

Network architectures and protocols

Exercises and tasks

Collected by Imre VARGA Ph.D

Exercise 0: To be up to date

Theoretical and practical courses are both important but useful only together.

- Always follow the lectures.
- Learn what the teacher talk about.
- Take notes at lessons.

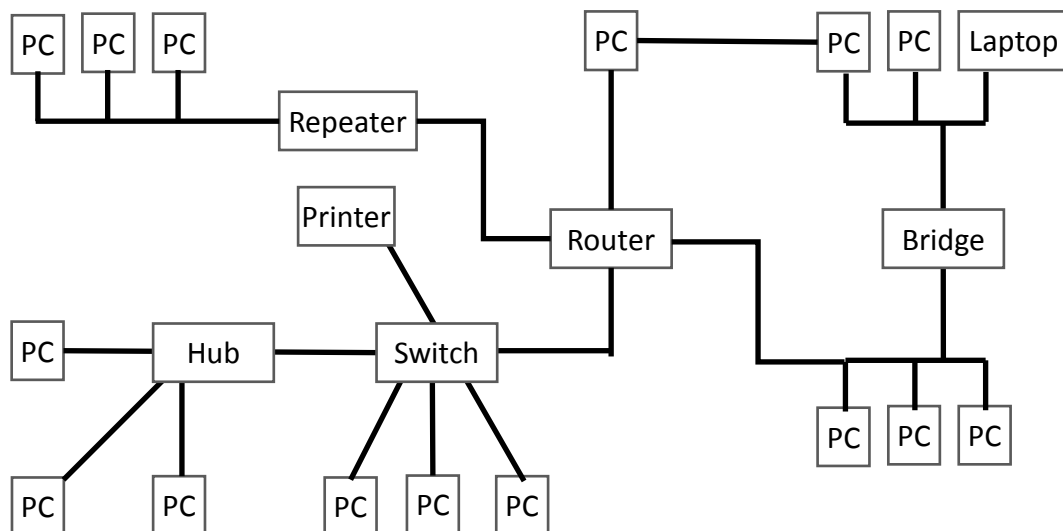
Exercise 1: Number systems

In computer science we often use both decimal, binary and hexadecimal notation.

- Convert the decimal 237 into binary.
- What is the 8 bits wide binary form of 14?
- Convert the binary 10101000 into decimal.
- How many 1s are in the binary form of 224?
- Convert the hexadecimal value BABE into binary.

Exercise 2: Domains of network

The following network is given:



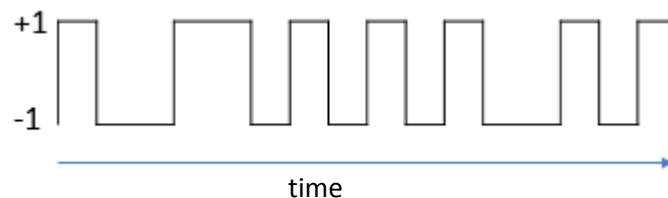
- Which is node, end-user node, interconnecting device?
- If the bottom-left PC sends a broadcast message, who will receive it?
- While the bottom-left PC sends information to the Printer, which nodes cannot communicate?
- Identify the collision domains?
- Identify the broadcast domains?

Exercise 3: Demonstration devices

- a) Look the passed round demonstration materials:
- ✓ blank coaxial cable,
 - ✓ BNC Tee adapter,
 - ✓ blank UTP cable,
 - ✓ blank STP cable,
 - ✓ blank F/STP cable
 - ✓ phone cable (with RJ-11 connector)
 - ✓ RJ-45 connector
 - ✓ crimping plier
 - ✓ cable tester
 - ✓ wired network card
 - ✓ Optical cable with ST connector
 - ✓ Optical-Ethernet converter
 - ✓ wireless network card
 - ✓ modem
 - ✓ switch
 - ✓ router
- b) Decide which cable is straight and which is cross-link.

Exercise 4: Sign coding

- a) Create NRZ, RZ, NRZI and PE code of the following 2 bytes long data.
01101111 00010110
- b) The following Manchester code is given. What is the coded bitseries?



Exercise 5: MAC address

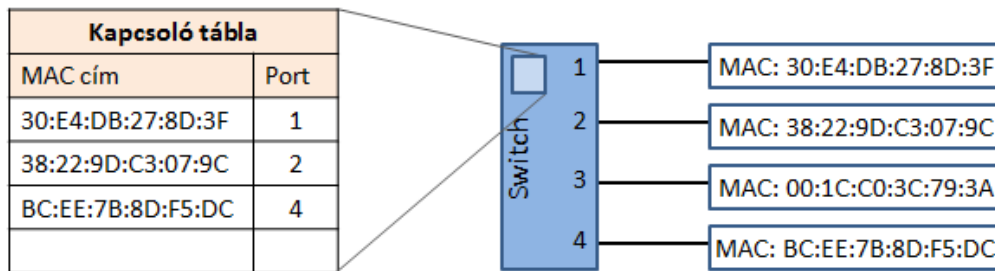
MAC addresses of 2 network card is given 20:25:64:4F:CF:BC and 20:25:98:4F:CF:B4.

- a) The producers of the cards are the same?
- b) Which company produced the first card?

Exercise 6: Ethernet

- a) Look and try the interactive animation on my homepage demonstrating the Ethernet frame sending and receiving.
(http://irh.inf.unideb.hu/user/vargai/download/network_en/Ethernet.ppsx)
- b) What is the MAC address of the wired network card of your computer?
- c) What is the maximum transmission speed of your Ethernet card? Use command line.
- d) Using command line, find out that the internet cable is connected to your computer or not.

4 PC is connected to a Switch. The MAC addresses and the content of the switching table is shown in the figure.



- e) What happens during the following frame sending?
- ✓ Source: 30:E4:DB:27:8D:3F Destination: 38:22:9D:C3:07:9C
 - ✓ Source: BC:EE:7B:8D:F5:DC Destination: 00:1C:C0:3C:79:3A
 - ✓ Source: 00:1C:C0:3C:79:3A Destination: FF:FF:FF:FF:FF:FF
- f) What happens if the 2nd and 3rd sending is replaced in time?

Exercise 7: IP addresses

- a) What is the class of 156.10.0.234 IP address?
- b) How many different A class network exist?
- c) How many hosts can be in a B class network?
- d) How many times more host can be in a B class network than in a C class one.
- e) What is the prefix length of a B class netmask?
- f) Convert the following binary netmask to dotted-decimal form.
- g) Convert the 255.255.192.0 dotted-decimal netmask to prefix length.
- h) What is the dotted-decimal form of the netmask which prefix length is 22?
- i) What is the network ID of 132.14.34.119/24 and 199.23.131.2/20?
- j) What is the broadcast address of 172.16.0.0/22 network?
- k) The host with IP 10.20.30.40 is inside the 10.16.0.0/255.240.0.0 network?
- l) What do you know about IP 127.0.0.1?
- m) How many nodes can be in the 192.168.128.0/24 network?
- n) Which network can have more hosts where the netmask is 255.255.224.0 or where the netmask prefix length is 18?
- o) A computer is a part of an operable network. Its IP address is 192.168.1.17 and its netmask prefix length is 30. What is the IP address of the node which is connected to this computer?
- p) Practice the IP addressing by the following interactive Excel file.
(http://irh.inf.unideb.hu/user/vargai/download/network_en/IP_addressing.xls)

Exercise 8: Command: ping

- a) Is the node with IP address 127.0.0.1 available from your computer?
- b) Is the node with IP address 193.6.128.5 available from your computer?
- c) Send only one 'ECHO-REQUEST' ICMP packet to IP 193.6.128.5.
- d) Using ping command find out how many hosts are between your computer and the node with IP address 195.140.224.235.

Exercise 9: Address resolution

- Try the following animation demonstrating the process of ARP (http://irh.inf.unideb.hu/user/vargai/download/network_en/ARP.ppsx)
- Look the ARP table of your computer.
- Ping one of the computers in the classroom. How the ARP table is changing?
- Ping a computer in an other network. How the ARP table is changing?
- Has effect of ping on ARP table, if there is a hub/switch/router between the two nodes?
- Look the `/etc/ethers` file.

Exercise 10: Subnetting

- How many bits are needed to identify 9 subnets?
- Can we divide the 192.168.0.64/26 network to 10 same-sized subnets?
- Split the 172.16.0.0/12 network to 11 subnets.
- How many nodes can be in one of the previous subnets?
- Split the 123.146.192.0/255.255.254.0 network to 6 same-sized subnets.
- Which is the largest subnet ID from the previous 6 subnets?
- What is the broadcast address of this subnet?
- Split the 192.168.0.0/24 subnet to 2 same-sized subnets.

You are the owner of the 152.129.0.0/16 network. In the following exercises the demands arrive with large time differences.

- Split your network according to the following demands requiring 1000, 4000 and 500 nodes.
- Split your network according to the following demands requiring 100, 1000, 500 and 500 nodes.
- Split your network to 5 different sized subnet, containing the possible maximal number of nodes.

Exercise 11: Routing

This is the routing table of your computer:

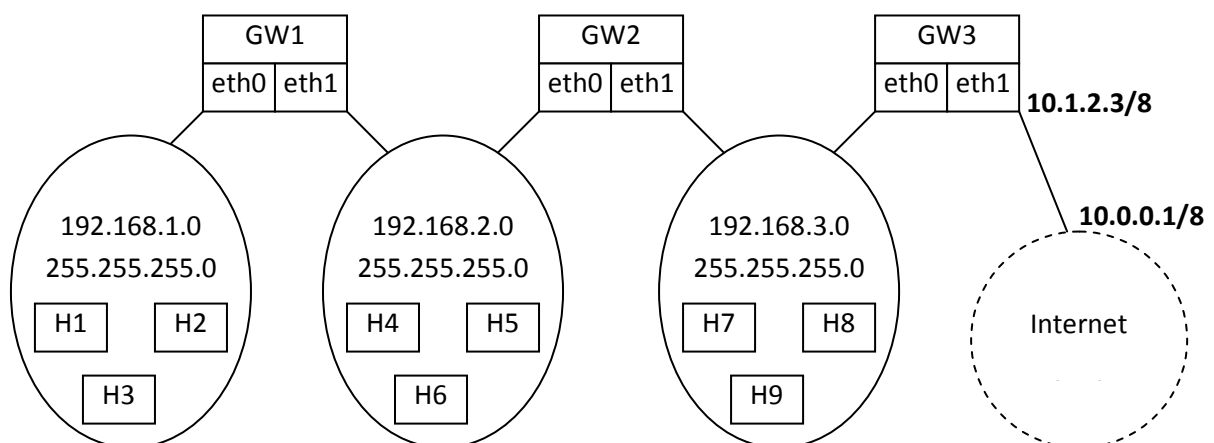
Destination			
network ID	gateway	netmask	interface
194.93.0.0	184.93.146.3	255.255.255.192	eth1
184.93.145.128	0.0.0.0	255.255.255.128	wlan0
184.93.146.0	0.0.0.0	255.255.255.0	eth1
184.93.146.0	0.0.0.0	255.255.254.0	eth1
184.93.128.0	0.0.0.0	255.255.128.0	eth2
184.92.0.0	0.0.0.0	255.254.0.0	eth3
0.0.0.0	184.92.192.1	0.0.0.0	eth3

- What is the default gateway of the computer?
- Is (one of) the network interface of your computer in the 194.93.0.0/26 network?
- Based on the routing table supposedly how many network cable is connected to the computer?
- On which interface does a packet to IP 184.93.146.5 leave the computer?
- On which interface does a packet to IP 184.93.145.117 leave the computer?
- On which interface does a packet to IP 184.93.147.52 IP leave the computer?

- g) In the frame of the previous packet there is a destination MAC address field. The MAC address of which computer is in this field?
- h) On which interface does a packet to IP 184.91.147.52 leave the computer?
- i) In the frame of the previous packet there is a destination MAC address field. The MAC address of which computer is in this field?
- j) On which interface does a packet to IP 194.93.0.245 leave the computer?
- k) In the frame of the previous packet there is a destination MAC address field. The MAC address of which computer is in this field?

Exercise 12: IP configuration

- a) What is the IP address and netmask of the wired interface of your computer? Record it.
- b) What is the default gateway of your computer? Record it.
- c) Stop the DHCP client on your computer.
- d) Deny/stop the wired interface of your Knoppix system.
- e) Enable of your wired interface. Do the network settings change?
- f) Setup the IP address and the netmask (which have been recorded) to your system.
- g) Setup the recorded default gateway into the routing table of your computer.
- h) List/enumerate 4 commands to find out the IP address of your default gateway.
- i) Change the MTU of the *eth0* interface to 1000 bytes.
- j) Create 4 subnets in the classroom and make them available from eachother. (Networks: 192.168.1.0/24, 192.168.2.0/24, 192.168.3.0/24, 192.168.4.0/24)
- k) Configure your computer to create two group of computers, where nodes inside the same group can communicate with each other, but computers in the other group are not available. Furthermore configure a “boss” computer, which can access all computer and (only) it has Internet connection.
- l) Configure the PC-s (Hx and GWx) of the following imaginary network according to the figure. (Hx hosts have only an *eth0* interface.)



- m) Configure the computers in the classroom to create two groups, where all traffic between nodes of the different groups go through one of the nodes, which is in a different (3rd) network.
- n) In the previous system follow a packet from one of the subnetworks to the other side by traceroute command.

- o) Discover the route to host 72.247.178.41 by the traceroute command. On which countries does the route go through?

Exercise 13: Protocols, services and ports

There is a computer which has correct network setting, but actually the network is not reachable.

- a) Find out is it able to use ICMP protocol.
- b) Search what is the well known port of HTTPS protocol.
- c) Decide that POP3 protocol is available with both TCP and UDP or not.

Exercise 14: inetd super-server

- a) Visit the `/etc/inetd.conf` file.
- b) Where can we found the FTP daemon on linux system?

Exercise 15: Access control

- a) Look the `/etc/hosts.allow` and `/etc/hosts.deny` files.
- b) How to set up that only „friend.hisdomain.hu” host has rights to access all the services of your Linux computer.
- c) Milyen beállításokkal érnéd el azt, hogy az „externaldomain.hu” címről mindenki elérje az ftp szolgáltatást a gépeden, csak az „enemy.externaldomain.hu” ne érjen el semmit?
- d) What is the consequence if the order of the following lines is replaced in the `/etc/hosts.deny` file?
`ALL : .xdomain.hu`
`ftpd : .xdomain.hu EXCEPT host.xdomain.hu : ALLOW`

Exercise 16: netstat command

The netstat command is useful to network statistics.

- a) How many packet has your computer transmitted?
- b) Check with netstat how many ICMP packets are sent by “ping -c 1 193.6.128.5” command.
- c) Find out how many TCP connections are established to your computer?
- d) Open a browser and then find out what is its local port number.

Exercise 17: nmap command

The nmap command do port scanning.

- a) Is there a web server on 193.6.135.80?
- b) If you have root privilege, find out what kind of operating system are on 45.33.32.156 host.

Exercise 18: netcat command

The netcat command is the Swiss army knife of networking.

- a) Start a server waiting for a client to connect on port 5000.
- b) In another terminal connect to the 5000 port of the localhost. (You can chat.)
- c) Find out is there an SMTP server on delfin.unideb.hu.
- d) Open a backdoor on your computer. (If somebody connect to port 4321, (s)he will be able to execute commands.)
- e) Transfer a file with the help of netcat.
- f) Create a simple web server which show an HTML file (only once) if somebody connect to it on 80 port. (Not easy.)
`(echo "http/1.0 200 OK"; echo; echo "<html><body>Hi</body></html>") | nc -q 1 -l -p 80`
- g) Is the default web port of node 193.6.135.80 open? Find out with netcat.
`nc -vzu 193.6.135.80 80`

Exercise 19: nslookup command

- a) Who is the name server of unideb.hu?
- b) What is the canonical name of www.unideb.hu?
- c) What is the IP address of www.unideb.hu?
- d) Which computer is the mail exchanger of unideb.hu?
- e) What is the name of host whose IP address is 193.6.128.5?
- f) What are the root name servers?
- g) What is the email address of the system administrator of the unideb.hu domain?
- h) Imagine that the primary name server of the unideb.hu is broken down. How many time is necessary to be unavailable the host www.unideb.hu?
- i) How many name servers are in the top level domain "hu"?
- j) Has the www.google.com IPv6 address?
- k) Has the nasa.gov TXT type resource record?
- l) Query all the resource record of unideb.hu with only one command.

Exercise 20: Client side DNS configuration

- a) Give a name to your computer.
- b) Give a name to the network your eth0 interface is connected.
- c) In my linux PC I want to reference with "roommate" name to the computer whose IP address is 172.16.1.134. Configure it.
- d) How can I configure my linux PC to use 193.6.128.5 as primary name server?
- e) How can I configure my linux PC to use ns.nic.hu. as primary name server?
- f) There is a computer with linux operating system and I want to configure resolver according to follows: if I write "windows.microsoft.com" into the browser address bar I would like the browser to connect to www.linux.com. How can I do this?

Exercise 21: HTML editing

The following html code of a simple webpage is given:

```
<html>
  <head>
    <title>Example</title>
  </head>
```

```

<body>
  <div style="text-align:center;">
    You can read more about <b>HTML</b>: <br>
    <a href="https://en.wikipedia.org/">Wikipedia</a>
  .<p></div>
  
  </body>
</html>

```

- Change the hyperlink to be referenced to "https://en.wikipedia.org/wiki/Html".
- Change the text of the hyperlink from "Wikipedia" to "Here".
- The "HTML" word be normal not bold.
- Enlarge the size of the image.
- Be the link and the other text in one row.
- Change the code to be right aligned.

Exercise 22: Browser in terminal

The telnet and the netcat command can be used as a (not graphical) web browser.

- Download and save the following file in terminal.
`http://irh.inf.unideb.hu/user/vargai/education_en.html`
- Open two terminals and a browser. Execute the `nc -l -p 80` command in the first terminal. Execute the `nc irh.inf.unideb.hu 80` command in the second terminal. Open the webpage
`http://127.0.0.1/user/vargai/education_en.html` in the browser. Copy the text appeared in the first terminal into the second terminal, then copy the text received in the second one to the first one.

Exercise 23: E-mail

Read the full content of the e-mail available on the webpage of the subject.

- Who is the sender and the addressee?
- This is a reply message. What is the ID of the original e-mail?
- What type of media is in the body of the e-mail?

Open mail relay is an SMTP server where anyone can send an e-mail without registration.

- If you know an open mail relay server, send an email to your existing e-mail address.

There is an account called 'proglabor' on the freemail.hu mail server. Its password is the same as its username.

- How many messages are in the INBOX of this account?
- What is the body of the first e-mail?

Exercise 24: FTP

Download the `rfc0959.txt` file which is in `documents/rfc` folder of `ftp.bme.hu` server.

- a) Use anonymous FTP in browser.
- b) Use ftp command in a terminal.
- c) Use terminals and the netcat command.

Exercise 25: Wireshark

- a) Catch real network traffic belonging to the following protocols on your PC by Wireshark.
IP, ICMP, ARP, DHCP, TCP, UDP, HTTP, POP3, SMTP, FTP, DNS!
- b) Interpret the content of the fields of different PUDs.

Exercise 26: Classification into layers

- a) Which layer of hybrid model do the following concepts belong to?
4B5B, ADSL, ARP, AS, ATM, BGP, browser, CDMA, CIDR, CSMA/CD, packet, DHCP, DNS, resource record, Ethernet, routing, FQDN, fragmentation, FTP, 3-way handshake, HTTP, HTML, hub, ICMP, IEEE802.11g, IEEE802.3, IMAP, IP, ISDN, sign coding, frame, coaxial cable, LLC, MAC, modem, MTU, multimode fiber, NAT, netmask, NRZI, OSPF, POP3, port, PPP, RARP, RIP, RJ45, router, RZ, SMTP, SOA, STP, switch, segment, TCP, token-ring, UDP, UTP, www, WPA2

Last exercise: Before and after the tests/exam

- a) Get ready for tests/exam. Learn and read from practical/theoretical material, read literature, understand what you learn.
- b) Don't forget what you have learned about networks after tests/exam. This knowledge is important on state/final exam and the in the world of professional work.