Template Week 6 – Networking

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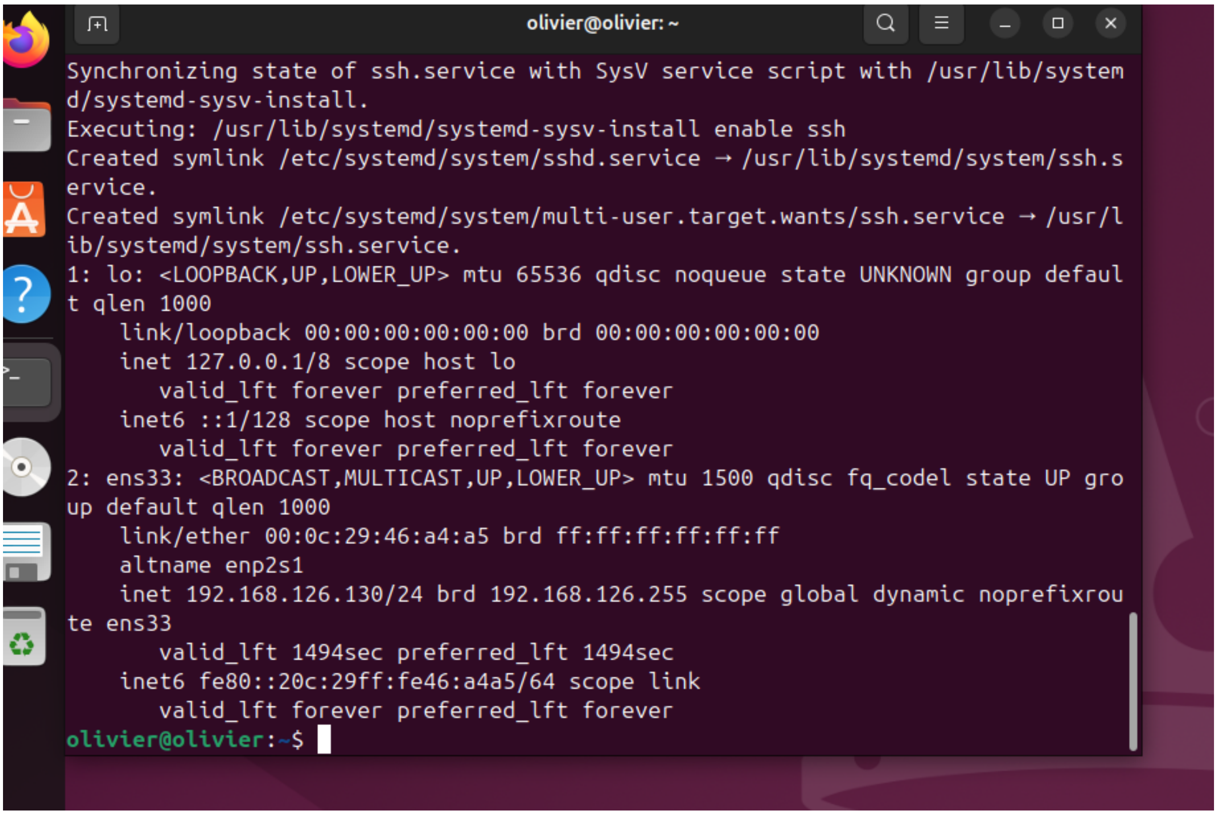
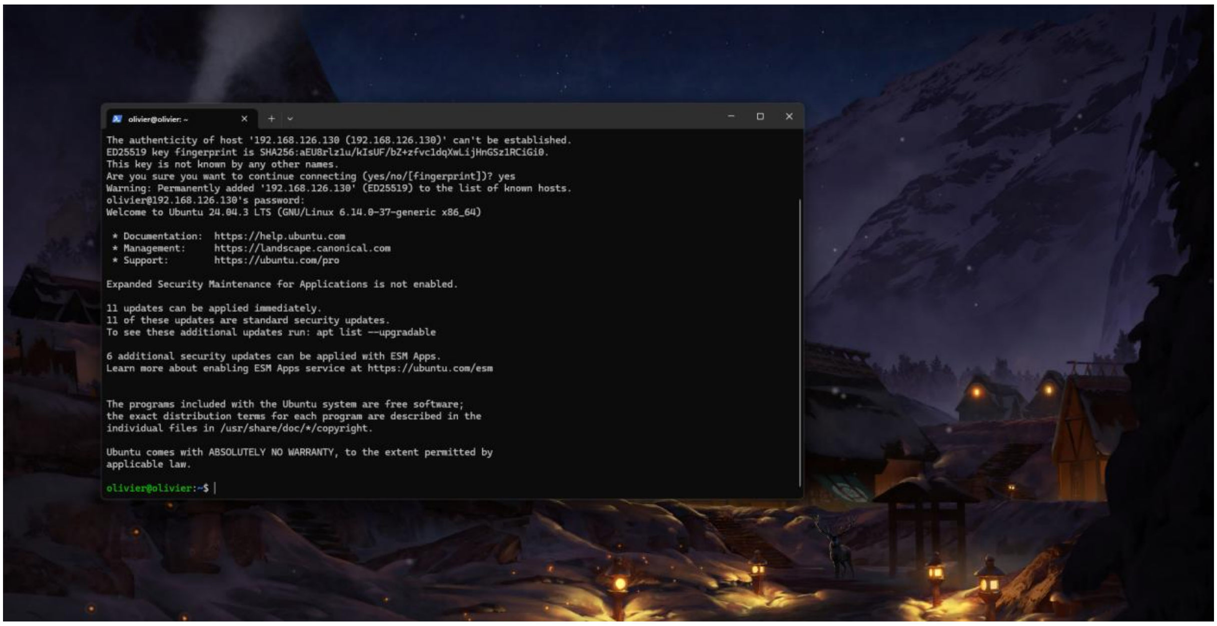
Assignment 6.1: Working from home

Screenshot installation openssh-server:

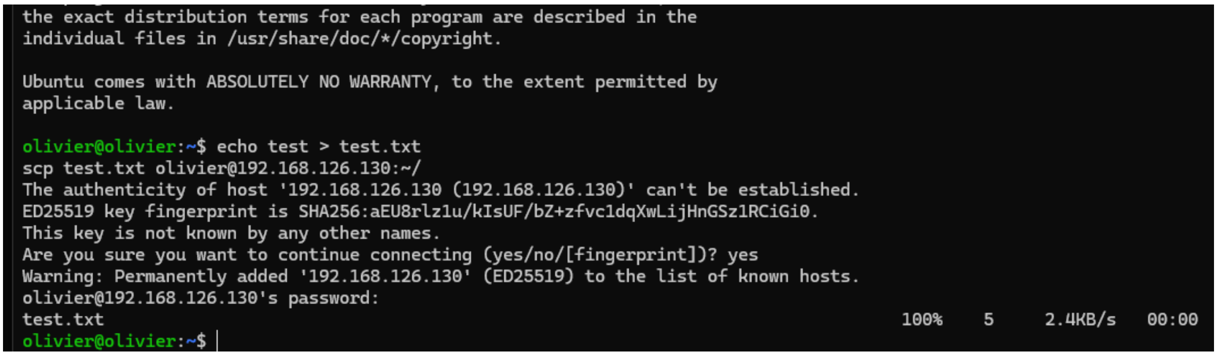


```
Synchronizing state of ssh.service with SysV service script with /usr/lib/system
d/systemd-sysv-install.
Executing: /usr/lib/systemd/systemd-sysv-install enable ssh
Created symlink /etc/systemd/system/sshd.service → /usr/lib/systemd/system/ssh.s
ervice.
Created symlink /etc/systemd/system/multi-user.target.wants/ssh.service → /usr/l
ib/systemd/system/ssh.service.
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group defaul
t 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: ens33: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP gro
up default qlen 1000
    link/ether 00:0c:29:46:a4:a5 brd ff:ff:ff:ff:ff:ff
    altname enp2s1
    inet 192.168.126.130/24 brd 192.168.126.255 scope global dynamic noprefixrou
te ens33
       valid_lft 1494sec preferred_lft 1494sec
    inet6 fe80::20c:29ff:fe46:a4a5/64 scope link
       valid_lft forever preferred_lft forever
olivier@olivier:~$
```

Screenshot successful SSH command execution:

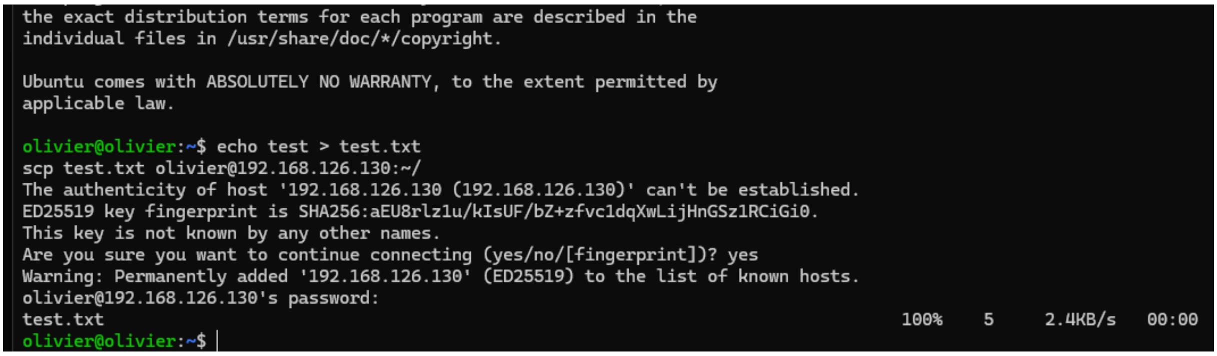


```
The authenticity of host '192.168.126.130 (192.168.126.130)' can't be established.
ED25519 key fingerprint is SHA256:aEU8rlz1u/kIsUF/bZ+zfvcldqXwLijHnGSz1RCiGi0.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.126.130' (ED25519) to the list of known hosts.
olivier@192.168.126.130's password:
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.14.0-37-generic x86_64)

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

Expanded Security Maintenance for Applications is not enabled.

11 updates can be applied immediately.
11 of these updates are standard security updates.
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


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.

olivier@olivier:~$ |
```



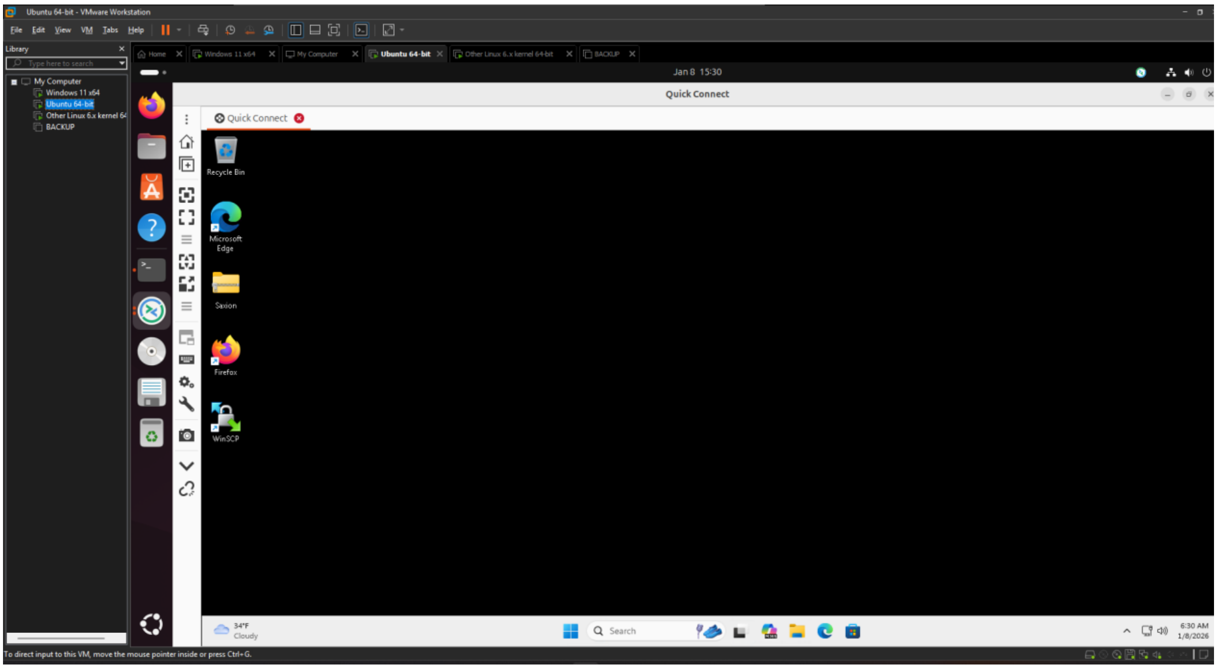
```
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

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

olivier@olivier:~$ echo test > test.txt
scp test.txt olivier@192.168.126.130:~/
The authenticity of host '192.168.126.130 (192.168.126.130)' can't be established.
ED25519 key fingerprint is SHA256:aEU8rlz1u/kIsUF/bZ+zfvc1dqXwLijHnGSz1RCiGi0.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.126.130' (ED25519) to the list of known hosts.
olivier@192.168.126.130's password:
test.txt                                                          100%    5     2.4KB/s   00:00
olivier@olivier:~$ 
```

Screenshot successful execution SCP command:



```
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.

olivier@olivier:~$ echo test > test.txt
scp test.txt olivier@192.168.126.130:~/
The authenticity of host '192.168.126.130 (192.168.126.130)' can't be established.
ED25519 key fingerprint is SHA256:aEU8rlz1u/kIsUF/bZ+zfvc1dqXwLijHnGSz1RCiGi0.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.126.130' (ED25519) to the list of known hosts.
olivier@192.168.126.130's password:
test.txt                                                          100%    5     2.4KB/s   00:00
olivier@olivier:~$ 
```

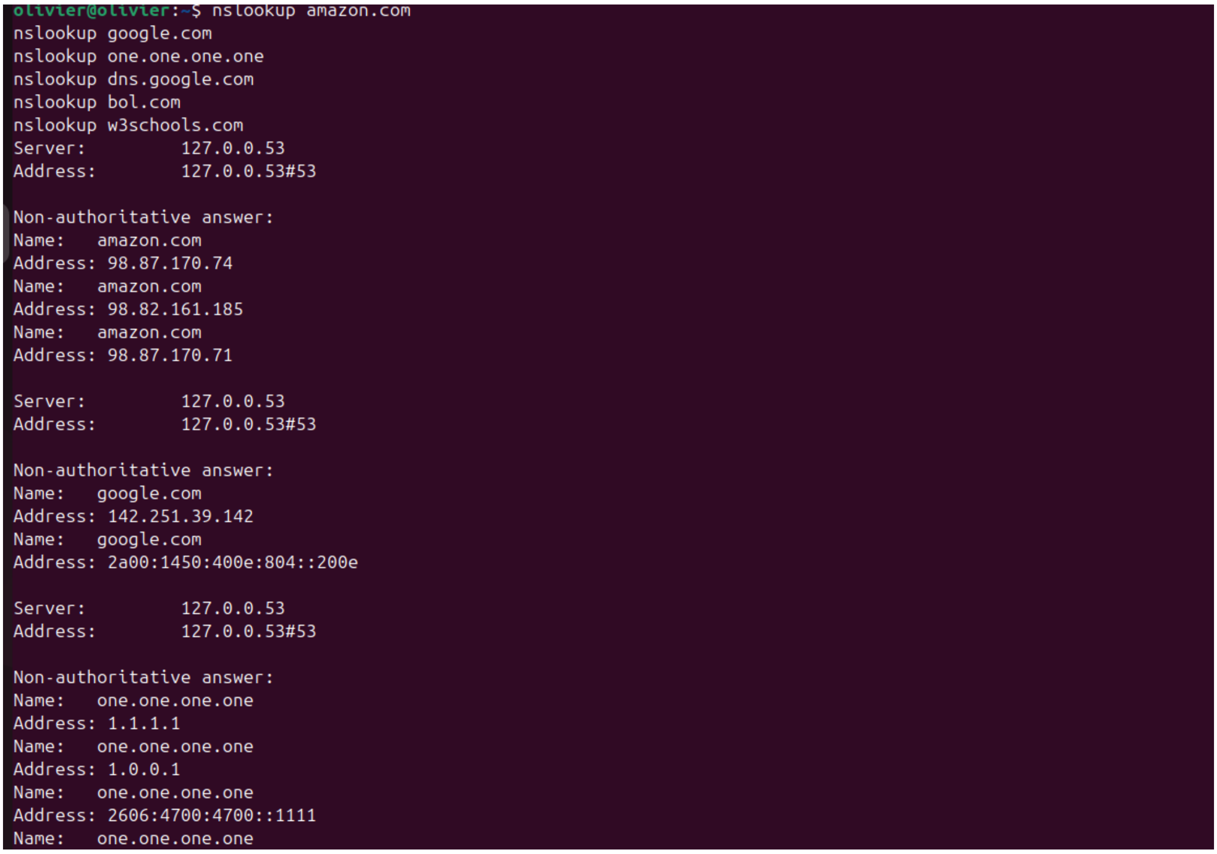
Screenshot remmina:



To direct input to this VM, move the mouse pointer inside or press Ctrl+G.

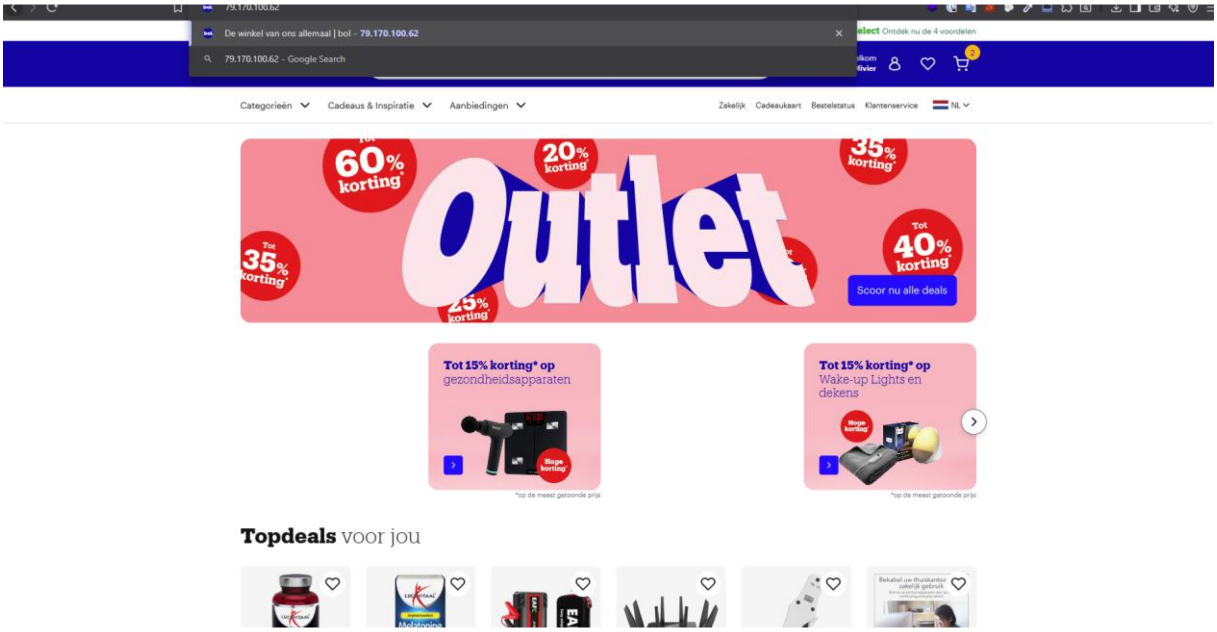
Assignment 6.2: IP addresses websites

Relevant screenshots nslookup command:



```
olivier@olivier:~$ nslookup amazon.com
nslookup google.com
nslookup one.one.one.one
nslookup dns.google.com
nslookup bol.com
nslookup w3schools.com
Server:         127.0.0.53
Address:        127.0.0.53#53

Non-authoritative answer:
Name:   amazon.com
Address: 98.87.170.74
Name:   amazon.com
Address: 98.82.161.185
Name:   amazon.com
Address: 98.87.170.71

Server:         127.0.0.53
Address:        127.0.0.53#53

Non-authoritative answer:
Name:   google.com
Address: 142.251.39.142
Name:   google.com
Address: 2a00:1450:400e:804::200e

Server:         127.0.0.53
Address:        127.0.0.53#53

Non-authoritative answer:
Name:   one.one.one.one
Address: 1.1.1.1
Name:   one.one.one.one
Address: 1.0.0.1
Name:   one.one.one.one
Address: 2606:4700:4700::1111
Name:   one.one.one.one
```

Screenshot website visit via IP address:



Assignment 6.3: subnetting

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

/25 betekent: 25 bits voor netwerk, 7 bits voor host

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

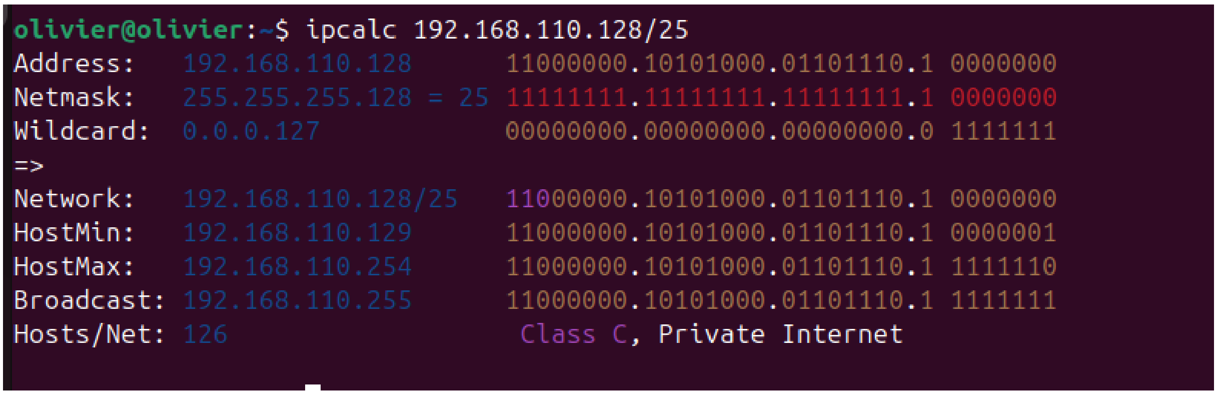
Van de 128 adressen zijn er 2 niet bruikbaar:

- Network address: 192.168.110.128
- Broadcast address: 192.168.110.255

Usable range: 192.168.110.129 - 192.168.110.254

Aantal bruikbaar: 128 - 2 = 126 adressen

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



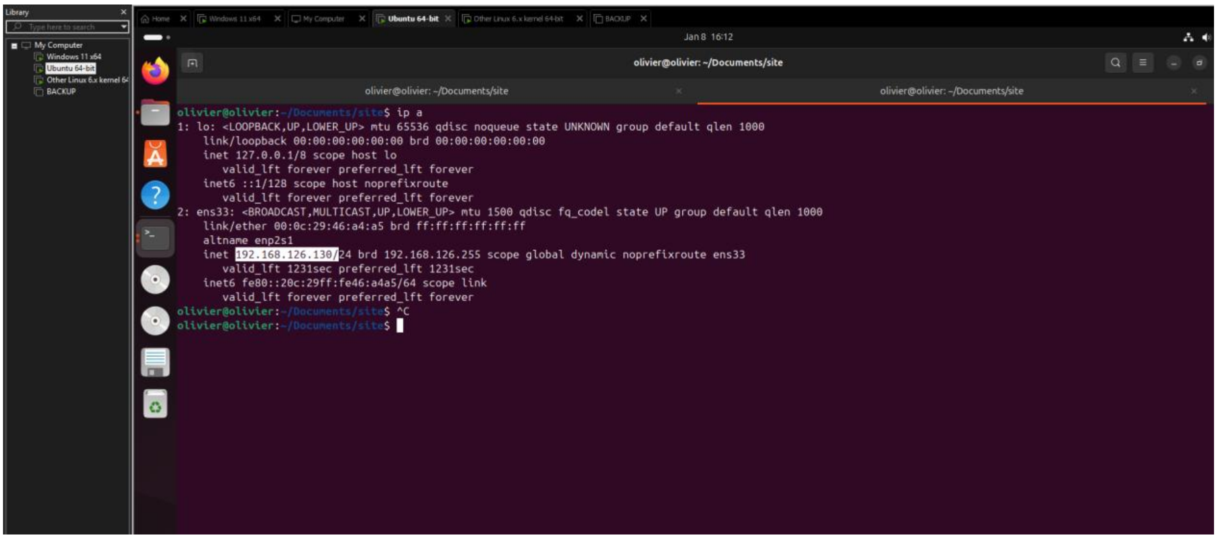
```
olivier@olivier:~$ ipcalc 192.168.110.128/25
Address:   192.168.110.128      11000000.10101000.01101110.1 0000000
Netmask:   255.255.255.128 = 25 11111111.11111111.11111111.1 0000000
Wildcard:  0.0.0.127            00000000.00000000.00000000.0 1111111
=>
Network:   192.168.110.128/25   11000000.10101000.01101110.1 0000000
HostMin:   192.168.110.129      11000000.10101000.01101110.1 0000001
HostMax:   192.168.110.254      11000000.10101000.01101110.1 1111110
Broadcast: 192.168.110.255      11000000.10101000.01101110.1 1111111
Hosts/Net: 126                   Class C, Private Internet
```

Explain the above calculation in your own words.

Een IP adres bestaat uit 32 bits. Bij /25 worden 25 bits gebruikt om het netwerk te identificeren en 7 bits blijven over voor apparaten (hosts). Met 7 bits kun je 2^7 = 128 combinaties maken, dus 128 IP adressen. Twee daarvan zijn gereserveerd: het eerste adres is het netwerkadres (identificeert het netwerk zelf) en het laatste is het broadcast adres (om alle apparaten tegelijk te bereiken). Daarom blijven er 126 adressen over voor computers en andere apparaten.

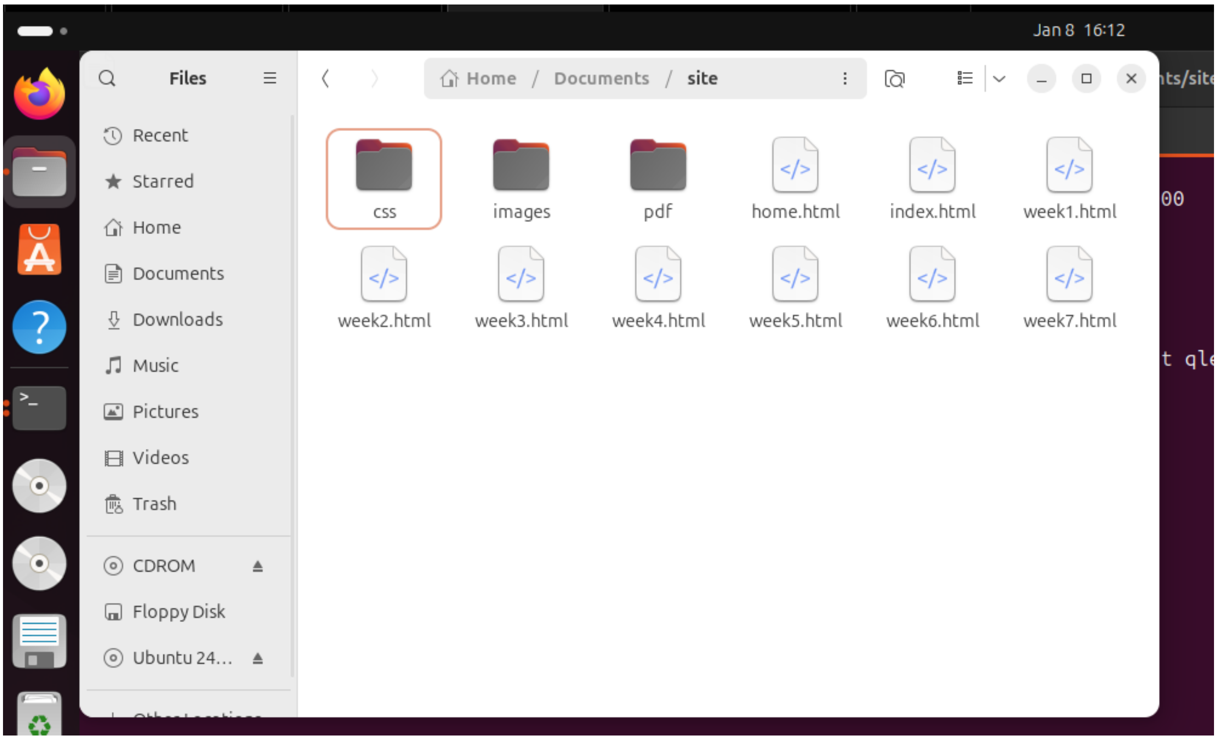
Assignment 6.4: HTML

Screenshot IP address Ubuntu VM:

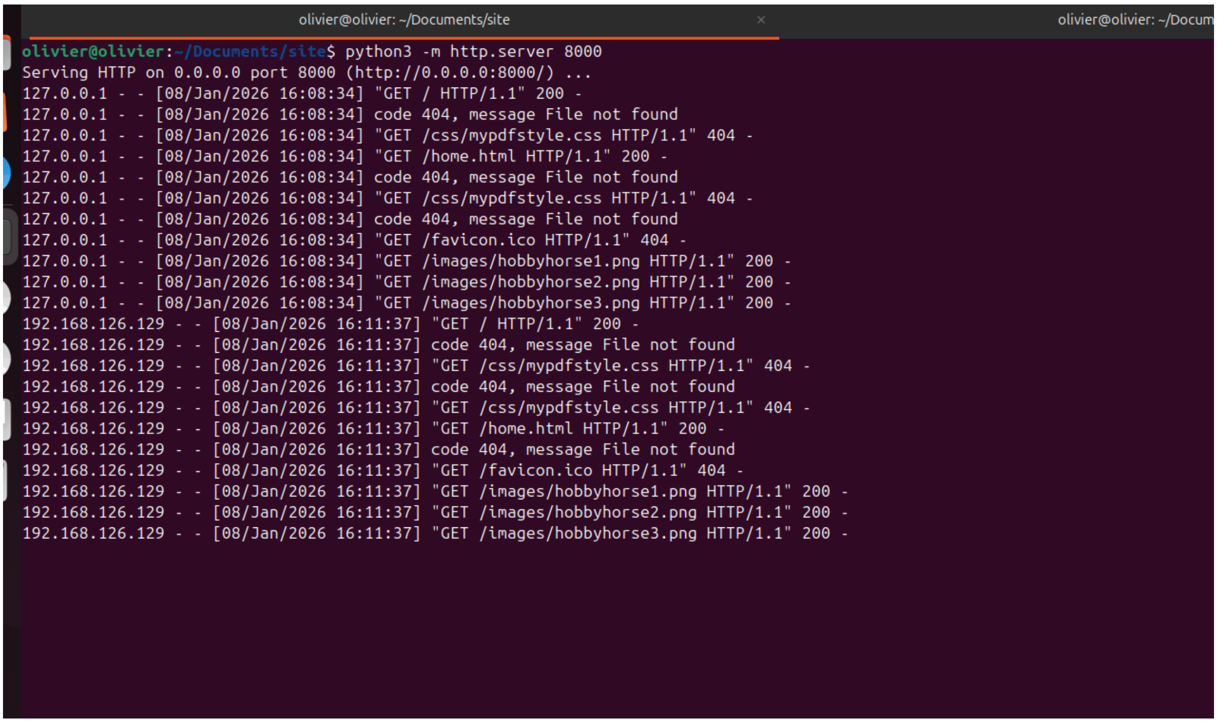

Library
Type here to search
My Computer
Windows 11 x64
Ubuntu 64-bit
Other Linux 6.x kernel 64
BACKUP
Home
Windows 11 x64
My Computer
Ubuntu 64-bit
Other Linux 6.x kernel 64-bit
BACKUP
Jan 8 16:12
olivier@olivier: ~/Documents/site
olivier@olivier: ~/Documents/site
olivier@olivier: ~/Documents/site

```
olivier@olivier:~/Documents/site$ 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: ens33: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 00:0c:29:46:a4:a5 brd ff:ff:ff:ff:ff:ff
    altname enp2s1
    inet 192.168.126.130/24 brd 192.168.126.255 scope global dynamic noprefixroute ens33
       valid_lft 1231sec preferred_lft 1231sec
    inet6 fe80::20c:29ff:fe46:a4a5/64 scope link
       valid_lft forever preferred_lft forever
olivier@olivier:~/Documents/site$ ^C
olivier@olivier:~/Documents/site$
```

Screenshot of Site directory contents:

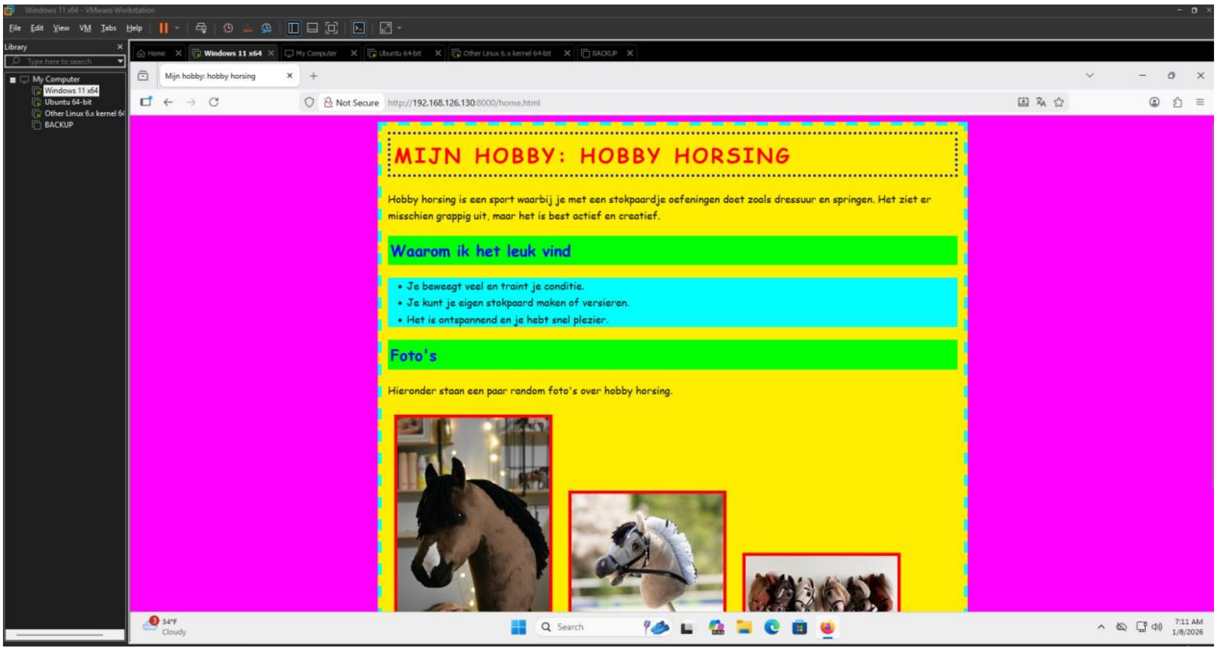


Screenshot python3 webserver command:



```
olivier@olivier:~/Documents/site$ python3 -m http.server 8000
Serving HTTP on 0.0.0.0 port 8000 (http://0.0.0.0:8000/) ...
127.0.0.1 - - [08/Jan/2026 16:08:34] "GET / HTTP/1.1" 200 -
127.0.0.1 - - [08/Jan/2026 16:08:34] code 404, message File not found
127.0.0.1 - - [08/Jan/2026 16:08:34] "GET /css/mypdfstyle.css HTTP/1.1" 404 -
127.0.0.1 - - [08/Jan/2026 16:08:34] "GET /home.html HTTP/1.1" 200 -
127.0.0.1 - - [08/Jan/2026 16:08:34] code 404, message File not found
127.0.0.1 - - [08/Jan/2026 16:08:34] "GET /css/mypdfstyle.css HTTP/1.1" 404 -
127.0.0.1 - - [08/Jan/2026 16:08:34] code 404, message File not found
127.0.0.1 - - [08/Jan/2026 16:08:34] "GET /favicon.ico HTTP/1.1" 404 -
127.0.0.1 - - [08/Jan/2026 16:08:34] "GET /images/hobbyhorse1.png HTTP/1.1" 200 -
127.0.0.1 - - [08/Jan/2026 16:08:34] "GET /images/hobbyhorse2.png HTTP/1.1" 200 -
127.0.0.1 - - [08/Jan/2026 16:08:34] "GET /images/hobbyhorse3.png HTTP/1.1" 200 -
192.168.126.129 - - [08/Jan/2026 16:11:37] "GET / HTTP/1.1" 200 -
192.168.126.129 - - [08/Jan/2026 16:11:37] code 404, message File not found
192.168.126.129 - - [08/Jan/2026 16:11:37] "GET /css/mypdfstyle.css HTTP/1.1" 404 -
192.168.126.129 - - [08/Jan/2026 16:11:37] code 404, message File not found
192.168.126.129 - - [08/Jan/2026 16:11:37] "GET /css/mypdfstyle.css HTTP/1.1" 404 -
192.168.126.129 - - [08/Jan/2026 16:11:37] "GET /home.html HTTP/1.1" 200 -
192.168.126.129 - - [08/Jan/2026 16:11:37] code 404, message File not found
192.168.126.129 - - [08/Jan/2026 16:11:37] "GET /favicon.ico HTTP/1.1" 404 -
192.168.126.129 - - [08/Jan/2026 16:11:37] "GET /images/hobbyhorse1.png HTTP/1.1" 200 -
192.168.126.129 - - [08/Jan/2026 16:11:37] "GET /images/hobbyhorse2.png HTTP/1.1" 200 -
192.168.126.129 - - [08/Jan/2026 16:11:37] "GET /images/hobbyhorse3.png HTTP/1.1" 200 -
```

Screenshot web browser visits your site


Mijn hobby: hobby horsing
Not Secure
http://192.168.126.130:8000/home.html
Windows 11 x64
My Computer
Ubuntu 64-bit
Other Linux 6.x kernel 64-bit
BACKUP
Search

MIJN HOBBY: HOBBY HORSING

Hobby horsing is een sport waarbij je met een stokpaardje oefeningen doet zoals dressuur en springen. Het ziet er misschien grappig uit, maar het is best actief en creatief.

Waarom ik het leuk vind

- Je beweegt veel en traint je conditie.
- Je kunt je eigen stokpaard maken of versieren.
- Het is ontspannend en je hebt snel plezier.

Foto's

Hieronder staan een paar random foto's over hobby horsing.

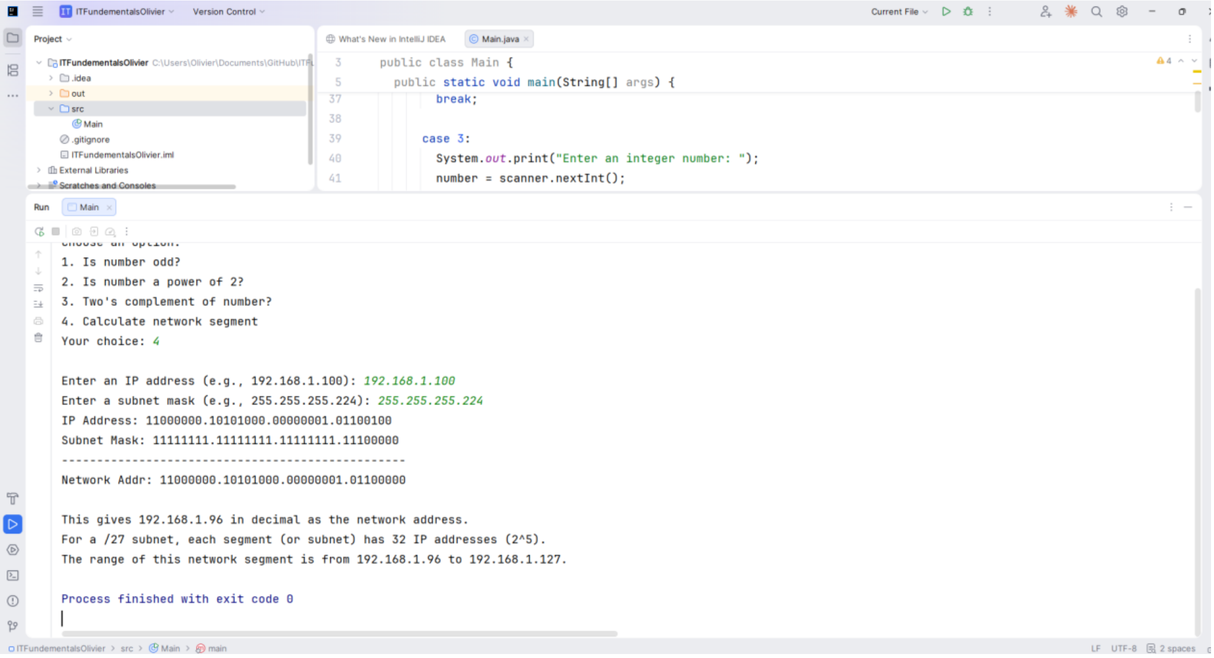
Assignment 6.5: Network segment

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.


ITFundementalsOlivier
Version Control
Current File
Project
ITFundementalsOlivier C:\Users\Olivier\Documents\GitHub\ITF
.idea
out
src
Main
.gitignore
ITFundementalsOlivier.iml
External Libraries
Scratches and Consoles
What's New in IntelliJ IDEA
Main.java
Run
Main
ITFundementalsOlivier > src > Main > main
LF
UTF-8
2 spaces

```
public class Main {
  public static void main(String[] args) {
        break;

      case 3:
        System.out.print("Enter an integer number: ");
        number = scanner.nextInt();
```

```
Choose an option:
1. Is number odd?
2. Is number a power of 2?
3. Two's complement of number?
4. Calculate network segment
Your choice: 4

Enter an IP address (e.g., 192.168.1.100): 192.168.1.100
Enter a subnet mask (e.g., 255.255.255.224): 255.255.255.224
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.

Process finished with exit code 0
```

```
import java.util.Scanner;

public class Main {

  public static void main(String[] args) {
    Scanner scanner = new Scanner(System.in);

    System.out.println("\nChoose an option:");
    System.out.println("1. Is number odd?");
    System.out.println("2. Is number a power of 2?");
    System.out.println("3. Two's complement of number?");
    System.out.println("4. Calculate network segment");
    System.out.print("Your choice: ");

    int choice = scanner.nextInt();
```

```
System.out.println();

switch (choice) {
 case 1:
  System.out.print("Enter an integer number: ");
  int number = scanner.nextInt();
  if (isOdd(number)) {
   System.out.println(number + " is odd.");
  } else {
   System.out.println(number + " is even.");
  }
  break;

 case 2:
  System.out.print("Enter an integer number: ");
  number = scanner.nextInt();
  if (isPowerOfTwo(number)) {
   System.out.println(number + " is a power of 2.");
  } else {
   System.out.println(number + " is NOT a power of 2.");
  }
  break;

 case 3:
  System.out.print("Enter an integer number: ");
  number = scanner.nextInt();
  int twosComp = twosComplement(number);
  System.out.println("Two's complement of " + number + " is: " + twosComp);
  break;

 case 4:
  System.out.print("Enter an IP address (e.g., 192.168.1.100): ");
  String ipInput = scanner.next();
  System.out.print("Enter a subnet mask (e.g., 255.255.255.224): ");
  String maskInput = scanner.next();

  int[] ipOctets = parseIp(ipInput);
  int[] maskOctets = parseIp(maskInput);

  if (ipOctets == null || maskOctets == null) {
   System.out.println("Invalid IP address or subnet mask.");
   break;
  }

  long ipLong = ipToLong(ipOctets);
  long maskLong = ipToLong(maskOctets);
  long networkLong = ipLong & maskLong;
  long broadcastLong = networkLong | (~maskLong & 0xFFFFFFFFL);
```

```
        int[] networkOctets = longToIp(networkLong);
        int[] broadcastOctets = longToIp(broadcastLong);
        int prefixLength = countMaskBits(maskLong);
        int hostBits = 32 - prefixLength;
        long addressesPerSubnet = 1L << hostBits;

        System.out.println("IP Address: " + toBinaryString(ipOctets));
        System.out.println("Subnet Mask: " + toBinaryString(maskOctets));
        System.out.println("-------------------------------------------------");
        System.out.println("Network Addr: " + toBinaryString(networkOctets));
        System.out.println();
        System.out.println("This gives " + toIpString(networkOctets) + " in decimal as the network
address.");
        System.out.println("For a /" + prefixLength + " subnet, each segment (or subnet) has "
          + addressesPerSubnet + " IP addresses (2^" + hostBits + ").");
        System.out.println("The range of this network segment is from " + toIpString(networkOctets)
          + " to " + toIpString(broadcastOctets) + ".");
        break;

      default:
        System.out.println("Invalid choice.");
    }

    scanner.close();
  }

  public static boolean isOdd(int n) {
    return (n & 1) == 1;
  }

  public static boolean isPowerOfTwo(int n) {
    if (n <= 0) return false;
    return (n & (n - 1)) == 0;
  }

  public static int twosComplement(int n) {
    return ~n + 1;
  }

  public static int[] parseIp(String input) {
    String[] parts = input.split("\\.");
    if (parts.length != 4) return null;

    int[] octets = new int[4];
    for (int i = 0; i < 4; i++) {
      try {
        int value = Integer.parseInt(parts[i]);
        if (value < 0 || value > 255) return null;
        octets[i] = value;
      } catch (NumberFormatException ex) {
        return null;
      }
    }

    return octets;
  }

  public static long ipToLong(int[] octets) {
    long result = 0;
    for (int octet : octets) {
      result = (result << 8) | (octet & 0xFF);
    }
    return result;
  }

  public static int[] longToIp(long value) {
    int[] octets = new int[4];
    for (int i = 0; i < 4; i++) {
      int shift = 24 - (8 * i);
      octets[i] = (int) ((value >> shift) & 0xFF);
    }
    return octets;
  }

  public static String toBinaryString(int[] octets) {
    StringBuilder sb = new StringBuilder();
    for (int i = 0; i < octets.length; i++) {
      if (i > 0) sb.append(".");
      String bin = Integer.toBinaryString(octets[i]);
      sb.append(String.format("%8s", bin).replace(' ', '0'));
    }
    return sb.toString();
  }

  public static String toIpString(int[] octets) {
    return octets[0] + "." + octets[1] + "." + octets[2] + "." + octets[3];
  }

  public static int countMaskBits(long maskLong) {
    int count = 0;
    for (int i = 31; i >= 0; i--) {
      if (((maskLong >> i) & 1L) == 1L) {
        count++;
      } else {
        break;
      }
    }
    return count;
  }
}
```

Ready? Save this file and export it as a pdf file with the name: **week6.pdf**