BCS THE CHARTERED INSTITUTE FOR IT
BCS HIGHER EDUCATION QUALIFICATIONS
BCS Level 5 Diploma in IT
MARCH 2014

EXAMINERS' REPORT
Computer Networks

General Comments

This session is again like the April 2013 session in terms of performance which is characterised by the declining percentage of pass. Except in one centre, where the performance is above this average, candidates sitting in the rest of the centres turned out a relatively poor overall performance which is attributed to poor responses to questions in both sections, indicative of poor preparation, and attention not paid to examiners' reports. . It is worth repeating this message again this year too that candidates need significantly better preparation based on good understanding of concepts to have a realistic chance of passing the paper, or getting better marks. The examiners' reports such as this which are available for 3 years of past sessions will help in examination preparation process for this paper. Good preparation hence, includes studying the topics well, understanding the basic concepts well, and reading examiners' reports like this so that a student knows what is expected of him/her.

.

Again this year too, it is worth saying that candidates still are not reading the questions carefully and well, which leads to poor understanding of what is expected as answers to those questions. There were a good number of borderline cases in this session.

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 1,000 symbols per second, determine the data transmission rate measured in:

   i. Baud

   (2 marks)

   ii. Bits per second

   (4 marks)

b) Wide Area Network (WAN) encapsulation protocols are used when connecting a router to an externally provided WAN service. These protocols are based on the High Level Data Link Control (HDLC) in which each message starts and ends with the unique flag sequence of 01111110. In order to prevent this flag sequence from occurring at other parts of the message, a process known as zero bit insertion, or bit stuffing is used. By considering the transmission of the following 5 message data bytes show how zero bit insertion is used when transmitting this message.

01111010 11111001 11111010 01111110 01101100

(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.

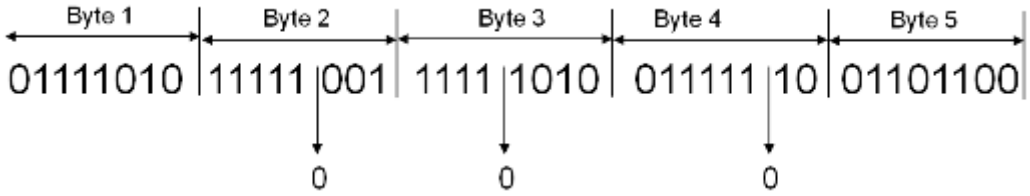
(5 marks)

Answer Pointers

a.
i. Baud is defined as the number of symbols per second. Therefore if the system transmits at 1000 symbols per second then the data rate is also 1000 baud.
(Marking scheme: 1 mark for Baud = 1 symbol per second, 1 mark for 1000 baud)

ii. A symbol is a voltage level that can have one of 8 possible values. Eight levels can be represented by 3 bits. Therefore one symbol represents 3 data bits.
If each symbol represents 3 bits then the transmission rate in bits per second will be 1000 x 3 = 3000 bits per second.
(Marking scheme: 2 marks for determining each symbol represents 2 bits and 2 marks for 30000 bits per second)

b.



With zero bit insertion, when five consecutive 1s are detected then an additional zero bit is inserted in the data stream as shown above. Note that the transmitted bytes must be considered as a continuous data stream.
(Marking scheme: 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 as shown above.)

c.
The key advantages are:

- Low signal loss thereby allowing long distance links between amplifiers/repeaters.
- The use of light for signalling as opposed to electrical signals, allows for higher bandwidth and hence, higher data carrying capacity.
- Fibre optic cables do not suffer from cross-talk interference when more than one fibre is placed alongside each other.
- Fibre optic cable is not subject to electromagnetic interference arising from nearby electrical equipment.

(Marking scheme: 2 marks for a valid reason taken from the above list)

d.
Wave division multiplexing (WDM) is a technique used in fibre optics in which different wavelengths of light are transmitted along the same fibre. Each wavelength carries its own data stream. In this way multiple data streams are ‘multiplexed’ over the same fibre hence greatly increasing its data carrying capacity.
(Marking scheme: 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
Question 1 was the second most popular question in section A of the paper. It was attempted by 134 candidates. A relatively easy question to answer, however the average mark was about 10 out of 25 and a pass mark of 47%. Part A was correctly answered by the majority of the candidates. Part B about zero bit insertion was not well answered by most of the candidates, indicating that the topic was not well understood or studied. Part C was attempted well by the majority of the candidates. Responses to part D varied indicating again some confusion or not correct understanding of the question by the candidates.

A2. This question is about protocol layers and the 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 Data Link layer

iii. The Application layer

(9 marks = 3 x 3 marks)

b. Figure 1 shows a small scale network comprising a computer, switch, router and server. Examine this network and determine the following:

i. which layers of the OSI Reference Model are used within the router

ii. which layers of the OSI reference Model are used within the switch

iii. which devices will use all seven layers of the OSI Reference Model

iv. which devices will use layer 4 of the ISO Reference Model

(9 Marks)

c. Referring again to Figure 1. By considering either the computer or server, produce a diagram of the OSI Reference Model that clearly shows how data is transferred through the model's layers.

(7 Marks)

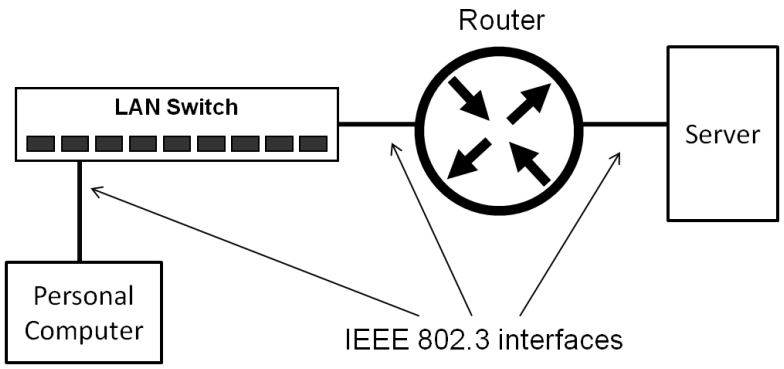


Figure 1

Answer Pointers

a.

i. Defines the electrical interface to a transmission medium
The physical properties of the transmission medium
The process by which digital data is represented on the transmission medium (coding)
(Marking scheme: 1 mark per point identified)

ii. The Data-Link layer is responsible for:
Organising the data bits into logical and defined structures known as frames. These frames can carry network dependent addressing for point to point communications on a single network, error detection fields for identifying the presence of bit errors, length and control information and data bytes which convey information from the higher layers.
This layer would also define the access protocols needed to transmit data over the attached media and protocols to achieve the reliable transmission of information between two points.
(Marking scheme: 1 mark for creation of frames, 1 mark for local addressing, 1 mark for error detection; 1 marks for media access method up to a maximum of 3)

iii. This layer interfaces with the 'user' of the communication service
This layer interacts with software applications that require a communication service
Application layer protocols are concerned with determining resource availability and synchronising communications between the user and communications service.
(Marking scheme: 1 mark per point identified)

b.

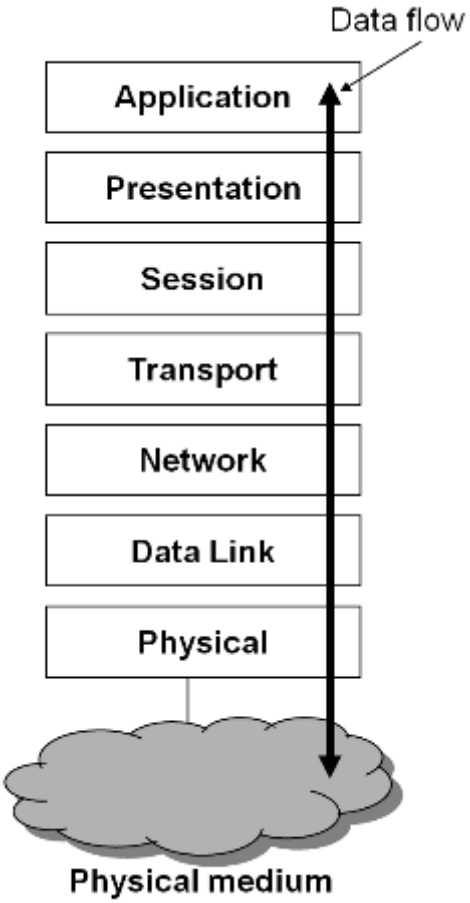
i. Physical, Data Link and Network
(Marking scheme: 1 mark for each correctly identified layer)

ii. Physical and Data Link
(Marking scheme: 1 mark for each correctly identified layer)

iii. Personal Computer and Server
(Marking scheme: 1 mark for each device)

iv. Personal Computer and Server
(Marking scheme: 1 mark for each device)

c.



(Marking scheme: 2 marks for correctly identifying the first four layers in the correct order, 3 marks for correctly identifying the top three layers in the correct order, 2 marks for showing that data travels vertically through the model)

Examiners' Guidance Notes

Question two was attempted by the majority of the candidates (155) and was correctly answered by a high majority of 92% (144)! The average mark was 16 out of 25. This indicates that candidates from all centres were well prepared for this question. It must be pointed out that a similar question that was in April 2012 paper, was poorly answered, the average mark then was 9 out of 25. Candidates showed a very good understanding of the OSI reference model. Most of the marks were lost for incorrectly answering part B.

A3. Asynchronous Transfer Mode (ATM) has seen widespread adoption within the Universal Mobile Telecommunication System, 3rd generation mobile phone networks. This question is about the features and operation of ATM.

a. Show by means of a diagram, the cell format using within an ATM network.

(5 marks)

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

(5 marks)

c. Explain the purpose and function of the ATM Adaptation Layer (AAL) protocol.

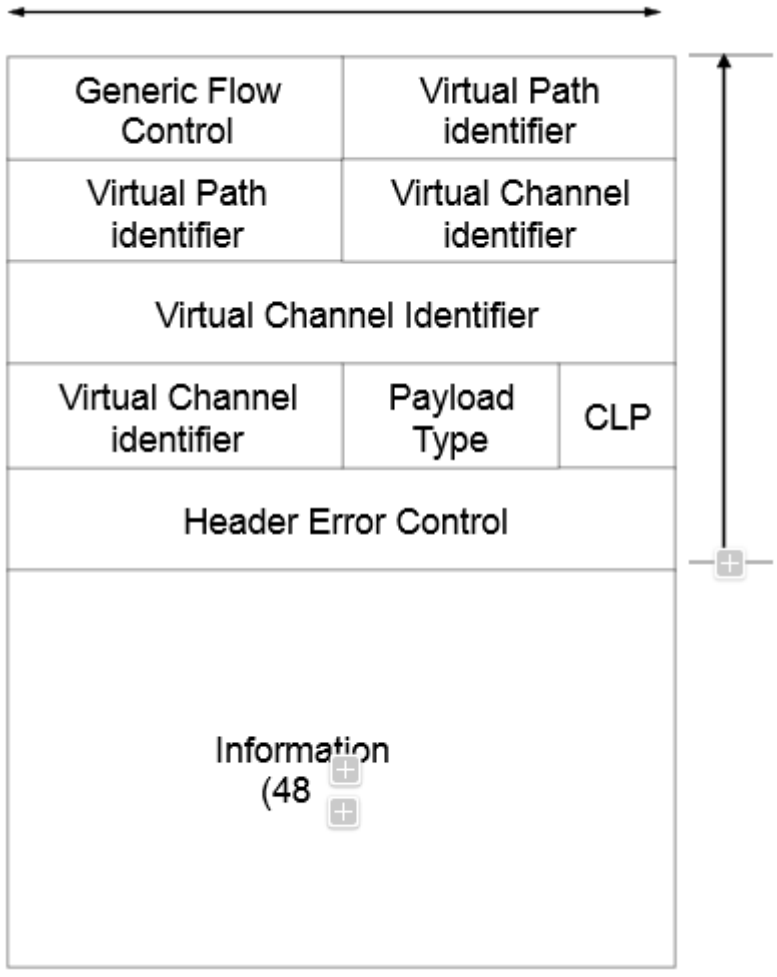
(9 marks)

d. A UMTS, 3rd generation mobile network, uses AAL2 for the circuit switched voice traffic and AAL5 for the transmission of data. Why are these two different AAL protocols needed?

(6 marks)

Answer Pointers

a.



(Marking scheme: 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)

b.
A virtual channel defines a single point to point connection, identified by its virtual channel identifier (VCI).
A virtual path however, is a bundle of virtual channels that share the same end-point. Hence, a virtual path can be considered as a container that contains several virtual channels. Each virtual path is identified by its unique virtual path identifier (VPI).
(Marking scheme: 2 marks for the VC, 3 marks for the VP)

c.
The ATM Adaptation Layer (AAL) protocol:
The AAL protocol exists only within the end stations and is not present within ATM switches.
The AAL protocol accepts data from higher layer protocols and mapping them onto 53 octet cells
Receiving ATM cells and combining these into data structures that are acceptable to the higher layer protocol
Providing the quality of service required by the connection by managing the flow of AM cells which includes transmission rate, guaranteed delivery time etc.
(Marking scheme: 2 marks for location of AAL, 2 marks for mapping higher layer protocol data into 53 octet cells, 2 marks for receiving ATM cells and converting back into higher layer protocol data, 3 marks for providing QoS)

d.
Voice transmission is a time critical service in that digital voice samples have to be transmitted through the network within a maximum time limit. AAL2 is therefore optimised as a variable bit rate, connection orientated, low latency service.

(Marking scheme: 1 for voice being time critical, 1 mark for needing to transmit voice samples within a maximum time, 1 mark for general features of AAL2)

Data transmission on the other hand is less time critical, the key requirement being to map large IP datagrams into a sequence of ATM cells. AAL5 is therefore optimised to send variable length data packets as a sequence of ATM cells. The final cell in the sequence provides information about the size and structure of the larger higher layer datagram contained within the ATM cell sequence.

(Marking scheme: 1 mark for data not being time critical, 1 mark for the key requirement being to convert higher layer large data packets into a sequence of ATM cells, 1 mark for general features of AAL5)

Examiners' Guidance Notes
The last question in section A was poorly answered. Only 62 candidates attempted the question with only 27 obtaining a pass mark. The average mark was 9 out of 25. Marks were lost across all the four parts of the question. This clearly indicates that the candidates were not prepared for ATM. A poor and disappointing attempt overall.

Section B

Answer Section B questions in Answer Book B

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

a) The Internet is often described as only offering a “best effort” service. What do people mean by describing it this way?

(5 marks)

b) Identify one application where a “best effort” service is not good enough; clearly explain your reasons.

(5 marks)

c) Why is it impossible for a router to provide an enhanced level of QoS to all traffic moving via it?

(5 marks)

d) What features must exist within a router, and how must a router use those features if it is to provide different levels of QoS to different types of traffic?

(10 marks)

Answer Pointers

a). The term “best effort network” means a network that makes reasonable efforts to deliver traffic (1) but promises no guarantees (1) and makes no attempt to prioritize traffic (1). Traffic may be delivered in the wrong order (1) or indeed, may be discarded (1). Other issues could be raised and will be rewarded if appropriate. The total mark for this part of the question will be capped at 5.

b). IP Video conferencing is an example of where best effort is not good enough (2). Traffic needs to be delivered in order (1) with relatively low delay (1) and the delay variation (jitter) needs to be low (1). Other applications could be raised, such as Voice over IP and will be rewarded if appropriate. The total mark for this part of the question will be capped at 5.

c). Resources within a router are limited (1), link speeds are limited (1). If one subset of traffic needs to be given better treatment that can only be done at the expense of giving other traffic worse treatment (2). If the router or links are running out of resources then they cannot be instantly increased (1). Other issues could be raised and will be rewarded if appropriate. The total mark for this part of the question will be capped at 5.

d). The key feature is that routers need to have multiple traffic queues (2) and ways to decide which queue traffic should enter each queue (2) and the order in which traffic is taken out of the various queues and sent out of interfaces (2). Traffic needs to be marked in some manner to indicate which queue should be used (2) and the traffic levels need to be policed to make sure it remains within plan (2). The router also needs to make sure than any traffic it forwards remains within agreed contracts as well else a receiving router may discard or downgrade its priority (2). Other issues could be raised and will be rewarded if appropriate. The total mark for this part of the question will be capped at 10.

Examiners' Guidance Notes

This question was attempted by about 85% of the candidates of whom a small proportion (24%) achieved a pass mark.

While a small numbers of good quality answers were submitted, many answers were fairly weak.

Many candidates did not understand the conventional meaning of “best effort”. In part a, we clearly said “only offering”, this should have further served to help people realise that “best effort” did *not* mean supremely high quality or in other words, did *not* guarantee some form of perfection. In answering part b, many candidates cited applications where upper layer protocols or the application itself could easily compensate for failings at the IP level rather than applications requiring features such as low latency etc that cannot be addressed by higher layer protocols. Part c asked about why it was impossible to provide enhanced QoS to *all* traffic. The key issue is that you can only give some traffic “better than average” treatment (i.e. enhanced QoS) if this is balanced by “worse than average” treatment to other traffic.

B5. The question is about the behaviour of Internet routers. At a simple level, routers conduct two tasks. They create routing tables and they forward individual packets.

a) What are the main priorities for a router when it is attempting to forward individual packets?

(5 marks)

b) Routers sometimes learn about connectivity within the networks of a small organisation using distance vector protocols. Describe the general behaviour of distance vector protocols illustrating your answer by reference to Routing Information Protocol (RIP).

(10 marks)

c) RIPv1 ceased to be sufficient as the Internet and its constituent networks evolved. Explain the restrictions of RIPv1 and how RIPv2 solved some of the problems also noting which problems still remain.

(10 marks)

Answer Pointers

a). The main priorities for routers are rapid forwarding (2) and taking decisions so as to move the packet so that it gets closer to the destination (2). It will do this using existing routing tables (1) and will *not* attempt to update those tables at that time (1). Other issues, such as locating MAC addresses for packets requiring local delivery could be raised and will be rewarded if appropriate. The total mark for this part of the question will be capped at 5.

b). Distance vector protocols operate by broadcasting (2) their complete routing table (2) routinely at regular intervals (2). RIP typically broadcasts every 30 seconds (2). The broadcasts include destinations reachable (1) and the distances (1) those networks. Other issues could be raised and will be rewarded if appropriate. The total mark for this part of the question will be capped at 10.

c). RIPv1 only allows for class–based addressing (1) which RIPv2 solves by including netmasks (1). RIPv1 only allow the distances to be up to 15 (1), 16 being considered to be infinity (1), i.e. unreachable (1). RIPv1 broadcast information, thus meaning it reaches all machines on a network connection even if they have no interest (1). RIPv2 uses a multicast destination (1) thus meaning traffic is only processed by machines that have joined the appropriate group (1). RIPv1 does not support third-party announcements (1) this is supported by RIPv2 which includes a next-hop field (1). RIPv1 has no authentication support (1) whereas RIPv2 dos have some simple support for this (1). Other issues could be raised and will be rewarded if appropriate. The total mark for this part of the question will be capped at 10.

Examiners' Guidance Notes

This question was attempted by about 56% of the candidates of whom a proportion of 39% achieved a pass mark.

The answers cover the full range of quality. A small number got almost full marks, but at the other end, a large number scored close to zero. As we have seen in previous years, many candidates still seem to falsely believe that routing tables are created by talking to other routers and exchanging large amounts of information at the time of forwarding of all packets which is simply not true.

B6. This question is about error control in communications systems.

a) Briefly explain the difference between single-bit errors and burst errors. (3 marks)

b) Imagine that a noise event causes a burst error to occur that lasts for 1 ms (milli second).
   i. If data is being transmitted at 10Mbps. If how many data bits will be affected?

(3 marks)

   ii. If data is being transmitted at 100Mbps. If how many data bits will be affected?

(3 marks)

c) Under what circumstances is the use of parity bits is an appropriate error control technique?

(3 marks)

d) Explain the meaning of the term “residual error rate” in the context of error detection schemes.

(3 marks)

e) Under what circumstances is the use of cyclic redundancy counts (CRC) an appropriate error control technique?

(3 marks)

f) Very briefly outline how the CRC method functions.

(7 marks)

Answer Pointers

a). Single bit errors are errors which only affect isolated bits (1). Burst errors are errors which affect many bits (1) within a block of bits (1).

b). This part of the question measures candidates understanding of several things including the practical reality of burst errors, understanding of time and bit rates, A time period of 1ms is the same as 1/1000, 0.001 of a second. If we are transmitting at the rate of 10mbps, then in 1ms 10,000 bits will have been transmitted (3) and thus affected by the burst. At 100mps, 100,000 will have been transmitted (3) and thus affected by the burst.

c). The use of parity bits is really only appropriate if just single bit errors are expected (3).

d). The residual error rate is a measure of the proportion of bits that remain corrupted and undetected, even though some form of error control system is in use (3).

e). The use of cyclic redundancy counts (CRC) is appropriate if burst errors are expected (3).

f). The CRC method works by taking a sequence of bits (1) and dividing (1) this by a predefined polynomial (1) and then transmitting the remainder (1) along with the data. On reception, the receiver conducts the same arithmetic (1) and if the answers match it assumes successful transmission (1) otherwise it notes an error (1). Readers might note that while this system will not report errors when good transmission has taken place, there is a low, but non-zero possibility that it might miss corruption under some complex corruption. (3). Other issues could be raised and will be rewarded if appropriate. The total mark for this part of the question will be capped at 7.

Examiners' Guidance Notes

This question was attempted by only 38% of the candidates of whom a proportion of 43% achieved a pass mark.

While a number of good quality answers were submitted, many answers were fairly weak. Part b of the question asked for some very simple arithmetic which many candidates got completely wrong. It is also clear that many candidates do not realise that in the world of “communications”, K and M almost always mean precisely 1000 and 1000000 and not 1024 or 1024*1024 respectively. In the answers to parts c and e some candidates suggested that the choice of error control technique could be selected *after* the errors had occurred. Clearly this is wrong, the strategy for error control and any related parameters need to be established between communicating parties before transmission links are established, not after the errors occur!