



**GTU Department of Computer Engineering**  
**CSE 344 - Spring 2023**  
**Final Project Report**

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**BibakBOXServer**

synchronise your files safely

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## 1 Server Client Communication

In this project, a custom communication protocol is implemented between the server and client to facilitate safe and reliable data exchange using stream sockets. The communication protocol allows for flexible data transmission, with each data packet terminated by an ETX character to indicate the end of the packet. This approach enables variable-sized data transfers and ensures that the boundaries of each packet can be accurately identified. In addition to the flexible data transmission, a structured metadata format is employed for exchanging file information. The metadata includes the file name and a struct stat object, providing comprehensive details such as size, permissions, and modification time. To ensure the integrity and reliability of the communication, stream sockets are used. Stream sockets provide a reliable, ordered, and error-checked stream of data between the server and client, ensuring that data is received in the same order and without errors. The combination of the custom communication protocol, structured metadata format, and the use of stream sockets enables seamless and secure transmission of data, accurate synchronization of files, and efficient tracking of changes between the server and client.

## 2 Synchronization

In the synchronization process between the server and client, several steps are followed to ensure that both sides have the same files and directories. The process begins with the server sending its file and directory metadata, including names, sizes, and last modification times, to the client. The client compares the server's file and directory metadata with its local directory to identify any mismatches. If a mismatch is detected, the client requests the file from the server by sending a message over the socket. The server responds by sending the file content to the client. This process continues until the server has traversed all its files. Once the server completes its traversal, the client starts the same process.

After the two-step synchronization process is completed, both the server and client have the same set of files, and the initial synchronization is achieved. To keep track of directories and their metadata, both the server and client build a directory tree that stores the names and struct stat information of the directories.

To identify modifications, the server and client compare the actual files within their respective directories to the corresponding entries in the directory tree. Variances in file sizes or last modification times serve as indicators of modifications. Additionally, the removal of files is detected by employing the lstat() function on each entry within the directory tree to confirm if it still exists within the local directory. Conversely, newly added files are identified by traversing the current level of the directory tree and comparing it against the contents of the actual directory.

When a modification is detected on either side, the other side is notified. If necessary, the server sends the file content to the client to update the file on the client's side. Note that certain file types, such as FIFO and directories, may not require file content sending.

When a change is detected, the related party immediately notifies the other party. In cases where the file content needs to be updated, the server carefully forwards the updated content to the client, ensuring the synchronization of the affected file. Certain file types, such as FIFO and directories, do not require file content to be transmitted. In addition to that server records all the operations on the directory by keeping a log file.

By adhering to this synchronization process, the server and client maintain a compatible synchronization state. Continuous monitoring of file and directory changes, combined with efficient exchange of metadata and file content, ensures that both ends remain compatible, maintaining a consistent and accurate representation of files and directories throughout the communication.

```
/* Remove the log file entry from the directory tree for not syncing */
update_dirtree(root, logfile_path, REM);

printf("Being synced %s...\n", rootpath);

/* First synchronization between server and client */
check_exit(sync_writer(sockfd, root, rootpath), "sync_writer");
check_exit(sync_reader(sockfd, root, NULL), "sync_reader");

printf("Directory %s is synchronized\n", rootpath);

print_dirtree(root, 0);

while (server_run) {
    /* Get the lock before making operation on the directory */
    pthread_check_exit(pthread_mutex_lock(&(sdir->mutex)), "pthread_mutex_lock");

    /* Check if there is any change on server directory */
    while (recv_header(sockfd, &head, cli_path) == 0 && head.event != DONE && head.event != CLOSE)
        handle_event(sockfd, root, &(head.st), sv_path, head.event, logfile);

    if (head.event == CLOSE) {
        /* Client requests for termination */
        printf("Client request for termination\n");
        pthread_check_exit(pthread_mutex_unlock(&(sdir->mutex)), "pthread_mutex_unlock");
        break;
    }

    /* Check if there is any change on client directory */
    compare_dirtree(root, rootpath, sockfd, skiplen, logfile);
    if (send_header_event(sockfd, DONE) == -1)
        perror("send_header_event");

    pthread_check_exit(pthread_mutex_unlock(&(sdir->mutex)), "pthread_mutex_unlock");
}

printf("Connection is closing...\n");
```

## Server Synchronization

### 3 Race Conditions

- Multiple worker thread same directory
- Worker thread queue (incoming clients taken from there)
- Log file
- Stdout

In the designed system, multiple clients have the capability to connect to the same server directory. To ensure proper synchronization and prevent race conditions, a mechanism is implemented using worker threads. Each server directory is associated with a unique mutex, allowing only a single worker thread to modify the actual directory content at any given time. This approach ensures that concurrent modifications from multiple clients do not result in conflicts or data inconsistencies within the directory.

The log file, which is shared among multiple clients, is another critical section that requires synchronization. To avoid race conditions and maintain data integrity, a mutex is employed to regulate access to the log file. This ensures that only one client can access the log file at a time, preventing conflicts and guaranteeing accurate recording of file operations.

the server-client communication incorporates a client's queue where incoming clients are pushed, and worker threads retrieve clients from this queue. To prevent race conditions and ensure proper synchronization, mutexes and condition variables are utilized.

```
void *worker_thread_func(void *args)
{
    char *sv_dirpath;
    struct client *cli;

    sv_dirpath = (char *) args;

    pthread_check_exit(pthread_mutex_lock(&mutex_clients), "pthread_mutex_lock");
    while (server_run) {
        cli = buff_pop(&waiting_clients);
        if (cli == NULL)
            pthread_check_exit(pthread_cond_wait(&cond_full, &mutex_clients), "pthread_cond_wait");
        else {
            pthread_check_exit(pthread_mutex_unlock(&mutex_clients), "pthread_mutex_unlock");

            print_threadsafe(STDOUT_FILENO, &mutex_stdout, "Client%d is connected\n", cli->id);
            handle_client(cli->sockfd, sv_dirpath);
            close(cli->sockfd);
            print_threadsafe(STDOUT_FILENO, &mutex_stdout, "Client%d is disconnected\n", cli->id);
            free(cli);

            pthread_check_exit(pthread_mutex_lock(&mutex_clients), "pthread_mutex_lock");
        }
    }
    pthread_check_exit(pthread_mutex_unlock(&mutex_clients), "pthread_mutex_unlock");

    return NULL;
}
```

#### synchronization in clients queue

By utilizing mutexes in proper places, the system effectively manages concurrent access and safeguards against race conditions. This enables multiple clients to interact with the server directory and log file simultaneously, ensuring synchronized and reliable operations.

## 4 Test Cases and Results

### 4.1 Connection

#### 4.1.1 Remote

```
ebylmz@EBY-MATEBOOK: /mn X ebylmz@EBY-MATEBOOK: /m X + v
PowerShell 7.3.4
PS C:\Users\ebylm> cd .\Documents\codes\System-Programming\hw\final\src\
PS C:\Users\ebylm\Documents\codes\System-Programming\hw\final\src> bash
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 172.22.181.66 netmask 255.255.240.0 broadcast 172.22.191.255
    inet6 fe80::215:5dff:fe5d:19eb prefixlen 64 scopeid 0x20<link>
    ether 00:15:5d:5d:19:eb txqueuelen 1000 (Ethernet)
    RX packets 56 bytes 16360 (16.3 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 48 bytes 6949 (6.9 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ ls -l svdir/clidir/
total 14652
-rwxrwxrwx 1 ebylmz ebylmz 118 Jun 16 20:40 a.py
-rwxrwxrwx 1 ebylmz ebylmz 15000015 Jun 16 20:41 a1.txt
-rwxrwxrwx 1 ebylmz ebylmz 590 Jun 16 20:41 sv.log
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ |
```

The server runs on WSL and the client runs on Linux virtual machine. By using ifconfig command we can figure out the IP address of the server and use that in client to connect the remote server.

```
ebylmz@EBY-MATEBOOK: /m X ebylmz@EBY-MATEBOOK: /mn X + v
make: *** [Makefile:22: runServer] Error 1
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ make runServer
./bibakBoxServer svdir 10 8080
Server started. Listening on port 8080...
New connection request from 172.22.176.1 as Client1
Client0 is connected
Being synced svdir/clidir...
Directory svdir/clidir is synchronized
'svdir/clidir/a.cpp' has been added!
'svdir/clidir/a.out' has been added!
lstat: No such file or directory
'a.out' has been removed!
'a.cpp' has been removed!
'svdir/clidir/a.py' has been added!
'svdir/clidir/yolo.v' has been added!
lstat: No such file or directory
'yolo.v' has been removed!
Client request for termination
Client0 is disconnected
New connection request from 172.22.176.1 as Client2
Client1 is connected
Being synced svdir/clidir...
Directory svdir/clidir is synchronized
Client request for termination
Client1 is disconnected
New connection request from 172.22.176.1 as Client3
Client2 is connected
Being synced svdir/clidir...
Directory svdir/clidir is synchronized
```

```
ebylmz@ebylmz: ~/cse/System-Programming/hw/final/src
'clidir/a.cpp' has been added!
'clidir/a.out' has been added!
^CExiting...
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ./bibakBoxClient clidir 8080 172.22.181.66
Connected to the server.
Being synced clidir...
Your directory synchronized
'clidir/a.py' has been added!
^CExiting...
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ./bibakBoxClient clidir 8080 172.22.181.66
Connected to the server.
Being synced clidir...
Your directory synchronized
'clidir/a.py' has been modified!
^CExiting...
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ./bibakBoxClient clidir 8080 172.22.181.66
Connected to the server.
Being synced clidir...
Your directory synchronized
'clidir/a1.txt' has been added!
```

#### 4.1.2 Localhost

```
ebylmz@ebylmz: ~/cse/System-Programming/hw/final/src
ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ make runServer
./bibakBoxServer svdir 10 8080
Server started. Listening on port 8080...
New connection request from 127.0.0.1 as Client1
Client0 is connected
Being synced svdir/clidir...
Directory svdir/clidir is synchronized
New connection request from 127.0.0.1 as Client2
Client1 is connected
Being synced svdir/mydir...
Directory svdir/mydir is synchronized
```

server

```
ebylmz@ebylmz: ~/cse/System-Programming/hw/final/src
ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ make runClient
./bibakBoxClient clidir 8080
Connected to the server.
Being synced clidir...
Your directory synchronized
```

Client0

```
ebylmz@ebylmz: ~/cse/System-Programming/hw/final/src
ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ./bibakBoxClient mydir 8080
127.0.0.1: Connection refused
Failed to connect to the server
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ./bibakBoxClient mydir 8080
Connected to the server.
Being synced mydir...
Your directory synchronized
█
```

Client1

## 4.2 Directory Operations ADD, REM, MOD

Add, remove, modification operations can be performed on regular type files and special type files such as symbolic links and FIFOs. In addition to type of the file big files (>10MB) is successfully synchronized.

```
ebylmz@EBY-MATEBOOK: /m x ebylmz@EBY-MATEBOOK: /m x ebylmz@EBY-MATEBOOK: /m x + v
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ make runServer
gcc -Wextra -Wall bibakBoxServer.c util.c sync.c -o bibakBoxServer
./bibakBoxServer svdir 10 8080
Server started. Listening on port 8080...
New connection request from 172.22.176.1 as Client1
Client0 is connected
Being synced svdir/clidir...
Directory svdir/clidir is synchronized
'svdir/clidir/a.cpp' has been added!
'svdir/clidir/b.cpp' has been added!
'svdir/clidir/hello.txt' has been added!
```

```
ebylmz@EBY-MATEBOOK: /m x ebylmz@EBY-MATEBOOK: /m x ebylmz@EBY-MATEBOOK: /m x + v
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ ls -l svdir/clidir/
total 0
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ ls -l svdir/clidir/
total 0
-rwxrwxrwx 1 ebylmz ebylmz 453 Jun 16 21:11 a.cpp
-rwxrwxrwx 1 ebylmz ebylmz 417 Jun 16 21:11 b.cpp
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ echo "hello world!" > svdir/clidir/hello.txt
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ ls -l svdir/clidir/
total 0
-rwxrwxrwx 1 ebylmz ebylmz 453 Jun 16 21:11 a.cpp
-rwxrwxrwx 1 ebylmz ebylmz 417 Jun 16 21:11 b.cpp
-rwxrwxrwx 1 ebylmz ebylmz 13 Jun 16 21:13 hello.txt
-rwxrwxrwx 1 ebylmz ebylmz 181 Jun 16 21:13 sv.log
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ ls -l svdir/clidir/
total 0
-rwxrwxrwx 1 ebylmz ebylmz 453 Jun 16 21:11 a.cpp
-rwxrwxrwx 1 ebylmz ebylmz 13 Jun 16 21:13 hello.txt
-rwxrwxrwx 1 ebylmz ebylmz 240 Jun 16 21:16 sv.log
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$
```



```
ebylmz@ebylmz: ~/cse/System-Programming/hw/final/src
ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ./bibakBoxClient clidir 8080 172.22.181.66
Connected to the server.
Being synced clidir...
Your directory synchronized

ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ls -l clidir/
total 8
-rw-rw-r-- 1 ebylmz ebylmz 453 Jun 16 21:11 a.cpp
-rw-rw-r-- 1 ebylmz ebylmz 417 Jun 16 21:11 b.cpp
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ls -l clidir/
total 12
-rw-rw-r-- 1 ebylmz ebylmz 453 Jun 16 21:11 a.cpp
-rw-rw-r-- 1 ebylmz ebylmz 417 Jun 16 21:11 b.cpp
-rwxrwxr-x 1 ebylmz ebylmz 13 Jun 16 21:13 hello.txt
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ rm clidir/b.cpp
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ls -l clidir/
total 8
-rw-rw-r-- 1 ebylmz ebylmz 453 Jun 16 21:11 a.cpp
-rwxrwxr-x 1 ebylmz ebylmz 13 Jun 16 21:13 hello.txt
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$
```

### 4.3 Multiple Client on Same Directory

1 server and 2 clients connect for the directory named “clidir”. Client0 initially has files “a.cpp” and “b.py”. Server and client1 have initially empty directory. After the connection is made all the 3 directory contains “a.cpp” and “b.p”. Then client1 removes a.cpp and that’s reflected to the other two directory.

```
ebylmz@EBY-MATEBOOK: /m x ebylmz@EBY-MATEBOOK: /mn x ebylmz@EBY-MATEBOOK: /mn x + v
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ make runServer
gcc -Wextra -Wall bibakBoxServer.c util.c sync.c -o bibakBoxServer
./bibakBoxServer svdir 10 8080
Server started. Listening on port 8080...
New connection request from 172.22.176.1 as Client1
Client0 is connected
Being synced svdir/clidir...
Directory svdir/clidir is synchronized
'svdir/clidir/a.cpp' has been added!
'svdir/clidir/b.py' has been added!
New connection request from 127.0.0.1 as Client2
Client1 is connected
Being synced svdir/clidir...
Directory svdir/clidir is synchronized
'svdir/clidir/a.cpp' has been modified!
'svdir/clidir/b.py' has been modified!
'a.cpp' has been removed!
```

Server

```
ebylmz@ebylmz: ~/cse/System-Programming/hw/final/src
ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ./bibakBoxClient clidir 8080 172.22.181.66
Connected to the server.
Being synced clidir...
Your directory synchronized
```

client0

```
ebylmz@EBY-MATEBOOK: /mnt x ebylmz@EBY-MATEBOOK: /m x ebylmz@EBY-MATEBOOK: /mn x + v
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ make runClient
gcc -Wextra -Wall bibakBoxClient.c util.c sync.c -o bibakBoxClient
./bibakBoxClient clidir 8080
Connected to the server.
Being synced clidir...
Your directory synchronized
'clidir/a.cpp' has been added!
'clidir/b.py' has been added!
'a.cpp' has been removed!
```

client1

```
ebylmz@EBY-MATEBOOK: /mnt x ebylmz@EBY-MATEBOOK: /mn x ebylmz@EBY-MATEBOOK: /m x + v
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ ls -l svdir/clidir/ clidir/
clidir/:
total 0

svdir/clidir/:
total 0
-rwxrwxrwx 1 ebylmz ebylmz 453 Jun 16 21:29 a.cpp
-rwxrwxrwx 1 ebylmz ebylmz 417 Jun 16 21:29 b.py
-rwxrwxrwx 1 ebylmz ebylmz 117 Jun 16 21:29 sv.log
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ echo "second client does not connect yet"
second client does not connect yet
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ ls -l svdir/clidir/ clidir/
clidir/:
total 0
-rwxrwxrwx 1 ebylmz ebylmz 453 Jun 16 21:30 a.cpp
-rwxrwxrwx 1 ebylmz ebylmz 417 Jun 16 21:30 b.py

svdir/clidir/:
total 0
-rwxrwxrwx 1 ebylmz ebylmz 453 Jun 16 21:30 a.cpp
-rwxrwxrwx 1 ebylmz ebylmz 417 Jun 16 21:30 b.py
-rwxrwxrwx 1 ebylmz ebylmz 351 Jun 16 21:30 sv.log
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ rm clidir/a.cpp
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ ls -l svdir/clidir/ clidir/
clidir/:
total 0
-rwxrwxrwx 1 ebylmz ebylmz 417 Jun 16 21:30 b.py

svdir/clidir/:
total 0
-rwxrwxrwx 1 ebylmz ebylmz 417 Jun 16 21:30 b.py
-rwxrwxrwx 1 ebylmz ebylmz 469 Jun 16 21:31 sv.log
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ |
```

```
ebylmz@ebylmz: ~/cse/System-Programming/hw/final/src
ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ls -l clidir/
total 8
-rw-rw-r-- 1 ebylmz ebylmz 453 Jun 16 21:29 a.cpp
-rw-rw-r-- 1 ebylmz ebylmz 417 Jun 16 21:29 b.py
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ls -l clidir/
total 4
-rw-rw-r-- 1 ebylmz ebylmz 417 Jun 16 21:30 b.py
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$
```

## 4.4 Log File

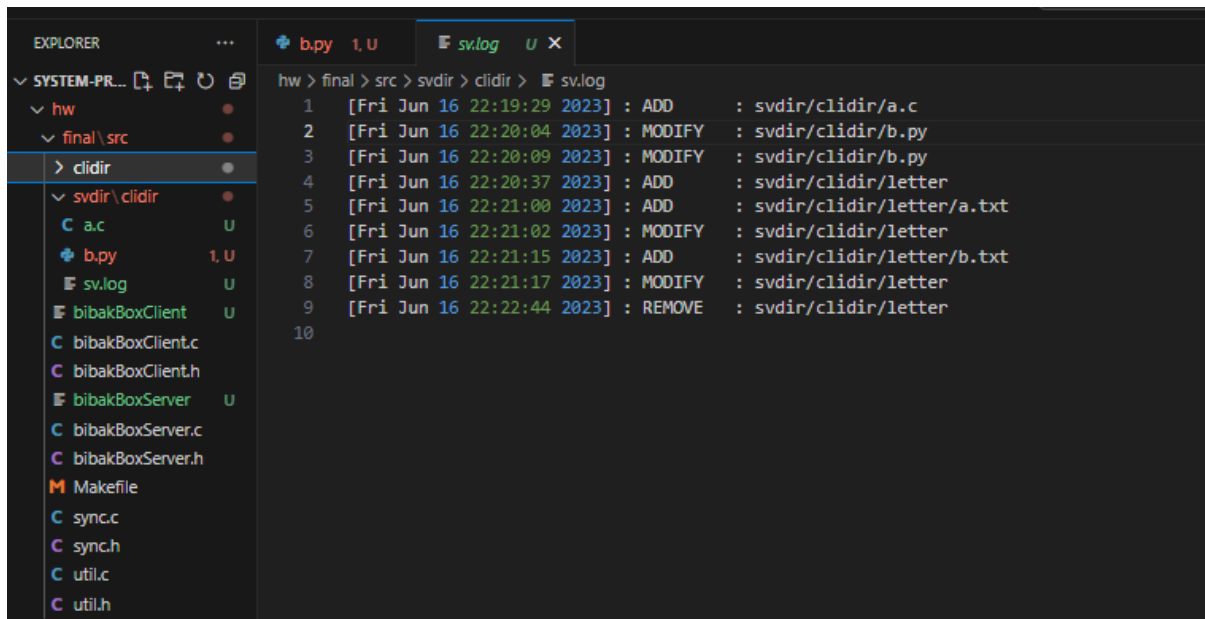
```
ebylmz@EBY-MATEBOOK: /mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ make runServer
./bibakBoxServer svdir 10 8080
Server started. Listening on port 8080...
New connection request from 172.22.176.1 as Client1
Client0 is connected
Being synced svdir/clidir...
Directory svdir/clidir is synchronized
'svdir/clidir/b.py' has been modified!
'svdir/clidir/b.py' has been modified!
'svdir/clidir/letter' has been modified!
'svdir/clidir/letter' has been modified!
'letter' has been removed!

ebylmz@EBY-MATEBOOK: /mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$
ebylmz@EBY-MATEBOOK: /mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ ls -l svdir/clidir/*
-rwxrwxrwx 1 ebylmz ebylmz 3530 Jun 16 22:19 svdir/clidir/a.c
-rwxrwxrwx 1 ebylmz ebylmz 587 Jun 16 22:20 svdir/clidir/b.py
-rwxrwxrwx 1 ebylmz ebylmz 485 Jun 16 22:21 svdir/clidir/sv.log

svdir/clidir/letter:
total 0
-rwxrwxrwx 1 ebylmz ebylmz 8 Jun 16 22:21 a.txt
-rwxrwxrwx 1 ebylmz ebylmz 6 Jun 16 22:21 b.txt
ebylmz@EBY-MATEBOOK: /mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ rm svdir/clidir/letter/
rm: cannot remove 'svdir/clidir/letter/': Is a directory
ebylmz@EBY-MATEBOOK: /mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ rm -rf svdir/clidir/letter/
ebylmz@EBY-MATEBOOK: /mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ ls -l svdir/clidir/*
-rwxrwxrwx 1 ebylmz ebylmz 3530 Jun 16 22:19 svdir/clidir/a.c
-rwxrwxrwx 1 ebylmz ebylmz 587 Jun 16 22:20 svdir/clidir/b.py
-rwxrwxrwx 1 ebylmz ebylmz 545 Jun 16 22:22 svdir/clidir/sv.log
ebylmz@EBY-MATEBOOK: /mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ |
```

```
ebylmz@ebylmz: ~/cse/System-Programming/hw/final/src
ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ls -l clidir/
total 4
-rw-rw-r-- 1 ebylmz ebylmz 672 Jun 16 22:18 b.py
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ cp util.c clidir/a.c
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ mkdir clidir/letter
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ echo "abcdefg" > clidir/letter/a.txt
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ echo "aeiou" > clidir/letter/b.txt
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ls -l clidir/
total 12
-rw-rw-r-- 1 ebylmz ebylmz 3530 Jun 16 22:19 a.c
-rw-rw-r-- 1 ebylmz ebylmz 587 Jun 16 22:20 b.py
drwxrwxr-x 2 ebylmz ebylmz 4096 Jun 16 22:21 letter
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ls -l clidir/
total 8
-rw-rw-r-- 1 ebylmz ebylmz 3530 Jun 16 22:19 a.c
-rw-rw-r-- 1 ebylmz ebylmz 587 Jun 16 22:20 b.py
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$
```

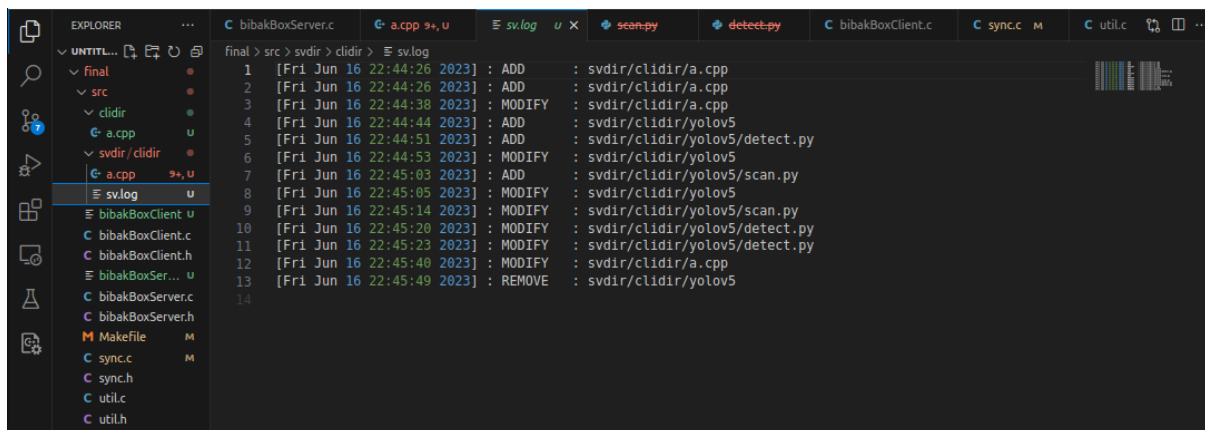
```
ebylmz@ebylmz: ~/cse/System-Programming/hw/final/src
ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ./bibakBoxClient clidir 8080 172.22.181.66
Connected to the server.
Being synced clidir...
Your directory synchronized
'clidir/b.py' has been modified!
^CExiting...
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ./bibakBoxClient clidir 8080 172.22.181.66
Connected to the server.
Being synced clidir...
Your directory synchronized
'clidir/a.c' has been added!
'clidir/letter' has been added!
'clidir/letter/a.txt' has been added!
'clidir/letter/b.txt' has been added!
```



```
hw > final > src > svdir > clidir > sv.log
1 [Fri Jun 16 22:19:29 2023] : ADD : svdir/clidir/a.c
2 [Fri Jun 16 22:20:04 2023] : MODIFY : svdir/clidir/b.py
3 [Fri Jun 16 22:20:09 2023] : MODIFY : svdir/clidir/b.py
4 [Fri Jun 16 22:20:37 2023] : ADD : svdir/clidir/letter
5 [Fri Jun 16 22:21:00 2023] : ADD : svdir/clidir/letter/a.txt
6 [Fri Jun 16 22:21:02 2023] : MODIFY : svdir/clidir/letter
7 [Fri Jun 16 22:21:15 2023] : ADD : svdir/clidir/letter/b.txt
8 [Fri Jun 16 22:21:17 2023] : MODIFY : svdir/clidir/letter
9 [Fri Jun 16 22:22:44 2023] : REMOVE : svdir/clidir/letter
10
```

svdir/clidir/sv.log

The log file needs to be protected for any removal or modification operation from the client side. This could be achieved by explicitly checking each file operation or better one keeping the log files in separate folder inside the server directory.



```
final > src > svdir > clidir > sv.log
1 [Fri Jun 16 22:44:26 2023] : ADD : svdir/clidir/a.cpp
2 [Fri Jun 16 22:44:26 2023] : ADD : svdir/clidir/a.cpp
3 [Fri Jun 16 22:44:38 2023] : MODIFY : svdir/clidir/a.cpp
4 [Fri Jun 16 22:44:44 2023] : ADD : svdir/clidir/yolov5
5 [Fri Jun 16 22:44:51 2023] : ADD : svdir/clidir/yolov5/detect.py
6 [Fri Jun 16 22:44:53 2023] : MODIFY : svdir/clidir/yolov5
7 [Fri Jun 16 22:45:03 2023] : ADD : svdir/clidir/yolov5/scan.py
8 [Fri Jun 16 22:45:05 2023] : MODIFY : svdir/clidir/yolov5
9 [Fri Jun 16 22:45:14 2023] : MODIFY : svdir/clidir/yolov5/scan.py
10 [Fri Jun 16 22:45:20 2023] : MODIFY : svdir/clidir/yolov5/detect.py
11 [Fri Jun 16 22:45:23 2023] : MODIFY : svdir/clidir/yolov5/detect.py
12 [Fri Jun 16 22:45:40 2023] : MODIFY : svdir/clidir/a.cpp
13 [Fri Jun 16 22:45:49 2023] : REMOVE : svdir/clidir/yolov5
14
```

Another log file example

## 4.5 Signal Handling

### 4.5.1 SIGINT to Server

When the server receives SIGINT signal, It notifies the clients to close their connection and then all the clients and the server close their resources and exit gracefully.

```
ebylmz@EBY-MATEBOOK: /mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ make runServer
gcc -Wextra -Wall bibakBoxServer.c util.c sync.c -o bibakBoxServer
./bibakBoxServer svdir 10 8080
Server started. Listening on port 8080...
New connection request from 172.22.176.1 as Client1
Client0 is connected
Being synced svdir/clidir...
Directory svdir/clidir is synchronized
'svdir/clidir/a.cpp' has been added!
'svdir/clidir/b.py' has been added!
New connection request from 127.0.0.1 as Client2
Client1 is connected
Being synced svdir/clidir...
Directory svdir/clidir is synchronized
'svdir/clidir/a.cpp' has been modified!
'svdir/clidir/b.py' has been modified!
'a.cpp' has been removed!
^C
Shutting down...Client1 is disconnected
Client0 is disconnected

ebylmz@EBY-MATEBOOK: /mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ |
```

```
ebylmz@ebylmz: ~/cse/System-Programming/hw/final/src
ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ./bibakBoxClient clidir 8080 172.22.181.66
Connected to the server.
Being synced clidir...
Your directory synchronized
Server connection is closing...
Exiting...
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$
```

Client0 terminates

```
ebylmz@EBY-MATEBOOK: /mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ make runClient
gcc -Wextra -Wall bibakBoxClient.c util.c sync.c -o bibakBoxClient
./bibakBoxClient clidir 8080
Connected to the server.
Being synced clidir...
Your directory synchronized
'clidir/a.cpp' has been added!
'clidir/b.py' has been added!
'a.cpp' has been removed!
Server connection is closing...
Exiting...
ebylmz@EBY-MATEBOOK: /mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ |
```

Client1 terminates

#### 4.5.2 SIGINT to Client

When the client receives SIGINT signal, it notifies to the server for disconnection and closes its resources and exits gracefully. The server continues its execution without any affect from the disconnected client.

```
ebylmz@ebylmz: ~/cse/System-Programming/hw/final/src
ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x ebylmz@ebylmz: ~/cse/Syste... x
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$ ./bibakBoxClient clidir 8080 172.22.181.66
Connected to the server.
Being synced clidir...
Your directory synchronized
'clidir/b.py' has been modified!
^CEXiting...
ebylmz@ebylmz:~/cse/System-Programming/hw/final/src$
```

Client1 disconnects

```
ebylmz@EBY-MATEBOOK: /mnt x ebylmz@EBY-MATEBOOK: /m x ebylmz@EBY-MATEBOOK: /mnt x + v
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ make runClient
./bibakBoxClient clidir 8080
Connected to the server.
Being synced clidir...
Your directory synchronized
^CEXiting...
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ |
```

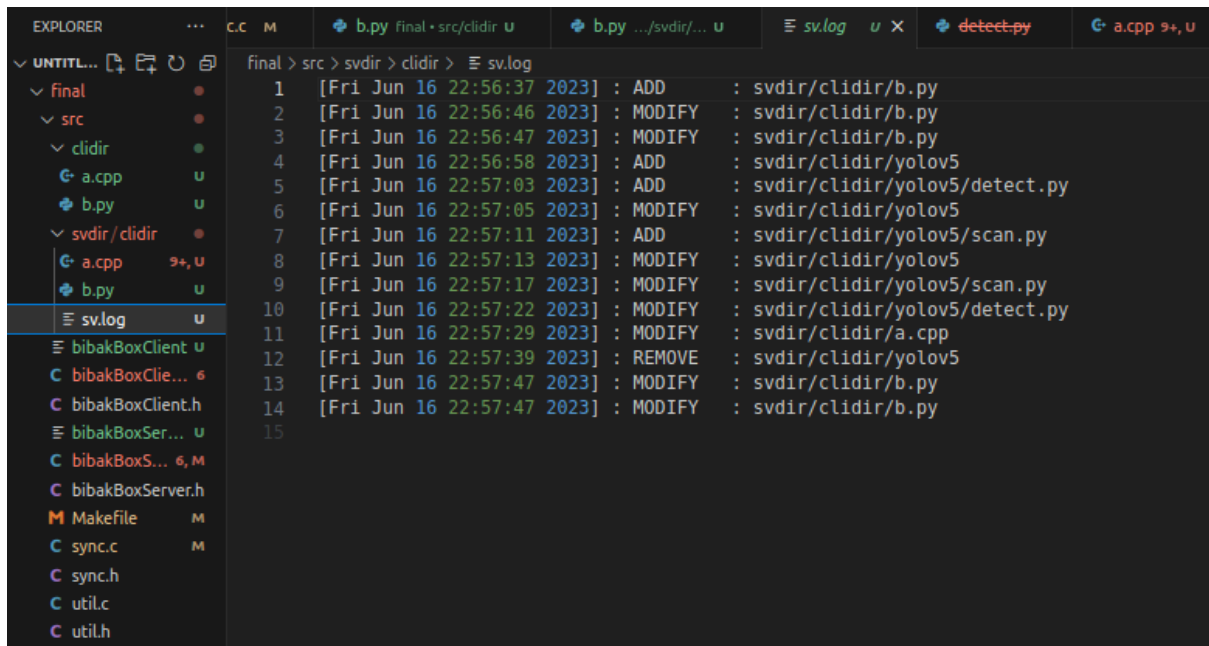
Client0 disconnects

```
ebylmz@EBY-MATEBOOK: /m x ebylmz@EBY-MATEBOOK: /mnt x ebylmz@EBY-MATEBOOK: /mnt x + v
ebylmz@EBY-MATEBOOK:/mnt/c/Users/ebylm/Documents/codes/System-Programming/hw/final/src$ make runServer
./bibakBoxServer svdir 10 8080
Server started. Listening on port 8080...
New connection request from 127.0.0.1 as Client1
Client0 is connected
Being synced svdir/clidir...
Directory svdir/clidir is synchronized
New connection request from 172.22.176.1 as Client2
Client1 is connected
Being synced svdir/clidir...
Directory svdir/clidir is synchronized
'svdir/clidir/b.py' has been modified!
'svdir/clidir/b.py' has been modified!
Client request for termination
Client1 is disconnected
Client request for termination
Client0 is disconnected
New connection request from 127.0.0.1 as Client3
Client2 is connected
Being synced svdir/clidir...
Directory svdir/clidir is synchronized
|
```

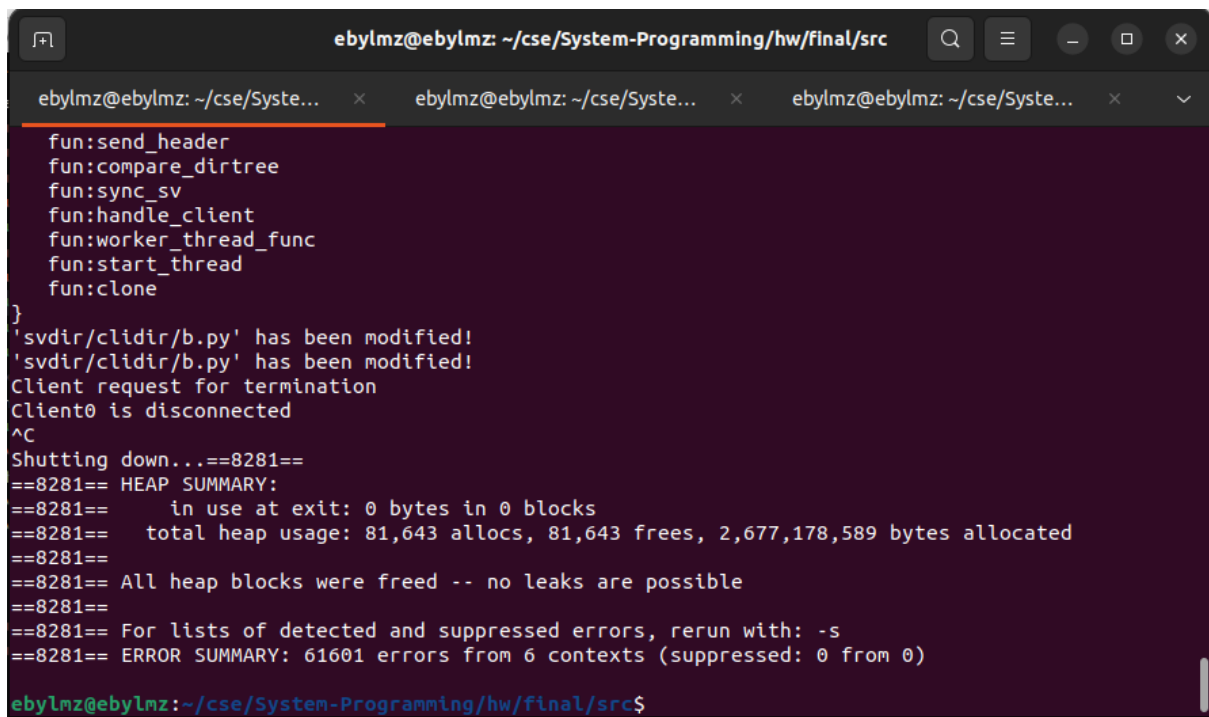
Client0 and Client1 disconnected, and server continues running by taking Client2

## 4.6 Memory Leak Check

The server-client model was tested by adding/removing/modifying directories/files and there were no memory leaks.



logfile



server



```
ebylmz@ebylmz: ~/cse/System-Programming/hw/final/src
==8293==
==8293== HEAP SUMMARY:
==8293==   in use at exit: 0 bytes in 0 blocks
==8293== total heap usage: 81,596 allocs, 81,596 frees, 2,677,229,803 bytes allocated
==8293==
==8293== All heap blocks were freed -- no leaks are possible
==8293==
==8293== ERROR SUMMARY: 61601 errors from 6 contexts (suppressed: 0 from 0)
==8293==
==8293== 1 errors in context 1 of 6:
==8293== Syscall param socketcall.sendto(msg) points to uninitialised byte(s)
==8293==   at 0x4992A60: send (send.c:28)
==8293==   by 0x10B7DF: send_header (in /home/ebylmz/cse/System-Programming/hw/final/src/bibakBoxClient)
==8293==   by 0x10B70E: send_header_event (in /home/ebylmz/cse/System-Programming/hw/final/src/bibakBoxClient)
==8293==   by 0x10AD1C: sync_cli (in /home/ebylmz/cse/System-Programming/hw/final/src/bibakBoxClient)
==8293==   by 0x10AA7B: main (in /home/ebylmz/cse/System-Programming/hw/final/src/bibakBoxClient)
==8293== Address 0x1ffefff734 is on thread 1's stack
==8293== in frame #2, created by send_header_event (???:)
==8293== Uninitialised value was created by a stack allocation
==8293==   at 0x10B6B2: send_header_event (in /home/ebylmz/cse/System-Programming/hw/final/src/b
```

Client