BCS THE CHARTERED INSTITUTE FOR IT

BCS Higher Education Qualifications
BCS Level 5 Diploma in IT

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EXAMINERS' REPORT

Computer Networks

General comments on candidates' performance

Question 2 was the most popular question and in this occasion 65% of the candidates obtained a favourable mark. The least popular question were questions 1 and 3 with a pass rate of 51% and 36% respectively.

The evidence shows that candidates would benefit from:

- taking actions to prepare thoroughly for the topics indicated in the syllabus;
- use the examiners' report for exam preparation;
- prepare to answer questions relating to specific scenarios.

Candidates are also encouraged to continue improving their examination skills. Candidates should read the questions carefully and focus only on what is been asked and not provide information that is not related to the question. As it can be seen in the report below, most of the questions could have been answered with short statements rather than extensive paragraphs.

It is also recommended to the candidates to read the recommended reading list.

Question A1

A1. This question is about the **TCP/IP protocol architecture**.

a) Define the concept of **protocol architecture**, such as TCP/IP/ highlighting the following elements:

i. What a protocol architecture is? **(6 marks)**

ii. How protocol architectures should work? **(4 marks)**

iii. Name two examples of protocol architecture's in networking. **(2 marks)**

b) Given the following protocols, indicate in which layer of the TCP/IP protocol architecture each can be found? **(5 marks)**

i. Ethernet
ii. SMTP
iii. Optical fibre
iv. UDP
v. IPv6

c) Name the Protocol Data Unit for each of the layers of the TCP/IP protocol architecture. **(4 marks)**

d) Briefly describe the concept and purpose of the encapsulation/de-capsulation process used in the TCP/IP protocol architecture. **(4 marks)**

Answer Pointers:

Part (a)

A protocol architecture is the layered structure of hardware and software that supports the exchange of data between systems and supports distributed applications.

At each layer of a protocol architecture, one or more common protocols are implemented in communicating systems. Each protocol provides a set of rules for the exchange of data between systems.

Two examples of protocol architecture's in networking are TCP/IP and OSI model.

Part (b)

The following network protocols can be found in the indicated TCP/IP layer: Ethernet – Network access; SMTP – Application; Optical fibre – Network access; UDP – Transport; IPv6 – Internet.

Part (c)

The protocol data unit (PDU) for each of the TCP/IP layers are Application – data; transport – segment; internet – packet; network access – bits.

Part (d)

In the source device, each layer of the TCP/IP protocol architecture adds control information to the data, so it can be processed properly. This is called encapsulation. When the data arrives to the destination each layer will remove the corresponding control information and process accordingly. This is called de-capsulation.

Examiner's Comments

This was one of the least popular questions of section A with an attempted ratio of 59% and with almost 51% of the candidates obtaining a passing mark. The highest mark for this question was 24 whilst the lowest one was 0.

There is evidence that most candidates provided an answer related to the OSI model when they were asked about TCP/IP. Most of the candidates would have performed better in this question if they have made that distinction. Candidates seem to understand the concepts evaluated in this question but some of them were missing important elements. Most provided "hints" of what each element was but did not provide a complete answer. Protocol architectures such as TCP/IP and the OSI model are extremely important for computer networks therefore candidates should have a full understanding of each of them.

Question A2

A2. This question is about the Transmission Control Protocol (TCP).

a) Briefly describe the purpose of TCP as well as the layer of the TCP/IP protocol architecture where it is found. **(3 marks)**

b) TCP implements a mechanism called the three-way handshake. Indicate the purpose of such mechanism and, using a diagram, give an example on how it works emphasising the values of the TCP flags used as well as the sequence number. **(8 marks)**

c) Briefly explain how TCP uses the **window size** and **acknowledgments** to provide flow control. **(8 marks)**

d) Describe three applications and application protocol that require the use of TCP. **(6 marks)**

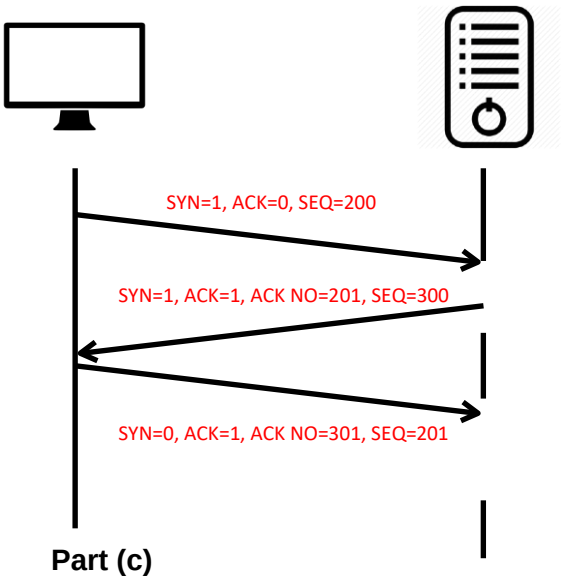
Answer Pointers:

Part (a)

TCP is designed to provide reliable communication between pairs of processes across a network. TCP can be found in the transport layer of the TCP/IP protocol architecture.

Part (b)

TCP uses the three-way handshake mechanism to establish a TCP connection. The following image shows an example of it.



Part (c)

The window size determines the number of bytes that can be sent before expecting an acknowledgement. A destination can decrease the windows size to inform the source to reduce the number of bytes it should send. The acknowledgement number is the number of the next expected byte. As the bytes are received and processed, the destination will send acknowledgements to inform the source that it can continue to send additional bytes.

Part (d)

Web traffic, e-mail (SMTP), remote connection, file transfer. Each of them requires a reliable communication that acknowledges data, resends lost data and delivers data in sequenced order.

Examiner's Comments

This question was the most popular of section A with an attempted ratio of 86% and 65% of the candidates obtaining a passing mark. The highest mark for this question was 23 whilst the lowest one was 0.

There is evidence that candidates confused the concept of TCP with the concept of TCP/IP as they seem to refer to them as the same. The majority did not state in which layer of the TCP/IP protocol architecture TCP resides. Many candidates did not explain the purpose of the three-way handshake and almost all didn't know how flags are used within this process. In part d, many candidates only provided the name of the protocol/application but failed to explain why they needed the services of a protocol such as TCP. Many candidates knew the concept of acknowledgement but failed to relate it to the concept of windowing. As in the question A1, most candidates provided "hints" of what they understood of TCP but failed to provide enough details that would make them get full marks.

Question A3

A3. This question is about digital data communication techniques.

a) The transmission of a stream of bits can be done in two ways: synchronously or asynchronously. Indicate how each work and which one is more suitable for the transmission of large blocks of bits. **(8marks)**

b) Explain the concept of **error detection** and describe one of the error-detection techniques used in digital data communications. **(6 marks)**

c) Indicate the purpose of the Hamming distance and provide an example on how it is used. **(5 marks)**

d) Describe the difference between full-duplex and half-duplex communications **(6 marks)**

Answer Pointers:

Part (a)

In synchronous transmission, the receiver must know the rate at which bits are being received so that it can sample the line at appropriate intervals to determine the value of each received bit. In asynchronous transmission, each character of data is treated independently. Each character begins with a start bit that alerts the receiver that a character is arriving. For large blocks, synchronous transmission is used.

Part (b)

Error detection is performed by calculating an error-detecting code that is a function of the bits being transmitted. The code is appended to the transmitted bits. The receiver calculates the code based on the incoming bits and compares it to the incoming code to check for errors. An example would be parity check or CRC, parity checks adds one bit at the end of the transmitted stream while CRC appends a group of bits that is calculated before transmission.

Part (c)

Hamming distance is used for error correction. The Hamming distance d(v1, v2) between two n-bit binary sequences, v1 and v2 is the number of bits in which v1 and v2 disagree. For example, if v1 = 011011 and v2 = 110001 then d(v1, v2) = 3.

Part (d)

Half-duplex transmission, only one of two stations on a point-to-point link may transmit at a time. Full-duplex transmission, two stations can simultaneously send and receive data from each other.

Examiner's Comments

This question was the second most popular of section A with an attempted ratio of almost 67% and almost 63% of the candidates obtaining a passing mark. The highest mark for this question was 22 whilst the lowest one was 0.

Most candidates demonstrated knowledge of certain elements related to error correction but some important details were missing in their answers hence the reason of not obtaining full marks.

Question B4

B4. This question is about Wide Area Networks (WANs).

a) Indicate in which layers of the OSI model do WANs operate and describe two WAN services offered in each of those layers (2 services per layer). **(6 marks)**

b) The following terms relate to WAN terminology:

(1) Demarcation point
(2) Data Terminal Equipment (DTE)
(3) Customer Premises Equipment (CPE)
(4) Data Communications Equipment (DCE)
(5) Local loop
(6) Central Office (CO)

The following are descriptions or definitions of the terms (in a different order)

(A) Physical network that connects the CPE to the CO.
(B) Primarily provides an interface to connect subscribers to a communication link in the WAN cloud.
(C) Local service provider facility or building that connects the CPE to the provider network.
(D) A customer device that connects to the local loop through the DCE.
(E) Separates customer equipment from service provider equipment.
(F) The devices owned or leased by the customer that connects to the carrier.

For each term, write down the description or definition that most closely matches it, e.g. (7) – (G). **(8 marks)**

c) Explain the main difference between a circuit-switched network and a packet-switched network. Indicate which one would have higher latency and jitter and explain why. **(6 marks)**

d) Given the following WAN access options indicate which type of network they are classified as (circuit-switched or packet-switched). **(5 marks)**

i. ATM
ii. ISDN
iii. MPLS
iv. Frame Relay
v. PTSN

Answer Pointers:

Part (a)

WANs operate in layers 1 (physical) and 2 (data link) of the OSI model. In layer 2 protocols define how data is encapsulated for transmission toward a remote location, in layer 1 protocols describe how to provide electrical, mechanical, operational, and functional connections to the services of a communications service provider.

Part (b)

The relation between the concepts is: (1) - (E), (2) - (D), (3) - (F), (4) - (B), (5) - (A), (6) - (C)

Part (c)

A circuit-switched network is one that established a dedicated circuit between nodes and terminals before the users may communicate. Packet switching splits traffic data into packets that are routed over a shared network. They do not require a circuit to be established. Latency and jitter are greater in packet-switched networks because the links are shared, and packets must be entirely received at one switch before moving to the next.

Part (d)

Packet-switched protocols are: ATM, MPLS and frame relay, circuit-switched protocols: PSTN and ISDN.

Examiner's Comments

This question was the least popular in section B, attracting just under 60% of candidates. The pass rate was low, at just over 36%. Although a number of good answers were obtained from candidates who answered this question, a large number of candidates made significant errors.

There is evidence that a number of candidates failed to demonstrate understanding of the format of the answer requested for part b), and instead of pairing the appropriate terms sought to answer the question, used a more expansive, essay style approach. Attempts to do this were largely unsuccessful, although credit was given where appropriate.

In part d), there seemed to be confusion in the answers provided regarding which protocols are packet switched and which are circuit switched – with a few candidates completely reversing the order.

Question B5

B5. This question is about the concept of Quality of Service (QoS).

a) Traffic can be characterised by four elements (1) latency, (2) jitter, (3) loss and, (4) bandwidth. Briefly describe each of those elements. **(8 marks)**

b) Given the following traffic characteristics, indicate whether they describe (1) voice, **(2)** video or (3) data traffic. **(9 marks)**

i. Can be very greedy consuming a large portion of network capacity.
ii. Without QoS and a significant amount of extra bandwidth capacity, this traffic typically degrades.
iii. Cannot be retransmitted if lost.
iv. Must receive a higher UDP priority.
v. Requires at least 384 Kbps of bandwidth.
vi. Traffic can be predictable and smooth.
vii. Does not consume a lot of network resources.
viii. Traffic can be smooth or bursty.
ix. Traffic can be unpredictable, inconsistent, and bursty.

c) Queuing is congestion management tool used in QoS to buffer and prioritise traffic. Name and describe two queuing algorithms available. **(4 marks)**

d) Name and briefly describe two QoS implementations in a network. **(4 marks)**.

Answer Pointers:

Part (a)

The concepts are defined as follows: (1) latency: amount of time a message takes to traverse a system, (2) jitter: variation in latency as measure in the variability over time of the packet latency across a network, (3) packet loss is measured as a percentage of packets lost with respect to packets sent, (4) amount of data that can be transmitted in a fixed amount of time.

Part (b)

Matching is as follows: i – data or video, ii – video, iii – voice or video, iv – voice or video, v – video, vi – voice, vii – voice, viii – data, ix – video. (1 mark per correct match).

Part (c)

Some queuing algorithms are:

- First in, first out (FIFO) – buffering and forwarding the packets in the order of arrival.
- Weighted Fair Queuing (WFQ) – applies priority to identified traffic and classifies it into conversations or flows.
- Class-Based weighted fair queuing (CBWFQ) – extends WFQ to provide support for user-defined traffic classes.
- Low Latency Queuing (LLQ) – allows delay-sensitive traffic such as voice to be sent before packets in other queues.

Part (d)

Possible models are:

- Best-effort: used when QoS is not required.
- Integrated services: defines a signalling process for applications to signal to the network that they require special QoS for a period and that bandwidth should be reserved.
- Differentiated Services: network devices recognise traffic classes and provide different levels of QoS to different traffic classes.

Examiner's Comments

This question was the most popular in section B, attracting 68% of candidates who took the exam. The question had a pass mark of just over 50%.

The descriptions in part a) were mostly appropriate, although some were too skeletal or vague to attract full marks. The answers to part b), as will be seen from the marking scheme, were allowed a degree of flexibility due to the nature of the material. Many candidates gave good, appropriate responses in part b).

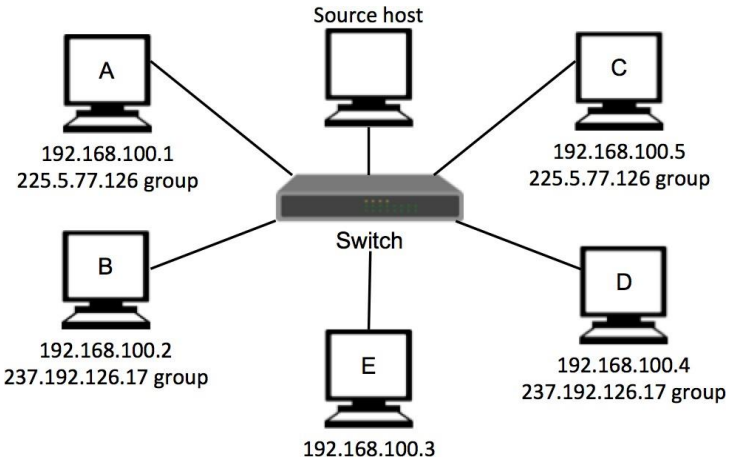
There is evidence that in part c) answers seemed to reflect a difference in the understanding of different cohorts of candidate. A few

candidates attempted to describe novel algorithms from first principles, but in general these were not successful.

Question B6

B6. This question is about IPv4 addressing.

a) Consider the following diagram and the IP addresses shown.



Identify which devices will receive the packet if the destination IP address and the type of IP address each is (unicast, broadcast or multicast). **(6 marks)**

i. 192.168.100.2
ii. 225.5.77.126
iii. 192.168.100.255

b) A host was given the IP address 198.168.4.121/27. Consider this address and indicate: **(8 marks)**

i. The network address to which the host belongs.
ii. The network broadcast address to which the host belongs.
iii. The total number of hosts available in the network.
iv. Can the following IP address be assigned as the default gateway of the host: 192.168.4.93? Why?

c) Describe the concept of public and private IPv4 addresses and give an example for each of them. **(6 marks)**

d) In IPv6, indicate the difference between a link-local address and a unique local address. Give an example of a unique local address. **(5 marks)**

Answer Pointers:

Part (a)

The given IP addresses are classified as follows: i. 192.168.100.2 is a unicast IP address and only B will receive it, ii. 225.5.77.126 is a multicast IP address and computers A and C will receive it, iii. 192.168.100.255 is a broadcast IP address and all devices will receive it (except for the source).

Part (b)

The values are as follows: i) network address: 192.168.4.96, ii) broadcast address: 192.168.4.127, iii) total number of available hosts: 30, iv) can 192.168.4.93 be the default gateway? No, it is outside the network address space.

Part (c)

Public IPv4 addresses are globally routed between ISP routers an example could be 151.231.230.180. Private IPv4 addresses are not unique and can be used by an internal network but they will not be routed by an ISP an example could be 10.0.0.1/8.

Part (d)

A link-local address is used to communicate with other devices on the same network or broadcast domain. A unique local address is similar to a private address in IPv4 but with the difference that they cannot be routable nor translated to a global IPv4 address. An example of a unique local address is: FC00::1/7.

Examiner's Comments

Just under 62% of candidates attempted this question and the pass rate was just under 60%, making it the best answered question in section B.

Candidates appeared to fall into two groups in their approaches to this question, and while a number of very good answers were obtained a significant number of candidates made initial errors in their understanding of the problem which impacted on their success.

A clear understanding of infrastructure examples such as this is core to the work of network managers worldwide, and candidates are recommended to pay attention to material of this kind. When they are carrying out exercises such as this in live commercial or public environments, they will have significant responsibility to both customers and the organisations for which they work.