University of Bath

DEPARTMENT OF COMPUTER SCIENCE EXAMINATION

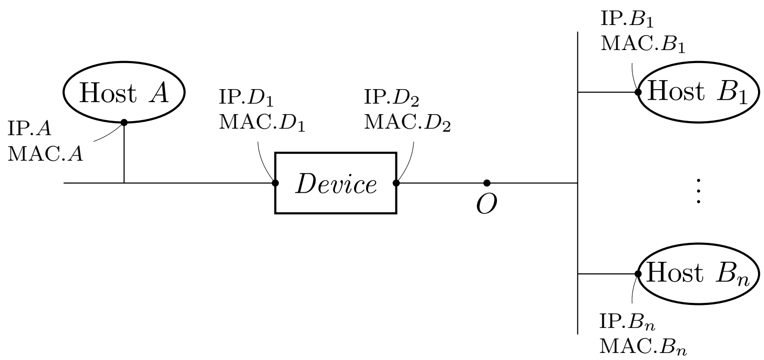
CM30078: NETWORKING

Candidates may use university-supplied calculators.

Full marks will be given for correct answers to THREE questions.
Only the best three answers will contribute towards the assessment.

Examiners will attach importance to the number of well-answered questions.

1. Consider the following isolated network:



Device is a machine that can be configured as a bridge or as a router, IP.X and MAC.Y are, respectively, IP addresses and MAC addresses at several interfaces (where they might or might not be used) and O is a point where packets can be observed. We assume that the network mask 255.255.255.0 is in place for all the machines on the network. Please answer the following questions.

a) Suppose that *Device* is configured as a bridge and

$$\begin{aligned} \text{IP.}A &= 192.168.1.1 \quad , \\ \text{MAC.}A &= \text{0A.0A.0A.0A.0A.0A} \quad . \end{aligned}$$

Give plausible IP and MAC addresses for all the interfaces where they are necessary. Which is the maximum value of n? [4]

b) Assume that the network is stable and configured as in (a). Give the ARP cache table of Host A and of Host B_1 (you can use symbolic addresses as in the figure). [4]

c) Assume that the network is configured as in (a). Which are the source and target IP and source and target MAC addresses of an IP packet in O travelling from Host A to Host B_1? [2]

d) Suppose that *Device* is configured as a router and

$$\begin{aligned} \text{IP.}A &= 192.168.1.1 \quad , \\ \text{MAC.}A &= \text{0A.0A.0A.0A.0A.0A} \quad . \end{aligned}$$

Give plausible IP and MAC addresses for all the interfaces where they are necessary. Which is the maximum value of n? [5]

e) Assume that the network is stable and configured as in (d). Give the ARP cache tables of the router (you can use symbolic addresses as in the figure). [3]

f) Assume that the network is configured as in (d). Which are the source and target IP and source and target MAC addresses of an IP packet in O travelling from Host A to Host B_1? [2]

g) Assume that the network is configured as in (d), and consider the problem of sending an IP packet from Host A to Host B_1. Explain step by step how Host A obtains the MAC address of the router for B_1 by looking into its tables and caches. [5]

2. Please answer the following questions concerning the network and transport layers.

a) Consider the following situation. Application A_1 on host S sends a UDP packet to host R with source and target ports P and Q, and the content of the packet is read by service B_1 on R. At the same time, application A_2 on host S opens a TCP connection towards host R with source and target ports P and Q, and the data sent over this connection is read by service B_2 on R. Is there any way for B_1 to read also data intended for B_2, or vice versa? Explain. [5]

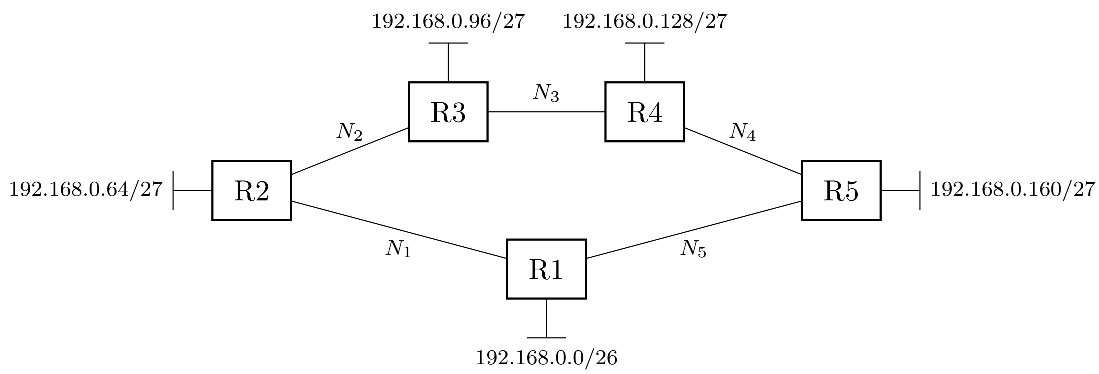
b) Can a block of data sent via UDP be fragmented by IP? Explain. [3]

c) Show an example of a network level device performing a technique that involves changing the source address of transiting IP packets. Briefly describe the purpose and operation of the technique. [7]

d) Are there any mechanisms by which packets belonging to the same TCP connection could follow different routes? Explain. [3]

e) Is it possible that `traceroute` showed what looks like a perfectly valid route, but that, in fact, no packet can actually follow such a route? If the answer is no, explain why; if the answer is yes, show an example. [7]

3. Consider the following isolated network, whose address space is 192.168.0.0/24:



$R1$, $R2$, $R3$, $R4$ and $R5$ are routers, each of which has three interfaces. $N1$, $N2$, $N3$, $N4$ and $N5$ are networks connecting the routers. Please answer the following questions:

a) Assign plausible address spaces to $N1$, $N2$, $N3$, $N4$ and $N5$, in such a way that as many as possible addresses are left free for future expansion of the network. [3]

b) Suppose that there is a host 192.168.0.120 with one interface, connected to one of the routers via a switch. Provide a plausible routing table for this host, assuming that the network is stable. Leave out nonessential information such as MSS, Window and irtt. [3]

c) Provide a plausible routing table for $R2$, assuming that the network is stable. Leave out nonessential information such as MSS, Window and irtt, but do include Metric and assume that routes with fewer hops are preferred. [10]

d) Suppose that the RIP routing protocol is used, and that its whole routing table is sent around every 30 seconds by every router. At some point, the direct link between R_1 and R_5 breaks. Is it possible that in this situation packets bounce back and forth for a while between some two routers? If yes, how and for how long? If not, why? [7]

e) Is it conceivable that, due to a misconfiguration of the routing tables in the above network, IP packets might circle forever? Justify your answer. [2]

4. Please answer the following questions concerning TCP strategies.

   a) Consider the advertised window mechanism: in which TCP packets can the window size information be found? Can this be 0? Explain your answer. [5]

   b) Explain the deadlock situation that the persist timer is supposed to prevent. [5]

   c) What is the purpose of the delayed ACK strategy? Show how it works on a simple example involving ACK piggybacking. [5]

   d) Explain Nagle's algorithm in two sentences, and then explain what a small segment is. [5]

   e) Let us adopt the slow start and congestion avoidance strategy. What is the congestion window, its purpose and how is it computed? Is it true that, even if we adopt that strategy, the advertised window is an upper limit for the data that can be transmitted at any given time? Explain. [5]