First name: _____ Family name: _____

# FINAL EXAM - SLOT 2
# TCP/IP NETWORKING
# Duration: 90 min.

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2009 January 30

The exam is in two time slots. Slot 2 covers part 1 of the course.

**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.

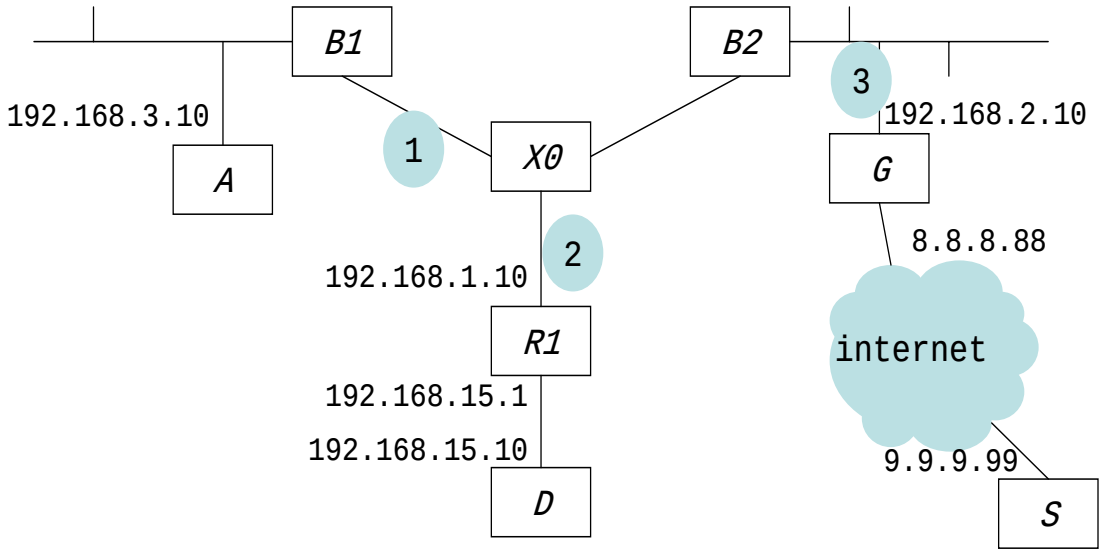


Figure 1: The network used in Question 2.1

## QUESTION 2.1

Consider the network in Figure 1. The version of IP used is IPv4.

- $B1$ and $B2$ are bridges
- $R1$ is a router
- $G$ is an application layer gateway
- $A, D$ and $S$ are hosts. $S$ is running a web server.
- Some of the IP addresses are shown on the figure. If you need to make assumptions about IP or MAC addresses, please write them down on the figure.
- all hosts generate packets with TTL=64.

1. Assume $X0$ is configured as a router.
   (a) Give a possible set of values for the subnet masks at $A$ and $G$.

   (b) $A$ sends one single ping packet to $D$. We assume that all caches are initially empty. We observe all packets resulting from this activity at observation points 1, 2 and 3. Give the MAC source and destination addresses observed in all of these packets. For those packets that are IP packets,

also give the IP source and destination addresses as well as the value of the TTL. Write your solution in the table below.

| At | MAC addr, source | MAC addr, destination | IP addr, source | IP addr, destination | TTL |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |

(c) The user at $A$ clicks on an HTML file that contains a link to a document located at $S$. We assume now that all caches contain correct values. We observe all packets resulting from this activity in the direction from $A$ to $S$ at observation points 1, 2 and 3, Give the MAC and IP source and destination addresses observed in all of these packets, as well as the value of the TTL. Write your solution in the table below.

| At | MAC addr, source | MAC addr, destination | IP addr, source | IP addr, destination | TTL |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |

2. Assume in this question that $X0$ is configured as a bridge.

   (a) Give a possible set of values for the subnet masks at $A$ and $G$.

   (b) $A$ sends one single ping packet to $D$. We assume that all caches are initially empty. We observe all packets resulting from this activity at observation points 1, 2 and 3. Give the MAC source and destination addresses observed in all of these packets. For those packets that are IP packets, also give the IP source and destination addresses as well as the value of the TTL. Write your solution in the table below.

| At | MAC addr, source | MAC addr, destination | IP addr, source | IP addr, destination | TTL |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |

3. Assume $X0$ is configured as a router. The netmasks at $A, D$ and $G$ are `255.255`. What additional function needs to be implemented at $X0$ for proper operation ?

4. Assume in this question that
   - we know that $X0$ works either as a bridge or as a router,
   - however, we do not know which of the two functions is activated, and it is impossible to log into $X0$ in order to read its configuration or get any other inside information.

   Can you find one mechanism that allows you to determine, by external observations, whether $X0$

works as a bridge or as a router ? Give all details.

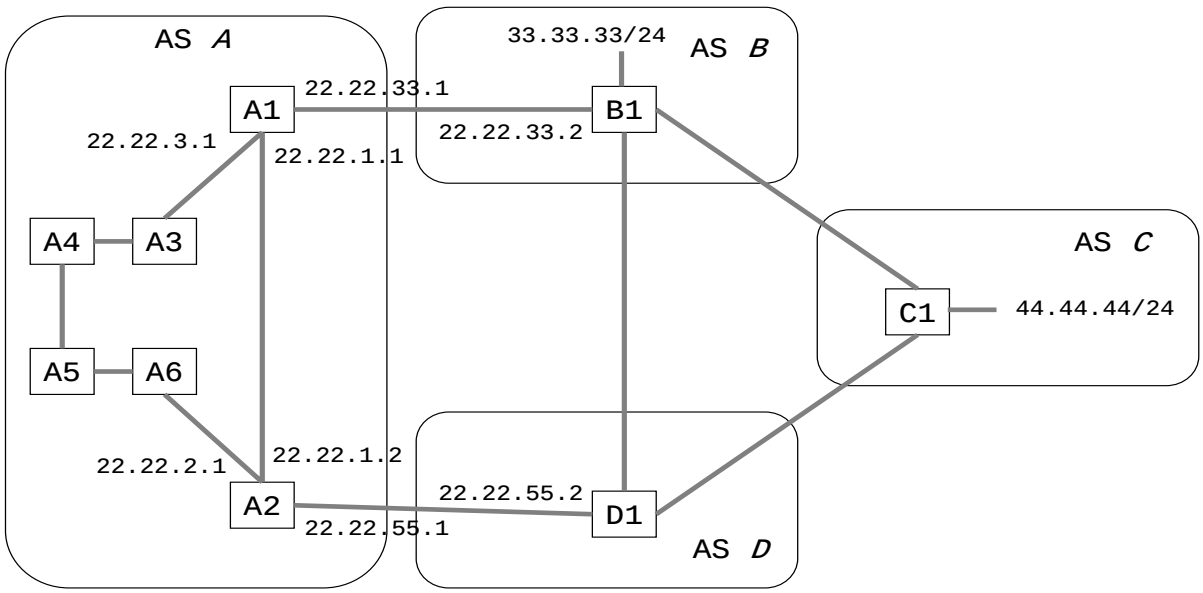


Figure 2: The network used in Question 2.2

## QUESTION 2.2

Consider the network in Figure 2.

- $A1$ to $A6$, $B1, C1$ and $D1$ are routers. All physical links are shown with thick lines. There are no other routers than shown on the figure.
- Some of the IP addresses are shown. If you need some IP addresses that are not indicated, please write them down on the figure.
- All routers in AS $A$ run RIP.
- All routers run BGP, unless otherwise specified. We do not re-distribute BGP into RIP.
- BGP routers ignore the values of `LOCAL-PREF`, `WEIGHT` and `MED`.

1. At time $t_0$, $B1$ sends to $A1$ the BGP announcements

   B1 to A1: `33.33.33/24, AS path =B, NEXT-HOP=22.22.33.2`

   B1 to A1: `44.44.44/24, AS path =B C, NEXT-HOP=22.22.33.2`

   Assume that, before $t_0$, $A1$ did not have any route in any of its `RIB-IN`s for these two destinations. Will $A1$ accept these routes ? To which routers will $A1$ announce a route to `33.33.33/24` ? to `44.44.44/24` ?

2. At time $t_1 > t_0$, $D1$ sends to $A2$ the BGP announcements

   D1 to A2: `33.33.33/24, AS path = D B, NEXT-HOP=22.22.55.2`

   D1 to A2: `44.44.44/24, AS path = D C, NEXT-HOP=22.22.55.2`

   Say which routes to `33.33.33/24` and to `44.44.44/24` the decision process at $A2$ will choose. Justify your answer.

   Same question for the decision process at $A5$.

3. Assume, in this question only, that at time $t_2 > t_1$ the link between $A1$ and $B1$ crashes. Explain what happens at all routers inside AS $A$. Which routes to `33.33.33/24` and to `44.44.44/24` will $A5$ now choose ?

4. Assume, in this question only, that $A3, A4, A5$ and $A6$ do *not* run BGP (but all routers in AS $A$ run RIP). Assume that $A1$ and $A2$ both advertise into RIP the prefix `*/0`. Assume that $A5$ has a packet to send to destination `33.33.33.1`. After all routing protocols have converged, what is the path followed by this packet until its exit point out of AS $A$ ?

   Assume now that the link between $A1$ and $A2$ crashes. Explain what will happen to BGP RIBs at $A1$

and $A2$; say in particular which routes to `22.22.22/24` and `33.33.33/24` will be selected at $A1$ and $A2$. Assume that $A5$ has a packet to send to destination `33.33.33.1`. After all routing protocols have converged after the failure, what is the path followed by this packet until its exit point out of AS $A$ ?