1.10 Networking and the Internet: 30-minute Pack

AQA 7517 · Calculators not allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Ravensmead Sixth Form College is installing a new computer network for its ICT suite, which will have 12 workstations connected to one central switch, plus a server. The network technician, Owen Fairweather, is considering three different topologies: star, bus and full mesh.

(a) Define the term 'network topology'. **(1)**

(b) Describe how data travels across a star topology when one workstation sends data to another. **(2)**

(c) State one advantage and one disadvantage of using a star topology for the ICT suite. **(2)**

(d) Explain one way in which a full mesh topology differs from a star topology, and explain why this makes a full mesh more resilient to a single point of failure. **(3)**

(e) Owen cannot decide between a star topology and a bus topology for the ICT suite. Recommend which topology he should use, justifying your answer with reference to two advantages of a star topology over a bus topology. **(3)**

(Total for Question 1 is 11 marks)

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2 SwiftShare is a new startup planning a file-sharing service that lets users upload and download large files directly to and from each other. Its founder, Meera Iqbal, is deciding whether to build the service using a client-server model or a peer-to-peer (P2P) model.

(a) State one characteristic that distinguishes a client-server network from a peer-to-peer network. **(1)**

(b) In a peer-to-peer network, explain what is meant by each node acting as both a client and a server. **(2)**

(c) State two advantages of a peer-to-peer model over a client-server model for sharing large files directly between users. **(2)**

(d) Discuss whether Meera should use a client-server model or a peer-to-peer model for SwiftShare's file-sharing service. In your answer, you should consider: the reliability and availability of files when the original uploader is offline; the cost and scalability of running the service as it grows; the level of central control needed over content moderation and security. **(6)**

(Total for Question 2 is 11 marks)

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3 Ravensmead's ICT suite uses the TCP/IP model to structure how data is sent across its network and out to the Internet.

(a) State the four layers of the TCP/IP model, in the correct order, starting with the layer closest to the application software. **(2)**

(b) Identify one protocol that operates at the Transport layer, and state its function. **(2)**

(c) Explain what is meant by 'encapsulation' as data passes down through the TCP/IP stack, using the example of sending an email with an attachment. **(3)**

(d) State the name given to a unit of data at the Transport layer, and the name given to a unit of data at the Link layer. **(2)**

(Total for Question 3 is 9 marks)

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Mark scheme · 1.10 Networking and the Internet: 30-minute Pack

Question 1

(a) the layout/arrangement of the devices (nodes) and the connections between them in a network (oe) **B1**

(a) Answer: A network topology is the layout or arrangement of the devices (nodes) in a network and the connections between them.

(b) every device is connected directly to a central device (a switch or hub), rather than to each other (oe) **B1**

(b) data sent from one workstation travels to the central switch first, which then forwards it on to the destination workstation (oe) **B1**

(b) Answer: In a star topology, every workstation connects directly to a central switch rather than to each other. When one workstation sends data to another, the data travels first to the central switch, which then forwards it on to the intended destination workstation.

(c) advantage: if one workstation's cable fails, only that workstation is affected; the rest of the network keeps working (oe) **B1**

(c) disadvantage: the central switch is a single point of failure; if it fails, the whole network goes down (oe, allow: uses more cabling than a bus) **B1**

(c) Answer: Advantage: if one workstation's cable fails, only that workstation loses its connection, and the rest of the ICT suite's network keeps working normally. Disadvantage: the central switch is a single point of failure, so if it fails, every workstation loses its connection at once.

(d) in a full mesh, every device has a direct connection to every other device, rather than all devices connecting only to one central switch (oe) **B1**

(d) because there is no single central device that all traffic must pass through, the failure of any one device or connection does not disconnect the rest of the network (oe) **B1**

(d) multiple alternative direct paths exist between devices, so data can still reach its destination via a different connection, unlike a star, where losing the central switch disconnects everyone (oe) **B1**

(d) Answer: In a full mesh, every device is connected directly to every other device, rather than all devices connecting only to one central switch as in a star. This means there is no single central device that all traffic depends on, so the failure of any one device or cable does not disconnect the rest of the network: data can still reach its destination via one of the other direct connections. In a star, by contrast, if the central switch fails, every workstation loses its connection at once.

(e) star topology recommended **B1**

(e) advantage 1: a single cable fault in a star only disconnects the one workstation concerned, whereas a break in a bus's shared backbone cable can bring down the whole network segment (oe) **B1**

(e) advantage 2: a star suffers less congestion/fewer collisions as more workstations are added, because each has its own dedicated connection to the switch, whereas a bus shares one single cable between all devices (oe) **B1**

(e) Answer: Owen should choose a star topology. First, in a star, a single faulty or damaged cable only disconnects the one workstation it serves, whereas in a bus topology a break anywhere in the shared backbone cable can bring down the whole network. Second, a star suffers less congestion as more workstations are added, because each workstation has its own dedicated connection to the switch, whereas in a bus every device shares the same single cable, increasing the chance of data collisions as traffic grows.

Question 2

(a) in a client-server network, one or more dedicated (central) servers provide services/resources to many client devices, whereas in a peer-to-peer network there is no dedicated server and all nodes have broadly equal status (oe) **B1**

(a) Answer: In a client-server network, one or more dedicated central servers provide services or resources to many separate client devices, whereas in a peer-to-peer network there is no dedicated server, and all nodes have broadly equal status.

(b) each node can act as a client, requesting/downloading a file or resource from another node (oe) **B1**

(b) at the same time, each node also acts as a server, by making its own files/resources available and uploading them to other nodes that request them (oe) **B1**

(b) Answer: Each node in a peer-to-peer network can act as a client, requesting and downloading a file from another node, while at the same time also acting as a server, by making its own files available and uploading them to other nodes that request them.

(c) no single central server is required, so there is no single point of failure and no dedicated server hardware/bandwidth needs to be bought and maintained (oe) **B1**

(c) as more users share/download a popular file, more peers hold copies of it, so the network's capacity to distribute that file can increase, rather than being limited by one server's bandwidth (oe) **B1**

(c) Answer: First, no single central server is required, so there is no single point of failure, and SwiftShare does not need to buy and maintain expensive dedicated server hardware and bandwidth. Second, as more users download a popular file, more peers end up holding a copy of it, so the network's overall capacity to supply that file can increase automatically, rather than being limited by one server's bandwidth.

(d) **L3** A balanced discussion covers reliability/availability, cost/scalability and central control, applied specifically to SwiftShare, and reaches a justified overall recommendation. **5-6**

(d) **L2** Some accurate points are made on two of the three areas above, with limited balance and/or limited application to SwiftShare. **3-4**

(d) **L1** A basic, one-sided or generic comment is made on client-server versus P2P, with little application to SwiftShare. **1-2**

(d) **L0** No creditable content. **0**

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(d) Indicative content:

- Reliability/availability: in a pure P2P model, a file is only available while at least one peer holding it is online; if the original uploader (and every other holder) goes offline, the file becomes unavailable, whereas a client-server model keeps every file available on a central server as long as that server is running, giving more consistent availability.
- Cost/scalability: a client-server model requires SwiftShare to buy and maintain server storage and bandwidth for every file uploaded, with costs rising directly with the number of users and files; a P2P model instead uses the storage and bandwidth of users' own devices, so it scales more cheaply, and can even become faster for popular files as more peers share them.
- Central control: a client-server model gives SwiftShare central control, making it far easier to monitor content, remove illegal or copyrighted files, apply consistent security updates, and take down harmful material quickly; a P2P model has no central point of control, making illegal content harder to detect and remove and security harder to enforce consistently across every user's device.
- Valid overall view: e.g. a hybrid approach (a central server for indexing, search and moderation, with the actual file transfer handled peer-to-peer) could combine the moderation benefits of client-server with the cost and scalability benefits of P2P; alternatively, a clearly justified single choice of one model for a cost-sensitive early-stage startup.

(d) Answer: Extended, levels-marked response: award marks holistically against the levels of response grid, using the indicative content as a guide to creditable points; there is no single correct wording.

Question 3

(a) correct four layers named: Application, Transport, Internet, Link (allow Network Access/Network Interface for Link) (oe) **B1**

(a) correct order given, starting nearest the application: Application, Transport, Internet, Link cao **B1**

(a) Answer: Application, Transport, Internet, Link.

(b) TCP (or UDP) correctly identified as operating at the Transport layer **B1**

(b) correct function stated, e.g. TCP establishes a connection and provides reliable, ordered delivery of data between two devices (or UDP provides fast, connectionless delivery with no guarantee of reliability) (oe) **B1**

(b) Answer: TCP (Transmission Control Protocol) operates at the Transport layer. Its function is to establish a connection between two devices and provide reliable, ordered delivery of data, using acknowledgements and retransmission of any lost data.

(c) as the email data passes down through each layer of the sending device's TCP/IP stack, each layer adds its own header (and, at the link layer, typically a trailer) to the data it receives from the layer above (oe) **B1**

(c) e.g. the Transport layer adds a header (containing port numbers and sequencing information), forming a segment; the Internet layer then adds a header (containing source and destination IP addresses), forming a packet (oe) **B1**

(c) the original email data ends up wrapped inside multiple layers of headers, like nested envelopes, which are then removed in reverse order (de-encapsulated) by the corresponding layer at the receiving device (oe) **B1**

(c) Answer: Encapsulation is the process by which each layer of the TCP/IP stack adds its own header (and, at the link layer, a trailer) to the data passed down from the layer above, as the email and its attachment travel down through the sending device's stack. For example, the Transport layer adds a header with port and sequencing information to form a segment, and the Internet layer adds a header with the source and destination IP addresses to form a packet. The result is that the original email data is wrapped inside several nested layers of headers, which are removed one by one, in reverse order, by the matching layer at the receiving device.

(d) Transport layer: segment **B1**

(d) Link layer: frame **B1**

(d) Answer: Transport layer: segment. Link layer: frame.

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