2018 EXAMINATIONS

Lancaster University

Part II

COMPUTING AND COMMUNICATIONS [2.5 Hours]

SCC.203 Computer Networks

Candidates are asked to answer THREE questions from FOUR; each question is worth a total of 25 marks.

Use a separate answer book for each question.

Question 1

1.a Communication is organised in multiple layers.

i. Explain what is achieved by layering and how this helps in dealing with complexity. **[2 marks]**

ii. "Modularization" also enables "exchangeability". What do these two concepts refer to and how can they help with the further development of the communication architecture? **[2 marks]**

iii. Name the four lower layers (in the correct order of the ISO/OSI reference model) and explain their function. Also, what is the difference between the ISO and Internet layered definition. **[3 marks]**

1.b There are two principle Application Architectures, i.e. client-server and peer-to-peer.

i. Explain the basic principles underlying both architectures. **[2 marks]**

ii. In your college you want to establish a content sharing system. You have 10 friends with desktop machines (they also have laptops and mobile devices e.g. smart phones), and another 20 friends have only laptops and mobile devices. There is also a college computer (Intel Core 2 CPU 6400 @ 2.31 GHz, 2 GB RAM, 250 GB). The desktops and college computer are connected via a LAN (i.e. Ethernet with 400Mb/s). Laptops and handhelds use a 100 Mb/s WLAN. What kind of architecture do you propose? Explain your answer. **[4 marks]**

1.c In Web applications the Hypertext Transfer Protocol (HTTP) is used as the application layer protocol. HTTP is a stateless protocol

i. Explain what "stateless" means. Also, explain how this is related to persistent and non-persistent HTTP. **[3 marks]**

ii. How do Cookies help to provide a user-server state? Explain how they work (use a diagram if you wish) and what they can be used for. Also discuss issues related to privacy and security in this context. **[3 marks]**

Question 1 continues on next page…

Question 1 continued…

1.d Within the network architecture there are the network and transport layers.

i. Explain the role and relationship of these two layers. **[2 marks]**

ii. The User Datagram Protocol (UDP) can be used as transport protocol on top of IP. Outline the features of UDP and explain its relationship to IP. **[2 marks]**

iii. UDP uses checksums to detect errors in transmitted segments. The sender computes the checksum from the segment content, which is treated as a sequence of 16bit integers. In the following example calculate the checksum.

1 0 1 0 1 0 1 0 0 0 1 0 1 0 1 0

1 0 0 1 1 0 0 1 0 0 0 1 1 0 0 1 **[2 marks]**

Total 25 marks

Question 2

2.a The Dynamic Host Configuration Protocol (DHCP) is used to assign and maintain addresses dynamically.

i. Describe the process that a computer without a pre-configured IP address goes through when first connecting to a network using DHCP. Us a flow diagram and specify the message types that are being used in this process. **[3 marks]**

ii. Explain the role of a DHCPREQUEST and when and how it is used. **[2 marks]**

iii. Discuss why in the context of increased mobility DHCP is essential. **[2 marks]**

2.b Network Address Translation (NAT) is used to represent a Local Area Network connected to the Internet by the NAT router through one IP Address only.

i. Explain how NAT works by using the example of a Web-request sent from a client in the NAT network 138.77.29.9 to www.nata.com with the IP address 127. 118.40.186:80. Use a diagram (if you wish) for the step-by-step explanation. **[3 marks]**

ii. NAT is said to improve security, why is this so and does this in your opinion outweigh the conceptual issues regarding NAT? Explain your answer. **[2 marks]**

2.c The bit stream 10111101 is coded by the Cyclic Redundancy Code (CRC) method. The generator polynomial x3 + x + 1 is used. What is the transmitted frame? Show how you calculate this. Further, explain what happens when the second bit from the left is transmitted wrongly. Can this error be detected at the receiver? **[6 marks]**

Question 2 continues on next page…

Question 2 continued…

2.d You are working for ComputerSolutions.com and are asked to set up a Local Area Network (LAN) at their new office. The decision was taken to use 802.3 Ethernet but the company is still discussing whether a standard Ethernet or Switched-Ethernet set-up should be used.

i. Compare standard Ethernet to Switched-Ethernet; specifically consider how hosts are connected to the network (use diagrams if you wish). In this context also explain the role of CSMA/CD. Is it needed in both cases? **[4 marks]**

ii. Ethernet Switches are self-learning. Explain what this means by describing step-by-step the process a frame with an unknown destination address arriving at the switch is going through. How does a switch deal with frames? **[2 marks]**

iii. What solution would you recommend considering that you need to connect 25 hosts but the only switches available have either 5 or 10 ports. **[1 marks]**

Total 25 marks

Question 3

3.a The Internet is built in a hierarchical manner, and is often referred to as a 'network-of-networks'.

i. Using an access technology of your choice, explain how this allows users to connect to the Internet. **[2 marks]**

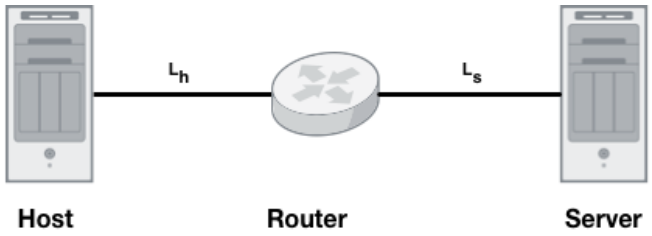
ii. Traditional telephone networks are considered to be circuit-switched. Describe the differences between this type and a packet-switched network. **[3 marks]**

iii. Using a diagram to assist you, briefly explain the role of Regional ISPs, Tier 1 ISPs, Content Delivery Networks and Internet Exchange Points in the Internet hierarchy. **[3 marks]**

3.b The performance of networks can be measured in many different ways.

i. Describe three of the four sources of delay found in a computer network. **[4 marks]**

ii. A client is connected to a server using a single router. Let L_s represent the link between the server and router, and L_h identify the link between the router and the host. We measure the number of bits transferred over each of these links for a given time period. For L_s, we note that the link transfers 6000 bits over 200 seconds, whilst for L_h, we measure 2000 bits over 100 seconds. Calculate the average throughput for each of these links, showing your working. Identify which link will prove to be the bottleneck for the client requesting content from the server and explain why this is the case.



[2 marks]

iii. Describe the process of packet loss in computer networks, including the conditions under which this may occur. **[3 marks]**

Question 3 continues on next page…

Question 3 continued…

3.c Email was once the Internet's most popular application, and is still one of the most widely used and important applications.

i. Nigel uses a web-based email account to send a message to Barbara. Barbara accesses her email from her mail server using POP3. Explain how the email message gets from Nigel's host to Barbara's host. Note that on the first try, Barbara's mail server is full. However, this clears soon after. Use a diagram to assist in this description, labelling the protocol used at each stage. **[3 marks]**

ii. Using your knowledge of the HTTP protocol, compare this with SMTP. **[3 marks]**

iii. Explain the advantages that the IMAP protocol has over POP3. **[2 marks]**

Total 25 marks

Question 4

4.a TCP is a protocol used to provide reliable data transfer over a fundamentally unreliable network.

i. A TCP segment header contains a sequence number. Explain how this field is used during data transfer, using an example to assist in your explanation. **[2 marks]**

ii. *Fast Retransmit* is used to reduce end-to-end delay. Using a sequence diagram illustrating communication between two hosts, demonstrate how this can be applied to retransmit missing segments before a segment's timer expires. Ensure that you show the sequence number and the size of each request, as well as the corresponding acknowledgment and value. Also show the timer that would otherwise apply without *Fast Retransmit*. **[3 marks]**

iii. Describe the process of initiating a TCP connection between a client and server. Include in your answer details of which flags are set in each message. **[3 marks]**

4.b The TCP protocol contains mechanisms to combat congestion in a network.

i. State the purpose of the congestion window in this context. **[3 marks]**

ii. TCP's *Slow Start* mechanism exponentially grows the congestion window. Explain each of the conditions in which TCP will halt this growth. **[3 marks]**

iii. Discuss why it is possible for application developers to gain an increased share of a network's capacity by using UDP over TCP. Include details of the impact on remaining TCP connections. **[2 marks]**

4.c Routing is the process by which packets are sent and delivered to hosts throughout the Internet.

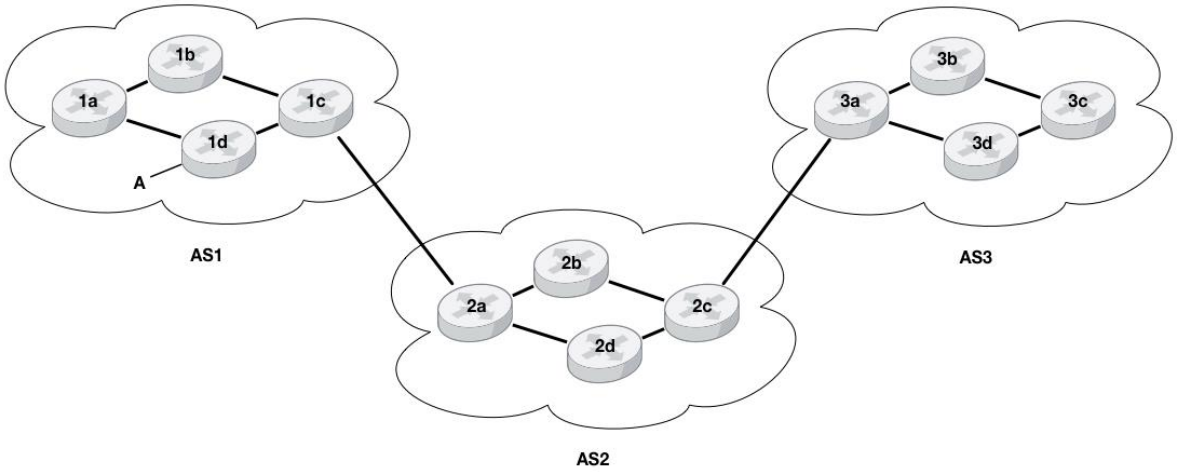
i. Explain the difference between *forwarding* and *routing* processes. Include in your explanation comments on how the two interact. **[3 marks]**

ii. OSPF and BGP are both routing protocols, but they are designed for use in very different contexts. Describe the purpose of each, making it clear where they are used in today's Internet. **[2 marks]**

Question 4 continues on next page…

Question 4 continued…

iii. Consider the network below, containing three autonomous systems, each with four routers. These are connected together as shown, with links between AS1–AS2 and AS2–AS3. Using your knowledge of BGP route advertisement, demonstrate the process by which a subnet with prefix A becomes reachable from AS2 and AS3. Include details of message content, and be clear where iBGP and eBGP connections are used to accomplish this.



[4 marks]

Total 25 marks

--- End of Paper ---