Collaborative Notepad

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1 Introduction

Collaborative Notepad is a program that allows two users to edit a text document. Each user will have to first connect to the server, and then they will be able to start editing a new document or join other users in editing one. The main target for this program is to allow easier collaboration between project partners, allowing them to simultaneously write in a single document. They will also be allowed to download that document, or create a new one if need arises.

1.1 Motivation

There are situations in which people need access to a centralized document that can be edited by more than one person. Examples of such circumstances are:

- A group of two or more students needs to write a report on a school project. The project could be composed of more tasks, and the report needs to cover all of them. The students, not wanting to waste time, divide the tasks between them and each one will start writing in the report document their own section. Without a program like the collaborative notepad they would have to write in different documents and then append them through other means, wasting time. Also, if one of them had to change something on their part, they would all need to update manually the full document as to take the change into consideration.
- A team is working on an app. Each programmer must code a part of the application, each with its own necessities. Assuming that the app has a graphical user interface, each programmer will ask the graphic designers for different assets. Without using a collaborative notepad, the graphic designers wouldn't have a centralized requirements list, and they could receive duplicate requests. These problems are eliminated when using said program because the programmers can read what the others need before submitting their own requests and not ask for assets already asked for, thus solving the duplicate request problems, and the final list would be in one location, in one document, easy to see and to read by the graphic designers.

2 Technologies

The communication the program will use is based on the Transmission Control Protocol (**TCP**). This choice was made to ensure a reliable and ordered transfer of data. Communication between different parts of the program is frequent, and synchronization between Clients connected to the same Session is vital. If even only one command between the Client and the Session (or reversed) gets corrupted on its way then it can cause major problem for the whole Session.

A constant connection between the member parts of the program is also very useful because Clients will usually send commands to the Session on a second basis, since a command is basically any letter written or erased.

The Sessions will be sub-parts of the Server, a Session being created at the request of the Client through **fork()**. It will have a Session port which will be used by the Server and the Clients to send messages to. The Session will only listen on that port, while sending messages to the Clients through their descriptors. The Clients' descriptors will be stored and will be used by the Server or the Sessions to communicate with them.

Whenever a Client connects to the Server a new thread will be created in the Server specifically for that Client. Much alike, when a Client is assigned to a Session, a new thread will be created in that Session, for communication with that Client.

All messages sent throughout the program will have the following structure, as to assure consistency:

$$[PORT][SIZE][MESSAGE]$$

Where $PORT$ is the port of the sender, $SIZE$ is the size of the message sent and $MESSAGE$ is an array of bytes of size $SIZE$. When reading a message the following steps will be followed:

1. Read an integer value, representing the port of the sender.
2. Read another integer value, representing the size of the message sent.
3. Read an array of bytes equal to the size read. This will be the actual message.

The Server will always use the port 49200. The range of ports assigned to the Session will be $49201 - 49300$. Therefore, a maximum of 100 Sessions will be able to exist at one time.

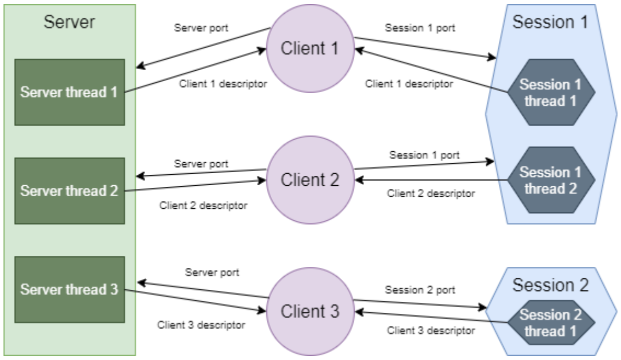


Fig. 1. Threads and Communication

3 Program architecture

The whole program will be composed of one Server and several Clients which will communicate using a certain protocol.

3.1 Core parts

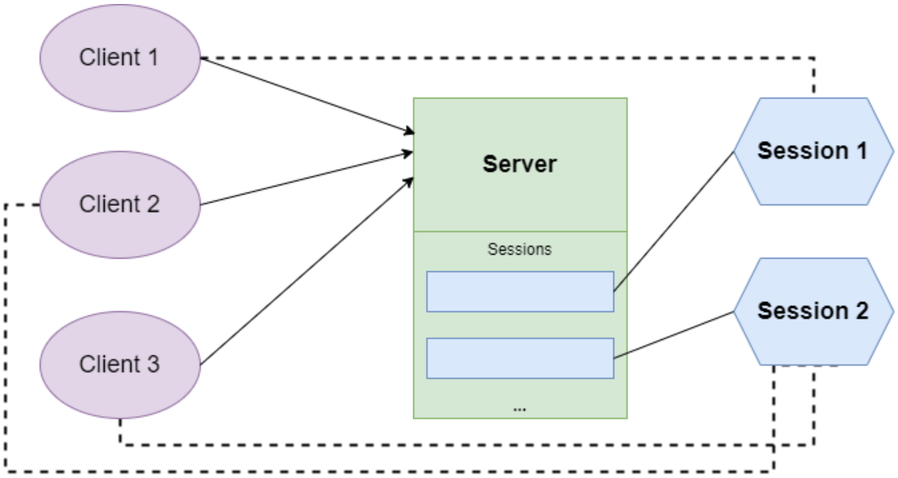


Fig. 2. Project architecture: Core parts

The Server

The Server is the most important part of this program. It goes through two stages throughout its lifetime. First it will start, initializing needed components and then it will start waiting for Clients. The most important data structure of the Server is the Session array.

The **Session array** will store the assigned port of each currently open Session. This will also store each Client connected to a certain Session, and other information about that Session, such as the name of the file that is being edited.

The Session

Sessions are sub-parts of the Server. When a Client wants to edit a document, they need to create a Session or join an existing one. They will then directly interact with their assigned Session. Each Session will make use of the following:

1. The **Session port**. This is assigned by the Server when the Session is created. This will be used to communicate with the Clients or will allow the server to send messages to the Session.
2. The **opened file**. It will be stored as a char array, and will not be changeable.
3. The **array of Clients**. This array will store the clients assigned to the current Session.

The Client

The Client is the part of the program used by the user. It will allow editing text through simple means such as **writing** or **erasing** or through more complex ones such as **copy**, **cut** and **paste**(Not yet implemented). A custom graphical interface will be used in order to properly handle all the events that can occur. Each Client makes use of only one important value for communication, the **Session port**. This is assigned to them when they connect to a Session.

3.2 Communication

During execution, communication can occur between the Client and the Server, between the Server and the Session or between the Session and the Client.

Communication between Client and Server

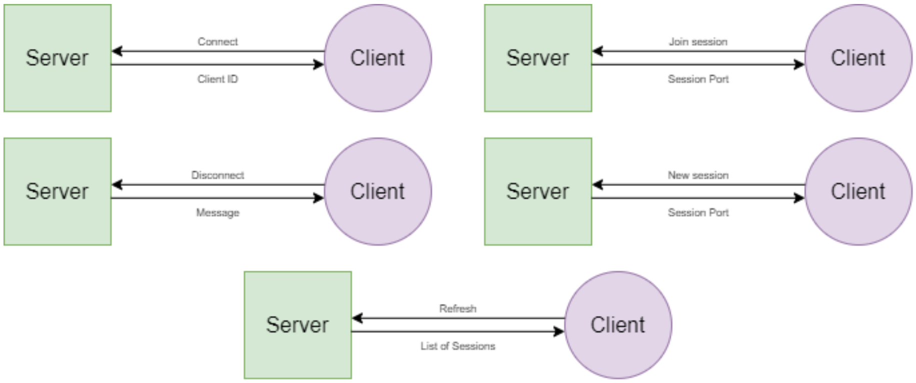


Fig. 3. Communication between Client and Server

All the communication that is going to take place between the Client and the Server will start from the former, the latter only responding accordingly. The Client can do the following:

1. **Connect**. This will connect the Client to the Server. A unique Client ID will be assigned to the Client and they will then be able to start editing a document of their choosing.

2. **Create a new Session**. This will create a new Session and then link the Client to it. The Client must choose the document they want to edit. The Server will then send them the Session port that they will be using.
3. **Join an existing Session**. This will allow the Client to be linked to an already existing Session in order to edit its document. The Client must click on the Session they want to join (from the Session list in the graphic interface). The Server will either link the Client with that Session and provide the port needed for communication or respond with an error message (sending a negative port which will be interpreted by the Client).
4. **Disconnect**. The user will leave the program and the Client ID of their Client will become once again free for the taking.

Communication between Server and Session

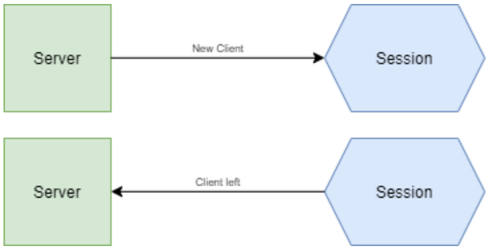


Fig. 4. Communication between Server and Session

The communication between the Server and any Session is limited, and there are only two cases in which it will happen:

1. A new Client was assigned to the Session. The Session will receive its Client port and update its array. It will not respond in any way to the Server.
2. A Client connected to the Session disconnected. The Server will unlink that Client from the Session.

Communication between Session and Client

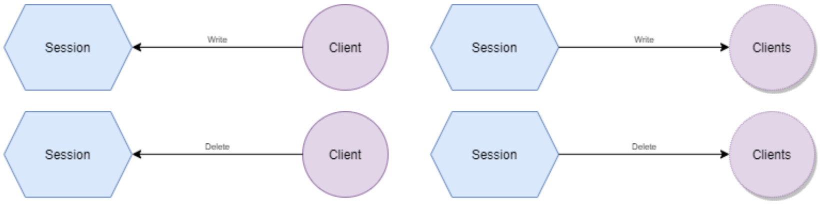


Fig. 5. Communication between Session and Client

Most of the communication that will happen will be between the Session and the Client. It will be done through the use of the Session port and the Client descriptor of each Client. There are multiple interactions that can happen:

1. A Client wrote something. This will send a signal to the Session, telling what they wrote and where. The Session will then do the following:
2. The Session sends a **write** command towards all the connected Clients. The written character and the position will be provided.
3. A Client erased something. This will send a signal to the Session, specifying at which position the operation occurred. The Session will then do the following:
4. The Session sends a **erase** command towards all the connected Clients. Only the position will be provided.

When entering a Session, the current text in the document is sent to the Client. When one Client changes something in the text of the Session it changes it in the text of all Clients, thus the need of communication from Session to all Clients. Every Client will execute every command, as to avoid sending the whole text after each change or making all clients open the document and read all of it, both of which would be way more costly (from the point of view of the execution time).

The Client also has access to the following two commands, which will not affect other Clients:

1. **Download**. This will download the document that is currently edited.
2. **Change Session**. This will disconnect the Client from the current Session. The Session will send a signal to the Server, and remove the Client's data from its arrays.

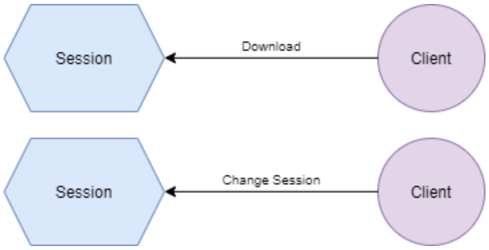


Fig. 6. Other commands that can be issued by the Client

4 Conclusions

4.1 Improvements to the base idea of the program

In the base description of the program it is specified that only two concurrent users are allowed to edit one document at the same time. The current version of the program, the one derived from the base idea, allows any number of users to edit any file. The architecture described in this paper allows such synchronization between any number of clients.

The User Interface(UI) is implemented using Gtk and Glib. It allows the user to easily create new sessions, see what sessions are currently running and join one of them. After entering a session, they can easily write in a custom-made text editor that allows the use of any character, bar the tab character('
t') which created many issues, the use of the two common erasing methods, **backspace** and **delete** and the use of arrows or the mouse to navigate. The user also has the option to save a file, it being saved as "Saved-UserID-initialFileName".

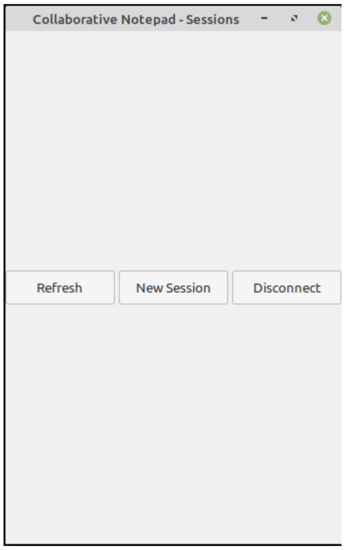
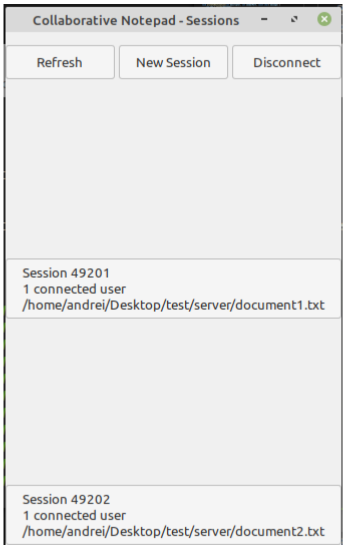


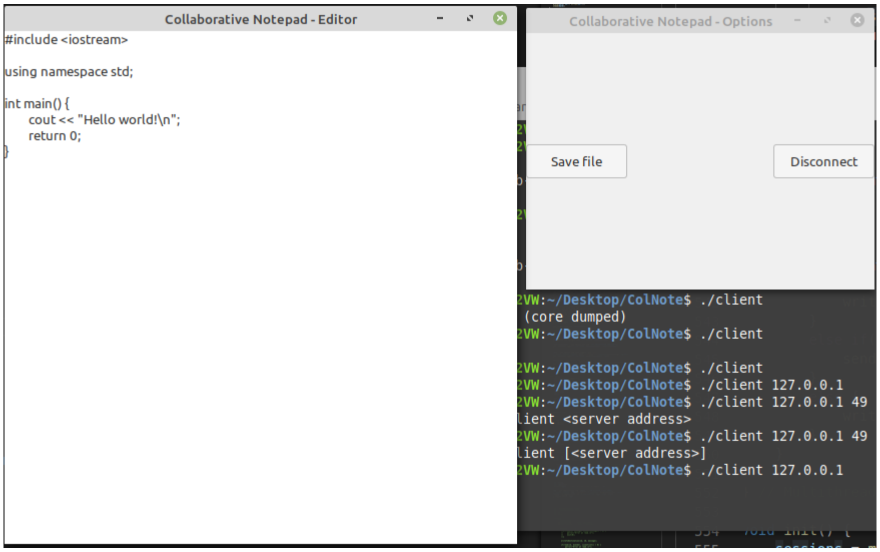
Fig. 7. UI - Main window



Session 49201
1 connected user
/home/andrei/Desktop/test/server/document1.txt

Session 49202
1 connected user
/home/andrei/Desktop/test/server/document2.txt

Fig. 8. UI - Session list


Collaborative Notepad - Editor
Collaborative Notepad - Options
Save file
Disconnect

```
#include <iostream>

using namespace std;

int main() {
    cout << "Hello world!\n";
    return 0;
}
```

```
2VW:~/Desktop/ColNote$ ./client
 (core dumped)
2VW:~/Desktop/ColNote$ ./client

2VW:~/Desktop/ColNote$ ./client
2VW:~/Desktop/ColNote$ ./client 127.0.0.1
2VW:~/Desktop/ColNote$ ./client 127.0.0.1 49
lient <server address>
2VW:~/Desktop/ColNote$ ./client 127.0.0.1 49
lient [<server address>]
2VW:~/Desktop/ColNote$ ./client 127.0.0.1
```

Fig. 9. UI - Editor and Options

4.2 Bugs and Glitches

There are a few known bugs and glitches. These are:

- If an user writes more than one letter at the same time it may, rarely, desynchronize him, his peers and the Session. This is caused by the travel time of messages between the clients and the session.
- Users can select text dragging the mouse while clicked. Erasing or writing over that selected text will cause a total desynchronization between the Session and that Client. This is caused because text selection was not yet handled.
- If an user writes too fast, the letters introduced by them may be handled in reverse order, resulting in the wrong output (For example, writing ”ab” too quickly may cause the Clients to receive ”ba”). This is also caused by the travel time between the Session and its Clients, but also by the way Clients handle commands.

4.3 Future Improvements

The first and utmost important improvement that can be made to the program is bug fixing. The first described bug and the third one can be solved by implementing some kind of queue of commands on the Client's side. Another possible solution is modifying the protocol used, as to include a timestamp for the event. If the Client receives a command from the Session and they can still read another one, they should read them both, sort them based on the timestamp and act accordingly. The second bug is the easiest to fix; text selection must be disabled for the editor window. These bugs and glitches were not solved in the latest version due to the need to re-implement the whole protocol, which could have probably caused other problems, and they will be handled in a future version.

Another improvement that can be made affects the interaction between a Client and its Session. Using the described architecture Clients are limited to simple operations such as **writing** and **erasing**. This means that keyboard shortcuts such as **CTRL+C (Copy)**, **CTRL+X (Cut)** and **CTRL+V (Paste)** are not supported. This can be improved by providing support for them, which should not be a tough task since the graphical interface is custom-made and these more complex operations can be reduced to series of basic ones.

Yet another improvement is the option to create files directly from the file chooser dialog. The Gtk file chooser dialog doesn't allow file creation, therefore a Client can only open an already existing file. This is inconvenient because they have to create a new file outside the program if needed, thus hindering the fluidity of the program. A new such window would allow user input through an ”Entry” widget and use the result accordingly, allowing both creating new files and saving files with a different name.

Besides these improvements, the speed and reliability of the whole program could be improved in some aspects with small modifications, thus further decreasing the desynchronization chances.

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   How to use Gtk containers https://developer.gnome.org/gtk3/stable/GtkContainer.html
   How to add signal listeners to an app with glib https://developer.gnome.org/gobject/stable/gobject-The-Base-Object-Type.html
   Information on Gtk Text buffers https://developer.gnome.org/gtk3/stable/GtkTextBuffer.html
   Keyboard input with Gtk and Glib https://developer.gnome.org/gdk3/stable/gdk3-Keyboard-Handling.html
   Information about Gtk Dialog boxes https://developer.gnome.org/gtk3/stable/GtkMessageDialog.html