

Computer Networks - Midterm

November 2, 2018

Duration: 2h15m

- This is a closed-book exam.
- Please write your answers on these sheets in a readable way, in English or in French.
- You can use extra sheets if necessary (don't forget to put your name on them).
- The total number of points is 100.
- This document contains 16 pages.
- Good luck!

Full Name (Nom et Prénom):

SCIPER No:

Division: ☐ Communication Systems ☐ Computer Science
 ☐ Other (mention it):

Year: ☐ Bachelor Year 2 ☐ Bachelor Year 3
 ☐ Other (mention it):

1 Short questions

(10 points)

For each question, please circle a single best answer.

1. Which of the following identifies a process?
 - (a) `http://www.epfl.ch`
 - (b) `http://www.epfl.ch/index.html`
 - (c) `www.epfl.ch:80`
 - (d) `192.168.76.3`
2. Which mechanism do proxy web servers use to check for stale cached data?
 - (a) Timestamps.
 - (b) Cookies.
 - (c) Conditional GET requests.
 - (d) All of the above.
3. Which of the following DNS servers is guaranteed to know the IP address of `www.epfl.ch`?
 - (a) An authoritative DNS server that is responsible for `epfl.ch`.
 - (b) A top-level-domain DNS server that is responsible for `.ch`.
 - (c) The root DNS server that is physically closest to EPFL.
 - (d) All of the above.
4. If a root DNS server stops caching name-to-IP mappings,
 - (a) it will start receiving more DNS requests.
 - (b) it will start sending more DNS requests.
 - (c) it will start sending incorrect DNS responses.
 - (d) nothing will change in its behavior.
5. According to the analysis we did in class, peer-to-peer file distribution scales better than client-server file distribution, because
 - (a) peer processes typically run on more powerful machines.
 - (b) peer processes typically consume fewer resources than client or server processes.
 - (c) as more peers join the system, there are more requests for download, but also more sources to download from.
 - (d) most peers tend to request the same few pieces of content.
6. Which is the minimum number of UDP sockets that a process must create in order to communicate with 1000 remote processes?
 - (a) 1.
 - (b) 2 (one for sending, and one for receiving traffic).
 - (c) 1000.
 - (d) I don't have enough information to answer.

7. Why do we use pipelining in reliable data delivery protocols?
- (a) To recover from packet corruption and loss.
 - (b) To reduce the transmission delay between sender and receiver.
 - (c) To reduce the RTT (round-trip time) between sender and receiver.
 - (d) To improve the throughput between sender and receiver.
8. If we want to significantly decrease the RTT between a sender and a receiver, we should
- (a) reduce the size of the packets they exchange.
 - (b) reduce the length of the links that interconnect them.
 - (c) increase the transmission rates of the links that interconnect them.
 - (d) do all of the above.
9. If we increase the size of a packet switch's forwarding table, the packets that traverse the switch may experience higher
- (a) transmission delay.
 - (b) propagation delay.
 - (c) queuing delay.
 - (d) None of the above.
10. A sender is connected to a receiver over three consecutive links. What will happen if we double the transmission rate of one of these links?
- (a) We will double the throughput from sender to receiver.
 - (b) We will halve the RTT between sender and receiver.
 - (c) We will impact neither the throughput nor the delay between sender and receiver.
 - (d) I don't have enough information to answer.

2 Lab-related questions

(15 points)

Question 1 (10 points):

Suppose you ping a given destination (e.g., `www.epfl.ch`) multiple times and with different packet sizes, and you obtain the following information:

Packet size	Average delay	Minimum delay
50	15.160	15.010
250	15.480	15.230
500	15.960	15.460
750	16.480	16.080
1000	16.960	16.560
1250	17.480	17.180
1500	17.960	17.510

What is a good approximation of the propagation+processing delay of the path from your machine to the target and back? What is a good approximation of the throughput of the bottleneck link on this path? Explain your answers.

Question 2 (5 points):

Are traceroutes always symmetric? In other words, does the traceroute from Alice to Bob always include the same nodes as the traceroute from Bob to Alice? Explain your answer.

3 Web browsing

(30 points)

Consider Figure 1.

All EPFL end-systems:

- Use local DNS server `ns.epfl.ch`, whose IP address they already know.
- Access the web through proxy web server `proxy.epfl.ch`, whose IP address they already know.
- Implement the following security measure: if an end-system sends out a DNS request and receives more than one DNS response to this request within a short period of time (all with the same destination port number), it drops all these DNS responses.

All DNS caches are initially empty. The proxy web server's web cache is initially empty.

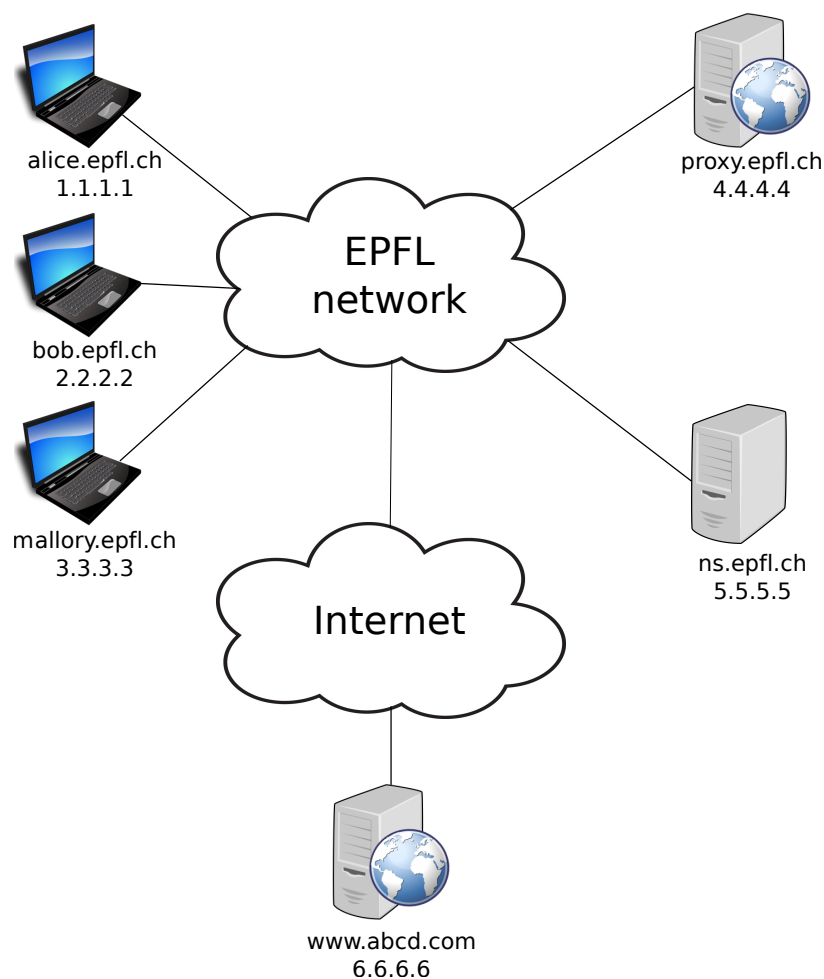


Figure 1: Topology for Problem 3.

Question 1 (12 points):

Mallory asks the local DNS server for the IP address of `www.abcd.com`.

Shortly after, Alice uses her web browser to retrieve page `http://www.abcd.com/index.html`, which includes two images: `http://www.abcd.com/img1.png` and `http://www.abcd.com/img2.png`.

- a. Which is the most efficient way for Alice's web browser to use the underlying transport layer protocol? **For the rest of Problem 3, assume that all web browsers use the underlying transport layer protocol as you described.**
- b. List all packets that are exchanged in the network **from the moment Alice sends her first packet**, including any connection-setup packets, by filling in Table 1. The number of rows in Table 1 does not imply anything about the size of the solution.

[illegible]

Question 2 (8 points):

Shortly after, Bob uses his web browser to retrieve page `http://www.abcd.com/news.html`, which references image `http://www.abcd.com/img1.png` (which was also referenced in Question 1).

List all packets that are exchanged in the network, including any connection-setup packets, by filling in Table 2. The number of rows in Table 2 does not imply anything about the size of the solution.

[illegible]

Table 2: Packets transmitted on the Internet, in Problem 3, Question 2

Question 3 (3 points):

What is the minimum number of sockets that `proxy.epfl.ch` uses in Question 1? What is each socket's type and purpose?

Question 4 (10 points):

Mallory knows that Bob is about to access a new page, `http://www.efgh.com/index.html`, and wants to make him access a fake page from her machine instead.

Can she do this? If no, explain why. If yes, explain in which scenario she can do it and how.

Recall that EPFL machines implement a special security measure.

4 Delay and transport layer

(45 points)

Figure 2 shows the topology of the EPFL network from Figure 1, but in more detail.

- Each link has length ℓ and propagation speed c .
- Each link is annotated with its transmission rate, which is the same in both directions of the link.
- Packet switches S_1 and S_2 perform store-and-forward packet switching and introduce insignificant processing delays. Each switch has a separate, infinite queue for each outgoing link. E.g., switch S_2 has three queues: one for packets going to the proxy web server, one for packets going to Deborah, and one for packets going to the other end-systems. As soon as S_2 receives a packet, it immediately places the packet in the corresponding queue, depending on the packet's destination.
- The end-systems communicate using a Go-Back-N transport layer protocol with sender window size $N = 10P$. There is no packet loss or corruption unless explicitly stated.

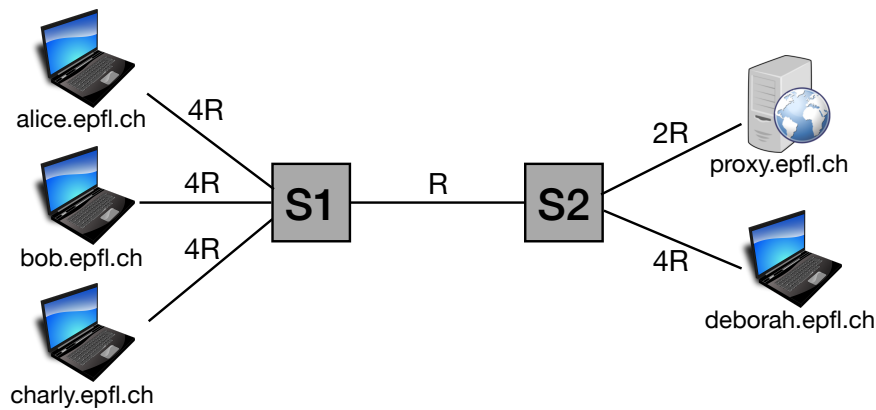


Figure 2: The topology of the EPFL network from Figure 1, in more detail

Question 1 (10 points):

- a. Alice sends a request to the proxy web server, which fits in a single packet of length Q .

How long does it take for this request to be fully delivered to the proxy web server? Explain your answer.

- b. The proxy web server splits a file into P packets of equal length L and sends them back-to-back to Alice.

How long does it take for this file to be fully delivered to Alice? Explain your answer.

Question 2 (10 points):

Consider again Question 1b and suppose that switch $S1$ is compromised and corrupts the payload of a single packet.

Which packet should that be so as to cause the maximum number of retransmissions?

Draw a diagram that shows all the packets transmitted by Alice and the proxy web server, including their sequence and acknowledgment numbers, and all the events that cause one or more retransmissions. Pick any number you want as the first sequence number.

Question 3 (10 points):

Alice has requested a file from the proxy web server, and the proxy web server has retrieved it. The proxy web server splits the file into 2 packets, the first of length L and the second of length $0.1L$, and sends them back-to-back to Alice.

a. What is the queuing delay of each packet? Explain your answer.

b. How long does it take for the file to be fully delivered to Alice? Explain your answer.

Question 4 (10 points):

Consider the same setup as in Question 3. Additionally, Deborah sends 3 packets of equal length L back-to-back to Charly. Deborah starts transmitting her first packet at exactly the same time that the proxy web server starts transmitting its first packet.

How long does it take for the proxy web server's file to be fully delivered to Alice? Explain your answer.

Question 5 (5 points):

In Question 4, could Alice retrieve the file faster by requesting it directly from the origin web server?
What does the answer depend on?