SCIPER: ____________________

First name: ____________________ Family name: ____________________

EXAM
TCP/IP NETWORKING
Duration: 3 hours
With Solutions

Jean-Yves Le Boudec

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INSTRUCTIONS

1. Write your solution into this document and return it to us (you do not need to return the figure sheet). You may use additional sheets if needed. Do not forget to put your name on this document and *all* additional sheets of your solution.
2. If you need to make assumptions in order to solve some questions, please write them down explicitly.
3. Figures are on a separate sheet, for your convenience.
4. No documents, no electronic equipments are allowed.
5. Justify every answer with a short explanation.

PROBLEM 1

Consider the network in Figure 1. $G, S1, S2, A$ are hosts; $X1, X2, X3$ are dual stack routers. All link costs are equal to 1.

- $S1$ is IPv6 only
- $S2$ and A are IPv4 only
- G is dual stack.
- The dotted circles identify observation points.

1. What are the 17th, 18th and 19th bits of the IPv6 address of G ?

   All three bits are 0.

   Are the IPv6 addresses of G and $S1$ valid ? If so, give their non compressed forms.

   Yes the addresses are valid and their non-compressed forms are:
   G: 2001:000a:000b:000a:0000:0000:0000:000a
   S1: 2001:000a:000b:000b:0000:0000:0000:000b

2. Give possible values for the network masks at all hosts. Give your answer in the table below.

Host	IPv4 mask	IPv6 mask
A	255.255.255.0	NA
G	255.255.255.0	ffff:ffff:ffff:ffff::
S1	NA	ffff:ffff:ffff:ffff::
S2	255.255.255.0	NA

3. We assume that all hosts are configured with correct masks and default gateway. All caches are empty; the routers have correct routing tables but their ARP tables are empty; then $S1$ sends one single IP packet to G's IPv6 address, with Hop Limit equal to 64. We observe all packets at the observation point 0. Explain which packets, resulting from this activity, are seen at this observation point. For each of the packets, give the value of the following fields:

   - MAC source address, MAC destination address (use the identifier of the machine on the figure to denote its MAC address; for example, $S1$'s MAC address is $S1$; a machine such as $X1$ has several MAC addresses; if necessary, specify for example $X1l$ for the left interface of $X1$, $X1t$ for the top, $X1b$ for the bottom and $X1r$ for the right).
   - For IP packets, give: source IPv6 address, destination IPv6 address, Hop Limit.

description	MAC source	MAC dest	IPv6 source	IPv6 dest
N.solicitation	X11	33:33:FF:00:00:0a	2001:a:b:a::1	ff02::1:ff00:a
N.advertisement	G	X11	2001:a:b:a::a	2001:a:b:a::1
S1→ G	X11	G	2001:a:b:b::b	2001:a:b:a::a

4. We assume again that all hosts and routers are configured with correct masks and default gateway. All caches are empty; the routers have correct routing tables but their ARP tables are empty; then $S2$ sends one single IP packet to G's IPv4 address, with TTL equal to 64. We observe all packets at the observation point 0. Explain which packets, resulting from this activity, are seen at this observation point. For each of the packets, give the value of the following fields:

   - MAC source address, MAC destination address (use the identifier of the machine on the figure to denote its MAC address; for example, $S1$'s MAC address is $S1$).
   - For IP packets, give: source IPv4 address, destination IPv4 address, TTL.

description	MAC source	MAC dest	IPv4 source	IPv4 dest	TTL
ARP request	X11	ff:ff:ff:ff:ff:ff	-	-	-
ARP reply	G	X11	-	-	-
S2→ G	X11	G	1.1.2.2	1.1.4.4	62

5. $S1$ runs an IPv6 only web server, with name `www.sovkom.an`. G is configured as a dual stack application layer gateway acting as web proxy. A wishes to access `www.sovkom.an` but does not run IPv6, therefore will access $S1$ via G.

   (a) By which mechanism will A discover that it should send its HTML requests to G ? Give one possible solution that does not involve any special configuration at A. Specify any additional assumption you may make.
   A will discover it via DNS, i.e., A will ask for www.sovkom.an with record A and the DNS server will reply to this query with the IPv4 address of the ALG (1.1.4.4)

   (b) A accesses $S1$ via G. At observation point 3 we observe one of the packets resulting from this activity; the packet we observe is the one containing the HTTP request. Explain whether it is an IPv4 or an IPv6 packet. Also give its MAC source and destination address, its IP (v4 or v6) source and destination address and its protocol type. Give the fields in the table below.
   It is an IPv4 packet.

MAC source	MAC dest	IP source	IP dest	Protocol
X3l	X1b	1.1.3.3	1.1.4.4	TCP

6. We now assume that $X1, X2$ and $X3$ are configured as bridges instead of routers.

   (a) Give possible values for the network masks at all hosts. Give your answer in the table below.

Host	IPv4 mask	IPv6 mask
A	255.255.0.0	NA
G	255.255.0.0	ffff:ffff:ffff::
S1	NA	ffff:ffff:ffff::
S2	255.255.0.0	NA

(b) We assume that all hosts are configured with correct masks and that the network has been operating for some time, so that all ARP caches are populated with correct values.

Then A sends one single UDP packet to $S2$, $S1$ sends one UDP packet to G and G sends one UDP packet to A. We observe all traffic resulting from this activity at observation points 1, 2 and 3. All IP packets are generated with TTL or Hop Limit equal to 64. Assume there is no packet loss.

For each of the three observation points, say what we see. Give the MAC and IP (v4 or v6) source and destination addresses and the TTL or Hop Limit value in the table below.

The spanning tree protocol will build a tree; therefore one link between the X's will be disabled. We cannot known which one unless we know the bridge labels. Assume for example that $X1$ is selected as root bridge. The link $X2 - X3$ is then disabled and the traffic from A to $S2$ will flow via $X1$. In this case we obtain:

Obs. Point	MAC source	MAC dest	IP source	IP dest	TTL\Hop Limit
1	S1	G	2001:a:b:b::b	2001:a:b:a::a	64
1	A	S2	1.1.3.3	1.1.2.2	64
3	A	S2	1.1.3.3	1.1.2.2	64
3	G	A	1.1.4.4	1.1.3.3	64

PROBLEM 2

Consider the network in Figure 2.

- A, B and S are hosts. A receives IPv4-only service from ISP1. B receives IPv6-only service from ISP2; S receives IPv4-only service from ISP2.
- $R11, R12, ..., R23$ are routers. $R12$ and $R22$ are 6to4 relay routers. $N2$ is a NAT64 box.
- The plain lines indicate direct (layer 2) connection.
- $DS1$ and $DS2$ are DNS servers. They are connected to both IPv4 and IPv6 and serve requests for both A and $AAAA$ records. In addition, $DS2$ implements DNS64.

1. A is a dual stack host that receives only an IPv4 address from the network. A uses 6to4 to connect to the v6 Internet. Give a possible value for A's 6to 4 IPv6 address.

   `2002:0303:0303:abcd:`EUI$_A$

   What should A's default gateway's IPv6 address be ?

   `2002:c058:6301::0`

2. B is an IPv6 only host. A sends one UDP packet to B. We observe this packet on the Ethernet link between A and $R11$. We find that the Ethernet header contains protocol type = 0800, i.e. this is an IPv4 packet. Say what the IPv4 source and destination addresses in this packet are; what is the protocol field in the IPv4 header ?
   IPv4$_{Src}$ = `3.3.3.3`
   IPv4$_{Dst}$ = `192.88.99.1`
   Protocol = 41 (Because we have an IPv6 packet carried in an IPv4 packet.)

   B responds to A with one single UDP packet. We observe this packet on the Ethernet link between B and $R23$. Which protocol type should we see in Ethernet header? Say what the IP (v4 or v6) source and destination addresses in this packet are.
   IPv6$_{Src}$ = `2001:a:a:a::2`
   IPv6$_{Dst}$ = `2002:0303:0303:abcd:EUI`
   Protocol = `0x86DD` (Because ethernet carries an IPv6 packet.)

   Will this packet go via $R12$ or via $R22$? (justify your answer).
   It will go via $R22$. (As routing on the Internet is based on shortest path, packets will go to the nearest of the two, *i.e.,* $R22$.)

3. S is an IPv4 only host that runs a web server. B runs a web browser and sends an HTML request to S. No application layer gateway is used. Consider the first TCP SYN packet related to this activity, sent by B to S; we observe this packet on the Ethernet link between B and $R23$. Which protocol type should we see in Ethernet header? Say what the IP (v4 or v6) source and destination addresses in this packet are.

   Protocol = `0x86DD`
   IPv6$_{Src}$ = `2001:a:a:a::2`
   IPv6$_{Dst}$ = `64:ff9b::0202:0202`
   $DS2$(*i.e.,* DNS64) will send this destination address to B.

4. We also observe this packet on the Ethernet link between $R21$ and S (we assume no packet is lost). Which protocol type should we see in Ethernet header? Say what the IP (v4 or v6) source and destination addresses in this packet are. Specify any assumption you may need to make.
   Here, NAT64 is used (N2). NAT64 was designed for client6 to server4 access. Destination (server) IP addresses are mapped to valid IPv6 addresses from the dedicated block `64:ff9b::/96`. Additionally, we introduce the assumption here that N2 owns the address pool `120.130.26/24`.

   IPv4$_{Src}$ = `120.130.26.33`
   IPv4$_{Dst}$ = `2.2.2.2`
   Protocol (Ethertype) = `0x0800` (IPv4 packet)

5. S responds to B with a TCP SYN ACK packet. Will this packet go via $R22$ or via $N2$? How does R21 know where to route this packet ? (justify your answer).
   Packet sent by S has:
   IPv4$_{Src}$ = `2.2.2.2`
   IPv4$_{Dst}$ = `120.130.26.33`
   The packet will go via N2 (NAT64). $R21$ knows where to send the packet based on its destination address ($N2$ announces the prefix for the IPv4 pool it has at its disposal, *i.e.,* `120.130.26/24`).

6. A runs a web browser and sends an HTML request to S. Consider the first TCP SYN packet related to this activity, sent by A to S; we observe this packet on the Ethernet link between A and $R11$. Which protocol type should we see in Ethernet header? Say what the IP (v4 or v6) source and destination addresses in this packet are.
   This is now IPv4 to IPv4 communication over an IPv4 network:
   Protocol (Ethertype) = `0x0800` (IPv4 packet)
   IPv4$_{Src}$ = `3.3.3.3`
   IPv4$_{Dst}$ = `2.2.2.2`

PROBLEM 3

Consider the network in Figure 3 on the figure sheet.

- A, B and S are hosts; $R1$ and $R2$ are routers. The user at A is uploading a very large file to S and, similarly, the user at B is uploading a very large file to S.
- The link rates are indicated on the figure.
- 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 A or B to S. We also neglect the impact of the acknowledgement flows in the reverse direction.
- The round trip time between A and S is 1000 ms, and the round trip time between B and S is 100 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 and is equal to 1250 Bytes = 10^4 bits.

1. Assume that some bandwidth manager is used, which allocates rates to flows according to max-min fairness. What are the values of the rates of the flows $A \to S$ and $B \to S$?
   The unique max-min fair allocation is obtained by water-filling. The bottleneck link is R1-R2 and the two flows get equal share on it. Therefore, both rates are: 1.1/2=0.55Mb/s
2. Same question with proportional fairness instead of max-min fairness.
   Let x_1 and x_2 be the rates of the two flows. The link R1-R2 is shared and fully utilized so:
   $$x_1 + x_2 = 1.1$$
   With proportional fairness the allocation can be found by maximizing:
   $$\ln(x_1) + \ln(x_2)$$
   Writing the above equation as a function of x1 only, one has:
   $$f(x_1) = \ln(x_1) + \ln(1.1 - x_1)$$
   By deriving this function we can find its maximum:
   $$f'(x_1) = \frac{1}{x_1} + \frac{-1}{1.1 - x_1} = \frac{1.1 - 2x_1}{x_1(1.1 - x_1)}$$
   By setting $f'(x_1) = 0$ we get x_1=0.55 and $x_2 = 1 - 0.55 = 0.55$
3. We now assume that the two flows are using TCP with ECN. What is the value of the rate of each flow ?
   Link R1-R2 is fully utilized so again we have:
   $$x_1 + x_2 = 1.1$$
   Second, the rates are inversely proportional to RTTs, thus:
   $$\frac{x_1}{\frac{1}{1000}} = \frac{x_2}{\frac{1}{100}} \Rightarrow x_2 = 10x_1$$
   From these two equations we can compute: $x_2 = 1Mb/s$ and $x_1 = 0.1Mb/s$

4. We continue to assume that the two flows are using TCP with ECN. We observe the IP headers of packets on the link from $R1$ to $R2$. Which proportion of packets do we see marked as "Congestion Experienced" ?
If the two flows were using TCP without ECN we could obtain by the loss throughput formula the loss ratio of the link i.e., the fraction q of the packets that is in average lost. Now, with ECN we could think that q is in average the fraction of packets that should be marked as congestion experienced in order to avoid having losses. Thus,the loss throughput formula tells us that

$$\theta = \frac{C \cdot MSS}{T\sqrt{q}}.$$

Therefore the fraction of marked packets is $q = (\frac{C \cdot MSS}{T\theta})^2$. Replacing with values of flow 1 (flow 2 gives the same result), we obtain:

$$q \approx \left(\frac{1.22 \cdot 10^4 bits}{1sec \cdot 0.1 \cdot 10^6 bits/sec}\right)^2 = 0.014884 \approx 1.49\%.$$

5. We continue to assume that the flows are using TCP and ECN, but now A cheats and uses a smart piece of software that allows it to open several TCP connections and use them in parallel in order to transfer one single file. Assume that A uses k TCP connections. What should the value of k be in order for A to obtain the same throughput as B ?
Let us denote by x_{iA} the rate of the $i-th$ TCP flow used by A and by x_B the rate of the flow of B. We can write the following equations:
First assuming full utilization we have:

$$\sum_{i=1}^{k} x_{iA} + x_B = 1.1$$

Second assuming all flows from A have the same RTT=1000ms then from the loss-throughput formula we have that:

$$x_{iA} = 0.1 x_B, i = 1, \cdots, k$$

Third, the goal is to achieve:

$$\sum_{i=1}^{k} x_{iA} = x_B$$

From the first and third equations we can compute: $x_B = 0.55$
From the second equation we compute $x_{iA} = x_A = 0.055, i = 1, \cdots, k$
Finally, from the third equation we have: $\sum_{i=1}^{k} x_{iA} = x_B \Rightarrow k x_A = x_B \Rightarrow k \cdot 0.055 = 0.55 \Rightarrow k = 10$

PROBLEM 4

Consider the network in Figure 4 on the figure sheet.

- $A1$, $A2$, $A3$, $A4$, $B1$ and $C1$ are BGP routers. A, B, C, D and E are AS numbers. Thick lines indicate physical connections. There are no other BGP routers in ASs A, B, C than shown on the figure. There are some BGP routers in ASs D and E that are not shown on the figure.
- Some IP addresses are shown. If you need any IP addresses that are not indicated, please mention them in your solution.

- Only IPv4 is used.
- RIP is run inside AS A (all link costs are equal to 1).
- Routers do not perform aggregation, unless explicitly mentioned.

1. At time t_0, $A1$ boots. All other routers are up and running. At time $t_1 > t_0$, $A1$ receives from $B1$ the announcements:

   ```
   66.66.0/17, AS path = B D E, NEXT-HOP=12.12.12.2
   66.66.128/17, AS path = B D E, NEXT-HOP=12.12.12.2
   ```

   No other announcements were received by $A1$ before this one. Explain what actions are performed by $A1$ upon receiving these routes. Say in particular to which BGP routers, if any, $A1$ will send announcements as a result.
   Solution. A1 will add both announcements to its LOC-RIB and to its routing table. Then A1 will announce this routes to all its I-BGP neighbours, i.e. to A2, A3, and A4.
2. At time $t_2 > t_1$, $A2$ receives from $C1$ the announcement

   ```
   66.66/16, AS path = C D E, NEXT-HOP=13.13.13.2
   ```

   Assume no other announcement than previously shown was sent by either $B1$ or $C1$. At time $t_3 > t_2$ BGP has stabilized again inside ASs A, B, C. $A4$ has a packet to forward with destination address `66.66.1.2`. Which path will this packet follow ? (Justify your answer in detail !)
   Solution. Upon receiving the above announcement, A2 adds this route to its LOC-RIB and to its routing table. It will then announce this route to its I-BGP neighbors (A2, A3 and A4). These routers will also add this route to their routing table.
   A4 uses the most specific prefix (longest prefix match) to choose the path to route the packet through. Therefore, the packet will follow the route which was announced by A1, i.e.

   ```
   66.66.0/17, AS path = B D E, NEXT-HOP=12.12.12.2
   ```

   Thus, the path it follows is A4-A3-A1-B1.
3. At time $t_4 > t_3$ $A1$ receives from $B1$ the announcement

   ```
   66.66/16, AS path = B E, NEXT-HOP=12.12.12.2
   ```

   At time $t_5 > t_4$, BGP has converged again (no BGP announcement was received from B or C between t_4 and t_5). Give all the routes to `66.66/16`, if any, that are stored in $A4$'s RIB-INs. Give their `NEXT-HOP` and `AS path` attributes. Which of this routes is selected by $A4$ as best route ?
   Solution. A1 already has an entry in its routing table to the destination network 66.66/16 which it learned from A2 through I-BGP. The entry in the routing table is now updated with this newly announced route from B1 because of the shortest AS path rule. A1 will also announce this path to its I-BGP neighbors. Therefore the routes for 66.66/16 present in RIB-IN of A4 are:

   ```
   66.66/16, AS path = B E, NEXT-HOP=12.12.12.2
   66.66/16, AS path = C D E, NEXT-HOP=13.13.13.2
   ```

   The best route chosen by A4 is the one with the shortest AS path, i.e., the first entry.
   $A4$ has a packet to forward with destination address `66.66.1.2`. Which path will this packet now follow ? (Justify your answer in detail !)
   Solution. The longest prefix match rule will again be applied. Therefore, the answer is still the same as the one for Q4.2.
4. At time $t_6 > t_5$, $A1$ receives from $B1$ the BGP message

   ```
   WITHDRAW 66.66.0/17, AS path = B D E, NEXT-HOP=12.12.12.2
   WITHDRAW 66.66.128/17, AS path = B D E, NEXT-HOP=12.12.12.2
   ```

We assume that no other announcement was sent by AS B or C between t_5 and t_6. Give all announcements that will be sent by $A1$ to other BGP routers as a consequence of these announcements.

Solution. A1 first removes the announced routes from its routing table and from its LOC-RIB entries. This changes the choice of best route to this prefix, which is now the other route. $A1$ then announces to its I-BGP neighbors that the routes to the above prefixes (with next hop 12.12.12.2) are not reachable any more. Since no alternative routes to these prefixes were announced previously, no other update messages will be announced by any router in AS A.

At time $t_7 > t_6$ BGP has stabilized again. $A4$ has a packet to forward with destination address `66.66.1.2`. Which path will this packet follow ? (Justify your answer in detail !)

Solution. The route which was chosen before based on the longest prefix match is now removed from the routing table of A4. However, A4 has a best route to the network with prefix 66.66/16 based on the shortest AS path as explained in 4.3. Since the destination address of the packet `66.66.1.2` belongs to the network with prefix 66.66/16, A4 will forward the packet using this route. Thus the packet follows the path A4-A3-A1-B1.

PROBLEM 5

Consider the network in Figure 5. Boxes $R1$ to $R7$ are routers. Every router has 2 or more interfaces, as shown on the figure.

All routers run an IPv6 distance vector routing protocol with route poisoning. Unless otherwise specified, the cost of a link between two routers is 1 and the cost from a router to a directly attached network is 1.

There is one IPv6 network between consecutive routers on the figure, with subnet prefix of length 64. For example, there is a network `2000:a:a:12::/64` between $R1$ and $R2$. All routers inject their directly attached networks into the distance vector routing protocol.

1. Give a possible value of the routing table at router $R5$, at a time t_1 such that the routing protocol has converged. Give the values in the table below (do not give the value of the "interface" field).

At $R5$		
Destination Network	Next-Hop	Distance
2000:a:a:12::/64	2000:a:a:45::1 or 2000:a:a:56::2	4
2000:a:a:23::/64	2000:a:a:45::1	3
2000:a:a:34::/64	2000:a:a:45::1	2
2000:a:a:45::/64	directly connected	1
2000:a:a:56::/64	directly connected	1
2000:a:a:67::/64	2000:a:a:56::2	2
2000:a:a:17::/64	2000:a:a:56::2	3

2. At time $t_2 > t_1$, $R1$ is configured as a Teredo relay router and now also injects the prefix `2001::/32` as a directly attached prefix. $R1$ does its job and sends a routing update to all its neighbors. Give a possible value of the routing table at router $R5$, at a time t_3 such that the routing protocol has converged again.

At $R5$		
Destination Network	Next-Hop	Distance
2000:a:a:12::/64	2000:a:a:45::1 or 2000:a:a:56::2	4
2000:a:a:23::/64	2000:a:a:45::1	3
2000:a:a:34::/64	2000:a:a:45::1	2
2000:a:a:45::/64	directly connected	1
2000:a:a:56::/64	directly connected	1
2000:a:a:67::/64	2000:a:a:56::2	2
2000:a:a:17::/64	2000:a:a:56::2	3
2001::/32	2000:a:a:56::2	4

3. At time $t_4 > t_3$, $R6$ is also configured as a Teredo relay router and injects the prefix `2001::/32` as a directly attached prefix. $R6$ does its job and sends a routing update to both of its neighbors. Assume that $t_4 - t_3$ is short enough, so that no other message was generated in the time interval $[t_3, t_4]$. Explain which computations $R7$ and $R5$ will perform upon receiving the routing update from $R6$.
At $R7$ the update does not come from the next hop, therefore $R7$ will compare its existing entry for the prefix `2001::/32` via $R1$ with the update from $R6$. As the distance in the update is the same as the existing one (2), $R7$ will do no change in its routing table.

   At $R5$ the update comes from the next hop, therefore $R5$ will accept the update as shortest path without comparing to the existing values and sets the distance from 4 to 2. The next hop remains the same.

4. At a time $t_5 > t_4$ such that the routing protocol has converged again, give the values of the routing table at $R5$.

At $R5$		
Destination Network	Next-Hop	Distance
2000:a:a:12::/64	2000:a:a:45::1 or 2000:a:a:56::2	4
2000:a:a:23::/64	2000:a:a:45::1	3
2000:a:a:34::/64	2000:a:a:45::1	2
2000:a:a:45::/64	directly connected	1
2000:a:a:56::/64	directly connected	1
2000:a:a:67::/64	2000:a:a:56::2	2
2000:a:a:17::/64	2000:a:a:56::2	3
2001::/32	2000:a:a:56::2	2

5. At time $t_6 > t_5$, the link between $R1$ and $R2$ breaks, but the interfaces with IP addresses `2000:a:a:12::1` and `2000:a:a:12::2` stay up; the loss of the link is detected immediately by $R2$. $R2$ does its job and sends a routing update to its neighbor $R3$. Assume that $t_6 - t_5$ is short enough, so that no other message was generated in the time interval $[t_5, t_6]$.
Explain which computation $R3$ will perform upon receiving the routing update from $R2$.
As the route poisoning is used $R3$ will update its routing table by setting distance to infinity for those networks that are routed through $R2$. In particular, those are `2000:a:a:17::/64`, `2001::/32` and possibly `2000:a:a:67::/64`. In addition, $R3$ will immediately inform $R4$ of these non-reachable routes.

6. Let $t_7 > t_6$ be the time at which the routing protocol converges again (the link between $R1$ and $R2$ is definitively lost). Give the values of the routing table at $R3$ at time t_7.

At $R3$		
Destination Network	Next-Hop	Distance
2000:a:a:12::/64	2000:a:a:23::1	2
2000:a:a:23::/64	directly connected	1
2000:a:a:34::/64	directly connected	1
2000:a:a:45::/64	2000:a:a:34::2	2
2000:a:a:56::/64	2000:a:a:34::2	3
2000:a:a:67::/64	2000:a:a:34::2	4
2000:a:a:17::/64	2000:a:a:34::2	5
2001::/32	2000:a:a:34::2	4

TCP IP EXAM - FIGURES

For your convenience, you can separate this sheet from the main document. Do not write your solution on this sheet, use only the main document. Do not return this sheet.

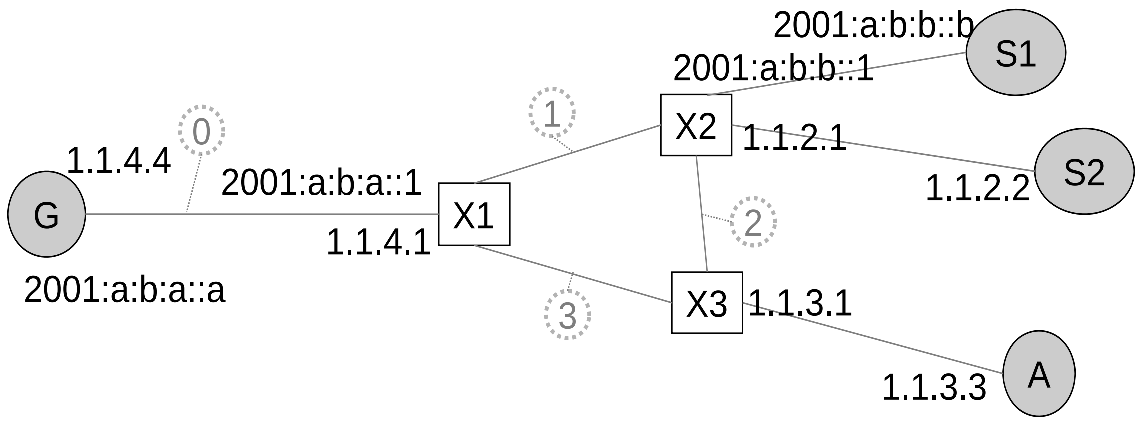

Figure 1: The network used in Problem 1

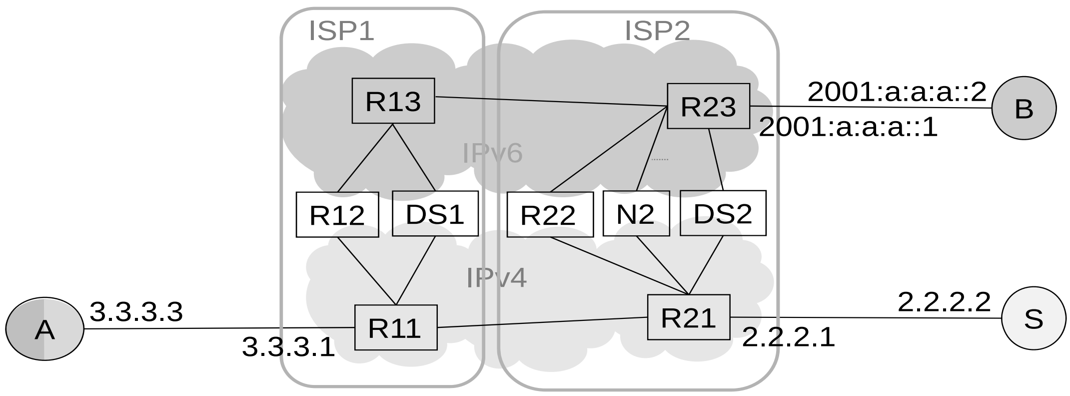

Figure 2: The network used in Problem 2

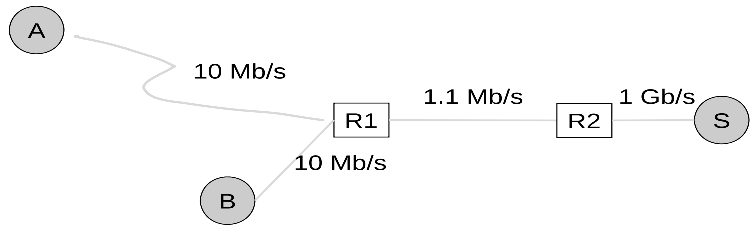

Figure 3: The network used in Problem 3

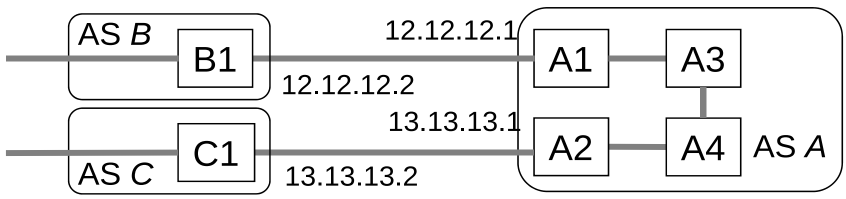

Figure 4: The network used in Problem 4

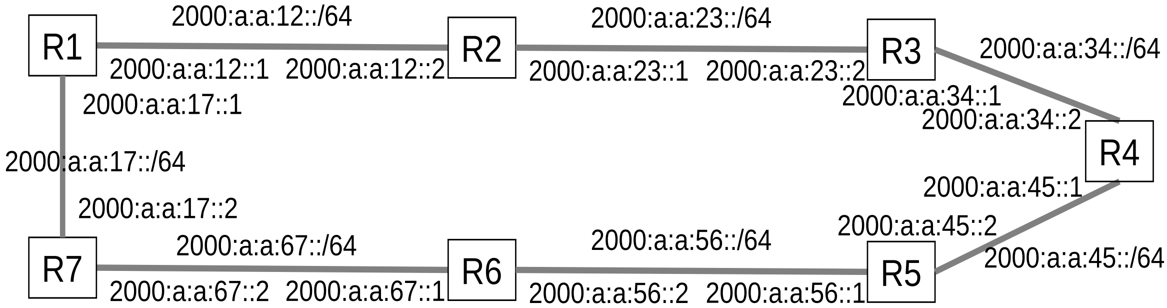

Figure 5: The network used in Problem 5