CS335a - Assignment 4

Fall 2025

Network Layer

Deadline: 15/12 at 10:59 (before the class begins)

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Grade: 130/100 (30 bonus pts)

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**

Submission Guidelines

- For each of the following exercises **show your calculations** and **explain your train of thoughts**. You don't have to write an essay but just enough to show that you understand the assignment and did not just copy-paste an answer.
- Compile your report into a **single PDF** file. Include there all the answers to the theoretical exercises and any screenshots.
- Use the elearn-page to submit your **PDF** file.
- Reports that are not in PDF format will not be accepted.

Exercise 1 - Short Answers [15 pts]

a. What is the function of DHCP?

b. In DHCP when a host sends a DHCP Request why is the source IP 0.0.0.0 and not the IP the DHCP server offered?

c. Explain what a router will do if it attempts to forward a packet whose source address is a private IP address toward the Internet. What mechanism is required to allow this packet to be routed?

d. What is the broadcast address of a network?

e. Which animated character's name can be used to remember the names of the DHCP messages?

Exercise 2 - Subnetting [20 pts]

You are given the network **10.10.8.0/24**.

a. The network must be split into **three subnets**:

- **Subnet 1** must support **up to 90 hosts**
- **Subnet 2** must support **up to 50 hosts**
- **Subnet 3** must support **up to 50 hosts**

Find a prefix for each subnet that satisfies the required number of hosts.
The host part must be the smallest possible to still satisfy the above (i.e., each subnet uses the minimum number of addresses)

Besides the prefix for each subnet, list the following:

- the **maximum number** of **available hosts**
- the **network** address
- the **broadcast** address

b. Now, a new **Subnet 4** is needed, and it must support **up to 10 hosts**. Note that there is *no remaining free address space* outside **10.10.8.0/24**. Note as well, that Subnet 1 does not need all its addresses to support 100 hosts.

i. Find a prefix for Subnet 4 such that:

- Subnet 1, 2 and 3 **remain unchanged** (keep their original prefixes).
- Subnet 4 is created **inside** Subnet 1, so that Subnet 1 still supports 100 hosts and Subnet 4 supports 10 hosts.

ii. If there is a packet with destination IP one that belongs to Subnet 4, is there any chance that a router will forward it to Subnet 1 instead, since it technically includes Subnet 4? If not, what is the algorithm/rule that prevents that?

Exercise 3 - Longest Prefix Match [20 pts]

A router has the following forwarding table. From which interface will each of the incoming packets with the displayed destination IP address be forwarded to? Do a detailed analysis on which interface will be chosen and for what reason (convert the IP addresses to binary notation in order to give specific reason for your answers).

Incoming Packets

a. `147.52.171.92`
b. `147.52.167.151`
c. `147.52.163.151`
d. `147.52.170.192`
e. `147.52.165.121`

Forwarding Table

Network Address	Network Mask	Interface
`147.52.170.0`	`255.255.254.0`	`eth0`
`147.52.168.0`	`255.255.254.0`	`eth1`
`147.52.170.0`	`255.255.255.0`	`eth5`
`147.52.166.0`	`255.255.254.0`	`eth2`
`147.52.164.0`	`255.255.252.0`	`eth3`
`0.0.0.0`	`0.0.0.0`	`eth4`

Exercise 4 - NAT [15 pts]

We have an app running on a server with IP 83.212.102.141 and port 16335. This app returns the IP and port of the packets it receives. Perform the following steps:

1. Open **Wireshark** and start capturing the traffic.
2. While Wireshark is active, send an **HTTP request** from a network that runs NAT (e.g. your home network). Please note that the university network does not run NAT.
3. For this you can either use the **curl command** (curl http://83.212.102.141:16335/) or just paste this: http://83.212.102.141:16335/ in your **browser's search bar**.

a. What is your IP based on what the server sees? Is that a public or private IP? Explain. Include a screenshot of the server's response.

b. Find the HTTP request packet on Wireshark. What is your actual IP? Is that a public or private IP? Explain. Include a screenshot of the HTTP request.

c. Let us analyze the results:

i. Do you see any differences on src IP and src port numbers between the request received at the server and the Wireshark packet capture? Why does that change occur?

ii. Do the dst IP and dst port number change, if not why?

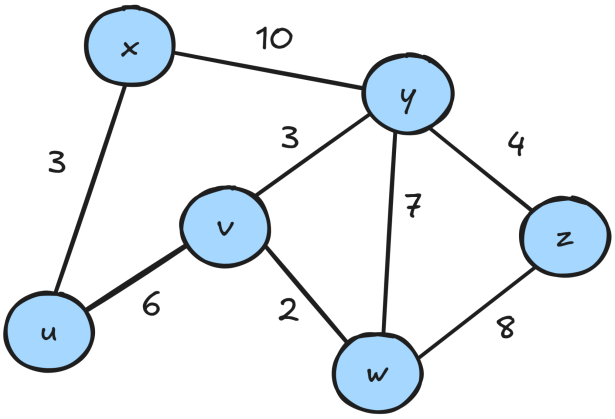
iii. If the src port remains the same, why could that be?

d. If we have NAT with port-address translation, what is the max number of simultaneous connections we could have? Explain.

Exercise 5 - Dijkstra [15 pts]

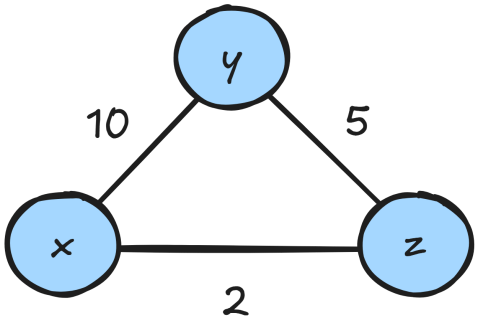
Using Dijkstra's algorithm, compute the least-cost path from node **u** to all the other nodes of the network.

a. Show your reasoning with a table similar to the one in the corresponding tutorial.
b. Draw the least-cost path graph.



Exercise 6 - Distance Vector [15 pts]

Compute the routing tables for nodes x, y, and z during the Distance Vector algorithm. Show the tables at each step until the algorithm converges.



Exercise 7 - Autonomous Systems [15 pts]

Interdomain routing allows Autonomous Systems (ASes) to exchange reachability information. Since this mechanism is vital for the sustainability of the internet, various tools have been implemented that allow us to retrieve information about the internet ecosystem. One such example is Hurricane Electric (https://bgp.he.net/) that can also provide a visual representation of the graph of the internet. For this assignment you are free to use HE or any other tool that you feel comfortable in order to investigate and answer the following questions.

a. Does the University of Crete own an Autonomous System (AS)? If yes, what is the Autonomous System Number (ASN)?

b. Which prefixes (blocks of IPs) does UoC own and which is its Regional Internet Registry (RIR)?

c. Who is the upstream provider (The autonomous system that forwards the traffic from UoC to the internet)? (Hint: use the Graph v4 tab). Click on the ASN of the upstream provider and go to the AS info tab to find its name.

Exercise 8 - Routing Protocols (BGP vs. OSPF) [15 pts]

Explain the key differences between the **Border Gateway Protocol (BGP)** and the **Open Shortest Path First (OSPF)** routing protocol. In your answer, address the following points:

1. **Type of routing problem each protocol solves**
    - What kind of networks does each protocol operate in? Is it intra or inter-AS routing?
2. **Routing algorithms**
    - What algorithm does each protocol use to choose routes?
    - What type of information does each protocol share with other routers?
    - How quickly does each protocol converge after changes (slow, fast), and why?
3. **Route selection**
    - In the default case, which is the path selected for each protocol?
    - Which value(s) can we manipulate to change the path selection for each protocol?