```
** Sample outputs below running multiple clients and one server **
Outside source used:
    A. https://www.youtube.com/watch?v=SMeDw2GDMsE
    B. https://www.youtube.com/watch?v=sP50GHDmfhY
Purpose of sources
    A. Understanding named pipes
    B. Understanding named pipes
//============================================================================
// Name        : source.cpp
// Author      : Andrew Jordan | Adam Moses
// Version     : 5.0
// Institution : CS415 Athens State University
// Instructor  : Dr.Adam Lewis
// Description : Client simulation using: Pthreads|Semaphores|Pipes|Shared Memory
// command line build with proper flags: g++ source.cpp -o client.out -lpthread
// start program from command line: ./client.out
//============================================================================
/*
Client Design:
Start Client
- Generate random 5 digit ID for the client.
- Open named pipe to server with preset name "/tmp/demo_fifo" -> Write only permission.
- Open/Create named pipe with ID for receiving back output from server.
- Open/Create semaphore with ID for locking and unlocking shared memory between
client/server.
Begin User Input
- Prompt input from user.
- Grab input from command line and save it.
- Send client ID to the server over named pipe.
- Client ID is sent each time a client sends a command to the server
        so that the server knows who to send the output back to.
- **Design change:
        - Server contains the parser because if a command from a client request input
redirection from
        a file, the server must be able to parse the command from a file, execute it
appropriately,
        and send the results back to the client. The parsing of input commands from the
client
        have been reassigned to the server to eliminate unneeded duplication of both
client and
        server parsing the same commands,speed executing commands, and set assigned roles.
**
- Open/Create shared memory between client/server.
- Shared memory is created based on client ID.
- Lock semaphore between client/server.
- Copy client input to shared memory between client/server.
- Unlock semaphore for the server to be able to read the shared memory.
- exit sending.
- Once command has been sent, client listens to its named pipe, based on ID, to receive
output from server.
- Output is displayed on the clients terminal.
- Repeat client/server |send ID/write to shared memory/receive output| until exit_ is
sent.
- exit_ command sends signal to the server to delete its id from the known client list
        and the server sends back a char $ that signals the client that the server is
        disconnected and then the client terminates.
*/
```

```cpp
//=========================================================================
// Name        : source.cpp
// Author      : Andrew Jordan | Adam Moses
// Version     : 5.0
// Institution : CS415 Athens State University
// Instructor  : Dr.Adam Lewis
// Description : Server simulation using: Pthreads|Semaphores|Pipes|Shared Memory
// command line build with proper flags: g++ source.cpp -o server.out -lpthread
// start program from command line: ./server.out
//=========================================================================
/*
Server Design:
Start Server
- Open named pipe to server with preset name "/tmp/demo_fifo" -> Read only permission.

|Executing User Input|
- Listen on named pipe for client ID.
- Read client ID once it is sent into the named pipe.
- Store client ID into vector of known client IDS on server.
- Start thread for the work of receive/parse/execute/send of client commands.
- Open shared memory between server/client based on client ID.
- **Design change:
        - Server contains the parser because if a command from a client request input
redirection from
        a file, the server must be able to parse the command from a file, execute it
appropriately,
        and send the results back to the client. The parsing of input commands from the
client
        have been reassigned to the server to eliminate unneeded duplication of both
client and
        server parsing the same commands,speed executing commands, and set assigned roles.
**
- Acess semaphore between server/client based on client ID.
- Lock semaphore.
- Read shared memory between server/client and save commands.
- Unlock semaphore for client writing to shared memory later on.
- Open named pipe back to client based on clients ID.
- Redirect STD out to named pipe back to client.
- Parse commands -> fork() -> execute -> output is automatically sent back to client.
- if command is cd/pwd -> change dir -> send present working directory back to client.
- Send char NULL back to client to signal output is finished.
- Redirect STD out back to server console.
- exit sending.
- Once command has been sent, Server listens to named pipe "/tmp/demo_fifo" for next
client.
- Repeat server/client |receive clint ID/parse/execute/send output| until exit_ is sent.
- exit_ command sends signal to the server to delete the client id who sent it from the
known
        client list and the server sends back a char $ that signals the client that the
server is
        disconnected and then the client terminates.
```

Client

```cpp
#include <iostream>
#include <sys/wait.h>
#include <dirent.h>
#include <string>
#include <ctype.h>
#include <algorithm>
#include <string.h>
#include <signal.h>
#include <signal.h>

// Used in named pipe
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <string.h>
// Used in IPC
#include<sys/ipc.h>
#include<sys/shm.h>
// Used in semaphore
#include<semaphore.h>
using namespace std;

void send(char *, int); // Opens shared memory to send input to server
char* S2C(string, int);// Converts a string to a cstring, returns a char*
void sig_handler(int);// Catches ctrl-C and calls quit_process()
void quit_process();  // Terminates current process with kill(pid,SIGTERM)

sem_t *sem_id;
char *id;
int fd;
int socket;

int main(void)
{
        srand((int)time(0));

        // Create random ID for client from 10000 - 19999
        int rnd_id = 10000 + rand() % 9999;
        string string_id = std::to_string(rnd_id);
        id = S2C(string_id, string_id.size()); // Store client id
        cout << "|Client:" << id << " starting up.|" << endl;


        // Create fifo for receiving output from server
        string temppath = "/tmp/" + std::string(id);
        const char *charpath = S2C(temppath, temppath.size()); // convert string path to
char*
```

```cpp
        // Create semaphore name
        string SEM_NAME = "/sem-" + std::string(id);
        const char *sempath = S2C(SEM_NAME, SEM_NAME.size()); // convert string path to
char*

        // Create semaphore on client
        sem_id = sem_open(sempath, O_CREAT, 0660, 0);
        if (sem_id == SEM_FAILED)
        {
                perror("sem_open");
                exit(1);
        }

        //Open fifo for receving output
        int code = mkfifo(charpath, 0666);
        // Error of fifo is already open
        if (code == -1)
                perror("mkfifo returned an error for receving - file may already exist");

        // Open pipe for receiving
        socket = open(charpath, O_RDWR);
        if (socket == -1)
        {
                perror("Cannot open fifo");
                exit(1);
        }
        // Create buffer to hold input from client
        char input[500];

        //Open fifo for write
        fd = open("/tmp/demo_fifo", O_WRONLY);
        if (fd == -1)
        {
                perror("Cannot open fifo");
                return EXIT_FAILURE;
        }

        while (true)
        {
                if (signal(SIGINT, sig_handler) == SIG_ERR)
                {
                        cout << "Signal not caught" << endl;
                }
                for (int i = 0; i<500; i++)
                        input[i] = '\0';

                cout << ">> |Please enter a command to the server:|" << endl;
                fgets(input, 500, stdin);

                // Send id of client to the server
                write(fd, id, strlen(id));
                // Send arguments via shared memory
                send(input, rnd_id);
                // Wait for reply from server
                char temp;
                while (true)
                {
                        read(socket, &temp, 1); // Read size of command
```

```cpp
                    if (temp == '\0')
                            break;
                    if (temp == '$')
                            quit_process();
                    cout << temp;
            }
            cout << ">> |Command returned successful.|" << endl;
    }// end infinite while
    return 0;
}
void send(char *input, int id_connection)
{
    // Used in creating shared memory
    int shared_size = 1000;
    int shmid;
    key_t key = id_connection;
    void *sharedptr;
    void *startptr;
    // Create shared memory
    shmid = shmget(key, shared_size, IPC_CREAT | 0666);
    if (shmid <0)
    {
            perror("shmget");
            exit(1);
    }
    // Attach shared memory
    sharedptr = shmat(shmid, NULL, 0);
    if (sharedptr == (char *)-1)
    {
            perror("shmat");
            exit(1);
    }
    // Set a pointer to the start of shared memory
    startptr = sharedptr;

    cout << "Sending:" << input << endl;
    //Send length of c-string
    *(int*)startptr = strlen(input);
    //Bump pointer
    startptr += sizeof(int);
    //Copy c-string into shared memory
    strcpy((char*)startptr, input);
    //Unblock server
    if (sem_post(sem_id) == -1)
            perror("sem_post: sem_id");

}//end send()
char* S2C(string segment, int mysize)
{
    //grab new memory for cstring
    char *temp = new char[mysize + 1];
    // transfer characters from string to new char array
    for (int i = 0; i < mysize; i++)
            temp[i] = segment[i];
    temp[mysize] = '\0';
    return temp;
}
void sig_handler(int sig)
```

```cpp
{
    if (sig == SIGINT)
        quit_process();
}
void quit_process()
{
    close(socket);
    close(fd);
    cout << "\nExiting.." << endl;
    pid_t myid = getpid();
    kill(myid, SIGTERM);
    exit(0);
}
```

Server

```cpp
#include <iostream>
#include <sys/wait.h>
#include <dirent.h>
#include <string>
#include <ctype.h>
#include <algorithm>
#include <string.h>
#include <signal.h>
#include <queue>
#include <signal.h>

// Used in fifo
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <string.h>
// Used in IPC
#include<sys/ipc.h>
#include<sys/shm.h>
// Used in semaphore
#include<semaphore.h>
#include <pthread.h>
#include <stdlib.h>
using namespace std;

struct args
{
    int argc;
    char **argv;
    char *id;
    char *connection;
    sem_t *sem_id;
    void *shdmem;
};
```

```cpp
struct client
{
        char *id;
        char *connection;
        sem_t *sem_id;
        void *shdmem;
};

void *branch(void*);              // Start commands for each new thread
void restore_output(int, int);    // Restore output to server
void set_connection(client*);     // Set std out to client
void set_semaphore(client*);      // Set semaphore for client to read shared memory
args* receive(client*);                 // Read shared memory from client
int output(args*, int);                 // Redirect output to specific file
int append(args*, int);                 // Append output to specific file
int input(args*, int);                  // Redirect std in from file

args* parser(char*);  // Parses arguments and stores them inside an args struct
char* S2C(string, int);// Converts a string to a cstring, returns a char* to be stored in
args
bool dir(args*);        // Changes and displays directories
void USER_PWD();        // Displays current working directory
void sig_handler(int);// Catches ctrl-C and calls quit_process()
void quit_process();  // Terminates current process with kill(pid,SIGTERM)

void add_client(args*);           // Adds client to list of users on server
void remove_client(args*);  // Removes client from list of users active

int from_client;
std::vector<int> clients;

int main(void)
{
        pthread_t SERVERpool[20]; //Number of threads used
        int pid = 0;

        puts(">> |Server is opening connection.|");
        //Open fifo for write
        int code = mkfifo("/tmp/demo_fifo", 0666);
        // Error of fifo is already open
        if (code == -1)
                perror("mkfifo returned an error - file may already exist");
        puts(">> |Connection to /tmp/demo_fifo is now open.|");

        // Open a temp file for the server to receive connections
        from_client = open("/tmp/demo_fifo", O_RDONLY);

        // Fifo not opended, exit
        if (from_client == -1)
        {
                perror("Cannot open FIFO for read");
                return EXIT_FAILURE;
        }

        while (true)
        {
                client *client1 = new client;
```

```cpp
            char *idbuff = new char[6];
            idbuff[5] = '\0';

            // Read information
            read(from_client, idbuff, 5);          // Read and store id of client
            client1->id = idbuff;                   // Save client id in struct
            set_connection(client1);               // Set connection back to client
            set_semaphore(client1);                 // Set semaphore between
processes
            args *aptr = receive(client1);         // Read and store commands from
client

            // Copy arguments over
            aptr->connection = client1->connection;
            aptr->id = client1->id;
            aptr->sem_id = client1->sem_id;
            aptr->shdmem = client1->shdmem;
            add_client(aptr);                       // Adds client to list of
active users

            // Begin work
            pthread_create(&SERVERpool[pid], NULL, &branch, aptr); //Send thread to do
work
            pthread_join(SERVERpool[pid], NULL);
            pid++;
      // Mark thread as used
            cout << ">> |Server executed successfully.|" << endl;
            cout << ">>" << endl;

            // Quit if all clients are off OR no more threads
            if (clients.size() == 0 || pid == 20)
                  quit_process();
      }//end infinite while
}//end main


void *branch(void *data_in)
{
      args *aptr = (args*)data_in;
      cout << ">> Server executing command from:" << aptr->id << endl;
      /* Steps:
      * A. Save stdout file descriptor
      * B. Open connection to client
      * C. Redirect stdout to client
      * D. Once cd or child finishes, redirect output to stdout
      */
      bool CDcmd = true; // Save if command was cd or execvp
      bool exitcond = false;
      int save_out = dup(STDOUT_FILENO);// Save file descriptor of stdout
      int newfd = open(aptr->connection, O_WRONLY);// Open fifo to send back output
      fflush(stdout);                    // Clear out std output
      close(STDOUT_FILENO);       // Close std output
      dup2(newfd, STDOUT_FILENO);// Redirect output to fifo client
      // Variables for error checking
      int checkEXEC = 0;
      int m = 0;

      // Check if exit command
```

```cpp
if (aptr->argv[0] == std::string("exit_"))
{
        cout << '$' << endl; // Send exit signal to client
        restore_output(newfd, save_out); // Restore output
        remove_client(aptr);
        exitcond = true;
}

// Check if command changes directories
CDcmd = dir(aptr);
// If command changed directory then restore std output
if (CDcmd)
{
        restore_output(newfd, save_out);
        pthread_exit(NULL);
}
// If no cd command -> fork() then execvp()
if (!CDcmd && !exitcond)
{
        /* Fork here and create child process
        * MYID > 0 : In parrent
        * MYID == 0 :In child
        * MYID == -1:Error
        */
        pid_t MYID = fork();
        if (MYID > 0)
        {
                if (wait(0) == -1)
                        perror("wait");
                restore_output(newfd, save_out); // Restore output
                cout << ">> |Parent process " << MYID << " continuing|" << endl;
                cout << ">> |Child process exiting|" << endl;
                kill(MYID, SIGTERM);
        }

        if (MYID == -1)
        {
                perror("fork");
                exit(1);
        }
        if (MYID == 0)
        {
                cout << ">> |Child on server executing|" << endl;
                for (int i = 0; i < aptr->argc; i++)
                {
                        if (aptr->argv[i] == std::string(">") ||
                                aptr->argv[i] == std::string("<") ||
                                aptr->argv[i] == std::string("<<") ||
                                aptr->argv[i] == std::string(">>"))
                        {
                                m = i;
                        }
                }//end for
                if (aptr->argv[m] == std::string(">"))
                        checkEXEC = output(aptr, m);

                if (aptr->argv[m] == std::string(">>"))
                        checkEXEC = append(aptr, m);
```

```cpp
                    if (aptr->argv[m] == std::string("<"))
                            checkEXEC = input(aptr, m);

                    if (m == 0)
                            checkEXEC = execvp(aptr->argv[0], aptr->argv);

                    if (checkEXEC == -1)
                            perror("exec");
            }//if MYID == 0
        }//else not cd command or exit command
        pthread_exit(NULL);
}//end branch
void restore_output(int newfd, int save_out)
{
        char L = '\0';
        write(newfd, &L, 1);// Disconnect client by sending null
        fflush(stdout);        // Clear out std output
        close(newfd); // Close redirected output
        dup2(save_out, STDOUT_FILENO);// Restore output to console
}
void set_connection(client *aptr)
{
        string temppath = "/tmp/" + std::string(aptr->id); // Make string of path to
client
        aptr->connection = S2C(temppath, temppath.size()); // convert string path to char*
}
void set_semaphore(client *aptr)
{
        // Create semaphore name
        string temppath = "/sem-" + std::string(aptr->id);
        const char *sempath = S2C(temppath, temppath.size()); // convert string path to
char*
        // Create semaphore on client
        aptr->sem_id = sem_open(sempath, O_CREAT, 0660, 0);
        if (aptr->sem_id == SEM_FAILED)
        {
                perror("sem_open");
                exit(1);
        }
}
args* receive(client *client1)
{
        int id_connection = atoi(client1->id);
        int shared_size = 1000;
        int counter = 0;
        string temp = "";

        // Used in opening connection
        int shmid;
        key_t key = id_connection;
        void *sharedptr;
        void *startptr;

        // Create shared memory
        shmid = shmget(key, shared_size, IPC_CREAT | O_RDONLY);
        if (shmid <0)
        {
```

```cpp
                perror("shmget");
                exit(1);
        }
        // Attach shared memory
        sharedptr = shmat(shmid, NULL, 0);
        if (sharedptr == (char *)-1)
        {
                perror("shmat");
                exit(1);
        }
        // Set a pointer to the start of shared memory
        startptr = sharedptr;
        client1->shdmem = sharedptr;
        // Lock semaphore
        if (sem_wait(client1->sem_id) == -1)
                perror("sem_wait: sem_id");
        // Grab length of argument
        counter = *(int*)startptr;
        // Bump pointer
        startptr += sizeof(int);
        // Set char to start of argument
        char *a = (char*)startptr;
        // Build argument string
        for (int i = 0; i<counter; i++)
                temp += *(a + i);

        // Convert string to char*
        char *newarg = S2C(temp, temp.size());
        cout << ">> Server received: " << newarg << " from client:" << id_connection <<
endl;
        return parser(newarg);
}// end receive()
int output(args *aptr, int m)
{
        int newfd = open(aptr->argv[m + 1], O_CREAT | O_WRONLY | O_TRUNC, 0644);
        close(STDOUT_FILENO);
        dup2(newfd, 1);
        aptr->argv[m] = NULL;
        return execvp(aptr->argv[0], aptr->argv);

}
int append(args *aptr, int m)
{
        int newfd = open(aptr->argv[m + 1],
                O_CREAT | O_WRONLY | O_APPEND, 0644);
        close(STDOUT_FILENO);
        dup2(newfd, 1);
        aptr->argv[m] = NULL;
        return execvp(aptr->argv[0], aptr->argv);

}
int input(args *aptr, int m)
{
        char buffer[1000];
        for (int i = 0; i < 1000; i++)
                buffer[i] = '\0';
        auto newID = open(aptr->argv[m + 1], O_CREAT | O_RDONLY, 0644);
        if (read(newID, buffer, 1000) == -1)
                exit(-1);
        // Parse commands from file and update args
```

```cpp
        args *temp = parser(buffer);
        args *newarguments = new args;
        newarguments->argv = new char*[(temp->argc) + 2];
        newarguments->argv[0] = aptr->argv[m - 1];
        for (int i = 1; i< (temp->argc) + 1; i++)
                newarguments->argv[i] = temp->argv[i - 1];

        newarguments->argv[(temp->argc) + 1] = '\0';
        //execute new args
        return execvp(newarguments->argv[0], newarguments->argv);
}
args* parser(char* argv)
{
        args *arguments = new args;
        string segment = "";
        int segment_size = 0;
        int i = 0;
        char *GGRTR = new char[3]{'>', '>', '\0'};
        char *LLESS = new char[3]{'<', '<', '\0'};
        char *GRTR = new char[2]{'>', '\0'};
        char *LESS = new char[2]{'<', '\0'};
        bool store_command = false;
        queue<char*> Qcommands;

        while (argv[i] != '\0')
        {
                while ((argv[i] != ' ')
                        && (argv[i] != '\n')
                        && (argv[i] != '\r')
                        && (argv[i] != '\t')
                        && (argv[i] != '>')
                        && (argv[i] != '<'))
                {
                        segment += argv[i];
                        segment_size++;
                        i++;
                        store_command = true;
                }
                if (store_command)
                {
                        Qcommands.push(S2C(segment, segment_size));
                        segment = "";
                        segment_size = 0;
                        store_command = false;
                }

                if (argv[i] == '>')
                {
                        int double_check = i;
                        if (argv[double_check + 1] == '>')
                        {
                                Qcommands.push(GGRTR);
                                i++;
                        }
                        if (argv[double_check + 1] != '>')
                                Qcommands.push(GRTR);
                }//end if >
```

```cpp
                if (argv[i] == '<')
                {
                        int double_check = i;
                        if (argv[double_check + 1] == '<')
                        {
                                Qcommands.push(LLESS);
                                i++;
                        }
                        if (argv[double_check + 1] != '<')
                                Qcommands.push(LESS);
                }//end if <
                i++;
        }//end while

        //Allocate memory for arguments inside of struct
        int counter = Qcommands.size();
        arguments->argc = counter;
        arguments->argv = new char*[counter + 1];

        // Transfer commands into struct
        for (int i = 0; i < counter; i++, Qcommands.pop())
                arguments->argv[i] = Qcommands.front();

        arguments->argv[counter] = '\0';
        //return pointer containing arguments
        return arguments;
}
char* S2C(string segment, int mysize)
{
        //grab new memory for cstring
        char *temp = new char[mysize + 1];
        // transfer characters from string to new char array
        for (int i = 0; i < mysize; i++)
                temp[i] = segment[i];
        temp[mysize] = '\0';
        return temp;
}
bool dir(args *cmdptr)
{
        int changedir_test = 0;
        bool temp = false;
        // cycle through commands
        for (int i = 0; i<cmdptr->argc; i++)
        {
                if (cmdptr->argv[i] == std::string("cd"))
                {
                        if (cmdptr->argv[i + 1] == '\0')
                                changedir_test = 1;
                        else if (cmdptr->argv[i + 1] == std::string(".."))
                                changedir_test = chdir("..");
                        else if (cmdptr->argv[i + 1] == std::string("../.."))
                                changedir_test = chdir("../..");
                        else if (cmdptr->argv[i + 1] != '\0')
                                changedir_test = chdir(cmdptr->argv[i + 1]);

                        if (changedir_test == -1)
                                cout << ">>Error:Did not change directories." << endl;
                        if (changedir_test != -1)
```

```cpp
                {
                        USER_PWD();
                        return true;
                }
        }// if cd

                if (cmdptr->argv[i] == std::string("pwd"))
                {
                        USER_PWD();
                        return true;
                }
        }// end for
        return temp;
}// end non_exe
void USER_PWD()
{
        char buffer[200];
        char *newpath = getcwd(buffer, 200);
        string currpath = newpath;
        cout << ">>" << currpath << endl;
}
void sig_handler(int sig)
{
        if (sig == SIGINT)
                quit_process();
}
void quit_process()
{
        close(from_client);
        cout << "\nExiting.." << endl;
        pid_t myid = getpid();
        kill(myid, SIGTERM);
        exit(0);
}
void add_client(args *aptr)
{
        bool add_client = true;
        int id = atoi(aptr->id);
        for (unsigned int i = 0; i<clients.size(); i++)
                if (clients[i] == id)
                        add_client = false;

        if (add_client)
                clients.push_back(id);
}
void remove_client(args *aptr)
{
        int id = atoi(aptr->id);
        if (shmdt(aptr->shdmem) < 0)
                cout << "|Error: detaching shared memory|" << endl;

        cout << ">> |Client:" << id << " Exiting.|" << endl;
        for (unsigned int i = 0; i<clients.size(); i++)
                if (clients[i] == id)
                {
                clients.erase(clients.begin() + i);
                break;
                }
```
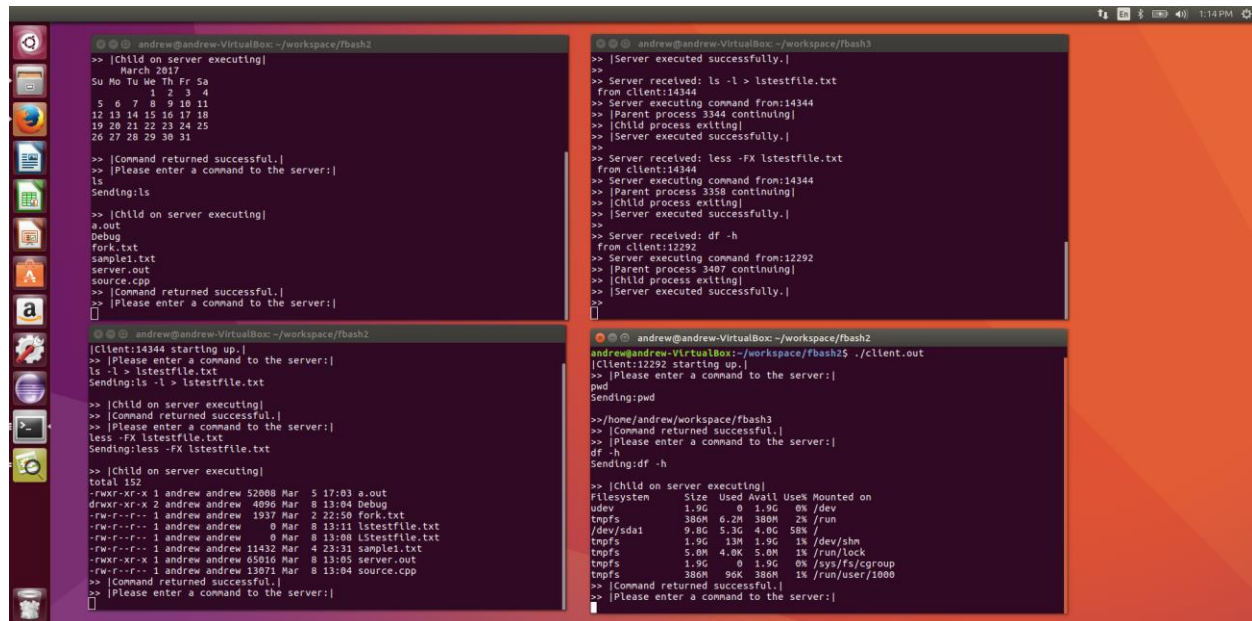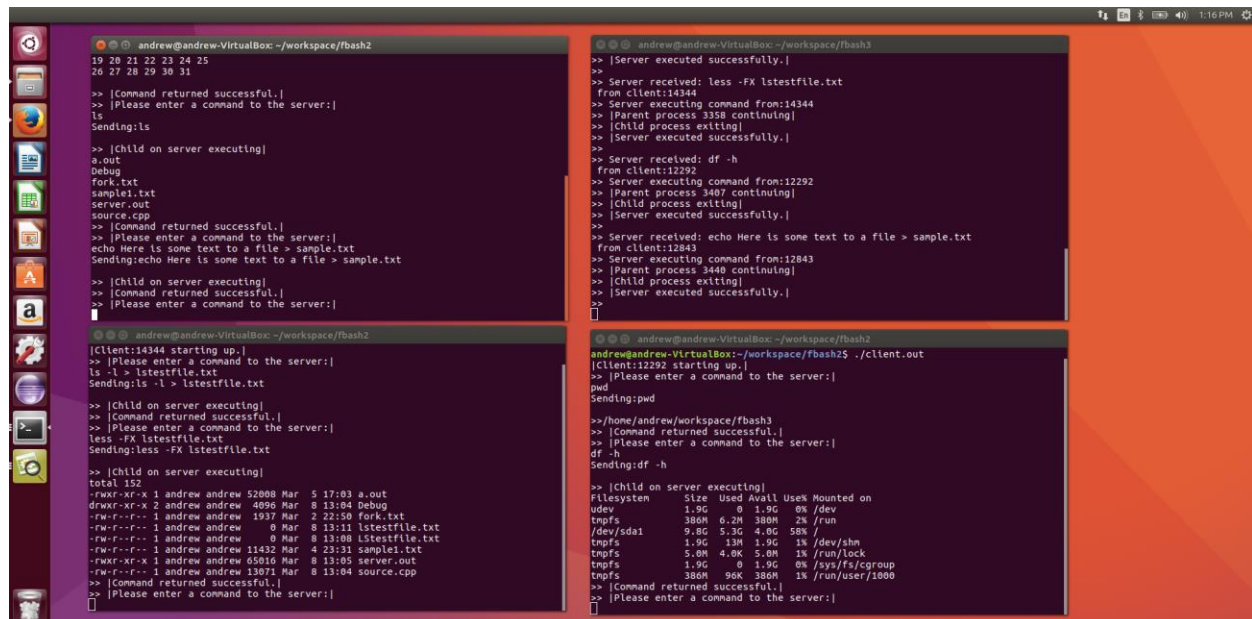
```cpp
    cout << ">> | " << clients.size() << " online.|" << endl;
}
```

Screenshot 1 (1:17 PM)

Terminal: andrew@andrew-VirtualBox: ~/workspace/fbash2

```
>> |Child on server executing|
a.out
Debug
fork.txt
sample1.txt
server.out
source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
echo Here is some text to a file > sample.txt
Sending:echo Here is some text to a file > sample.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX sample.txt
Sending:less -FX sample.txt

>> |Child on server executing|
Here is some text to a file
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal: andrew@andrew-VirtualBox: ~/workspace/fbash3

```
>> |Server executed successfully.|
>>
>> Server received: df -h
 from client:12292
>> Server executing command from:12292
>> |Parent process 3407 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: echo Here is some text to a file > sample.txt
 from client:12843
>> Server executing command from:12843
>> |Parent process 3440 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: less -FX sample.txt
 from client:12843
>> Server executing command from:12843
>> |Parent process 3471 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
```

Terminal: andrew@andrew-VirtualBox: ~/workspace/fbash2

```
|Client:14344 starting up.|
>> |Please enter a command to the server:|
ls -l > lstestfile.txt
Sending:ls -l > lstestfile.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX lstestfile.txt
Sending:less -FX lstestfile.txt

>> |Child on server executing|
total 152
-rwxr-xr-x 1 andrew andrew 52008 Mar  5 17:03 a.out
drwxr-xr-x 2 andrew andrew  4096 Mar  8 13:04 Debug
-rw-r--r-- 1 andrew andrew  1937 Mar  2 22:50 fork.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:11 lstestfile.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:08 LStestfile.txt
-rw-r--r-- 1 andrew andrew 11432 Mar  4 23:31 sample1.txt
-rwxr-xr-x 1 andrew andrew 65016 Mar  8 13:05 server.out
-rw-r--r-- 1 andrew andrew 13071 Mar  8 13:04 source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal: andrew@andrew-VirtualBox: ~/workspace/fbash2

```
andrew@andrew-VirtualBox:~/workspace/fbash2$ ./client.out
|Client:12292 starting up.|
>> |Please enter a command to the server:|
pwd
Sending:pwd

>>/home/andrew/workspace/fbash3
>> |Command returned successful.|
>> |Please enter a command to the server:|
df -h
Sending:df -h

>> |Child on server executing|
Filesystem      Size  Used Avail Use% Mounted on
udev            1.9G     0  1.9G   0% /dev
tmpfs           386M  6.2M  380M   2% /run
/dev/sda1       9.8G  5.3G  4.0G  58% /
tmpfs           1.9G   13M  1.9G   1% /dev/shm
tmpfs           5.0M  4.0K  5.0M   1% /run/lock
tmpfs           1.9G     0  1.9G   0% /sys/fs/cgroup
tmpfs           386M   96K  386M   1% /run/user/1000
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Screenshot 2 (1:18 PM)

Terminal: andrew@andrew-VirtualBox: ~/workspace/fbash2

```
server.out
source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
echo Here is some text to a file > sample.txt
Sending:echo Here is some text to a file > sample.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX sample.txt
Sending:less -FX sample.txt

>> |Child on server executing|
Here is some text to a file
>> |Command returned successful.|
>> |Please enter a command to the server:|
echo |APPENDED TEXT| Here is some new text >> sample.txt
Sending:echo |APPENDED TEXT| Here is some new text >> sample.txt

>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal: andrew@andrew-VirtualBox: ~/workspace/fbash3

```
>> |Server executed successfully.|
>>
>> Server received: echo Here is some text to a file > sample.txt
 from client:12843
>> Server executing command from:12843
>> |Parent process 3440 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: less -FX sample.txt
 from client:12843
>> Server executing command from:12843
>> |Parent process 3471 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: echo |APPENDED TEXT| Here is some new text >> sample.txt
 from client:12843
>> Server executing command from:12843
>> |Parent process 3504 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
```

Terminal: andrew@andrew-VirtualBox: ~/workspace/fbash2

```
|Client:14344 starting up.|
>> |Please enter a command to the server:|
ls -l > lstestfile.txt
Sending:ls -l > lstestfile.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX lstestfile.txt
Sending:less -FX lstestfile.txt

>> |Child on server executing|
total 152
-rwxr-xr-x 1 andrew andrew 52008 Mar  5 17:03 a.out
drwxr-xr-x 2 andrew andrew  4096 Mar  8 13:04 Debug
-rw-r--r-- 1 andrew andrew  1937 Mar  2 22:50 fork.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:11 lstestfile.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:08 LStestfile.txt
-rw-r--r-- 1 andrew andrew 11432 Mar  4 23:31 sample1.txt
-rwxr-xr-x 1 andrew andrew 65016 Mar  8 13:05 server.out
-rw-r--r-- 1 andrew andrew 13071 Mar  8 13:04 source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal: andrew@andrew-VirtualBox: ~/workspace/fbash2

```
andrew@andrew-VirtualBox:~/workspace/fbash2$ ./client.out
|Client:12292 starting up.|
>> |Please enter a command to the server:|
pwd
Sending:pwd

>>/home/andrew/workspace/fbash3
>> |Command returned successful.|
>> |Please enter a command to the server:|
df -h
Sending:df -h

>> |Child on server executing|
Filesystem      Size  Used Avail Use% Mounted on
udev            1.9G     0  1.9G   0% /dev
tmpfs           386M  6.2M  380M   2% /run
/dev/sda1       9.8G  5.3G  4.0G  58% /
tmpfs           1.9G   13M  1.9G   1% /dev/shm
tmpfs           5.0M  4.0K  5.0M   1% /run/lock
tmpfs           1.9G     0  1.9G   0% /sys/fs/cgroup
tmpfs           386M   96K  386M   1% /run/user/1000
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Screenshot 1 (1:19 PM)

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2 (top-left)
```
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX sample.txt
Sending:less -FX sample.txt

>> |Child on server executing|
Here is some text to a file
>> |Please enter a command to the server:|
echo |APPENDED TEXT| Here is some new text >> sample.txt
Sending:echo |APPENDED TEXT| Here is some new text >> sample.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX sample.txt
Sending:less -FX sample.txt

>> |Child on server executing|
Here is some text to a file
|APPENDED TEXT| Here is some new text
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash3 (top-right)
```
>> |Server executed successfully.|
>>
>> Server received: less -FX sample.txt
 from client:12843
>> Server executing command from:12843
>> |Parent process 3471 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: echo |APPENDED TEXT| Here is some new text >> sample.txt
 from client:12843
>> Server executing command from:12843
>> |Parent process 3504 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: less -FX sample.txt
 from client:12843
>> Server executing command from:12843
>> |Parent process 3520 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2 (bottom-left)
```
|Client:14344 starting up.|
>> |Please enter a command to the server:|
ls -l > lstestfile.txt
Sending:ls -l > lstestfile.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX lstestfile.txt
Sending:less -FX lstestfile.txt

>> |Child on server executing|
total 152
-rwxr-xr-x 1 andrew andrew 52008 Mar  5 17:03 a.out
drwxr-xr-x 2 andrew andrew  4096 Mar  8 13:04 Debug
-rw-r--r-- 1 andrew andrew  1937 Mar  2 22:50 fork.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:11 lstestfile.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:08 LStestfile.txt
-rw-r--r-- 1 andrew andrew 11432 Mar  4 23:31 sample1.txt
-rwxr-xr-x 1 andrew andrew 65016 Mar  8 13:05 server.out
-rw-r--r-- 1 andrew andrew 13071 Mar  8 13:04 source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2 (bottom-right)
```
andrew@andrew-VirtualBox:~/workspace/fbash2$ ./client.out
|Client:12292 starting up.|
>> |Please enter a command to the server:|
pwd
Sending:pwd

>>/home/andrew/workspace/fbash3
>> |Command returned successful.|
>> |Please enter a command to the server:|
df -h
Sending:df -h

>> |Child on server executing|
Filesystem      Size  Used Avail Use% Mounted on
udev            1.9G     0  1.9G   0% /dev
tmpfs           386M  6.2M  380M   2% /run
/dev/sda1       9.8G  5.3G  4.0G  58% /
tmpfs           1.9G   13M  1.9G   1% /dev/shm
tmpfs           5.0M  4.0K  5.0M   1% /run/lock
tmpfs           1.9G     0  1.9G   0% /sys/fs/cgroup
tmpfs           386M   96K  386M   1% /run/user/1000
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Screenshot 2 (1:20 PM)

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2 (top-left)
```
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX sample.txt
Sending:less -FX sample.txt

>> |Child on server executing|
Here is some text to a file
>> |Command returned successful.|
>> |Please enter a command to the server:|
echo |APPENDED TEXT| Here is some new text >> sample.txt
Sending:echo |APPENDED TEXT| Here is some new text >> sample.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX sample.txt
Sending:less -FX sample.txt

>> |Child on server executing|
Here is some text to a file
|APPENDED TEXT| Here is some new text
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash3 (top-right)
```
>> |Parent process 3471 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: echo |APPENDED TEXT| Here is some new text >> sample.txt
 from client:12843
>> Server executing command from:12843
>> |Parent process 3504 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: less -FX sample.txt
 from client:12843
>> Server executing command from:12843
>> |Parent process 3520 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: cd ..
 from client:12292
>> Server executing command from:12292
>> Server executed successfully.|
>>
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2 (bottom-left)
```
|Client:14344 starting up.|
>> |Please enter a command to the server:|
ls -l > lstestfile.txt
Sending:ls -l > lstestfile.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX lstestfile.txt
Sending:less -FX lstestfile.txt

>> |Child on server executing|
total 152
-rwxr-xr-x 1 andrew andrew 52008 Mar  5 17:03 a.out
drwxr-xr-x 2 andrew andrew  4096 Mar  8 13:04 Debug
-rw-r--r-- 1 andrew andrew  1937 Mar  2 22:50 fork.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:11 lstestfile.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:08 LStestfile.txt
-rw-r--r-- 1 andrew andrew 11432 Mar  4 23:31 sample1.txt
-rwxr-xr-x 1 andrew andrew 65016 Mar  8 13:05 server.out
-rw-r--r-- 1 andrew andrew 13071 Mar  8 13:04 source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2 (bottom-right)
```
>>/home/andrew/workspace/fbash3
>> |Command returned successful.|
>> |Please enter a command to the server:|
df -h
Sending:df -h

>> |Child on server executing|
Filesystem      Size  Used Avail Use% Mounted on
udev            1.9G     0  1.9G   0% /dev
tmpfs           386M  6.2M  380M   2% /run
/dev/sda1       9.8G  5.3G  4.0G  58% /
tmpfs           1.9G   13M  1.9G   1% /dev/shm
tmpfs           5.0M  4.0K  5.0M   1% /run/lock
tmpfs           1.9G     0  1.9G   0% /sys/fs/cgroup
tmpfs           386M   96K  386M   1% /run/user/1000
>> |Command returned successful.|
>> |Please enter a command to the server:|
cd ..
Sending:cd ..

>>/home/andrew/workspace
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Screenshot 1 — top

Window: andrew@andrew-VirtualBox: ~/workspace/fbash2

```
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX sample.txt
Sending:less -FX sample.txt

>> |Child on server executing|
Here is some text to a file
>> |Command returned successful.|
>> |Please enter a command to the server:|
echo |APPENDED TEXT| Here is some new text >> sample.txt
Sending:echo |APPENDED TEXT| Here is some new text >> sample.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX sample.txt
Sending:less -FX sample.txt

>> |Child on server executing|
Here is some text to a file
|APPENDED TEXT| Here is some new text
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Window: andrew@andrew-VirtualBox: ~/workspace/fbash3

```
from client:12843
>> Server executing command from:12843
>> |Parent process 3504 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: less -FX sample.txt
from client:12843
>> Server executing command from:12843
>> |Parent process 3520 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: cd ..
from client:12292
>> Server executing command from:12292
>> |Server executed successfully.|
>>
>> Server received: cd ../..
from client:12292
>> Server executing command from:12292
>> |Server executed successfully.|
```

Window: andrew@andrew-VirtualBox: ~/workspace/fbash2

```
|Client:14344 starting up.|
>> |Please enter a command to the server:|
ls -l > lstestfile.txt
Sending:ls -l > lstestfile.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX lstestfile.txt
Sending:less -FX lstestfile.txt

>> |Child on server executing|
total 152
-rwxr-xr-x 1 andrew andrew 52008 Mar  5 17:03 a.out
drwxr-xr-x 2 andrew andrew  4096 Mar  8 13:04 Debug
-rw-r--r-- 1 andrew andrew  1937 Mar  2 22:50 fork.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:11 lstestfile.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:08 LStestfile.txt
-rw-r--r-- 1 andrew andrew 11432 Mar  4 23:31 sample1.txt
-rwxr-xr-x 1 andrew andrew 65016 Mar  8 13:05 server.out
-rw-r--r-- 1 andrew andrew 13071 Mar  8 13:04 source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Window: andrew@andrew-VirtualBox: ~/workspace/fbash2

```
>> |Child on server executing|
Filesystem     Size  Used Avail Use% Mounted on
udev           1.9G     0  1.9G   0% /dev
tmpfs          386M  6.2M  380M   2% /run
/dev/sda1      9.8G  5.3G  4.0G  58% /
tmpfs          1.9G   13M  1.9G   1% /dev/shm
tmpfs          5.0M  4.0K  5.0M   1% /run/lock
tmpfs          1.9G     0  1.9G   0% /sys/fs/cgroup
tmpfs          386M  96K  386M   1% /run/user/1000
>> |Command returned successful.|
>> |Please enter a command to the server:|
cd ..
Sending:cd ..

>>/home/andrew/workspace
>> |Command returned successful.|
>> |Please enter a command to the server:|
cd ../..
Sending:cd ../..

>>/home
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Screenshot 2 — bottom

Window: andrew@andrew-VirtualBox: ~/workspace/fbash2

```
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX sample.txt
Sending:less -FX sample.txt

>> |Child on server executing|
Here is some text to a file
>> |Command returned successful.|
>> |Please enter a command to the server:|
echo |APPENDED TEXT| Here is some new text >> sample.txt
Sending:echo |APPENDED TEXT| Here is some new text >> sample.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX sample.txt
Sending:less -FX sample.txt

>> |Child on server executing|
Here is some text to a file
|APPENDED TEXT| Here is some new text
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Window: andrew@andrew-VirtualBox: ~/workspace/fbash3

```
>>
>> Server received: less -FX sample.txt
from client:12843
>> Server executing command from:12843
>> |Parent process 3520 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: cd ..
from client:12292
>> Server executing command from:12292
>> |Server executed successfully.|
>>
>> Server received: cd ../..
from client:12292
>> Server executing command from:12292
>> |Server executed successfully.|
>>
>> Server received: pwd
from client:12292
>> Server executing command from:12292
>> |Server executed successfully.|
>>
```

Window: andrew@andrew-VirtualBox: ~/workspace/fbash2

```
|Client:14344 starting up.|
>> |Please enter a command to the server:|
ls -l > lstestfile.txt
Sending:ls -l > lstestfile.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX lstestfile.txt
Sending:less -FX lstestfile.txt

>> |Child on server executing|
total 152
-rwxr-xr-x 1 andrew andrew 52008 Mar  5 17:03 a.out
drwxr-xr-x 2 andrew andrew  4096 Mar  8 13:04 Debug
-rw-r--r-- 1 andrew andrew  1937 Mar  2 22:50 fork.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:11 lstestfile.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:08 LStestfile.txt
-rw-r--r-- 1 andrew andrew 11432 Mar  4 23:31 sample1.txt
-rwxr-xr-x 1 andrew andrew 65016 Mar  8 13:05 server.out
-rw-r--r-- 1 andrew andrew 13071 Mar  8 13:04 source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Window: andrew@andrew-VirtualBox: ~/workspace/fbash2

```
tmpfs          5.0M  4.0K  5.0M   1% /run/lock
tmpfs          1.9G     0  1.9G   0% /sys/fs/cgroup
tmpfs          386M  96K  386M   1% /run/user/1000
>> |Command returned successful.|
>> |Please enter a command to the server:|
cd ..
Sending:cd ..

>>/home/andrew/workspace
>> |Command returned successful.|
>> |Please enter a command to the server:|
cd ../..
Sending:cd ../..

>>/home
>> |Command returned successful.|
>> |Please enter a command to the server:|
pwd
Sending:pwd

>>/home
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Screen 1 (1:29 PM)

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
andrew@andrew-VirtualBox:~$ cd workspace/fbash2
andrew@andrew-VirtualBox:~/workspace/fbash2$ ./client.out
|Client:14699 starting up.|
>> |Please enter a command to the server:|
df -h > diskinfo.txt
Sending:df -h > diskinfo.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash3

```
 from client:18835
>> Server executing command from:18835
>> |Server executed successfully.|
>>
>> Server received: cd fbash3
 from client:18835
>> Server executing command from:18835
>> |Server executed successfully.|
>>
>> Server received: ls
 from client:18835
>> Server executing command from:18835
>> |Parent process 3746 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: df -h > diskinfo.txt
 from client:14699
>> Server executing command from:14699
>> |Parent process 3810 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
>> |Command returned successful.|
>> |Please enter a command to the server:|
cd fbash3
Sending:cd fbash3

>>/home/andrew/workspace/fbash3
>> |Command returned successful.|
>> |Please enter a command to the server:|
ls
Sending:ls

>> |Child on server executing|
a.out
Debug
fork.txt
lstestfile.txt
LStestfile.txt
sample1.txt
sample.txt
server.out
source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
>> |Please enter a command to the server:|
ls
Sending:ls

>> |Child on server executing|
Desktop
Documents
Downloads
examples.desktop
Music
Pictures
Public
Templates
Videos
workspace
>> |Command returned successful.|
>> |Please enter a command to the server:|
cd workspace/fbash2
Sending:cd workspace/fbash2

>>/home/andrew/workspace/fbash2
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Screen 2 (1:22 PM)

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX sample.txt
Sending:less -FX sample.txt

>> |Child on server executing|
Here is some text to a file
>> |Command returned successful.|
>> |Please enter a command to the server:|
echo |APPENDED TEXT| Here is some new text >> sample.txt
Sending:echo |APPENDED TEXT| Here is some new text >> sample.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX sample.txt
Sending:less -FX sample.txt

>> |Child on server executing|
Here is some text to a file
|APPENDED TEXT| Here is some new text
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash3

```
>>
>> Server received: ls
 from client:12292
>> Server executing command from:12292
>> |Parent process 3613 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: cd andrew
 from client:12292
>> Server executing command from:12292
>> |Server executed successfully.|
>>
>> Server received: ls
 from client:12292
>> Server executing command from:12292
>> |Parent process 3619 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
Exiting..
Terminated
andrew@andrew-VirtualBox:~/workspace/fbash3$
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
|Client:14344 starting up.|
>> |Please enter a command to the server:|
ls -l > lstestfile.txt
Sending:ls -l > lstestfile.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX lstestfile.txt
Sending:less -FX lstestfile.txt

>> |Child on server executing|
total 152
-rwxr-xr-x 1 andrew andrew 52008 Mar  5 17:03 a.out
drwxr-xr-x 2 andrew andrew  4096 Mar  8 13:04 Debug
-rw-r--r-- 1 andrew andrew  1937 Mar  2 22:50 fork.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:11 lstestfile.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:08 LStestfile.txt
-rw-r--r-- 1 andrew andrew 11432 Mar  4 23:31 sample1.txt
-rwxr-xr-x 1 andrew andrew 65016 Mar  8 13:05 server.out
-rw-r--r-- 1 andrew andrew 13071 Mar  8 13:04 source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
>> |Please enter a command to the server:|
cd andrew
Sending:cd andrew

>>/home/andrew
>> |Command returned successful.|
>> |Please enter a command to the server:|
ls
Sending:ls

>> |Child on server executing|
Desktop
Documents
Downloads
examples.desktop
Music
Pictures
Public
Templates
Videos
workspace
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Top screenshot (1:30 PM)

Terminal 1 (top-left) — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
andrew@andrew-VirtualBox:~/workspace/fbash2$ ./client.out
|Client:14699 starting up.|
>> |Please enter a command to the server:|
df -h > diskinfo.txt
Sending:df -h > diskinfo.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX diskinfo.txt
Sending:less -FX diskinfo.txt

>> |Child on server executing|
Filesystem      Size  Used Avail Use% Mounted on
udev            1.9G     0  1.9G   0% /dev
tmpfs           386M  6.2M  380M   2% /run
/dev/sda1       9.8G  5.4G  4.0G  58% /
tmpfs           1.9G   13M  1.9G   1% /dev/shm
tmpfs           5.0M  4.0K  5.0M   1% /run/lock
tmpfs           1.9G     0  1.9G   0% /sys/fs/cgroup
tmpfs           386M  104K  386M   1% /run/user/1000
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal 2 (top-right) — andrew@andrew-VirtualBox: ~/workspace/fbash3

```
>> |Server executed successfully.|
>>
>> Server received: ls
   from client:18835
>> Server executing command from:18835
>> |Parent process 3746 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: df -h > diskinfo.txt
   from client:14699
>> Server executing command from:14699
>> |Parent process 3810 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: less -FX diskinfo.txt
   from client:14699
>> Server executing command from:14699
>> |Parent process 3834 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
```

Terminal 3 (bottom-left) — andrew@andrew-VirtualBox: ~/workspace/fbash3

```
>> |Command returned successful.|
>> |Please enter a command to the server:|
cd fbash3
Sending:cd fbash3

>>/home/andrew/workspace/fbash3
>> |Command returned successful.|
>> |Please enter a command to the server:|
ls
Sending:ls

>> |Child on server executing|
a.out
Debug
fork.txt
lstestfile.txt
LStestfile.txt
sample1.txt
sample.txt
server.out
source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal 4 (bottom-right) — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
>> |Please enter a command to the server:|
ls
Sending:ls

>> |Child on server executing|
Desktop
Documents
Downloads
examples.desktop
Music
Pictures
Public
Templates
Videos
workspace
>> |Command returned successful.|
>> |Please enter a command to the server:|
cd workspace/fbash2
Sending:cd workspace/fbash2

>>/home/andrew/workspace/fbash2
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Bottom screenshot (1:31 PM)

Terminal 1 (top-left) — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
andrew@andrew-VirtualBox:~/workspace/fbash2$ ./client.out
|Client:14699 starting up.|
>> |Please enter a command to the server:|
df -h > diskinfo.txt
Sending:df -h > diskinfo.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX diskinfo.txt
Sending:less -FX diskinfo.txt

>> |Child on server executing|
Filesystem      Size  Used Avail Use% Mounted on
udev            1.9G     0  1.9G   0% /dev
tmpfs           386M  6.2M  380M   2% /run
/dev/sda1       9.8G  5.4G  4.0G  58% /
tmpfs           1.9G   13M  1.9G   1% /dev/shm
tmpfs           5.0M  4.0K  5.0M   1% /run/lock
tmpfs           1.9G     0  1.9G   0% /sys/fs/cgroup
tmpfs           386M  104K  386M   1% /run/user/1000
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal 2 (top-right) — andrew@andrew-VirtualBox: ~/workspace/fbash3

```
   from client:14699
>> Server executing command from:14699
>> |Parent process 3834 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: cd /
   from client:19259
>> Server executing command from:19259
>> |Server executed successfully.|
>>
>> Server received: pwd
   from client:19259
>> Server executing command from:19259
>> |Server executed successfully.|
>>
>> Server received: ls
   from client:19259
>> Server executing command from:19259
>> |Parent process 3866 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
```

Terminal 3 (bottom-left) — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
>> |Command returned successful.|
>> |Please enter a command to the server:|
cd fbash3
Sending:cd fbash3

>>/home/andrew/workspace/fbash3
>> |Command returned successful.|
>> |Please enter a command to the server:|
ls
Sending:ls

>> |Child on server executing|
a.out
Debug
fork.txt
lstestfile.txt
LStestfile.txt
sample1.txt
sample.txt
server.out
source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal 4 (bottom-right) — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
home
initrd.img
initrd.img.old
lib
lib64
lost+found
media
mnt
opt
proc
root
run
sbin
snap
srv
sys
tmp
usr
var
vmlinuz
vmlinuz.old
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Screenshot 1 (top)

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX diskinfo.txt
Sending:less -FX diskinfo.txt

>> |Child on server executing|
Filesystem      Size  Used Avail Use% Mounted on
udev            1.9G     0  1.9G   0% /dev
tmpfs           386M  6.2M  380M   2% /run
/dev/sda1       9.8G  5.4G  4.0G  58% /
tmpfs           1.9G   13M  1.9G   1% /dev/shm
tmpfs           5.0M  4.0K  5.0M   1% /run/lock
tmpfs           1.9G     0  1.9G   0% /sys/fs/cgroup
tmpfs           386M  104K  386M   1% /run/user/1000
>> |Command returned successful.|
>> |Please enter a command to the server:|
exit_
Sending:exit_

Exiting..
Terminated
andrew@andrew-VirtualBox:~/workspace/fbash2$
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash3

```
 from client:19259
>> Server executing command from:19259
>> |Server executed successfully.|
>>
>> Server received: pwd
 from client:19259
>> Server executing command from:19259
>> |Server executed successfully.|
>>
>> Server received: ls
 from client:19259
>> Server executing command from:19259
>> |Parent process 3866 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: exit_
 from client:14699
>> Server executing command from:14699
>> |Client:14699 Exiting.|
>> | 2 online.|
>> |Server executed successfully.|
>>
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
>> |Command returned successful.|
>> |Please enter a command to the server:|
cd fbash3
Sending:cd fbash3

>>/home/andrew/workspace/fbash3
>> |Command returned successful.|
>> |Please enter a command to the server:|
ls
Sending:ls

>> |Child on server executing|
a.out
Debug
fork.txt
lstestfile.txt
LStestfile.txt
sample1.txt
sample.txt
server.out
source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
home
initrd.img
initrd.img.old
lib
lib64
lost+found
media
mnt
opt
proc
root
run
sbin
snap
srv
sys
tmp
usr
var
vmlinuz
vmlinuz.old
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Screenshot 2 (bottom)

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX diskinfo.txt
Sending:less -FX diskinfo.txt

>> |Child on server executing|
Filesystem      Size  Used Avail Use% Mounted on
udev            1.9G     0  1.9G   0% /dev
tmpfs           386M  6.2M  380M   2% /run
/dev/sda1       9.8G  5.4G  4.0G  58% /
tmpfs           1.9G   13M  1.9G   1% /dev/shm
tmpfs           5.0M  4.0K  5.0M   1% /run/lock
tmpfs           1.9G     0  1.9G   0% /sys/fs/cgroup
tmpfs           386M  104K  386M   1% /run/user/1000
>> |Command returned successful.|
>> |Please enter a command to the server:|
exit_
Sending:exit_

Exiting..
Terminated
andrew@andrew-VirtualBox:~/workspace/fbash2$
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash3

```
 from client:19259
>> Server executing command from:19259
>> |Parent process 3866 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: exit_
 from client:14699
>> Server executing command from:14699
>> |Client:14699 Exiting.|
>> | 2 online.|
>> |Server executed successfully.|
>>
>> Server received: exit_
 from client:18835
>> Server executing command from:18835
>> |Client:18835 Exiting.|
>> | 1 online.|
>> |Server executed successfully.|
>>

Exiting..
Terminated
andrew@andrew-VirtualBox:~/workspace/fbash3$
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
>> |Command returned successful.|
>> |Please enter a command to the server:|
ls
Sending:ls

>> |Child on server executing|
a.out
Debug
fork.txt
lstestfile.txt
LStestfile.txt
sample1.txt
sample.txt
server.out
source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
exit_
Sending:exit_

Exiting..
Terminated
andrew@andrew-VirtualBox:~/workspace/fbash2$
```

Terminal — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
home
initrd.img
initrd.img.old
lib
lib64
lost+found
media
mnt
opt
proc
root
run
sbin
snap
srv
sys
tmp
usr
var
vmlinuz
vmlinuz.old
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal 1 (top-left) — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
>> |Child on server executing|
     March 2017
Su Mo Tu We Th Fr Sa
          1  2  3  4
 5  6  7  8  9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30 31

>> |Command returned successful.|
>> |Please enter a command to the server:|
ls
Sending:ls

>> |Child on server executing|
a.out
Debug
fork.txt
sample1.txt
server.out
source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal 2 (top-right) — andrew@andrew-VirtualBox: ~/workspace/fbash3

```
>> |Server executed successfully.|
>>
>> Server received: exit_
   from client:19609
>> Server executing command from:19609
>> |Client:19609 Exiting.|
>> | 2 online.|
>> |Server executed successfully.|
>>
>> Server received: ls -l > lstestfile.txt
   from client:14344
>> Server executing command from:14344
>> |Parent process 3344 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: less -FX lstestfile.txt
   from client:14344
>> Server executing command from:14344
>> |Parent process 3358 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
```

Terminal 3 (bottom-left) — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
|Client:14344 starting up.|
>> |Please enter a command to the server:|
ls -l > lstestfile.txt
Sending:ls -l > lstestfile.txt

>> |Child on server executing|
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX lstestfile.txt
Sending:less -FX lstestfile.txt

>> |Child on server executing|
total 152
-rwxr-xr-x 1 andrew andrew 52008 Mar  5 17:03 a.out
drwxr-xr-x 2 andrew andrew  4096 Mar  8 13:04 Debug
-rw-r--r-- 1 andrew andrew  1937 Mar  2 22:50 fork.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:11 lstestfile.txt
-rw-r--r-- 1 andrew andrew     0 Mar  8 13:08 LStestfile.txt
-rw-r--r-- 1 andrew andrew 11432 Mar  4 23:31 sample1.txt
-rwxr-xr-x 1 andrew andrew 65016 Mar  8 13:05 server.out
-rw-r--r-- 1 andrew andrew 13071 Mar  8 13:04 source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal 4 (bottom-right) — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
andrew@andrew-VirtualBox:~$ cd workspace/fbash2
andrew@andrew-VirtualBox:~/workspace/fbash2$ ./client.out
|Client:12292 starting up.|
>> |Please enter a command to the server:|
pwd
Sending:pwd

>>/home/andrew/workspace/fbash3
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Second screenshot (1:07 PM)

Terminal 1 (top-left) — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
ead
source.cpp: In function 'void send(char*, int)':
source.cpp:158:24: warning: pointer of type 'void *' used in arithmetic [-Wpoint
er-arith]
    startptr += sizeof(int);
                       ^
andrew@andrew-VirtualBox:~/workspace/fbash2$ ./client.out
|Client:12843 starting up.|
>> |Please enter a command to the server:|
cal
Sending:cal

>> |Child on server executing|
     March 2017
Su Mo Tu We Th Fr Sa
          1  2  3  4
 5  6  7  8  9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30 31

>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal 2 (top-right) — andrew@andrew-VirtualBox: ~/workspace/fbash3

```
                  ^
andrew@andrew-VirtualBox:~/workspace/fbash3$ ./server.out
>> |Server is opening connection.|
>> |Connection to /tmp/demo_fifo is now open.|
>> Server received: cal
   from client:12843
>> Server executing command from:12843
>> |Parent process 3174 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: date
   from client:19609
>> Server executing command from:19609
>> |Parent process 3176 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: pwd
   from client:12292
>> Server executing command from:12292
>> |Server executed successfully.|
>>
```

Terminal 3 (bottom-left) — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
andrew@andrew-VirtualBox:~$ cd workspace/fbash2
andrew@andrew-VirtualBox:~/workspace/fbash2$ ./client.out
|Client:19609 starting up.|
>> |Please enter a command to the server:|
date
Sending:date

>> |Child on server executing|
Wed Mar  8 13:06:55 CST 2017
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal 4 (bottom-right) — andrew@andrew-VirtualBox: ~/workspace/fbash2

```
andrew@andrew-VirtualBox:~$ cd workspace/fbash2
andrew@andrew-VirtualBox:~/workspace/fbash2$ ./client.out
|Client:12292 starting up.|
>> |Please enter a command to the server:|
pwd
Sending:pwd

>>/home/andrew/workspace/fbash3
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Top screenshot (1:41 PM):

```
andrew@andrew-VirtualBox: ~/workspace/fbash2
andrew@andrew-VirtualBox:~$ cd workspace/fbash2
andrew@andrew-VirtualBox:~/workspace/fbash2$ ./client.out
|Client:16046 starting up.|
>> |Please enter a command to the server:|
date
Sending:date

>> |Child on server executing|
Wed Mar  8 13:40:43 CST 2017
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

```
andrew@andrew-VirtualBox: ~/workspace/fbash3
>> |Server executed successfully.|
>>
>> Server received: cal
   from client:14053
>> Server executing command from:14053
>> |Parent process 4108 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: ls
   from client:19245
>> Server executing command from:19245
>> |Parent process 4110 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: less -FX diskinfo.txt
   from client:19245
>> Server executing command from:19245
>> |Parent process 4113 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
```

```
andrew@andrew-VirtualBox: ~/worksp
andrew@andrew-VirtualBox:~$ cd workspac
andrew@andrew-VirtualBox:~/workspace/fb
|Client:16946 starting up.|
>> |Please enter a command to the server
pwd
Sending:pwd
>>/home/andrew/workspace/fbash3
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

```
andrew@andrew-VirtualBox: ~/workspace/fb
andrew@andrew-VirtualBox:~$ cd workspace/fbas
andrew@andrew-VirtualBox:~/workspace/fbash2$
|Client:14053 starting up.|
>> |Please enter a command to the server:|
cal
Sending:cal

>> |Child on server executing|
      March 2017
Su Mo Tu We Th Fr Sa
          1  2  3  4
 5  6  7  8  9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30 31

>> |Command returned successful.|
>> |Please enter a command to the server:|
```

```
/fbash2
                                    ted on
tmpfs          5.0M  4.0K  5.0M   1% /run/lock
tmpfs          1.9G     0  1.9G   0% /sys/fs/cgroup
tmpfs          386M  104K  386M   1% /run/user/1000
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Bottom screenshot (1:42 PM):

```
andrew@andrew-VirtualBox: ~/workspace/fbash2
andrew@andrew-VirtualBox:~$ cd workspace/fbash2
andrew@andrew-VirtualBox:~/workspace/fbash2$ ./client.out
|Client:16046 starting up.|
>> |Please enter a command to the server:|
date
Sending:date

>> |Child on server executing|
Wed Mar  8 13:40:43 CST 2017
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

```
andrew@andrew-VirtualBox: ~/workspace/fbash3
>> |Server executed successfully.|
>>
>> Server received: ls
   from client:19245
>> Server executing command from:19245
>> |Parent process 4110 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: less -FX diskinfo.txt
   from client:19245
>> Server executing command from:19245
>> |Parent process 4113 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: exit_
   from client:16946
>> Server executing command from:16946
>> |Client:16946 Exiting.|
>> | 3 online.|
>> |Server executed successfully.|
>>
```

```
andrew@andrew-VirtualBox: ~/worksp
andrew@andrew-VirtualBox:~$ cd workspac
andrew@andrew-VirtualBox:~/workspace/fb
|Client:16946 starting up.|
>> |Please enter a command to the server
pwd
Sending:pwd
>>/home/andrew/workspace/fbash3
>> |Command returned successful.|
>> |Please enter a command to the server:|
exit_
Sending:exit_

Exiting..
Terminated
andrew@andrew-VirtualBox:~/workspace/fbash2$
```

```
andrew@andrew-VirtualBox: ~/workspace/fb
andrew@andrew-VirtualBox:~$ cd workspace/fbas
andrew@andrew-VirtualBox:~/workspace/fbash2$
|Client:14053 starting up.|
>> |Please enter a command to the server:|
cal
Sending:cal

>> |Child on server executing|
      March 2017
Su Mo Tu We Th Fr Sa
          1  2  3  4
 5  6  7  8  9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30 31

>> |Command returned successful.|
>> |Please enter a command to the server:|
```

```
/fbash2
                                    ted on
tmpfs          5.0M  4.0K  5.0M   1% /shm
tmpfs          1.9G     0  1.9G   0% /run/lock
tmpfs          1.9G     0  1.9G   0% /sys/fs/cgroup
tmpfs          386M  104K  386M   1% /run/user/1000
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Top screenshot — top-left terminal (fbash2):

```
andrew@andrew-VirtualBox: ~/workspace/fbash2
andrew@andrew-VirtualBox:~$ cd workspace/fbash2
andrew@andrew-VirtualBox:~/workspace/fbash2$ ./client.out
|Client:16046 starting up.|
>> |Please enter a command to the server:|
date
Sending:date

>> |Child on server executing|
Wed Mar  8 13:40:43 CST 2017
>> |Command returned successful.|
>> |Please enter a command to the server:|
exit_
Sending:exit_


Exiting..
Terminated
andrew@andrew-VirtualBox:~/workspace/fbash2$
```

Top screenshot — top-right terminal (fbash3):

```
andrew@andrew-VirtualBox: ~/workspace/fbash3
>> |Server executed successfully.|
>>
>> Server received: less -FX diskinfo.txt
   from client:19245
>> Server executing command from:19245
>> |Parent process 4113 continuing|
>> |Child process exiting|
>> |Server executed successfully.|
>>
>> Server received: exit_
   from client:16946
>> Server executing command from:16946
>> |Client:16946 Exiting.|
>> | 3 online.|
>> |Server executed successfully.|
>>
>> Server received: exit_
   from client:16046
>> Server executing command from:16046
>> |Client:16046 Exiting.|
>> | 2 online.|
>> |Server executed successfully.|
>>
```

Top screenshot — bottom-left terminal (fbash2):

```
andrew@andrew-VirtualBox: ~/workspace/fbash2
andrew@andrew-VirtualBox:~$ cd workspace/fbash2
andrew@andrew-VirtualBox:~/workspace/fbash2$ ./client.out
|Client:14053 starting up.|
>> |Please enter a command to the server:|
cal
Sending:cal

>> |Child on server executing|
     March 2017
Su Mo Tu We Th Fr Sa
          1  2  3  4
 5  6  7  8  9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30 31

>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Top screenshot — bottom-right terminal (fbash2):

```
andrew@andrew-VirtualBox: ~/workspace/fbash2
fork.txt
lstestfile.txt
LStestfile.txt
sample1.txt
sample.txt
server.out
source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX diskinfo.txt
Sending:less -FX diskinfo.txt

>> |Child on server executing|
Filesystem      Size  Used Avail Use% Mounted on
udev            1.9G     0  1.9G   0% /dev
tmpfs           386M  6.2M  380M   2% /run
/dev/sda1       9.8G  5.4G  4.0G  58% /
tmpfs           1.9G   13M  1.9G   1% /dev/shm
tmpfs           5.0M  4.0K  5.0M   1% /run/lock
tmpfs           1.9G     0  1.9G   0% /sys/fs/cgroup
tmpfs           386M  104K  386M   1% /run/user/1000
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Bottom screenshot — top-right terminal (fbash3):

```
andrew@andrew-VirtualBox: ~/workspace/fbash3
>> |Server executed successfully.|
>>
>> Server received: exit_
   from client:16946
>> Server executing command from:16946
>> |Client:16946 Exiting.|
>> | 3 online.|
>> |Server executed successfully.|
>>
>> Server received: exit_
   from client:16046
>> Server executing command from:16046
>> |Client:16046 Exiting.|
>> | 2 online.|
>> |Server executed successfully.|
>>
>> Server received: exit_
   from client:14053
>> Server executing command from:14053
>> |Client:14053 Exiting.|
>> | 1 online.|
>> |Server executed successfully.|
>>
```

Bottom screenshot — bottom-left terminal (fbash2):

```
andrew@andrew-VirtualBox: ~/workspace/fbash2
andrew@andrew-VirtualBox:~/workspace/fbash2$ ./client.out
|Client:14053 starting up.|
>> |Please enter a command to the server:|
cal
Sending:cal

>> |Child on server executing|
     March 2017
Su Mo Tu We Th Fr Sa
          1  2  3  4
 5  6  7  8  9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30 31

>> |Command returned successful.|
>> |Please enter a command to the server:|
exit_
Sending:exit_


Exiting..
Terminated
andrew@andrew-VirtualBox:~/workspace/fbash2$
```

Bottom screenshot — bottom-right terminal (fbash2):

```
andrew@andrew-VirtualBox: ~/workspace/fbash2
fork.txt
lstestfile.txt
LStestfile.txt
sample1.txt
sample.txt
server.out
source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX diskinfo.txt
Sending:less -FX diskinfo.txt

>> |Child on server executing|
Filesystem      Size  Used Avail Use% Mounted on
udev            1.9G     0  1.9G   0% /dev
tmpfs           386M  6.2M  380M   2% /run
/dev/sda1       9.8G  5.4G  4.0G  58% /
tmpfs           1.9G   13M  1.9G   1% /dev/shm
tmpfs           5.0M  4.0K  5.0M   1% /run/lock
tmpfs           1.9G     0  1.9G   0% /sys/fs/cgroup
tmpfs           386M  104K  386M   1% /run/user/1000
>> |Command returned successful.|
>> |Please enter a command to the server:|
```

Terminal 1 (fbash3):

```
andrew@andrew-VirtualBox: ~/workspace/fbash3
 from client:16046
>> Server executing command from:16046
>> |Client:16046 Exiting.|
>> | 2 online.|
>> |Server executed successfully.|
>>
>> Server received: exit_
 from client:14053
>> Server executing command from:14053
>> |Client:14053 Exiting.|
>> | 1 online.|
>> |Server executed successfully.|
>>
>> Server received: exit_
 from client:19245
>> Server executing command from:19245
>> |Client:19245 Exiting.|
>> | 0 online.|
>> |Server executed successfully.|
>>

Exiting..
Terminated
andrew@andrew-VirtualBox:~/workspace/fbash3$
```

Terminal 2 (fbash2):

```
andrew@andrew-VirtualBox: ~/workspace/fbash2
source.cpp
>> |Command returned successful.|
>> |Please enter a command to the server:|
less -FX diskinfo.txt
Sending:less -FX diskinfo.txt

>> |Child on server executing|
Filesystem      Size  Used Avail Use% Mounted on
udev            1.9G     0  1.9G   0% /dev
tmpfs           386M  6.2M  380M   2% /run
/dev/sda1       9.8G  5.4G  4.0G  58% /
tmpfs           1.9G   13M  1.9G   1% /dev/shm
tmpfs           5.0M  4.0K  5.0M   1% /run/lock
tmpfs           1.9G     0  1.9G   0% /sys/fs/cgroup
tmpfs           386M  184K  386M   1% /run/user/1000
>> |Command returned successful.|
>> |Please enter a command to the server:|
exit_
Sending:exit_

Exiting..
Terminated
andrew@andrew-VirtualBox:~/workspace/fbash2$
```