NATIONAL UNIVERSITY OF SINGAPORE

CS2105 — INTRODUCTION TO COMPUTER NETWORKS

Semester 1, 2018/2109

Time Allowed: 2 Hours

INSTRUCTIONS TO STUDENTS

1. Please write your Student Number only. Do not write your name.
2. The assessment has one question booklet and one answer booklet.
3. The question booklet contains **FOURTEEN (14) questions** and comprises **EIGHT (8) pages** including this cover page.
4. The answer booklet contains **FOUR (4)** pages.
5. Weightage of questions is given in square brackets. The maximum attainable score is 50.
6. This is a **CLOSED** book assessment, but you are allowed to bring **ONE (1)** double-sided A4-size, sheet of notes.
7. The use of electronic calculators is permitted for this assessment.
8. Write all your answers legibly in the **ANSWER BOOKLET**.

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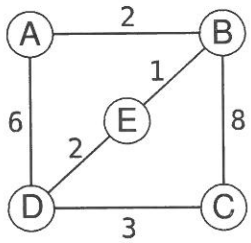
It may be used as scratch paper.

Short Answer Questions [Total: 34 marks]

9. **[Total: 6 marks]** Consider the following network topology where each router runs the distance vector algorithm with ***poisoned reverse***:



   (a) [2 marks] Show the contents of router A's distance vector table before any distance vector exchange takes place.

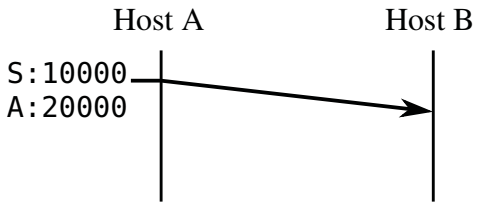
   (b) [2 marks] All routers exchange distance vectors with their neighbours before updating their tables. Show the contents of A's distance vector table after the exchange and update takes place.

   (c) [2 marks] At this point, router A exchanges its distance vector with its neighbours. Show the contents of the distance vector that A exchanges with B.

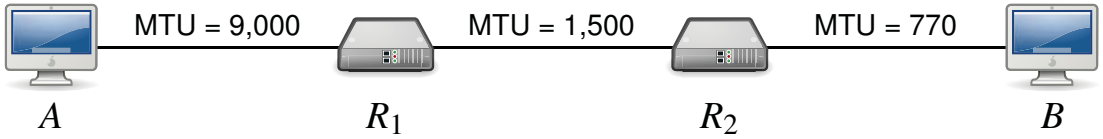
10. **[Total: 6 marks]** A TCP connection has been established between two hosts A and B. The MSS of the connection allows each TCP packet to contain at most 1,000 bytes of application data. Suppose at this point in time, both hosts each has 3,000 bytes of data to send to the other host and it was done by sending the least number of segments.

(a) [2 marks] What is the total number of TCP segments that was sent by both hosts?

(b) [4 marks] Suppose the first segment was sent by host A and has sequence number 10,000 and acknowledgement number 20,000 as shown. Complete the trace of the conversation by showing the sequence and acknowledgement number of all the segments sent and received between *A* and *B*.



11. [**Total: 6 marks**] Two hosts are separated by two routers with links of different MTU size as shown below. Host *A* sends a non-fragmented IPv4 datagram of Id 54 and length 3,000 bytes (inclusive of the 20 bytes IP header) to host *B*. Assume there are no data corruption or packet losses.

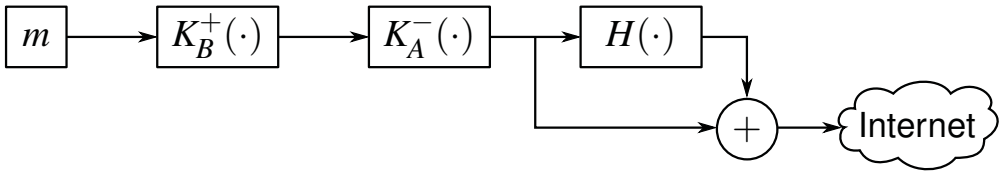


(a) [2 marks] List the IP fragments along with the information in their header sent by R_1 in increasing order of offset.

(b) [2 marks] List the IP fragments along with the information in their header sent by R_2 in increasing order of offset.

(c) [2 marks] Many Gigabit Ethernet networks support *jumbo frames* where the MTU can be as large as 9,000 bytes even though the IEEE 802.3 Ethernet only mandates that devices support an MTU of up to 1,500 bytes. What is an advantage of doing so?

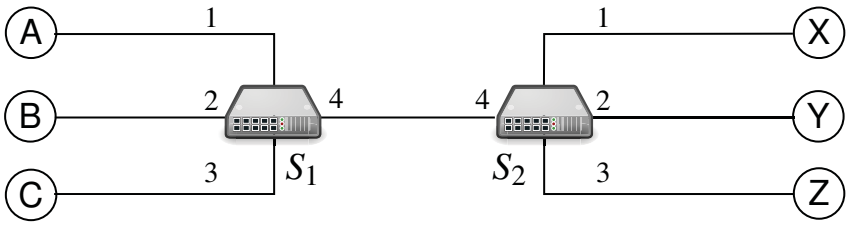
12. [**Total: 6 marks**] Alice is sending a message m to Bob using public key cryptography. Let Alice's public and private key pair be K_A^+ and K_A^-, and Bob's public and private key pair be K_B^+ and K_B^-. Assume that all the public keys as well as the hash algorithm H are known by everyone including Trudy the intruder. Suppose Alice is sending the message m using the protocol shown below.



(a) [2 marks] Show what Bob needs to do to read the message m.

(b) [4 marks] Does the protocol provide confidentiality, integrity, authenticity, and non-repudiation? For each of those properties, explain your answer.

13. [**Total: 6 marks**] Consider the network below with two switches S_1 and S_2 where both switches currently have empty switch tables. We denote the MAC address of a node with a subscript. For instance, MAC address of B is MAC_B.



(a) [2 marks] Node A wants to communicate to node Z, but having just joined the network, it does not know the MAC address of Z (i.e., MAC_Z). What kind of message should node A send? State the source and destination MAC address (i.e., MAC_{src} and MAC_{dst}) of the message.

(b) [2 marks] What will be the state of the switch table for both S_1 and S_2 **after** node Z replies node A its MAC address?

(c) [2 marks] At this point, switch S_1 is restarted and loses all data in its switch table while switch S_2 retains its state given in part (b). Node B now sends a frame with a source address of MAC_B and destination addresss of MAC_Z. Which nodes will receive this frame? Note that a node may receive a frame but ignore it if the destination address does not match its own.

14. [**Total: 4 marks**] Two stations, A and B, connected in a bus topology. They are separated 1,000 m away with the propagation speed of 2×10^8 m/s and transmission rate of 10 Gbps. Assume that they are using CSMA/CD. Consider the scenario where station A starts transmitting at time $t = 0$ s.

(a) [2 marks] At what time does station B receives the first bit?

(b) [2 marks] Assume that the time you computed in part (a) is time t_1. Consider the case that station B starts sending a frame just before time t_1 causing a collision. What should the minimum frame size be such that station A will detect the collision?

— E N D O F P A P E R —

Scratch Paper

– H A P P Y H O L I D A Y S ! –