Operating Systems

Phase-3 Report

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Operating Systems Project Report

Basic CLI Implementation in Server with Multiple Clients (phase 3):

In this phase, we built upon phase 1 and phase 2 and created a socket communication model where the CLI shell was usable from the client end, and multiple clients could access the server at the same time.

Overview of Phase 1:

In phase 1, we built a CLI shell that supported single, double or triple piped commands, general command line Linus commands etc.

Overview of Phase 2:

In this phase, we had built upon phase 1 and created a socket communication model where the shell was usable from the client end.

Code Supports:

1. Ctrl+C to exit
2. “exit” command to exit
3. Single, double or triple piped commands like:

   cat file3.txt | grep “yasin” | tee file4.txt | wc –l
4. Supports error checking from input

*handled using signal.h header file

5. Inputting invalid commands wait a bit and direct you to inputting the correct command again
6. Handles empty command

List of Unsupported Commands:

1. cd
2. ping
3. man

Multiple Client Code Testing: With and without error in input:

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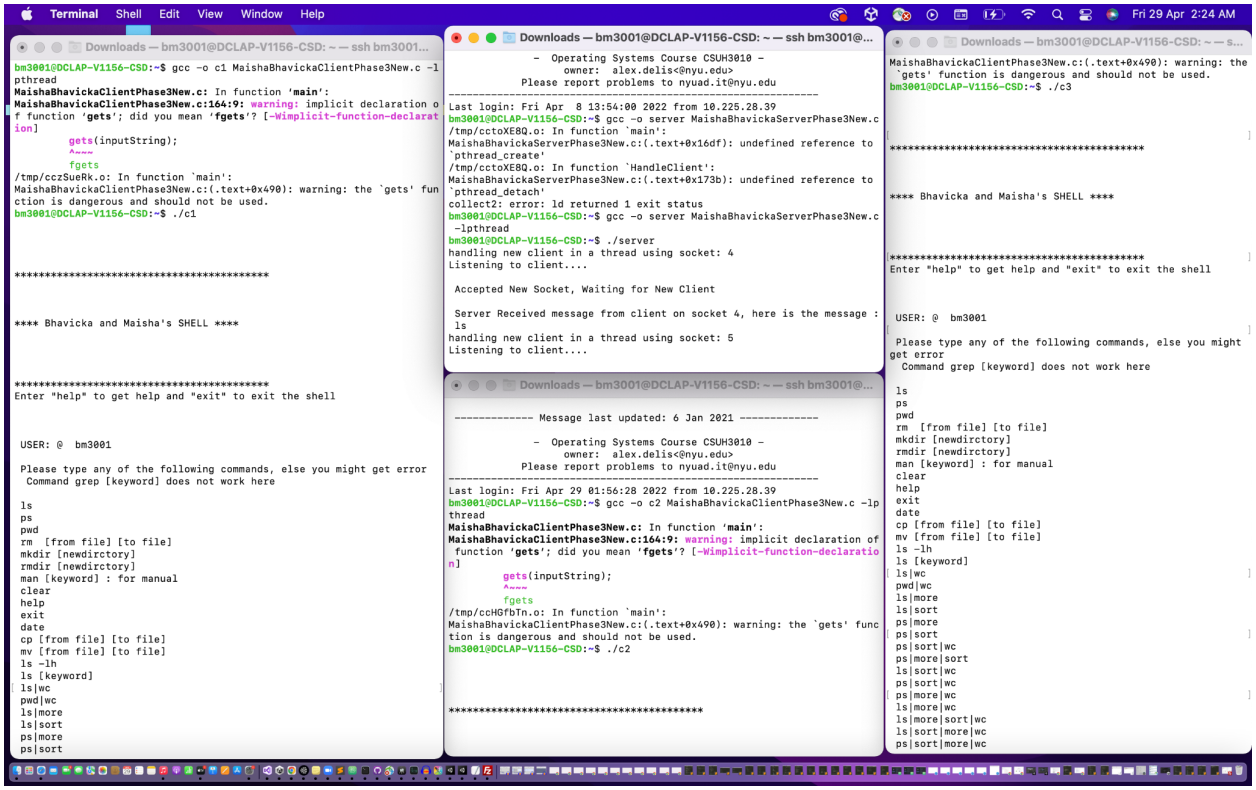

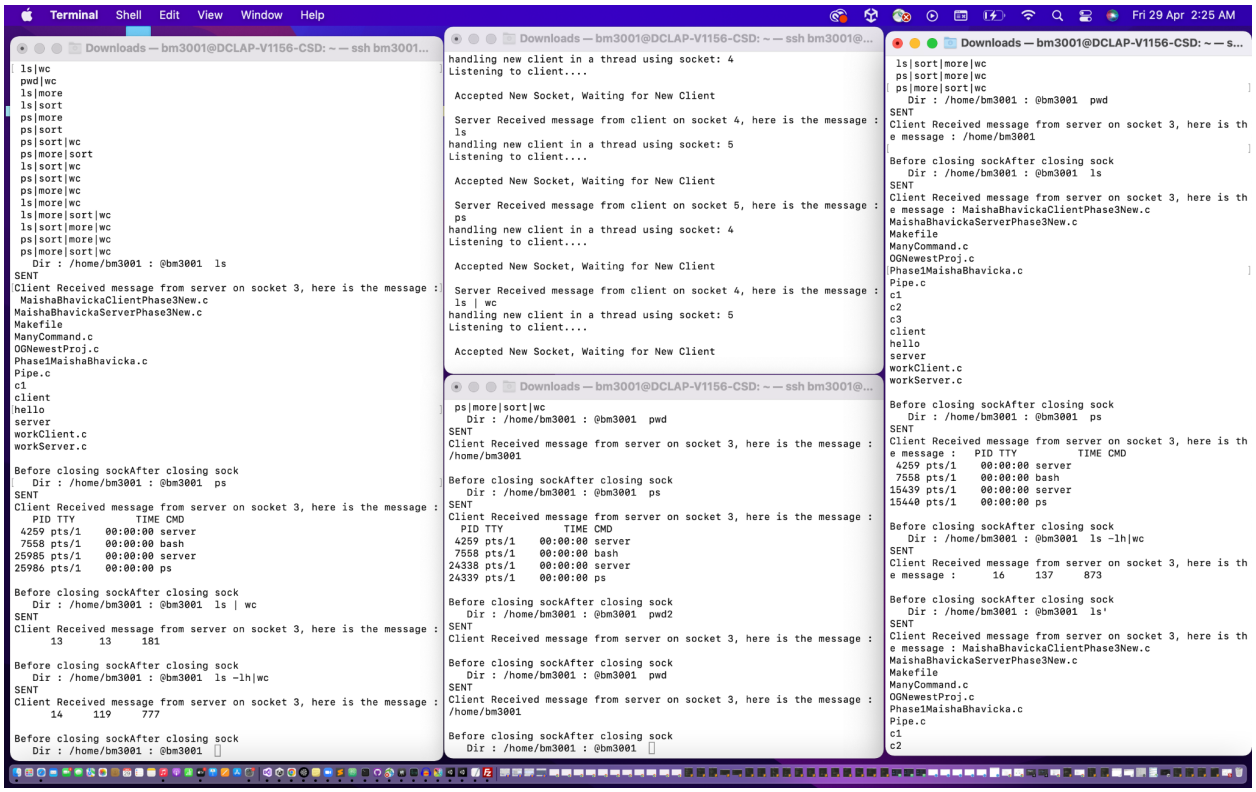

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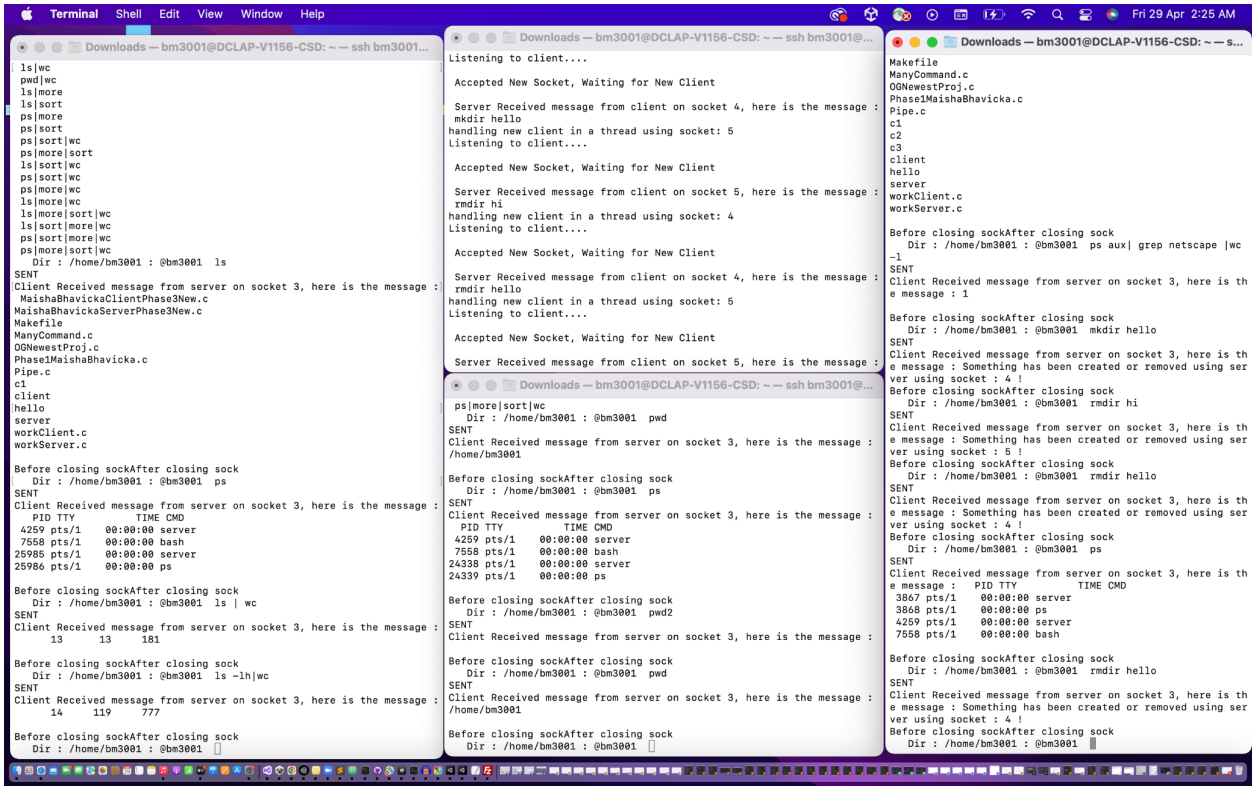

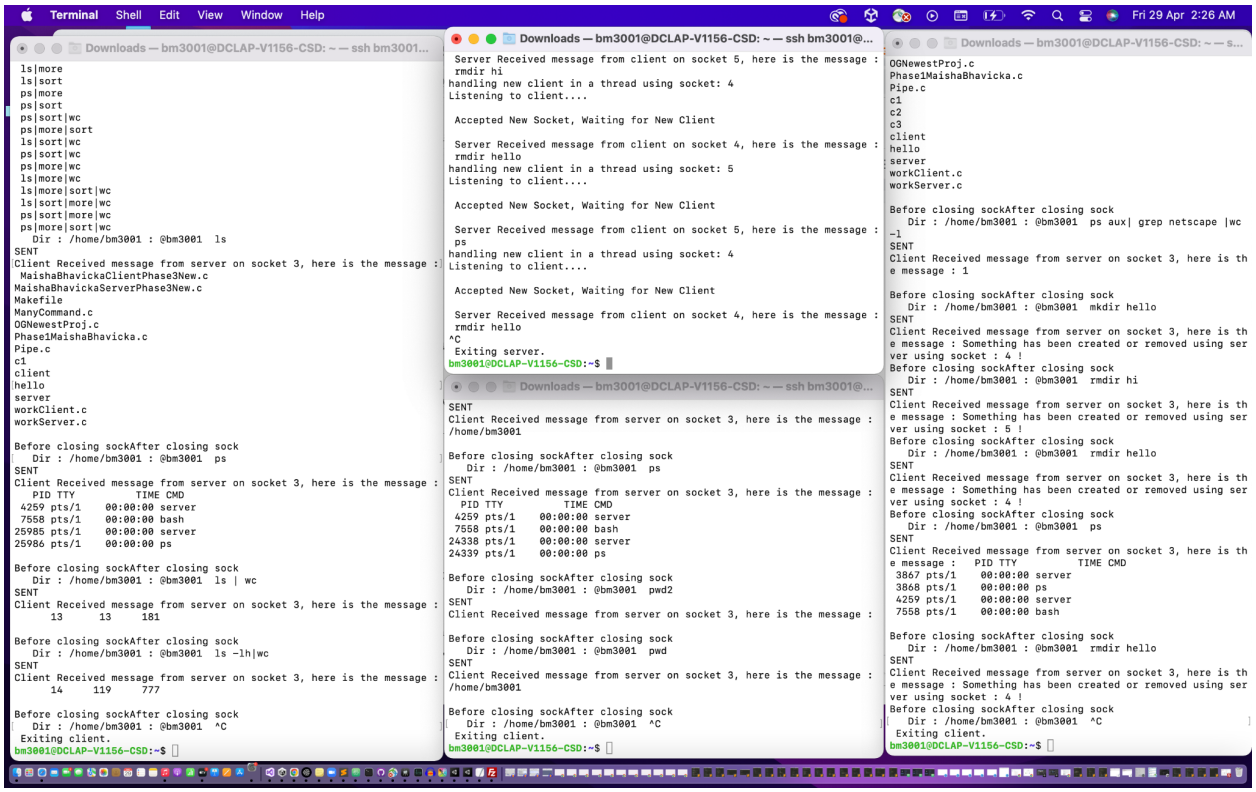

*handled using signal.h header file

How to Run

We've provided a Makefile with our two C files. Once you have downloaded them all in the same place, open two (or more) terminal windows. On one (or more), write make client, on the other, run make server. Make sure they are all in the same directory. After this, you can enter ./server and ./client to run the server and client respectively. Make sure to run the server first, otherwise the connection will fail. You can run make clean to get rid of the object files afterwards. Alternatively, you can also just run make at the beginning which will make all files and then run ./server and ./client on different terminals.

Running without a Makefile: You can run without a Makefile, you just need to have two or more terminals open, and then run both the client.c and the server.c in separate terminals. Make sure to run the server first. Give your CLI command inputs on the client terminal, which is processed in server and you see the results in client terminal. Then on the client terminal, you can enter the commands you want and you will get the outputs there. If you get the error "bind failed: Address already in use" enter "kill -9 $(lsof -t -i:5564)" and rerun the commands.

How to exit Client:

To get out of the terminal, use *exit* command. This will exit the current client and the server will wait for the connection of a new client.

Also, using Ctrl+C will exit the client or server*

Adding a New Client after Exiting from an old one:

Take out a separate terminal and run the .c file using gcc -o c VWorkingClient.c. Start using the new client without an issue. The same terminal as the former exited client might not work in the remote server. So, nevertheless, take out a new terminal everytime you add a new client.

*handled using signal.h header file

The user defined functions used in the code:

```
void init_shell()
```

It prints the username of the PC running the shell for which we use the getenv() function.

```
void printDir()
```

Everytime to when the user is prompted to type a shell command, the directory of the shell file where the shell script is running gets printed.

```
commandList()
```

Prints all the available commands

```
void parseSpace(char* inputString,char** parsedArgs )
```

Parses the spaces in single line commands

```
void execArgs(char** parsedArgs, int newsocket)
```

This function executes the user commands for single line commands using execvp in a child process.

So, we pass a vector as well as the name of the command to execvp to run the command.

```
int parsePipe(char* inputString, char** parsedArgsPiped)
```

Parses the pipes in piped commands : We then pass our input string into a function which counts the number of pipes (“|”) in the input. If there are 0 pipes, which means it’s a normal separate command, it is passed into a functions which parses the input according to space and then these parsed arguments are passed into a method called execArgs which forks a child and uses execvp inside it to execute the commands.

In the case that there are pipes, we create pipe mechanisms to write the output of the first child to the read end of the next pipe/parent, whatever the case might be.

```
void execArgsPiped1(char** parsedArgsPiped, int newsocket)
```

*handled using signal.h header file

This function executes the user commands for one piped commands using execvp in 2 separate child processes. So, we pass a vector as well as the name of the command to execvp to run the command. We redirect the output to the client using dup2();

```
void execArgsPiped2(char** parsedpipe, int newsocket)
```

This function executes the user commands for two piped commands using execvp in 3 separate child processes. So, we pass a vector as well as the name of the command to execvp to run the command. We redirect the output to the client using dup2();

```
void execArgsPiped3(char** parsedpipe, int newsocket)
```

This function executes the user commands for two piped commands using execvp in 4 separate child processes. So, we pass a vector as well as the name of the command to execvp to run the command. We redirect the output to the client using dup2();

Server-Client Communication:

The goal of this phase was to create a server which could provide remote accessibility to our shell. The client could send a request to the server and it would get the output from there. This is how we went about implementing that:

Socket creation:

int server_fd = socket(domain, type, protocol)

server_fd: socket descriptor, an integer (like a file-handle)

domain: integer, specifies communication domain. Since we are communicating between processes on different hosts connected by IPV4, we use AF_INET

type: communication type SOCK_STREAM: TCP(reliable, connection oriented)

SOCK_DGRAM: UDP(unreliable, connectionless), we build a tcp socket, so use

*handled using signal.h header file

SOCK_STREAM.

protocol: Protocol value for Internet Protocol(IP), which is 0. This is the same number which appears on protocol field in the IP header of a packet

Bind:

int bind(int server_fd, const struct sockaddr *addr, socklen_t addrlen);

After creation of the socket, bind function binds the socket to the address and port number specified in addr(custom data structure).

Listen:

int listen(int server_fd, int backlog);

It puts the server socket in a passive mode, where it waits for the client to approach the server to make a connection. The backlog defines the maximum length to which the queue of pending connections for sockfd may grow. In our code, we have used 10 because if a connection request arrives when the queue is full, the client may receive an error with an indication of ECONNREFUSED.

Accept:

int new_socket= accept(int server_fd, struct sockaddr *addr, socklen_t *addrlen);

It extracts the first connection request on the queue of pending connections for the listening socket, server_fd, creates a new connected socket, and returns a new file descriptor referring to that socket. At this point, connection is established between client and server, and they are ready to transfer data.

Reading the message:

*handled using signal.h header file

Here int read(new_socket, message, 1024); Reads the message from the client using socket new_socket and stores the string in the message.

Stages for Client

Socket connection: Exactly same as that of server's socket creation

Connect:

int connect(int sockfd, const struct sockaddr *addr, socklen_t addrlen);

The connect() system call connects the socket referred to by the file descriptor sockfd to the address specified by addr. Server's address and port is specified in addr.

Problems Faced and Solution:

1. *How to exit from Parent in the main function of the server.c, when the child in the main is handling every operation [here, we actually are terminating the functions with this specific client.c]?*

   We added a global variable flag that becomes 1 in the child when exit has been typed, as it's a global variable, it's value in parent also gets updated and in parent we also close socket if flag==1, after which at the beginning of the loop which keeps server alive till infinity we add flag=0 to initiate the start of a new client.
2. *Changes that allowed us to stop the break in client / server when we input wrong command:*

*handled using signal.h header file

We forked a child in the main and the whole program of phase 2 is handled in the child, and we don't have any wait functions in the execArgs functions, aside from the parent in the main function

3. *Buffer Overflow and Buffer Not being emptied:*

   We used the buffer polling technique of using the recv function to force read all the characters in the buffer to empty out the buffer before a new request is sent.

4. *Exiting with Ctrl+C:*

   Using signal.h header file and signal(SIGINT, serverExitHandler) function handled this signal operation

*handled using signal.h header file