

First name: _____ Family name: _____

FINAL EXAM - SLOT 1
TCP/IP NETWORKING
Duration: 90 min.

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The exam is in two time slots. Slot 1 must be completed entirely (sheets returned to us) before starting slot 2. Its duration is indicated on the top of this document.

Slot 1 covers part 2 of the course and is mandatory for everyone.

Slot 2 starts once slot 1 is over and covers part 1 of the course. If you had the maximum grade at the mid term, you should skip slot 2. If you are finished with slot 1 ahead of time, you may leave the room and come back for the beginning of slot 2.

Reminder: Your final theory grade is

$$T = \frac{\max(M_1, F_1) + F_2}{2}$$

where F_1, F_2 are your grades at this exam, and M_1 is your grade at the mid term. Slot 1 gives you grade F_2 , slot 2 gives grade F_1 .

Write your solution into this document and return it to us. You may use additional sheets if needed. Do not forget to put your name on this document and *all* additional sheets of your solution.

If you need to make assumptions in order to solve some questions, please write them down explicitly.

No documents, no electronic equipments are allowed.

You can write your solution in English or French.

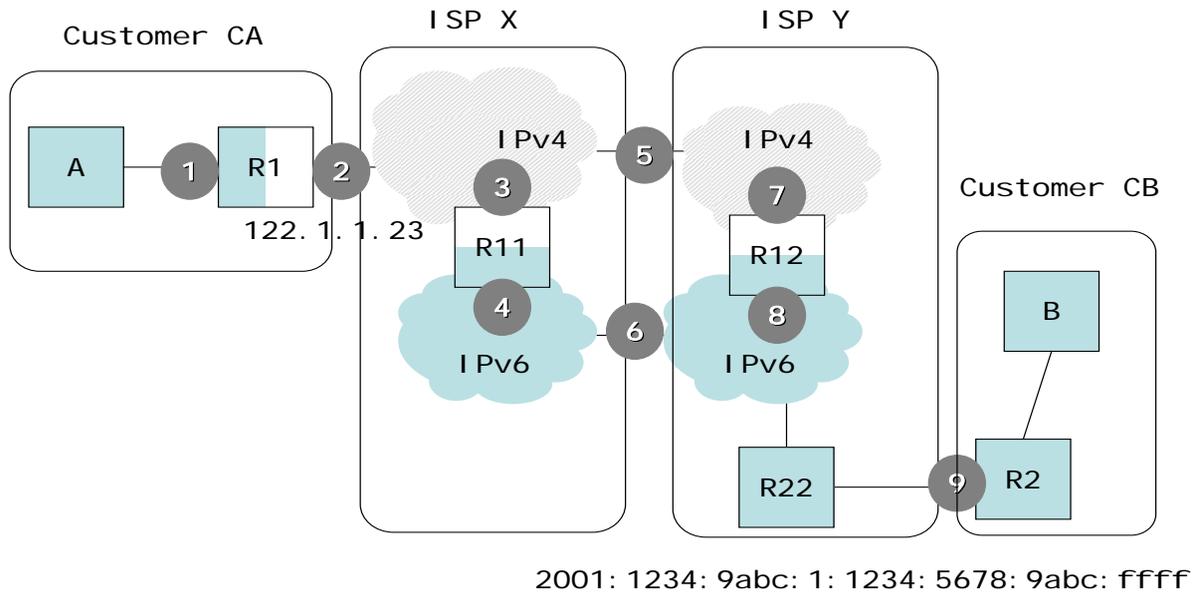


Figure 1: The network used in Question 1.1

QUESTION 1.1

Consider the network in Figure 1. Customers CA and CB have IPv6 networks, all of their hosts are IPv6 only. CB is connected to the IPv6 internet (by means of Internet Service Provider Y). In contrast, CA is connected only to the IPv4 internet (by means of Internet Service Provider X).

Both X and Y are connected to both the IPv4 and IPv6 internets.

CA's connection to X is by means of router R1, which has an IPv6 interface (1 on the figure) and an IPv4 interface (2 on the figure). The IPv4 address of interface 2 is 122.1.1.23.

CB's connection to Y is by means of router R2, which has only IPv6 interfaces. The address of interface 9 (see figure) is 2001:1234:9abc:1:1234:5678:9abc:ffff.

1. What is the value of the 49th to 64th bits of interface 9's IPV6 address ? Of the 128th bit ?

2. Give a possible value for A's IP address.

3. A sends one packet to B. Say at which of the points labeled 1 to 9 the packet will be visible. At each of these points, give *all* IP addresses (IPv4, IPv6, source, destination) that may be visible in the packet. Same question for a packet sent by B to A.

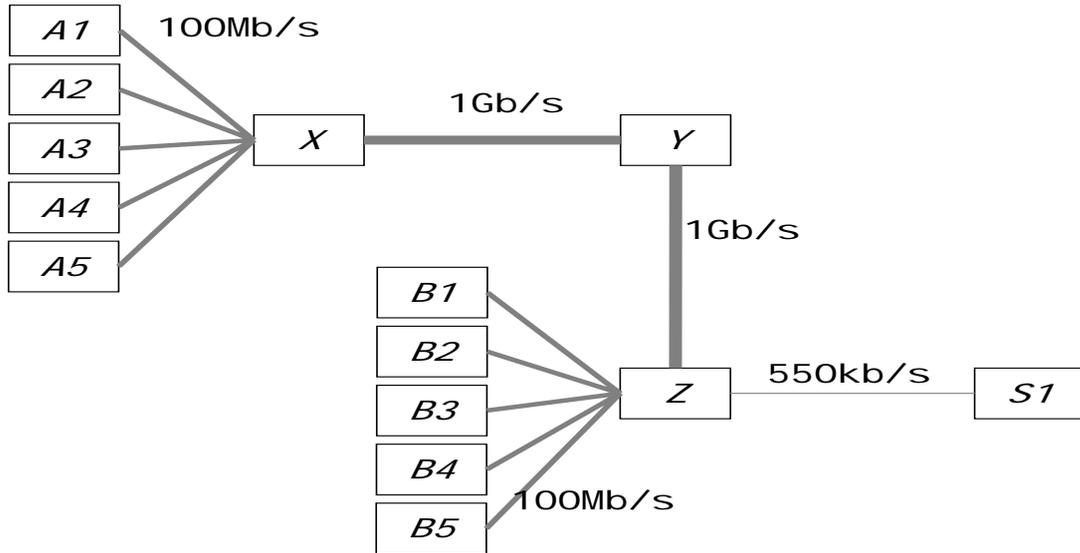


Figure 2: The network used in Question 1.2

QUESTION 1.2

Consider the network in Figure 2. Hosts A_1 to A_5 and B_1 to B_5 are downloading content from server S_1 . The boxes X, Y, Z are routers, unless otherwise specified.

- The link rates are indicated on the figure. In particular, the link rates between A_i and X as well as between B_i and Z are 100 Mb/s, for $i = 1$ to 5.
- All links are full duplex with same rate in both directions.
- There is no other system than shown on the figure, and we neglect all flows other than from S_1 to A_i and B_i . We also neglect the impact of the acknowledgement flows in the reverse direction.
- The round trip time from S_1 to A_i is 200 ms. The round trip time from S_1 to B_i is 20 ms. These numbers include all processing times.
- We neglect all overheads and assume that the link capacities can be fully utilized.
- The MSS is the same for all flows.

1. Assume that, by some mechanism which we do not specify, the rates of the 10 flows (from S_1 to A_i and B_i) are allocated according to max-min fairness. What are the values of the rates ?

2. Same question with proportional fairness instead of max-min fairness.

3. We now assume that the 10 flows are using TCP. What is the value of the rate of each flow ?

4. Assume now that Y is a web proxy instead of a router. All flows use TCP. The round trip time from Z to A_i is 190 ms; the round trip time from S_1 to Z is 20 ms. What is the value of the rate of each flow ?

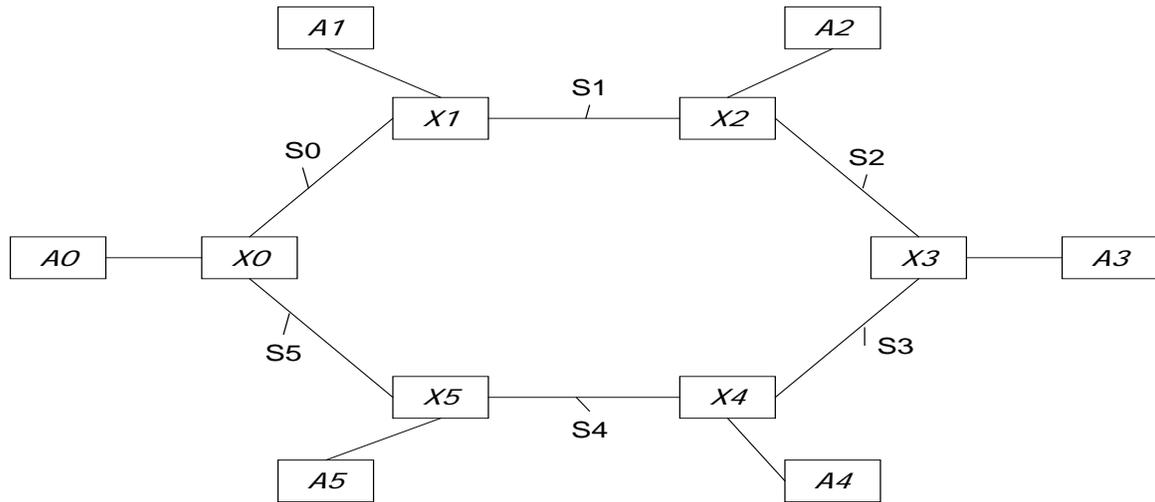


Figure 3: The network used in Question 1.3

QUESTION 1.3

Consider the network in Figure 3. A_0 to A_5 are hosts. The links are bi-directional. For every $i = 0, \dots, 5$:

- there is one flow of data from A_i to A_j , with $j = i+2 \pmod 6$ (i.e. there are 6 flows of data: $A_0 \rightarrow A_2$, $A_1 \rightarrow A_3$, ..., $A_4 \rightarrow A_0$ and $A_5 \rightarrow A_1$)
- there is a packet sniffer, called S_i on the link between X_i and $X_{i+1} \pmod 6$. The packet sniffer can see all packets flowing on the link in either direction.

1. X_1 to X_6 are routers running OSPF. All link costs are equal. Which of the six flows can be observed at the observation point S_i , $i = 0 \dots 5$?

2. $X1$ to $X6$ are transparent bridges. Which of the six flows can be observed at the observation point $S_i, i = 0 \dots 5$?

3. $X1$ to $X6$ are again routers, running some unspecified routing protocol. We would like that the flow $A0 \rightarrow A2$ goes via $X0, X1, X2$ whereas the flow $A1 \rightarrow A3$ should go the long way, i.e. via $X1, X0, X5, X4, X3$. Is this possible ? If not, why ? If so, by which mechanisms ?