MAC level, WLANs fragment any large data frames into multiple smaller frames (3). Acknowledgements and retransmissions at the wireless level can also help to recover from problems (2).

Examiners' Guidance Notes

This question was attempted by about 57% of the candidates of whom only a very small proportion (16%) achieved a pass mark.

Many candidates confused the use of the acronym WAN, which normally means “wide area network” with WLAN, more normally used for Wireless Local Area Network. This meant it was hard to assess the true quality of some candidates’ answers. If candidates use technical terms or acronyms they should be very confident they are using the term correctly.

Some candidates falsely claimed that wireless LANs have higher bit rates than cabled networks. This is false; our fastest current WLANs go to a few hundred mbps whereas

some cabled networks can move data at several giga bits per second. Some candidates also falsely claim that wireless networks have more connected computers than cabled networks, this again is generally false.