

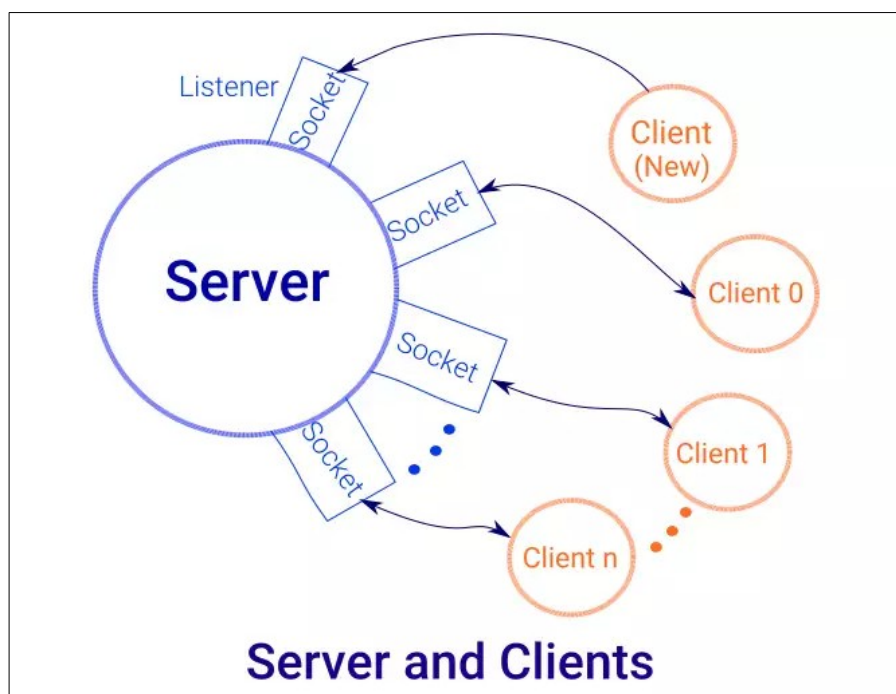
# CSE 344 – System Programming

## Final Project Report

16.06.2023

### 1) System Architecture

- In this project we were suppose to implement simplified version of Dropbox.
- The system consists of two main components: a server and clients.
- **The server** listens for incoming connections, reads client requests and writes back to the clients via sockets.
- **Clients** connect to the server using sockets and each client is assigned a separate thread for communication.



## 2) Design Decisions and Implementation Details

### General Information :

- On both sides, I am keeping the files inside the directories using the following file struct :

```
typedef struct{
    char name[512];
    char content[4096];
    mode_t mode;    // Permissions
    long size;
    time_t modifiedTime;
} file;
```

- The algorithm I implemented to ensure that the directories be synchronized can be summarized as follows:
  - In both sides, I continuously perform read() and write() operations through sockets within a loop.
  - Firstly, I check if there are any changes in the server directory. If there are no changes, I send -1 to indicate that. If there are changes, I send the byte count of the directory content and then send all the files within the directory to the client via the socket. After the client finishes reading everything, it sends an "ok" message, which the server reads, and the program continues.
  - Then, the same process is performed by the client. This way, they synchronize their directories with each other.

(You can review this structure based on the draft design I have drawn on the two pages later.)

### BibakBOXServer.c

- It takes input from the user,
- Creates a socket and starts listening for incoming connections,
- When a connection is received, it sends all the files in the server directory to the client initially for synchronization at the beginning,
- The respective thread terminates when the client disconnects.
- When a SIGINT signal is received, the server shuts down.
- The server is responsible for writing the log file.

### **BibakBOXClient.c**

- It takes input from the user,
- It has an optional parameter [server\_address] which allows connecting to a different computer by providing the IP address,
- It creates a socket and connects to the server,
- When a SIGINT signal is received or the server is closed, the client also shuts down.

### **Makefile**

- It compiles the project as a whole.

## **3) Which requirements I met / did not meet?**

- A thread pool structure has been implemented in the project.
- The signal SIGINT is working on both sides.
- When there is a connection, the connection address is printed to the screen on both sides.
- I have performed error checks as much as possible. The usage is printed to the screen.
- It works for the created, deleted and updated changes of the files on both sides.
- I keep the files in the directory in a struct file that I created on both sides. I send the files through sockets mutually. That's why it works on different computers as well.
- The program works fine with a single client, but when multiple clients are connected, it may not always work properly. (I used a mutex as a synchronization mechanism but sometimes certain clients fail to access the necessary information coming from server.)
- If directories contain subfolders, I couldn't take that part into account due to the time constraints.
- There is logging, but not exactly as requested. I keep the log file directly in the project's working directory, not in the server or client directory. And inside the log file, I only write that a change occurred on the side where the change occurred whenever there is a change in any directory.

# threadMain Server

while( ) {

```
accept()
totalClient++;
read FolderContent()
fileCount
```

write (&total\_bytes)

while (remaining > 0) {

write (filelist + ...)

}

read ("ok")

while ( ) {

compose Files ( --

if (choice) {

write (-1);

read ("ok");

else {

memset (filelist)

fileCount = read Folder

write (&total\_bytes)

while (remaining > 0) {

write (filelist)

}

read ("ok");

}

/\* ----- \*/

read (&received\_byte)

if (received == -1) {

write ("ok");

}

else {

while (remaining > 0) {

read (receiveBuff)

}

re Create Folder ( )

fileCount = read Folder Content

write ("ok");

}

}

totalClient --

# Client

main

empty-dir ( )

socket ( )

connect ( )

read (&received\_bytes)

while (remaining > 0) {

read (receiveBuff + total...)

}

re Create Folder

fileCount = read FolderContent

write ("ok")

while ( ) {

read (&received\_byte)

if (received == -1) {

write ("ok");

}

else {

while (remaining\_bytes > 0) {

read (receiveBuff)

}

write ("ok");

}

/\* ----- \*/

compose Files ( -- )

if (choice) {

write (-1);

read ("ok");

}

else {

memset (file..)

fileCount = read FolderContent ( )

write (&total\_bytes)

while (remaining\_bytes > 0) {

write (filelist + ...)

}

read ("ok");

}

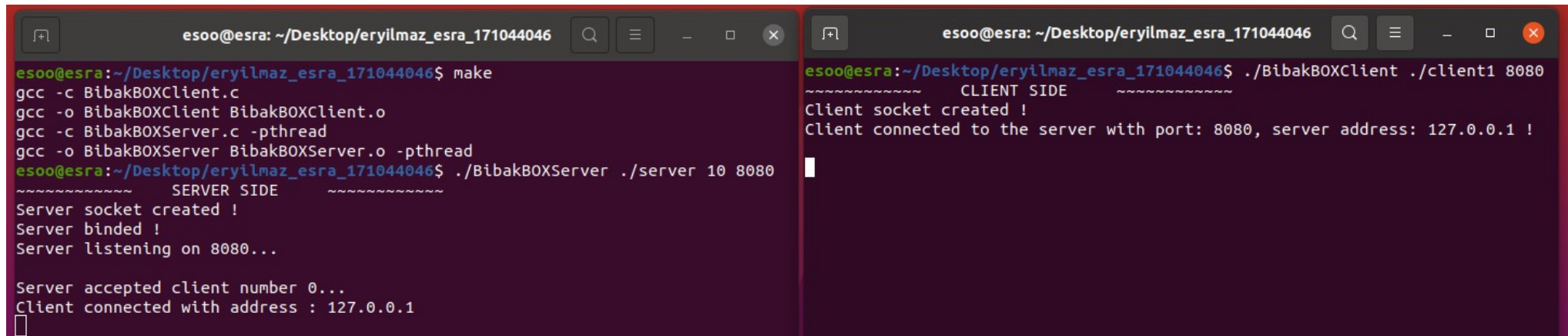
}

}



## 4) Tests

### - Usage :

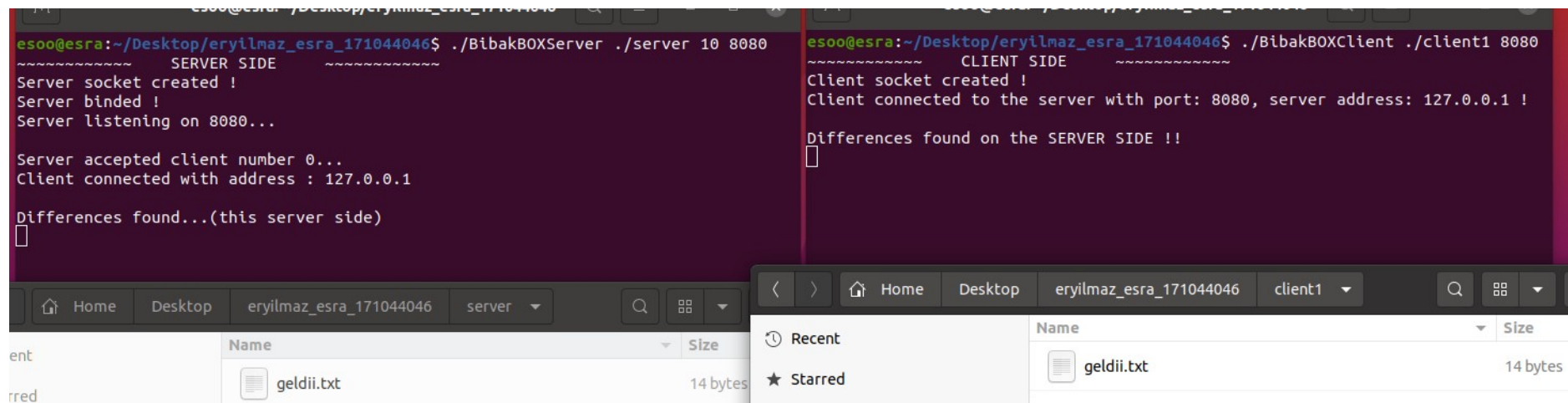


```
esoo@esra: ~/Desktop/eryilmaz_esra_171044046
esoo@esra:~/Desktop/eryilmaz_esra_171044046$ make
gcc -c BibakBOXClient.c
gcc -o BibakBOXClient BibakBOXClient.o
gcc -c BibakBOXServer.c -pthread
gcc -o BibakBOXServer BibakBOXServer.o -pthread
esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXServer ./server 10 8080
~~~~~ SERVER SIDE ~~~~~
Server socket created !
Server binded !
Server listening on 8080...

Server accepted client number 0...
Client connected with address : 127.0.0.1
█

esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXClient ./client1 8080
~~~~~ CLIENT SIDE ~~~~~
Client socket created !
Client connected to the server with port: 8080, server address: 127.0.0.1 !
█
```

- **Test case 1** : The server was started and then 1 client connected. A file was created in the server directory and it was also reflected in the client directory.



```
esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXServer ./server 10 8080
~~~~~ SERVER SIDE ~~~~~
Server socket created !
Server binded !
Server listening on 8080...

Server accepted client number 0...
Client connected with address : 127.0.0.1

Differences found...(this server side)
█

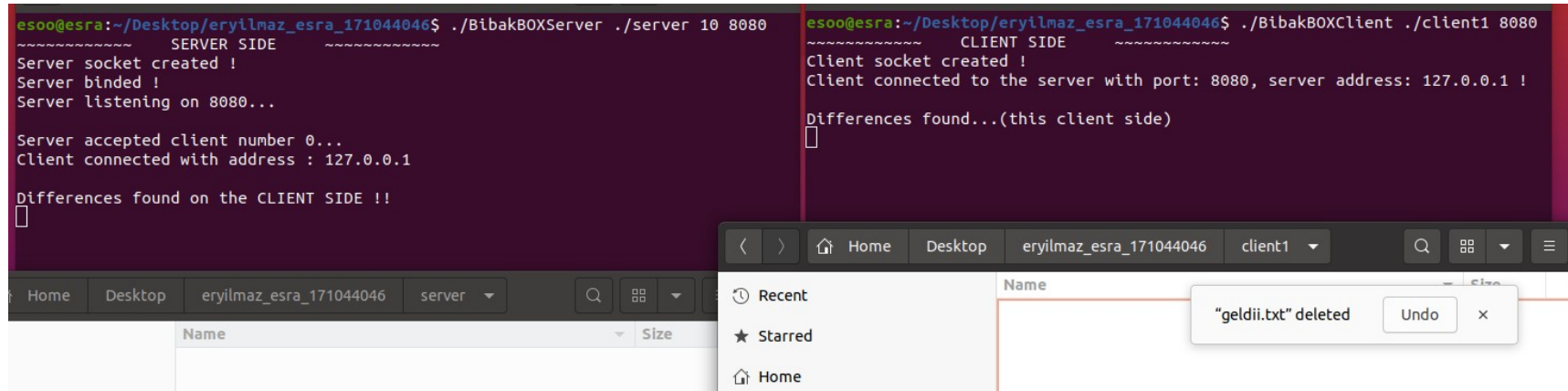
esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXClient ./client1 8080
~~~~~ CLIENT SIDE ~~~~~
Client socket created !
Client connected to the server with port: 8080, server address: 127.0.0.1 !

Differences found on the SERVER SIDE !!
█
```

Name	Size
geldii.txt	14 bytes

Name	Size
geldii.txt	14 bytes

- **Test case 2 :** The server was started and then 1 client connected. A file was deleted in the client directory and it was also reflected in the server directory.



The screenshot shows two terminal windows side-by-side. The left window is the server terminal, and the right window is the client terminal. Both show successful connection and file synchronization. A file manager window is open in the foreground, showing the 'client1' directory. A dialog box indicates that 'geldii.txt' has been deleted, with 'Undo' and 'X' buttons.

```
esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXServer ./server 10 8080
~~~~~ SERVER SIDE ~~~~~
Server socket created !
Server binded !
Server listening on 8080...

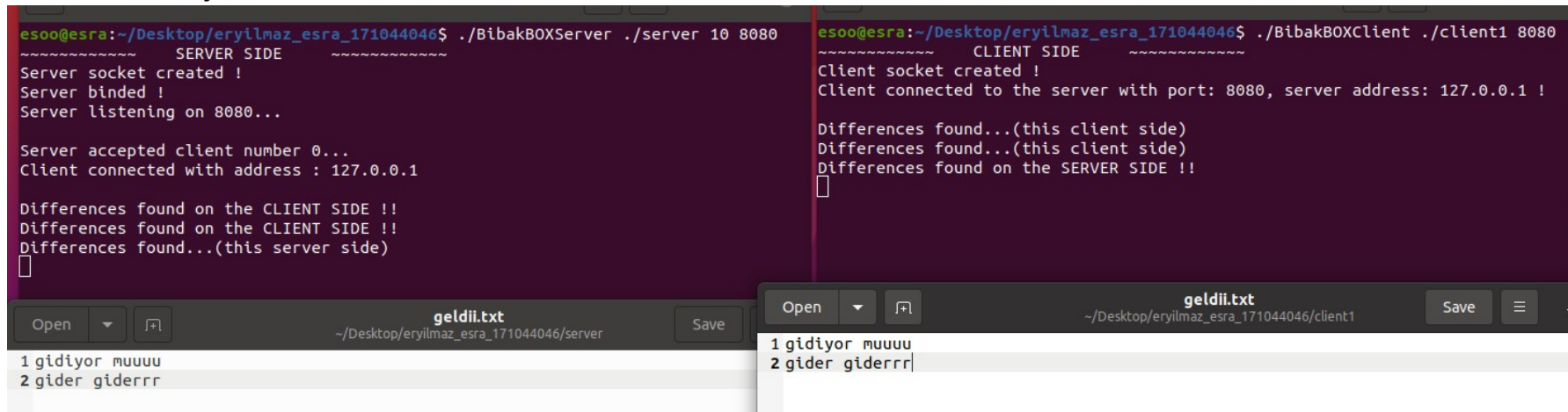
Server accepted client number 0...
Client connected with address : 127.0.0.1

Differences found on the CLIENT SIDE !!
[]

esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXClient ./client1 8080
~~~~~ CLIENT SIDE ~~~~~
Client socket created !
Client connected to the server with port: 8080, server address: 127.0.0.1 !

Differences found...(this client side)
[]
```

- **Test case 3 :** The server was started and then 1 client connected. A file was updated in the server directory and it was also reflected in the client directory.



The screenshot shows two terminal windows side-by-side. The left window is the server terminal, and the right window is the client terminal. Both show successful connection and file synchronization. Two file manager windows are open in the foreground, showing the 'server' and 'client1' directories. Both windows show the same file content: '1 gidiyor muuuu' and '2 gider giderrr'.

```
esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXServer ./server 10 8080
~~~~~ SERVER SIDE ~~~~~
Server socket created !
Server binded !
Server listening on 8080...

Server accepted client number 0...
Client connected with address : 127.0.0.1

Differences found on the CLIENT SIDE !!
Differences found on the CLIENT SIDE !!
Differences found...(this server side)
[]

esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXClient ./client1 8080
~~~~~ CLIENT SIDE ~~~~~
Client socket created !
Client connected to the server with port: 8080, server address: 127.0.0.1 !

Differences found...(this client side)
Differences found...(this client side)
Differences found on the SERVER SIDE !!
[]
```

- **Test case 4** : The server was run with a thread pool size of 10 and 10 clients were run in parallel. Communication has been established but the clients do not always communicate properly with the server.

```
esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXServer ./server 10 8080
SERVER SIDE
Server socket created !
Server binded !
Server listening on 8080...

Server accepted client number 0...
Client connected with address : 127.0.0.1

Server accepted client number 1...
Client connected with address : 127.0.0.1

Server accepted client number 2...
Client connected with address : 127.0.0.1

Server accepted client number 3...
Client connected with address : 127.0.0.1

Server accepted client number 4...
Client connected with address : 127.0.0.1

Server accepted client number 5...
Client connected with address : 127.0.0.1

Server accepted client number 6...
Client connected with address : 127.0.0.1

Server accepted client number 7...
Client connected with address : 127.0.0.1

Server accepted client number 8...
Client connected with address : 127.0.0.1

Server accepted client number 9...
Client connected with address : 127.0.0.1

esoo@esra:~/Desktop/eryilmaz_esra_171044046$ bash test.sh
CLIENT SIDE
Client socket created !
Client socket created !
Client socket created !
Client connected to the server with port: 8080, server address: 127.0.0.1 !

CLIENT SIDE
Client connected to the server with port: 8080, server address: 127.0.0.1 !

CLIENT SIDE
Client socket created !
Client socket created !
Client socket created !
Client socket created !
Client socket created !
Client socket created !
Client socket created !
Client socket created !
Client connected to the server with port: 8080, server address: 127.0.0.1 !

CLIENT SIDE~
Client socket created !
CLIENT SIDE
CLIENT SIDE
Client socket created !
Client socket created !
Client connected to the server with port: 8080, server address: 127.0.0.1 !

Client connected to the server with port: 8080, server address: 127.0.0.1 !
Client connected to the server with port: 8080, server address: 127.0.0.1 !
Client connected to the server with port: 8080, server address: 127.0.0.1 !
Client connected to the server with port: 8080, server address: 127.0.0.1 !
Client connected to the server with port: 8080, server address: 127.0.0.1 !
Client connected to the server with port: 8080, server address: 127.0.0.1 !
Client connected to the server with port: 8080, server address: 127.0.0.1 !

s
```

```
testsh x
1 #!/bin/bash
2
3 for i in {1..10}
4 do
5     ./BibakBOXClient client"$i" 8080 &
6 done
```



- **Test case 5** : The server was run with a thread pool size of 20, and 2 clients were run consecutively. Communication was established and it was observed that the file operations were done correctly.

The screenshot displays a terminal window with three separate command-line sessions. The first session runs the server, which listens on port 8080 and accepts two clients. The second session runs the first client, which connects to the server and reports differences found on the server side. The third session runs the second client, which also connects to the server and reports differences found on the server side. Below the terminal windows, a file explorer shows the directory structure created by the program, including folders for client1, client2, and server, each containing 12 items.

```
esoo@esra: ~/Desktop/eryilmaz_esra_171044046
esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXServer ./server 20 8080
~~~~~ SERVER SIDE ~~~~~
Server socket created !
Server binded !
Server listening on 8080...

Server accepted client number 0...
Client connected with address : 127.0.0.1

Server accepted client number 1...
Client connected with address : 127.0.0.1

Differences found...(this server side)
Differences found...(this server side)
```

Name	Size
client1	12 items
client2	12 items
server	12 items

```
esoo@esra: ~/Desktop/eryilmaz_esra_171044046
esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXClient ./client1 8080
~~~~~ CLIENT SIDE ~~~~~
Client socket created !
Client connected to the server with port: 8080, server address: 127.0.0.1 !

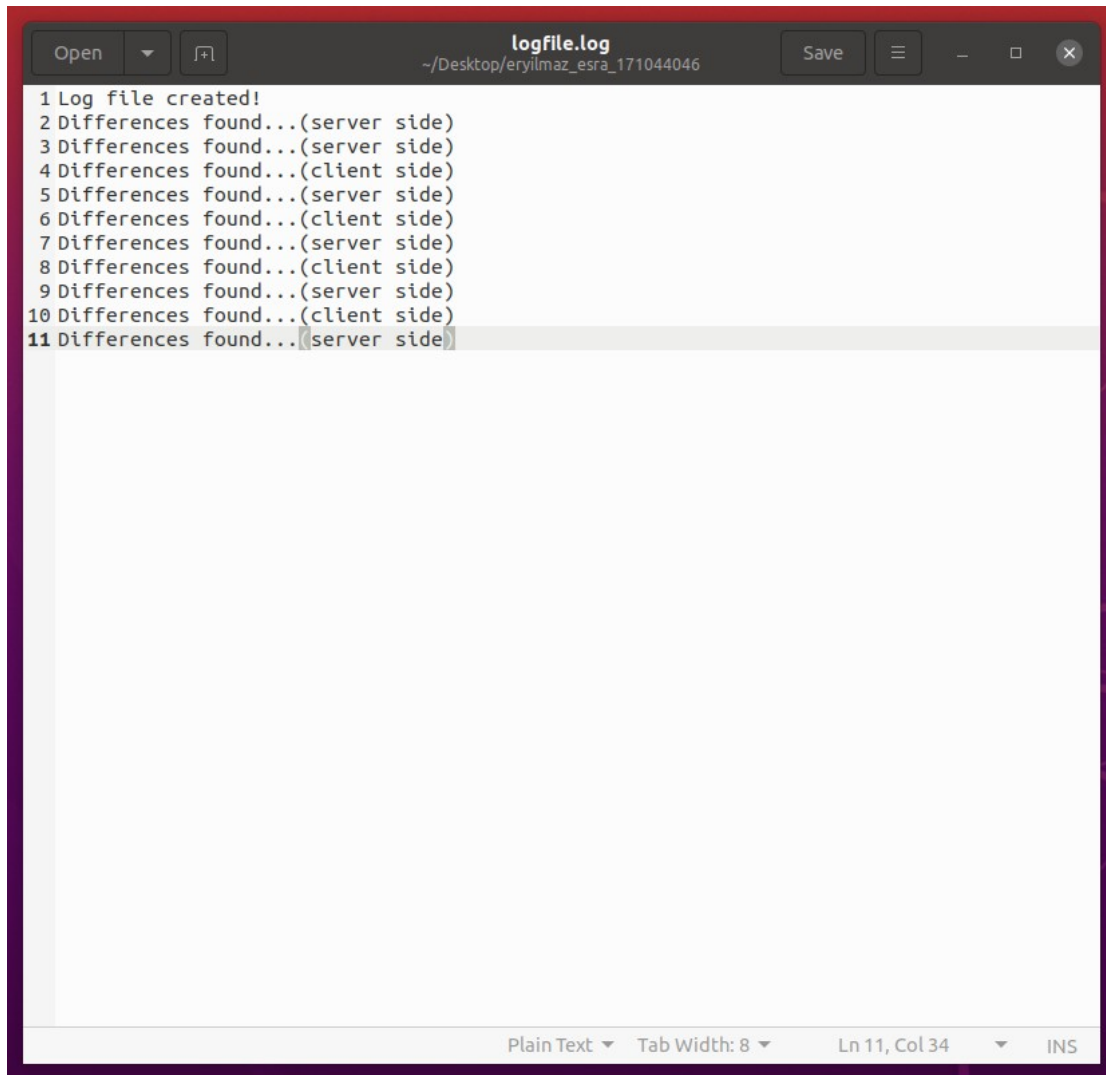
Differences found on the SERVER SIDE !!

esoo@esra: ~/Desktop/eryilmaz_esra_171044046
esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXClient ./client2 8080
~~~~~ CLIENT SIDE ~~~~~
The folder ./client2 does not exist, the program created it!!
Client socket created !
Client connected to the server with port: 8080, server address: 127.0.0.1 !

Differences found on the SERVER SIDE !!
```



- **Test case 6** : The server was started and then 1 client connected. Various operations were performed in both the server and client directories and the contents of the log file at the end are as follows:

A screenshot of a text editor window titled "logfile.log" with a path of "~/Desktop/eryilmaz\_esra\_171044046". The window contains 11 lines of log data. The first line is "1 Log file created!". The subsequent lines are numbered 2 through 11, each starting with "Differences found..." followed by either "(server side)" or "(client side)". The text is as follows:

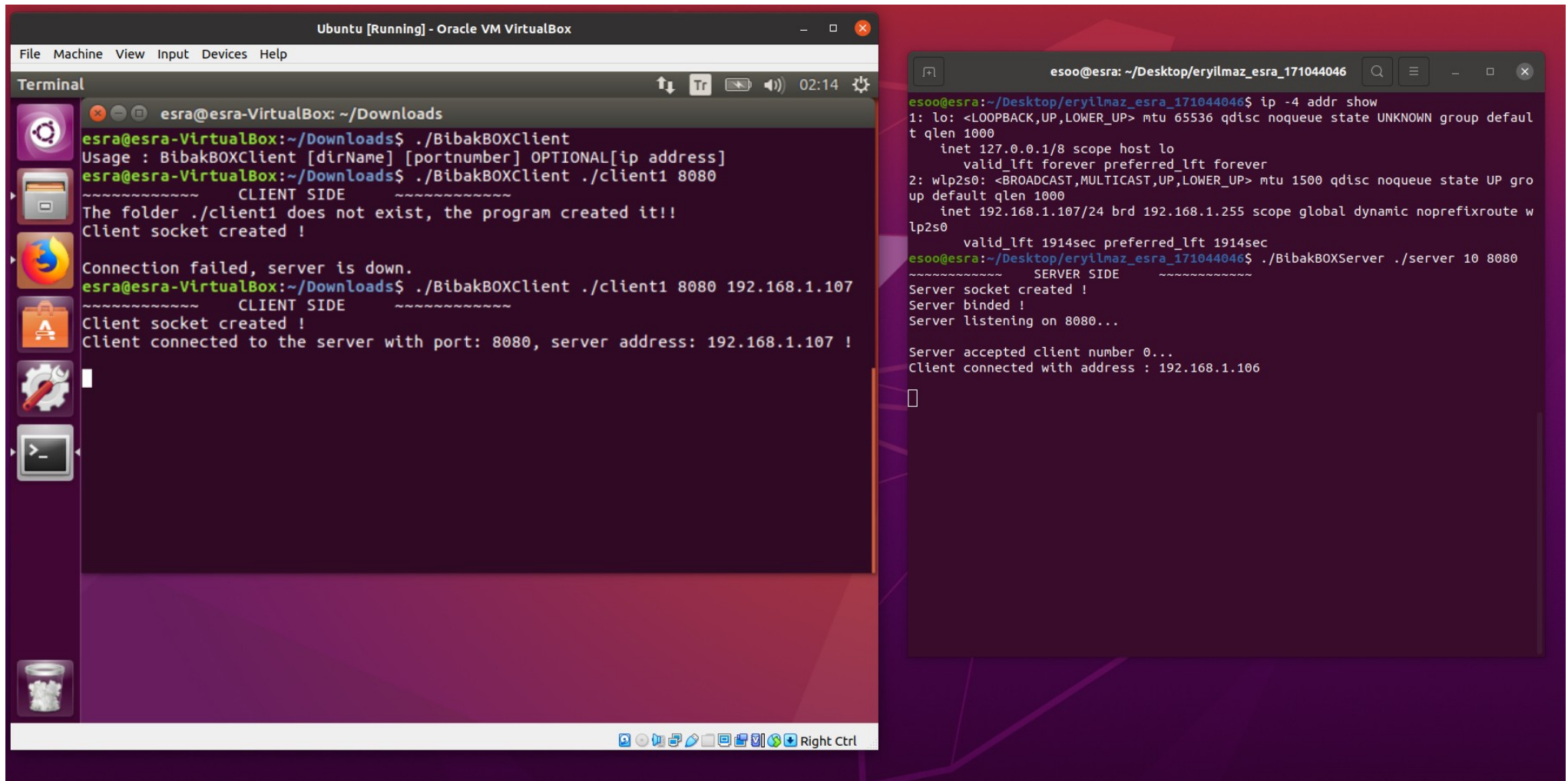
```
1 Log file created!
2 Differences found...(server side)
3 Differences found...(server side)
4 Differences found...(client side)
5 Differences found...(server side)
6 Differences found...(client side)
7 Differences found...(server side)
8 Differences found...(client side)
9 Differences found...(server side)
10 Differences found...(client side)
11 Differences found...(server side)
```

The status bar at the bottom indicates "Plain Text", "Tab Width: 8", "Ln 11, Col 34", and "INS".

```
Open [icon] logfile.log ~/Desktop/eryilmaz_esra_171044046 Save [icon] [icon] [icon] [icon]
1 Log file created!
2 Differences found...(server side)
3 Differences found...(server side)
4 Differences found...(client side)
5 Differences found...(server side)
6 Differences found...(client side)
7 Differences found...(server side)
8 Differences found...(client side)
9 Differences found...(server side)
10 Differences found...(client side)
11 Differences found...(server side)
Plain Text Tab Width: 8 Ln 11, Col 34 INS
```

- **Test case 7** : The server and client were run on different computers:

Firstly, the connection was established :



The image shows two terminal windows side-by-side in an Oracle VM VirtualBox environment. The left window is titled 'Ubuntu [Running] - Oracle VM VirtualBox' and shows a terminal session for 'esra@esra-VirtualBox: ~/Downloads'. The right window is titled 'esoo@esra: ~/Desktop/eryilmaz\_esra\_171044046' and shows a terminal session for 'esoo@esra: ~/Desktop/eryilmaz\_esra\_171044046\$'.

**Left Terminal (Client Side):**

```
esra@esra-VirtualBox: ~/Downloads
esra@esra-VirtualBox:~/Downloads$ ./BibakBOXClient
Usage : BibakBOXClient [dirName] [portnumber] OPTIONAL[ip address]
esra@esra-VirtualBox:~/Downloads$ ./BibakBOXClient ./client1 8080
~~~~~ CLIENT SIDE ~~~~~
The folder ./client1 does not exist, the program created it!!
Client socket created !
Connection failed, server is down.
esra@esra-VirtualBox:~/Downloads$ ./BibakBOXClient ./client1 8080 192.168.1.107
~~~~~ CLIENT SIDE ~~~~~
Client socket created !
Client connected to the server with port: 8080, server address: 192.168.1.107 !
```

**Right Terminal (Server Side):**

```
esoo@esra: ~/Desktop/eryilmaz_esra_171044046$ ip -4 addr show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
2: wlp2s0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group default qlen 1000
    inet 192.168.1.107/24 brd 192.168.1.255 scope global dynamic noprefixroute wlp2s0
        valid_lft 1914sec preferred_lft 1914sec
esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXServer ./server 10 8080
~~~~~ SERVER SIDE ~~~~~
Server socket created !
Server binded !
Server listening on 8080...

Server accepted client number 0...
Client connected with address : 192.168.1.106
```

Afterwards, a file was created on the client side and it was tested whether the file reached the server :

The image displays a virtual machine environment with two main windows. The left window is titled 'Ubuntu [Running] - Oracle VM VirtualBox' and shows a terminal session. The right window is titled 'esoo@esra: ~/Desktop/eryilmaz\_esra\_171044046' and shows a server-side log.

**Client Side (Terminal):**

```
esra@esra-VirtualBox: ~/Downloads
esra@esra-VirtualBox:~/Downloads$ ./BibakBOXClient ./client1 8080 192.168.1.107
~~~~~ CLIENT SIDE ~~~~~
Client socket created !
Client connected to the server with port: 8080, server address: 192.168.1.107 !
Differences found...(this client side)
^C
Exiting client...
esra@esra-VirtualBox:~/Downloads$
```

**Client Side (File Manager):**

The file manager window shows the 'client1' directory. It contains a single file named 'Untitled Document'.

**Server Side (Terminal):**

```
esoo@esra: ~/Desktop/eryilmaz_esra_171044046
esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXServer ./server 10 8080
~~~~~ SERVER SIDE ~~~~~
Server socket created !
Server binded !
Server listening on 8080...

Server accepted client number 0...
Client connected with address : 192.168.1.106

Differences found on the CLIENT SIDE !!
one client was closed...
[]
```

**Server Side (File Manager):**

The file manager window shows the 'server' directory. It contains a single file named 'Untitled Document'.

## - Test case 8 : Signal test

```
esoo@esra: ~/Desktop/eryilmaz_esra_171044046
esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXServer ./server 10 8080
~~~~~ SERVER SIDE ~~~~~
Server socket created !
Server binded !
Server listening on 8080...

Server accepted client number 0...
Client connected with address : 127.0.0.1

Differences found on the CLIENT SIDE !!
Differences found...(this server side)
Differences found on the CLIENT SIDE !!
Differences found...(this server side)
Differences found...(this server side)
^C
Exiting BibakBOXServer...

esoo@esra:~/Desktop/eryilmaz_esra_171044046$

esoo@esra: ~/Desktop/eryilmaz_esra_171044046
esoo@esra:~/Desktop/eryilmaz_esra_171044046$ ./BibakBOXClient ./client1 8080
~~~~~ CLIENT SIDE ~~~~~
Client socket created !
Client connected to the server with port: 8080, server address: 127.0.0.1 !

Differences found...(this client side)
Differences found on the SERVER SIDE !!
Differences found...(this client side)
Differences found on the SERVER SIDE !!
Differences found on the SERVER SIDE !!
Connection was closed...

Exiting client...

esoo@esra:~/Desktop/eryilmaz_esra_171044046$
```