CS335a - Assignment 1

Fall 2025

Main Topics: Packet vs. Circuit Switching,
Delays & Throughput,
Network Measurements & Analysis

Deadline: 17/10 at 10:59 (before the class begins)

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For any questions, send an email to the mailing list: **hy335a-list@csd.uoc.gr**

If your question might reveal part of your answer, send it directly to the TAs mailing list: **hy335a@csd.uoc.gr**

Layers - Encapsulation/Decapsulation

Exercise 1 [6 pts]

Answer the following questions with a brief explanation:

A) If we have **different applications** running simultaneously on a computer, which are sending and receiving data at the same time, is there a possibility that the data between them could get "mixed up"? If not, which layer of the model ensures that the data is kept separate?

B) If you switch from **Ethernet** to **Wi-Fi**, which layer(s) are directly affected?

C) Both the **Network and the Data Link layers** are important for "sending" data. Which is the role of each layer? Hint: you can answer using this prompt: The Network layer is responsible to route packets from ____ to ____ whereas the link layer is responsible for data transfer between ____

D) If two computers use different operating systems (e.g., Windows and Linux), can they still communicate? Why?

Exercise 2 [6 pts]

Select the correct option for the following. There is only one correct answer. Briefly **justify your choice**.

A) What happens during the transmission of a packet from one router to another?

i) The packet is not encapsulated/decapsulated.
ii) Encapsulation/decapsulation occurs, and some fields of the MAC header are changed.
iii) Encapsulation/decapsulation occurs, and the IP addresses of the sender and receiver are changed.

B) During encapsulation, the Transport layer "segment" is converted into a:

i) Frame
ii) Datagram
iii) Message
iv) Bit stream

C) During the encapsulation process, what does the Network layer do with the header of the Transport layer?

i) It removes the header of the Transport layer.
ii) It keeps the header unchanged.
iii) It adds its own header.
iv) It replaces the Transport layer header with a new one.

D) During decapsulation, what does the Data Link layer at the receiver do with the IP header?

i) It removes the IP header.
ii) It keeps the IP header unchanged.
iii) It processes and modifies the IP header.
iv) It removes only the frame header/trailer; the IP header is handled by the Network layer.

Structure of the Internet

Exercise 3 [12 pts]

Assume a network with the following entities:

- **Access ISP 1:** "AlphaNet" ⟶ Connects Host A (Access Network 1)
- **Access ISP 2:** "BetaLink" ⟶ Connects Host B (Access Network 2)
- **Regional ISP:** "GammaRegional" ⟶ Connects the Access ISPs with the Tier-1 ISPs
- **Tier-1 ISPs:** "TierOneX" and "TierOneY"
- **IXPs: "EuroIX" and "GlobalIX":** ⟶ Exchange points between Tier-1 ISPs
- **Peering Links:** Links between Tier-1 ISPs and other networks

A) Draw the hierarchical structure of the network.
Note: There is not a single "correct" topology – the diagram should, however, correctly represent the hierarchical levels and connections.

B) Which possible paths can the packets take from Host A to Host B? Describe at least two different paths through Tier-1 ISPs and IXPs.

C) Suppose there is also a Content Provider Network (CPN) named "StreamPlus."

i) How does the existence of the CPN change the network topology?

ii) How does it affect the possible paths?

Packet vs. Circuit Switching

Exercise 4 [10 pts]

Consider an application that transmits data at a constant rate. Also, once such an application starts it runs for a relatively long time. Answer the following questions with a brief explanation:

A) For this application, would a packet-switched network or a circuit-switched network be more appropriate? Why?

B) Assume a packet-switched network is used and the only traffic in the network comes from applications like this one. Further assume the sum of the data rates of the applications is less than the capacity of every link. Is any form of congestion control needed? Why?

Exercise 5 [9 pts]

Consider the following circuit-switched network. It consists of 4 switches and 4 links, each link has 4 circuits.

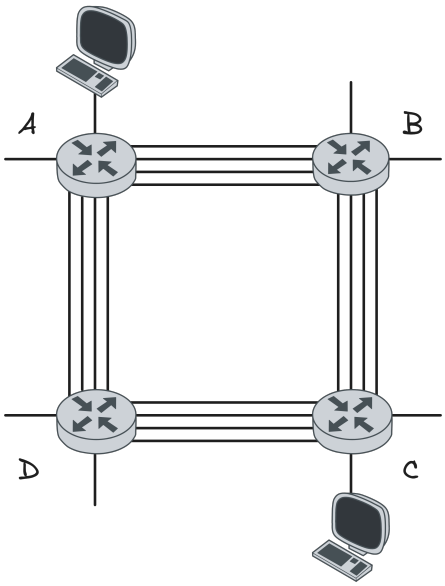

Figure 1: Circuit-Switched Network

A) What is the maximum number of simultaneous connections that can be in progress at any given time within this network?

B) Suppose that all connections are between switches A and C. What is the maximum number of simultaneous connections that can be in progress?

C) Suppose we want to establish four connections between switches A and C, and another four connections between switches B and D. Can we route these calls through the four links so as to serve all eight connections?

Delays & Throughput

Exercise 6 [9 pts]

Consider two computers, A and B, connected by a single link with a rate of R bps. Assume the two computers are m meters apart, and the propagation speed on the link is s meters per second. Host A is going to send a packet of size L to host B.

A) Express the propagation delay d_{prop} as a function of m and s.

B) Express the transmission delay d_{trans} as a function of L and R.

C) Ignoring processing delay and queueing delay, find an expression for the end-to-end delay.

D) Suppose computer A starts transmitting the packet at time $t = 0$. At time $t = d_{trans}$, where is the **last bit** of the packet?

E) Suppose the propagation delay is greater than the transmission delay. At time $t = d_{trans}$, where is the **first bit** of the packet?

F) Suppose the propagation delay is less than the transmission delay. At time $t = d_{trans}$, where is the **first bit** of the packet?

G) Suppose $s = 2{,}5 \cdot 10^8$ m/s, $L = 1500$ Bytes, and $R = 10$ Mbps. Find the distance m such that d_{prop} *is equal to* d_{trans}.

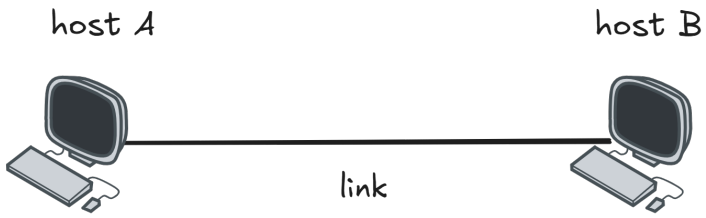

Figure 2: Topology 1

Exercise 7 [10 pts]

Host A wants to send a single packet of size 1500 Bytes to host B. The links between these nodes have different transmission rates and distances: the first link has a rate of 10 Mbps and a length of 100 km, the second link has a rate of 5 Mbps and a length of 200 km, and the third link has a rate of 20 Mbps and a length of 50 km. The propagation speed along all links is 2×10^8 m/s.

Each router introduces a processing delay of 1 ms, and queuing delays at R1 and R2 are 2 ms and 4 ms, respectively. Hosts A and B are assumed to have zero processing or queuing delays.

Your task is to compute the end-to-end delay for this packet. Show your calculations for each link and explain how the total delay is obtained.

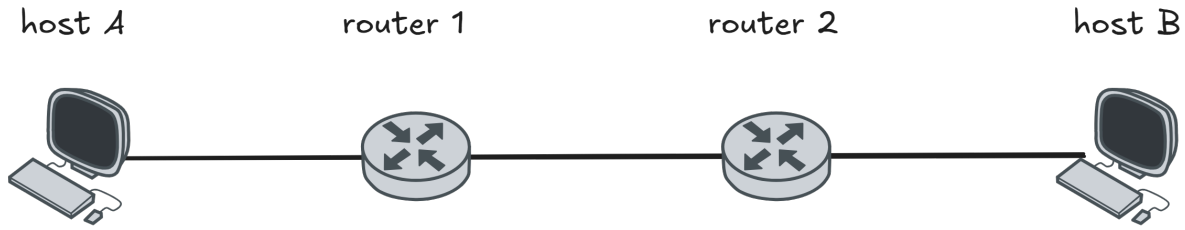

Figure 3: Topology 2

Exercise 8 [8 pts]

Suppose Host A wants to send a large file to Host B. The path from Host A to Host B consists of three links with the following transmission rates: $R_1 = 1$ Mbps, $R_2 = 3$ Mbps, and $R_3 = 500$ kbps. (see Topology 2 in Figure 3)

A) Assuming there is no other traffic in the network, what is the throughput for transferring the file?

B) Suppose the file size is 6 million bytes. How long will it take to transfer the file from Host A to Host B? (Ignore all propagation, processing, and queuing delays.)

Network Measurements & Analysis

Exercise 9 - Ping [10 pts]

Use the ping command with destination “www.physics.uoc.gr”

A) Attach a screenshot of the result

B) Analyze the fields from the command’s output

Exercise 10 - Traceroute [20 pts]

A) Describe how the traceroute from host A to host B will work in the diagram below.
- Refer to all the packets that will be sent during the process (requests and responses).
- For each packet report the values of their fields TTL, source IP and destination IP.

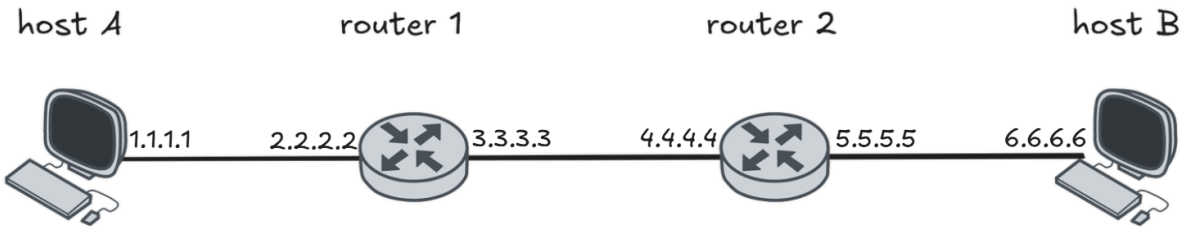

Figure 4: Topology 2

B) Run a traceroute with destination "www.math.uoc.gr" while you are on a network outside of the university.
- Attach a screenshot of the outcome.
- If "*" appear, try to provide possible reasons why they show up.
- After connecting to the university's VPN, run traceroute to "www.math.uoc.gr" again and attach the screenshot. What do you observe compared to the previous traceroute?

Exercise 11 - Wireshark [20 pts]

A) Ping the CSD website "www.csd.uoc.gr". While doing this, have Wireshark running to capture the traffic.
- Attach a screenshot with the output of ping.
- Attach another screenshot from Wireshark showing only the replies received from the CSD server. How did you achieve this?

B) On the course's website you will find a CSV file ("capture.csv") containing packet captures from Wireshark. Using Python load the CSV file (hint: pandas library) and answer the following:
- Calculate the total amount of data sent, both in Bytes and in Megabytes (MB).
- Find all the packets related with the ping command. Find to which IP addresses they were sent, and how many bytes were sent to each address respectively.
- Create a piechart that showcases the number of packets belonging to the protocols TCP, DNS, ARP and ICMP. Make it so that each slice shows the percentages of the slice (hint: matplotlib library).

Submission Guidelines

- Compile your report into a **single** PDF file. Include there all the answers to the theoretical exercises and any screenshots.
- Create a `.zip` file that includes your report and the `.py` file.
- Use the elearn-page to submit your `.zip` file.
- Reports that are not in PDF format will not be accepted.
- To prevent plagiarism, in each assignment series a random sample of students will be selected for further oral examination.