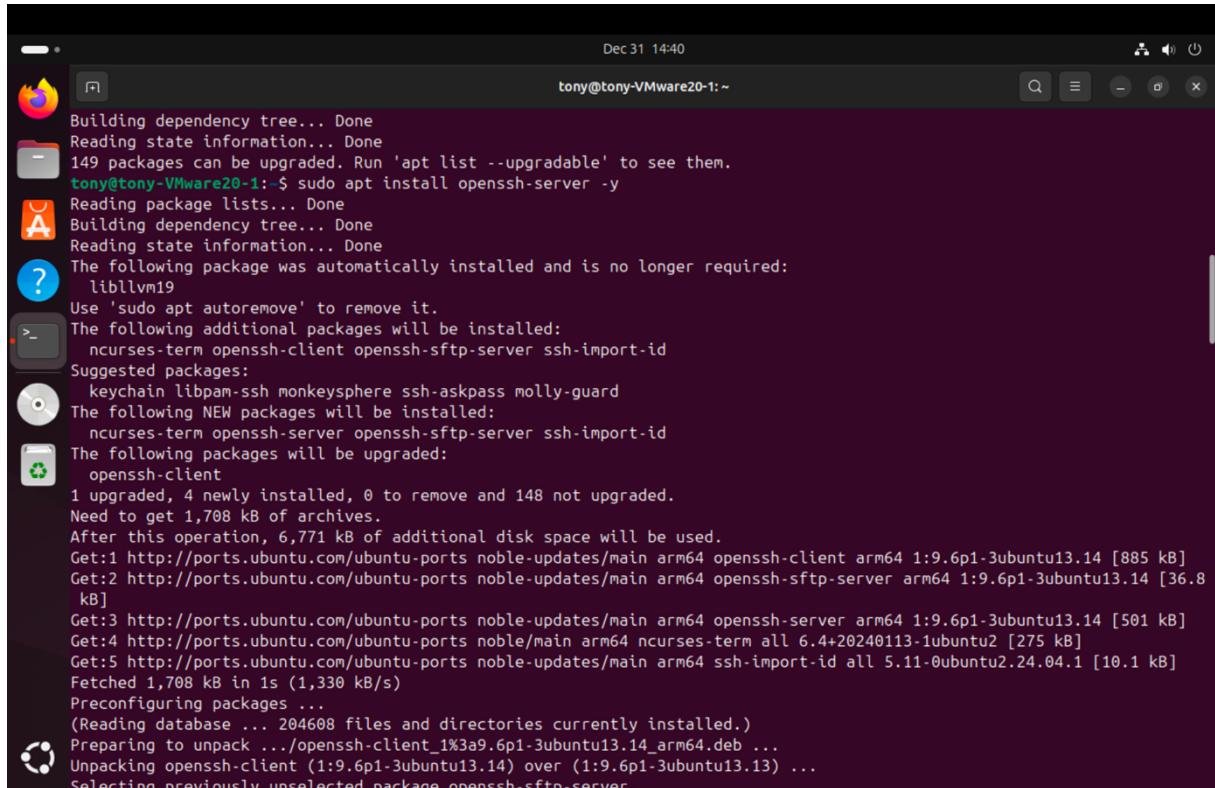


Template Week 6 – Networking

Student number: 588963

Assignment 6.1: Working from home

Screenshot installation openssh-server:



```
Dec 31 14:40
tony@tony-VMware20-1:~$ sudo apt install openssh-server -y
Building dependency tree... Done
Reading state information... Done
149 packages can be upgraded. Run 'apt list --upgradable' to see them.
tony@tony-VMware20-1:~$ sudo apt install openssh-server -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following package was automatically installed and is no longer required:
liblvm19
Use 'sudo apt autoremove' to remove it.
The following additional packages will be installed:
  ncurses-term openssh-client openssh-sftp-server ssh-import-id
Suggested packages:
  keychain libpam-ssh monkeysphere ssh-askpass molly-guard
The following NEW packages will be installed:
  ncurses-term openssh-server openssh-sftp-server ssh-import-id
The following packages will be upgraded:
  openssh-client
1 upgraded, 4 newly installed, 0 to remove and 148 not upgraded.
Need to get 1,708 kB of archives.
After this operation, 6,771 kB of additional disk space will be used.
Get:1 http://ports.ubuntu.com/ubuntu-ports noble-updates/main arm64 openssh-client arm64 1:9.6p1-3ubuntu13.14 [885 kB]
Get:2 http://ports.ubuntu.com/ubuntu-ports noble-updates/main arm64 openssh-sftp-server arm64 1:9.6p1-3ubuntu13.14 [36.8 kB]
Get:3 http://ports.ubuntu.com/ubuntu-ports noble-updates/main arm64 openssh-server arm64 1:9.6p1-3ubuntu13.14 [501 kB]
Get:4 http://ports.ubuntu.com/ubuntu-ports noble/main arm64 ncurses-term all 6.4+20240113-1ubuntu2 [275 kB]
Get:5 http://ports.ubuntu.com/ubuntu-ports noble-updates/main arm64 ssh-import-id all 5.11-0ubuntu2.24.04.1 [10.1 kB]
Fetched 1,708 kB in 1s (1,330 kB/s)
Preconfiguring packages ...
(Reading database ... 204608 files and directories currently installed.)
Preparing to unpack .../openssh-client_1%3a9.6p1-3ubuntu13.14_arm64.deb ...
Unpacking openssh-client (1:9.6p1-3ubuntu13.14) over (1:9.6p1-3ubuntu13.13) ...
Selection previously unselected package openssh-sftp-server.
```

```
Dec 31 14:40 tony@tony-VMware20-1:~  
Preparing to unpack .../openssh-server_1%3a9.6p1-3ubuntu13.14_arm64.deb ...  
Unpacking openssh-server (1:9.6p1-3ubuntu13.14) ...  
Selecting previously unselected package ncurses-term.  
Preparing to unpack .../ncurses-term_6.4+20240113-1ubuntu2_all.deb ...  
Unpacking ncurses-term (6.4+20240113-1ubuntu2) ...  
Selecting previously unselected package ssh-import-id.  
Preparing to unpack .../ssh-import-id_5.11-0ubuntu2.24.04.1_all.deb ...  
Unpacking ssh-import-id (5.11-0ubuntu2.24.04.1) ...  
Setting up openssh-client (1:9.6p1-3ubuntu13.14) ...  
Setting up ssh-import-id (5.11-0ubuntu2.24.04.1) ...  
Setting up ncurses-term (6.4+20240113-1ubuntu2) ...  
Setting up openssh-sftp-server (1:9.6p1-3ubuntu13.14) ...  
Setting up openssh-server (1:9.6p1-3ubuntu13.14) ...  
  
Creating config file /etc/ssh/sshd_config with new version  
Created symlink /etc/systemd/system/sockets.target.wants/ssh.socket → /usr/lib/s  
ystemd/system/ssh.socket.  
Created symlink /etc/systemd/system/ssh.service.requires/ssh.socket → /usr/lib/s  
ystemd/system/ssh.socket.  
Processing triggers for man-db (2.12.0-4build2) ...  
Processing triggers for ufw (0.36.2-6) ...  
tony@tony-VMware20-1:~$ sudo systemctl enable --now ssh  
Synchronizing state of ssh.service with SysV service script with /usr/lib/systemd/systemd-sysv-install.  
Executing: /usr/lib/systemd/systemd-sysv-install enable ssh  
Created symlink /etc/systemd/system/sshd.service → /usr/lib/systemd/system/ssh.service.  
Created symlink /etc/systemd/system/multi-user.target.wants/ssh.service → /usr/lib/systemd/system/ssh.service.  
tony@tony-VMware20-1:~$ sudo systemctl status ssh  
● ssh.service - OpenBSD Secure Shell server  
  Loaded: loaded (/usr/lib/systemd/system/ssh.service; enabled; preset: enabled)  
  Active: active (running) since Wed 2025-12-31 14:39:23 CET; 12s ago  
    TriggeredBy: ● ssh.socket  
              Docs: man:sshd(8)  
                      man:sshd_config(5)
```

```
Dec 31 14:40 tony@tony-VMware20-1:~  
Memory: 1.1M (peak: 1.6M)  
CPU: 13ms  
CGroup: /system.slice/ssh.service  
        └─4124 "sshd: /usr/sbin/sshd -D [listener] 0 of 10-100 startups"  
  
Dec 31 14:39:23 tony-VMware20-1 systemd[1]: Starting ssh.service - OpenBSD Secu  
Dec 31 14:39:23 tony-VMware20-1 sshd[4124]: Server listening on 0.0.0.0 port 22.  
Dec 31 14:39:23 tony-VMware20-1 sshd[4124]: Server listening on :: port 22.  
Dec 31 14:39:23 tony-VMware20-1 systemd[1]: Started ssh.service - OpenBSD Secu  
lines 1-18/18 (END)...skipping...  
● ssh.service - OpenBSD Secure Shell server  
  Loaded: loaded (/usr/lib/systemd/system/ssh.service; enabled; preset: enabled)  
  Active: active (running) since Wed 2025-12-31 14:39:23 CET; 12s ago  
    TriggeredBy: ● ssh.socket  
              Docs: man:sshd(8)  
                      man:sshd_config(5)  
  Process: 4123 ExecStartPre=/usr/sbin/sshd -t (code=exited, status=0/SUCCESS)  
  Main PID: 4124 (sshd)  
    Tasks: 1 (limit: 4547)  
   Memory: 1.1M (peak: 1.6M)  
      CPU: 13ms  
     CGroup: /system.slice/ssh.service  
             └─4124 "sshd: /usr/sbin/sshd -D [listener] 0 of 10-100 startups"  
  
Dec 31 14:39:23 tony-VMware20-1 systemd[1]: Starting ssh.service - OpenBSD Secure Shell server...  
Dec 31 14:39:23 tony-VMware20-1 sshd[4124]: Server listening on 0.0.0.0 port 22.  
Dec 31 14:39:23 tony-VMware20-1 sshd[4124]: Server listening on :: port 22.  
Dec 31 14:39:23 tony-VMware20-1 systemd[1]: Started ssh.service - OpenBSD Secure Shell server.
```

Screenshot successful SSH command execution:

```
tony@tony-VMware20-1:~> ssh tony@192.168.139.131
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

PS C:\Users\toni> ssh tony@192.168.139.131
The authenticity of host '192.168.139.131 (192.168.139.131)' can't be established.
ED25519 key fingerprint is SHA256:TWFPKzoRegMNsXyj8W7LDaR1O15ZDvPZa6vDwXc3DU.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.139.131' (ED25519) to the list of known hosts.
tony@192.168.139.131's password:
Permission denied, please try again.
tony@192.168.139.131's password:
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.14.0-36-generic aarch64)

 * Documentation: https://help.ubuntu.com
 * Management: https://landscape.canonical.com
 * Support: https://ubuntu.com/pro

Expanded Security Maintenance for Applications is not enabled.

119 updates can be applied immediately.
To see these additional updates run: apt list --upgradable

6 additional security updates can be applied with ESM Apps.
Learn more about enabling ESM Apps service at https://ubuntu.com/esm

*** System restart required ***

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

tony@tony-VMware20-1:~$
```

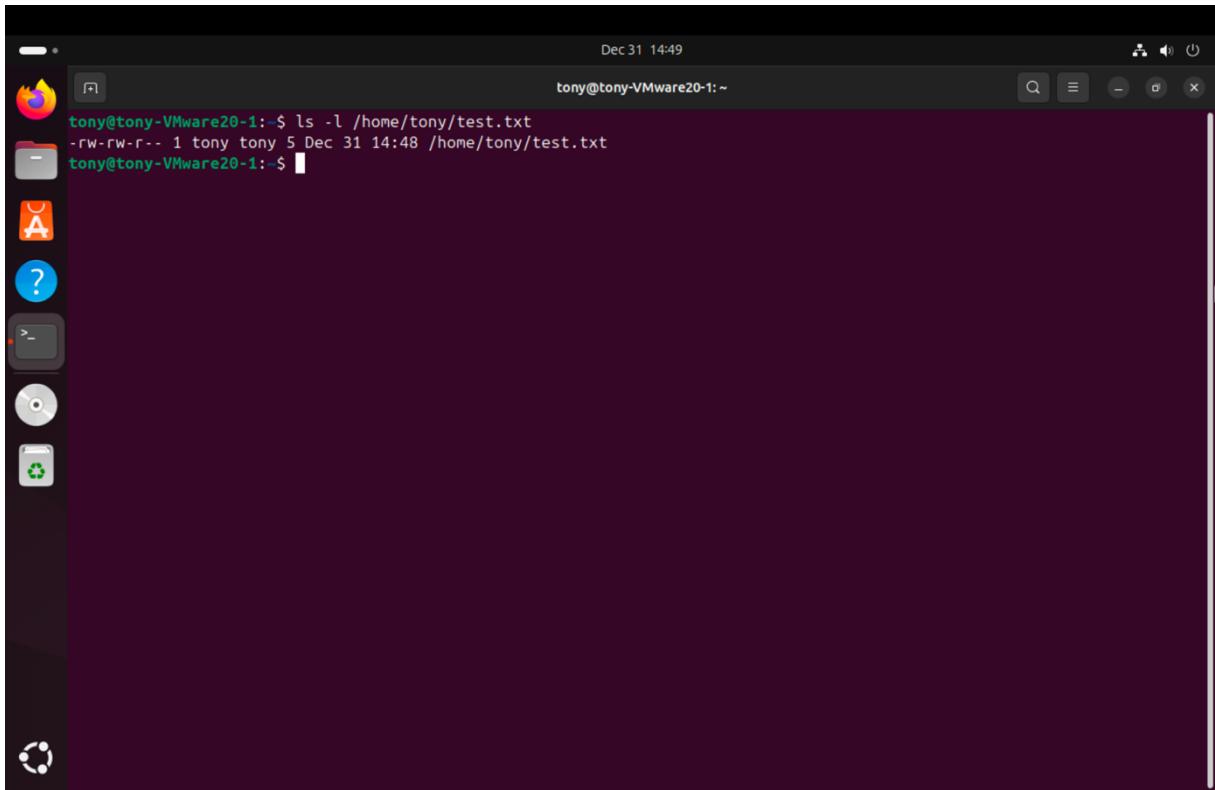
Screenshot successful execution SCP command:

```
tony@tony-VMware20-1:~> echo test > test.txt
Learn more about enabling ESM Apps service at https://ubuntu.com/esm
*** System restart required ***

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

tony@tony-VMware20-1:~$ scp test.txt tony@192.168.139.131:/home/tony/
The authenticity of host '192.168.139.131 (192.168.139.131)' can't be established.
ED25519 key fingerprint is SHA256:TWFPKzoRegMNsXyj8W7LDaR1O15ZDvPZa6vDwXc3DU.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.139.131' (ED25519) to the list of known hosts.
tony@192.168.139.131's password:
test.txt          100%   5    14.6KB/s  00:00
tony@tony-VMware20-1:~$ |
```



Screenshot remmina:

Assignment 6.2: IP addresses websites

Relevant screenshots nslookup command:

```

Last login: Tue Dec 30 13:26:16 on console
tonyjarwa@mac ~ % nslookup

> amazon.com
Server:      2a02:44b:c58e:8:3ae1:f4ff:fefb:d5a0
Address:      2a02:44b:c58e:8:3ae1:f4ff:fefb:d5a0#53

Non-authoritative answer:
Name:  amazon.com
Address:  98.87.170.71
Name:  amazon.com
Address:  98.87.170.74
Name:  amazon.com
Address:  98.82.161.185
> google.com
Server:      2a02:44b:c58e:8:3ae1:f4ff:fefb:d5a0
Address:      2a02:44b:c58e:8:3ae1:f4ff:fefb:d5a0#53

Non-authoritative answer:
Name:  google.com
Address:  142.250.179.174
> one.one.one.one
Server:      2a02:44b:c58e:8:3ae1:f4ff:fefb:d5a0
Address:      2a02:44b:c58e:8:3ae1:f4ff:fefb:d5a0#53

Non-authoritative answer:
Name:  one.one.one.one
Address:  1.0.0.1
Name:  one.one.one.one
Address:  1.1.1.1
> dns.google.com
Server:      2a02:44b:c58e:8:3ae1:f4ff:fefb:d5a0
Address:      2a02:44b:c58e:8:3ae1:f4ff:fefb:d5a0#53

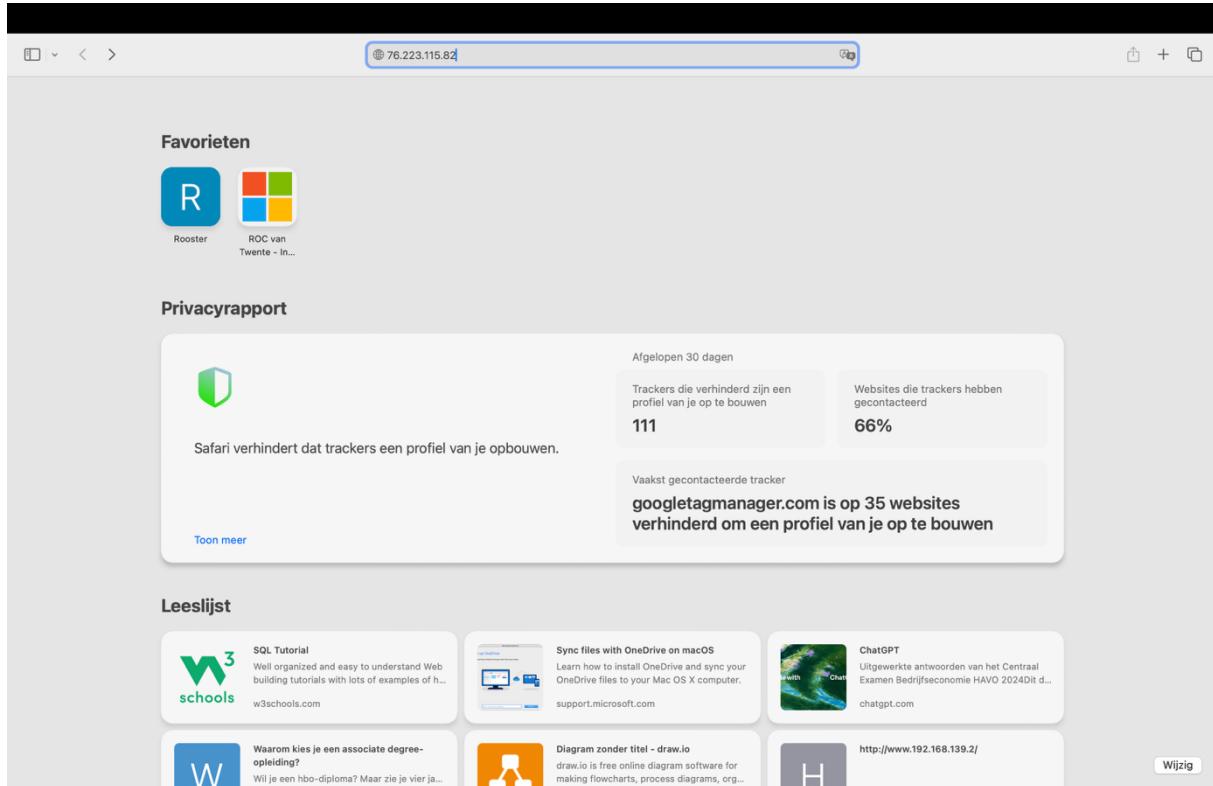
Non-authoritative answer:
Name:  dns.google.com
Address:  8.8.8.8
Name:  dns.google.com
Address:  8.8.4.4
> bol.com
Server:      2a02:44b:c58e:8:3ae1:f4ff:fefb:d5a0
Address:      2a02:44b:c58e:8:3ae1:f4ff:fefb:d5a0#53

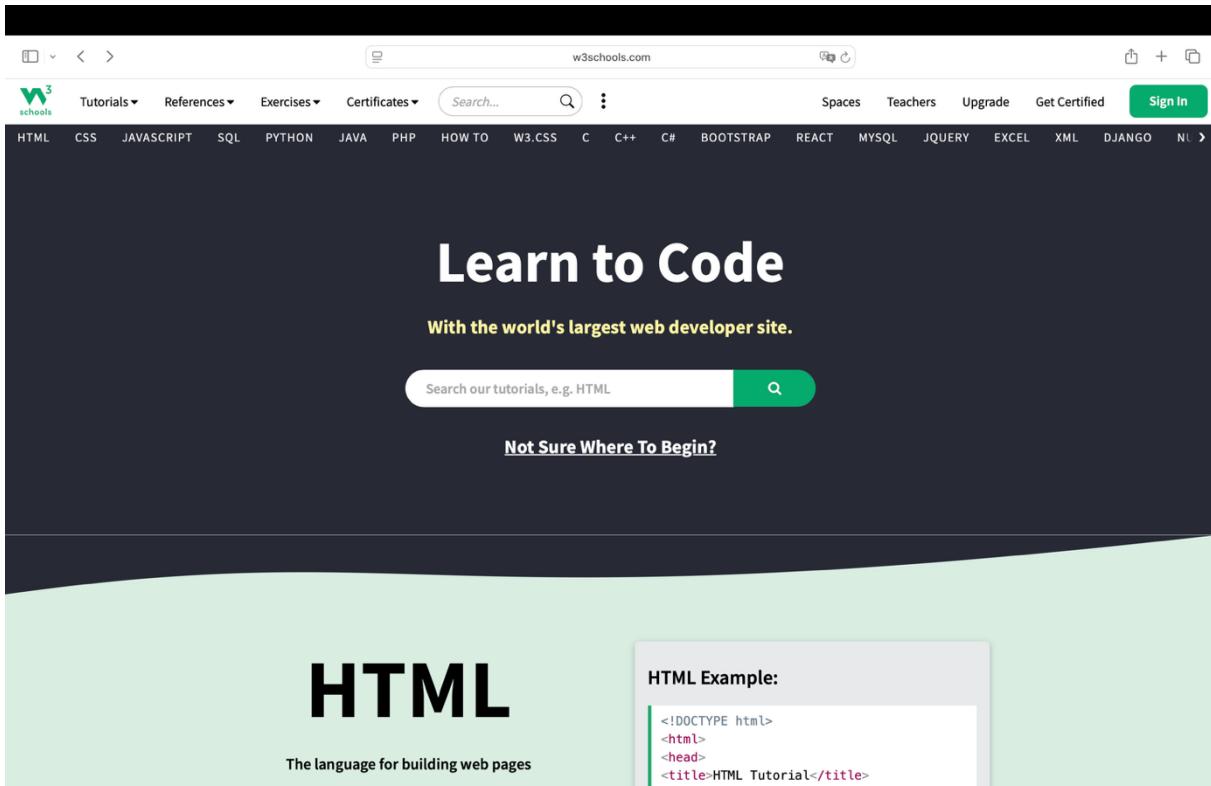
Non-authoritative answer:
Name:  bol.com
Address:  79.170.100.42
> w3schools.com
Server:      2a02:44b:c58e:8:3ae1:f4ff:fefb:d5a0
Address:      2a02:44b:c58e:8:3ae1:f4ff:fefb:d5a0#53

Non-authoritative answer:
Name:  w3schools.com
Address:  76.223.115.82
Name:  w3schools.com
Address:  13.248.240.133
> exit
tonyjarwa@mac ~ %

```

Screenshot website visit via IP address:





Assignment 6.3: subnetting

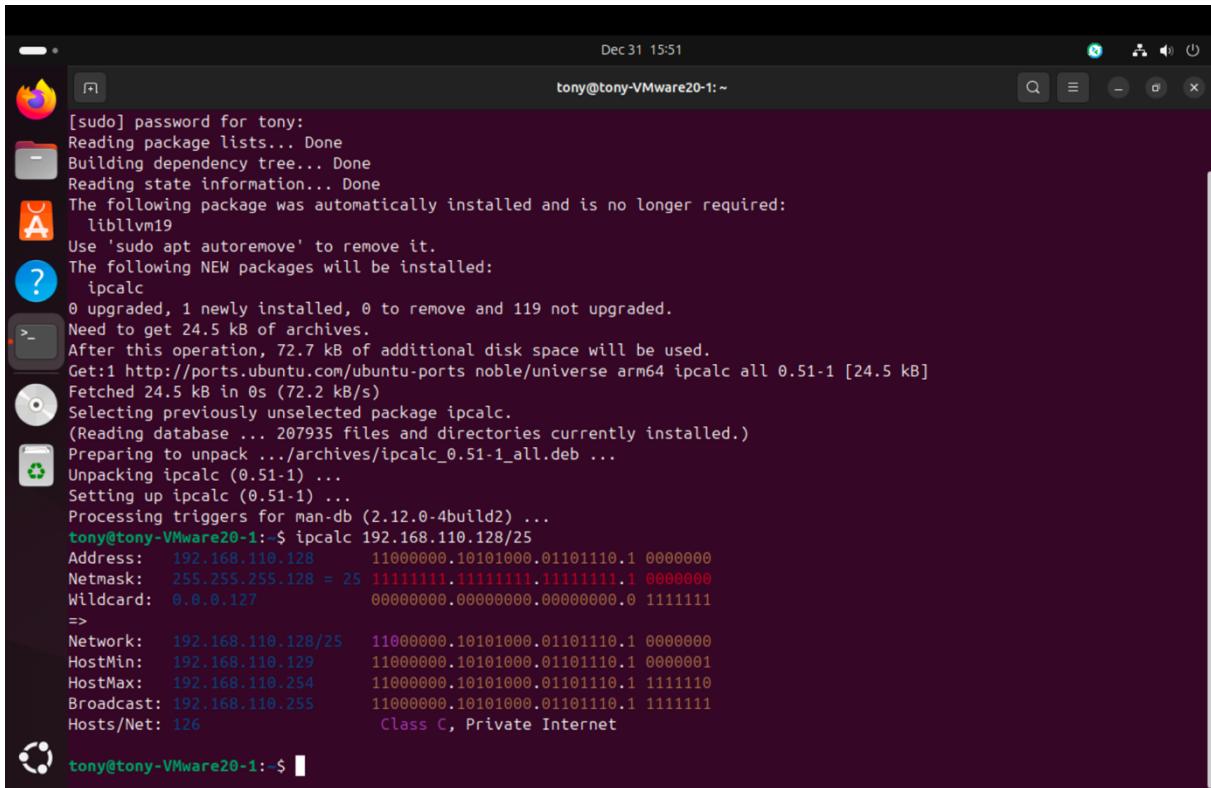
How many IP addresses are in this network configuration 192.168.110.128/25?

$2^7 = 128$ IP-adressen

What is the usable IP range to hand out to the connected computers?

192.168.110.129 – 192.168.110.254

Check your two previous answers with this Linux command: `ipcalc 192.168.110.128/25`



```
[sudo] password for tony:  
Reading package lists... Done  
Building dependency tree... Done  
Reading state information... Done  
The following package was automatically installed and is no longer required:  
libllvm19  
Use 'sudo apt autoremove' to remove it.  
The following NEW packages will be installed:  
ipcalc  
0 upgraded, 1 newly installed, 0 to remove and 119 not upgraded.  
Need to get 24.5 kB of archives.  
After this operation, 72.7 kB of additional disk space will be used.  
Get:1 http://ports.ubuntu.com/ubuntu-ports noble/universe arm64 ipcalc all 0.51-1 [24.5 kB]  
Fetched 24.5 kB in 0s (72.2 kB/s)  
Selecting previously unselected package ipcalc.  
(Reading database ... 207935 files and directories currently installed.)  
Preparing to unpack .../archives/ipcalc_0.51-1_all.deb ...  
Unpacking ipcalc (0.51-1) ...  
Setting up ipcalc (0.51-1) ...  
Processing triggers for man-db (2.12.0-4build2) ...  
tony@tony-VMware20-1:~$ ipcalc 192.168.110.128/25  
Address: 192.168.110.128      11000000.10101000.01101110.1 00000000  
Netmask: 255.255.255.128 = 25 11111111.11111111.11111111.1 00000000  
Wildcard: 0.0.0.127          00000000.00000000.00000000.0 11111111  
=>  
Network: 192.168.110.128/25  11000000.10101000.01101110.1 00000000  
HostMin: 192.168.110.129    11000000.10101000.01101110.1 00000001  
HostMax: 192.168.110.254    11000000.10101000.01101110.1 11111110  
Broadcast: 192.168.110.255  11000000.10101000.01101110.1 11111111  
Hosts/Net: 126              Class C, Private Internet
```

Explain the above calculation in your own words.

/25 subnet means that 25 bits are used and 7 bits are available. The result in 128 IP addresses, the first one (192.168.110.128) is the network address and the last address (192.168.110.255) is the broadcast address, all addresses between these two are usable for hosts so, 126 usable IP addresses.

Assignment 6.4: HTML

Screenshot IP address Ubuntu VM:

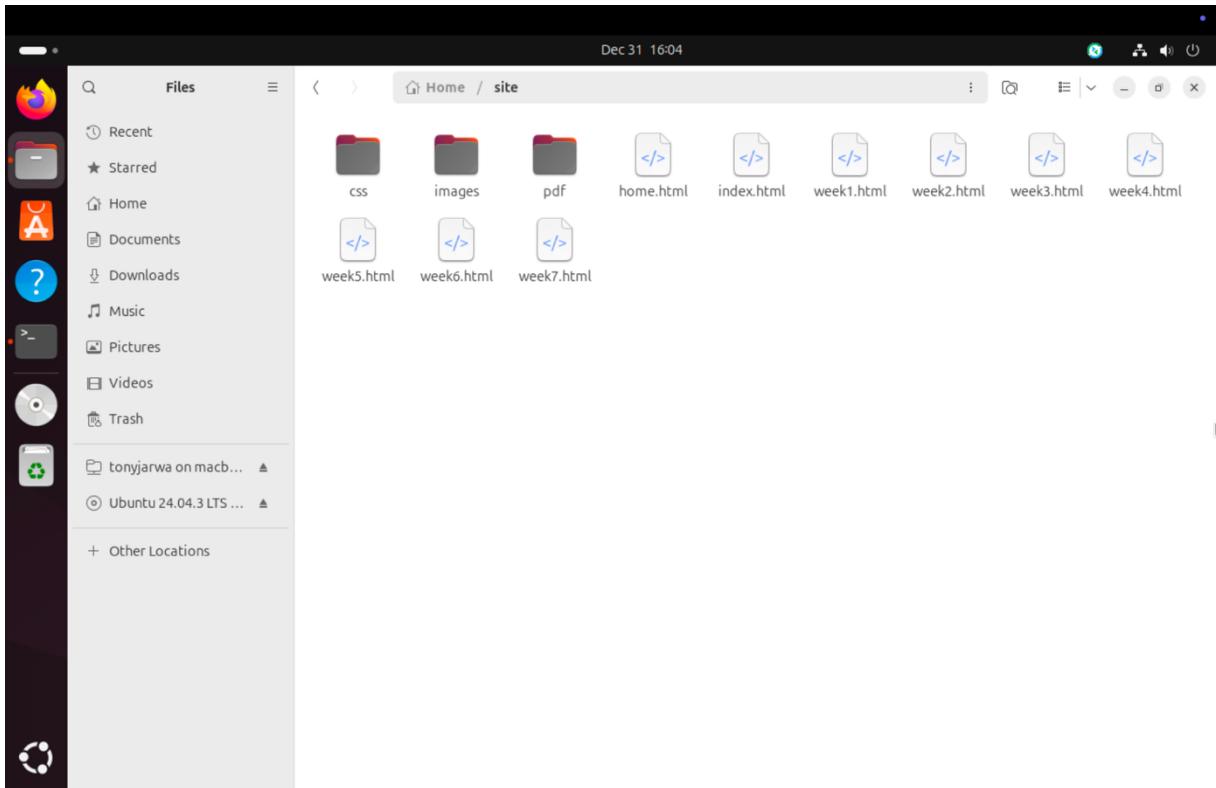
Dec 31 16:02 tony@tony-VMware20-1:~

```
tony@tony-VMware20-1:~$ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
        inet 127.0.0.1/8 scope host lo
            valid_lft forever preferred_lft forever
        inet6 ::1/128 scope host noprefixroute
            valid_lft forever preferred_lft forever
2: ens160: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 00:0c:29:4a:12:e1 brd ff:ff:ff:ff:ff:ff
        altname enp2s0
        inet 192.168.139.131/24 brd 192.168.139.255 scope global dynamic noprefixroute ens160
            valid_lft 1340sec preferred_lft 1340sec
        inet6 fe80::5f71:87e:476:715d/64 scope link noprefixroute
            valid_lft forever preferred_lft forever
tony@tony-VMware20-1:~$
```

Screenshot of Site directory contents:

Dec 31 16:04 tony@tony-VMware20-1:~

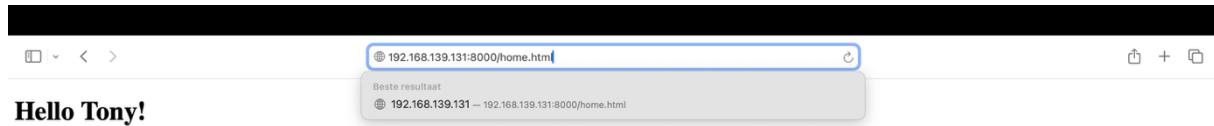
```
tony@tony-VMware20-1:~$ cd ~
tony@tony-VMware20-1:~$ ls -l site
total 48
drwxrwxr-x 2 tony tony 4096 Sep  9  2023 css
-rw-rw-r-- 1 tony tony 139 Sep  9  2023 home.html
drwxrwxr-x 2 tony tony 4096 Sep  6  2023 images
-rw-rw-r-- 1 tony tony 637 Sep  9  2023 index.html
drwxrwxr-x 2 tony tony 4096 Sep  9  2023 pdf
-rw-rw-r-- 1 tony tony 325 Sep  9  2023 week1.html
-rw-rw-r-- 1 tony tony 325 Sep  9  2023 week2.html
-rw-rw-r-- 1 tony tony 325 Sep  9  2023 week3.html
-rw-rw-r-- 1 tony tony 325 Sep  9  2023 week4.html
-rw-rw-r-- 1 tony tony 325 Sep  9  2023 week5.html
-rw-rw-r-- 1 tony tony 325 Sep  9  2023 week6.html
-rw-rw-r-- 1 tony tony 325 Sep  9  2023 week7.html
tony@tony-VMware20-1:~$
```



Screenshot python3 webserver command:

A screenshot of a terminal window titled "site". The terminal shows the command "python3 -m http.server 8000" being run by the user "tony@tony-VMware20-1". The output indicates that the server is serving HTTP on port 8000. The terminal interface includes a dark theme with light-colored text and icons.

Screenshot web browser visits your site



Assignment 6.5: Network segment

Remember that bitwise java application you've made in week 2? Expand that application so that you can also calculate a network segment as explained in the PowerPoint slides of week 6. Use the bitwise & AND operator. You need to be able to input two Strings. An IP address and a subnet.

IP: 192.168.1.100 and subnet: 255.255.255.224 for /27

Example: 192.168.1.100/27

Calculate the network segment

IP Address: 11000000.10101000.00000001.01100100

Subnet Mask: 11111111.11111111.11111111.11100000

Network Addr: 11000000.10101000.00000001.01100000

This gives 192.168.1.96 in decimal as the network address.

For a /27 subnet, each segment (or subnet) has 32 IP addresses (2^5).

The range of this network segment is from 192.168.1.96 to 192.168.1.127.

Paste source code here, with a screenshot of a working application.

```
public class Application implements Runnable {
```

```

public static void main(String[] args) {
    SaxionApp.start(new Application(), 800, 800);
}

public void run() {

    drawMenu();

    int input = -1;
    while (input != 0) {
        input = SaxionApp.readInt();

        if (input == 1) {
            SaxionApp.print("Enter an integer number: ");
            int number = SaxionApp.readInt();

            if (isOdd(number)) {
                SaxionApp.printLine(number + " is odd.");
            } else {
                SaxionApp.printLine(number + " is even.");
            }
        } else if (input == 2) {
            SaxionApp.print("Enter an integer number: ");
            int number = SaxionApp.readInt();

            if (isPowerOfTwo(number)) {
                SaxionApp.printLine(number + " is a power of 2.");
            } else {
                SaxionApp.printLine(number + " is NOT a power of 2.");
            }
        }

        } else if (input == 3) {
            SaxionApp.print("Enter an integer number: ");
            int number = SaxionApp.readInt();

            int result = twosComplement(number);
            SaxionApp.printLine("Two's complement of " + number + " = "
+ result);

        } else if (input == 4) {
            SaxionApp.print("Enter IP address: ");
            String ip = SaxionApp.readString();

            SaxionApp.print("Enter subnet mask: ");
            String subnet = SaxionApp.readString();

            calculateNetwork(ip, subnet);

        } else if (input == 0) {
            SaxionApp.printLine("Exiting... ");
        } else {
            SaxionApp.printLine("Invalid choice. Try again.");
        }
        if (input != 0) {
            SaxionApp.printLine();
            SaxionApp.printLine("=====");
            SaxionApp.printLine("Choose another option or 0 to exit:");
        }
    }
}

```

```

        }

    }

    boolean isOdd(int number) {
        return (number & 1) == 1;
    }

    boolean isPowerOfTwo(int number) {
        return number > 0 && (number & (number - 1)) == 0;
    }

    int twosComplement(int number) {
        return ~number + 1;
    }

    public void drawMenu() {
        SaxonApp.printLine("=====");
        SaxonApp.printLine(" Bitwise Operations");
        SaxonApp.printLine("=====");
        SaxonApp.printLine("1. Is number odd?");
        SaxonApp.printLine("2. Is number a power of 2?");
        SaxonApp.printLine("3. Two's complement of number?");
        SaxonApp.printLine("4. Calculate network segment");
        SaxonApp.printLine("0. Exit");
        SaxonApp.print("What would you like to do? ");
    }

    void calculateNetwork(String ip, String subnet) {
        String[] ipParts = ip.split("\\.");
        String[] subnetParts = subnet.split("\\.");

        int ip1 = Integer.parseInt(ipParts[0]);
        int ip2 = Integer.parseInt(ipParts[1]);
        int ip3 = Integer.parseInt(ipParts[2]);
        int ip4 = Integer.parseInt(ipParts[3]);

        int sub1 = Integer.parseInt(subnetParts[0]);
        int sub2 = Integer.parseInt(subnetParts[1]);
        int sub3 = Integer.parseInt(subnetParts[2]);
        int sub4 = Integer.parseInt(subnetParts[3]);

        int net1 = ip1 & sub1;
        int net2 = ip2 & sub2;
        int net3 = ip3 & sub3;
        int net4 = ip4 & sub4;

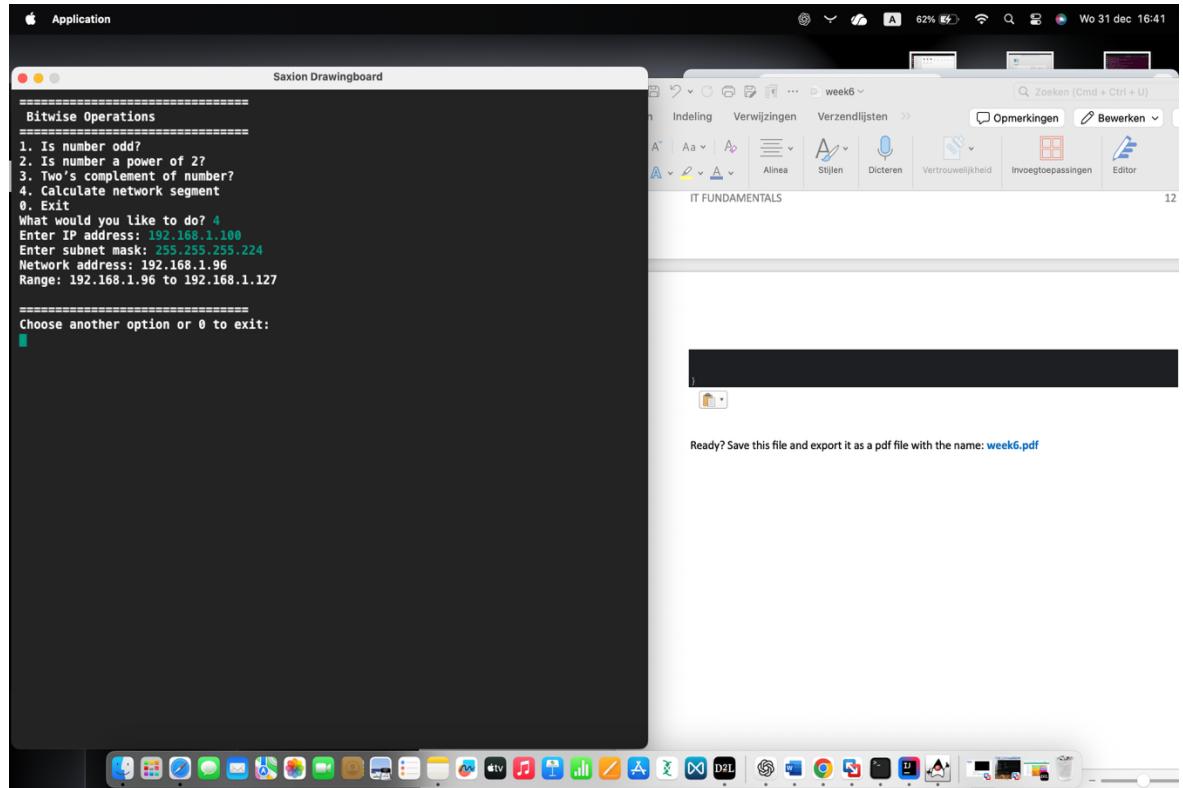
        SaxonApp.printLine("Network address: "
            + net1 + "." + net2 + "." + net3 + "." + net4);

        int rangeStart = net4;
        int rangeEnd = net4 + 31;

        SaxonApp.printLine("Range: "
            + net1 + "." + net2 + "." + net3 + "."
            + rangeStart
            + " to "
            + net1 + "." + net2 + "." + net3 + "."
            + rangeEnd);
    }
}

```

```
}
```



Ready? Save this file and export it as a pdf file with the name: [week6.pdf](#)