



Relazione sul Progetto dell'Esame di  
**Sistemi Operativi**  
Anno Accademico 2016/17

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June 25, 2017

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# 1 Primo Esercizio

## Simulatore di chiamate a procedura

### 1.1 Descrizione dell'implementazione

L'obiettivo del primo esercizio è quello di implementare uno scheduler di processi. Quest'ultimo deve permettere all'utente di poter creare, eseguire ed eliminare i processi stessi secondo una politica di priorità od esecuzioni rimanenti.

Abbiamo organizzato il codice in tre files: due librerie *config.h* e *taskmanager.h* ed un programma, *scheduler.c*. All'interno di *config.h* vengono unicamente definite due stringhe utilizzate nella formattazione dell'output. All'interno di *taskmanager.h* abbiamo invece definito la **struct** *TaskElement*, ovvero l'elemento **Task**, descritto da 5 campi fondamentali che rappresentano un processo all'interno della nostra implementazione:

1. *ID* : Un numero intero univoco che viene automaticamente assegnato alla creazione del task.
2. *nameTask* : Nome del task, di massimo 8 caratteri, scelto dall'utente alla creazione.
3. *priority* : Numero intero che rappresenta la priorità del task.
4. *remainingExe* : Numero intero che rappresenta il numero di esecuzioni rimanenti (burst) del task.
5. *\*nextTask* : Puntatore al task successivo

Sempre all'interno di *taskmanager.h* vi sono le implementazioni delle operazioni che il nostro scheduler sarà in grado di effettuare, definite dalle seguenti funzioni:

- **setExeNumber(void)** : Permette l'inserimento del numero di esecuzioni rimanenti *n*, effettuando i controlli sulla legalità dell'input (  $1 < n < 99$  ).
- **setPriority(void)** : Permette l'inserimento della priorità *p*, effettuando i controlli sulla legalità dell'input (  $1 < p < 9$  ).
- **setTaskName(Task\*)** : Permette l'inserimento del nome del task, effettuando i controlli sulla lunghezza massima della stringa inserita (al massimo 8 caratteri).
- **isEmptyTaskList(Task\*)** : Esegue il controllo sulla lista di task, restituendo 0 nel caso sia vuota.
- **selectTask(Task\*)** : Restituisce il task con il PID richiesto dall'utente, dopo aver eseguito la ricerca nella lista.
- **modifyPriority(Task\*)** : Permette di modificare la priorità del task selezionato.
- **modifyExecNumb(Task\*)** : Permette di modificare il numero di esecuzioni rimanenti del task selezionato.
- **newTaskElement(Task\*,int)** : Permette la creazione di un nuovo task, allocandolo in memoria con l'utilizzo di una `malloc`.
- **printTask(Task\*)** : Esegue la stampa degli elementi del task coerentemente con la richiesta nella specifica dell'esercizio.
- **printListTask(Task\*)** : Esegue la stampa dell'intera lista dei task, richiamando la funzione `printTask`.
- **deleteTask(Task\*, Task\*)** : Permette l'eliminazione di un task dalla lista, semplicemente collegando il puntatore *nextTask* dell'elemento precedente al task successivo a quello che deve essere eliminato.
- **executeTask(Task\*)** : Esegue il task in testa alla coda, eseguendo i controlli sul numero di esecuzioni rimanenti.

Le operazioni legate allo scheduling sono state poi affidate a *scheduler.c3*, il quale contiene le funzioni:

- `getChoice(void)` : Stampa il menu di scelta delle operazioni eseguibili e restituisce la risposta data in input dall'utente.
- `switchPolicy(char)` : Permette di modificare la politica di scheduling, passando da priorità ad esecuzioni rimanenti.
- `sortListByPriority(Task*)` : Ordina la lista dei task per valori decrescenti della priorità (  $max(p) = 9$  ).
- `sortListByExecution(Task*)` : Ordina la lista dei task per valori decrescenti del numero di esecuzioni rimanenti (  $max(n) = 99$  ).
- `swapTask(Task*, Task*, Task*)` : Permette l'inversione dell'ordine di due task.
- `main()` : Main del programma.

## 1.2 Codice

```

1 #ifndef CONFIG_H_
2 #define CONFIG_H_
3
4 #define POINTSHEAD "
5 #define SEPARATOR "+-----+\n\r"
6
7 #endif /* CONFIG_H_ */

```

Listing 1: config.c

```

1 #include <string.h>
2 #include <stdio.h>
3 #include <stdlib.h>
4
5 #include "config.h"
6
7 typedef struct TaskElement {
8     int ID;
9     char nameTask[9]; // the ninth element of the name must be
10     int priority;
11     int remainingExe;
12     struct TaskElement *nextTask;
13 } Task;
14
15 int setExeNumber(void);
16 int setPriority(void);
17 void setTaskName(Task*);
18 int isEmptyTaskList(Task*);
19 Task* selectTask(Task*);
20 void modifyPriority(Task*);
21 void modifyExecNumb(Task*);
22 Task* newTaskElement(Task*, int);
23 void printTask(Task*);
24 void printListTasks(Task*);
25 Task* deleteTask(Task*, Task*);
26 int executeTask(Task*);
27
28 /*
29 *
30 * PURPOSE : Setter remainingExe member of struct TaskElement, this function is use by
31 *           newTaskElement
32 * RETURN : int -> number of remaining execution
33 */
34 int setExeNumber() {
35     int exeNum = 0;
36     do {
37         printf("\n\rInsert the number of remaning executions : ");
38         scanf("%i", &exeNum);
39         if ((exeNum < 0) || (exeNum > 99)) {
40             printf("\n\rError! It must be a number between 1 and 99. \n\r");

```

```

41     }
42 } while ((exeNum <= 0) || (exeNum > 99));
43 return exeNum;
44 }
45
46 /*
47 *
48 * PURPOSE : Setter priority member of struct TaskElement, this function is use by
              newTaskElement
49 * RETURN : int -> number of priority
50 *
51 */
52 int setPriority() {
53     int priority = 0;
54     do {
55         printf("\n\rInsert the priority (ascending order): ");
56         scanf("%i", &priority);
57         if (((priority < 0) || (priority > 9))) {
58             printf("\n\rError! It must be a number between 1 and 9\n\r");
59         }
60     } while ((priority < 0) || (priority > 9));
61     return priority;
62 }
63
64 /*
65 *
66 * PURPOSE : Setter name member of struct TaskElement, this function is use by
              newTaskElement
67 * PARAMS : Task* actualTask -> pointer of the task that want to set name
68 * RETURN : void
69 *
70 */
71 void setTaskName(Task *actualTask) {
72     char name[256];
73     do {
74         printf("\n\rName this task (max 8 chars) : ");
75         scanf("%s", name);
76         if (strlen(name)>0 && strlen(name)<=8) {
77             strcpy(actualTask->nameTask, name);
78             for (int i = strlen(name); i<=9 ;i++) {
79                 actualTask->nameTask[i] = '\0'; // this for cycle set all character of the name
80                 task with the null character
81             }
82             return;
83         } else {
84             printf("\n\rThe name of the task must be less than 8");
85         }
86     } while (strlen(name)>8);
87     printf("Something went wrong\n\rThe name of the task it will be setted -default-");
88     strcpy(actualTask->nameTask, "default\0");
89     return;
90 }
91
92 /*
93 *
94 * PURPOSE : Check if the list is empty
95 * PARAMS : Task* firstTask -> pointer of the first (head) task of the list
96 * RETURN : int -> return 0 if the list is empty, return 1 if the list is not empty
97 *
98 */
99 int isEmptyTaskList(Task *firstTask) {
100     return !(firstTask->ID);
101 }
102
103 /*
104 *
105 * PURPOSE : It ask the ID of the Task and finds the Task with that ID
106 * PARAMS : Task* firstTask -> pointer of the first (head) task of the list
107 * RETURN : Task* -> return the pointer of the task found
108 *
109 */
110 Task* selectTask(Task* firstTask) {
111     int id;

```

```

111     printf("Select the task...\nInsert the ID : ");
112     scanf("%d", &id);
113     while (firstTask->ID != id) {
114         firstTask = firstTask->nextTask;
115         if (firstTask == NULL) {
116             printf("\n\rError! No tasks with this ID!\n\r");
117             return firstTask;
118         }
119     }
120     return firstTask;
121 }
122
123 /*
124 *
125 * PURPOSE : Modify the priority of the task
126 * PARAMS : Task* thisTask -> pointer of the task to change
127 * RETURN : void
128 *
129 */
130 void modifyPriority(Task *thisTask) {
131     thisTask = selectTask(thisTask);
132     if (thisTask == NULL) {
133         return;
134     }
135     thisTask->priority = setPriority();
136     return;
137 }
138
139 /*
140 *
141 * PURPOSE : Modify the execution number of the task
142 * PARAMS : Task* thisTask -> pointer of the task to change
143 * RETURN : void
144 *
145 */
146 void modifyExecNumb(Task *thisTask) {
147     thisTask = selectTask(thisTask);
148     if (thisTask == NULL) {
149         return;
150     }
151     thisTask->remainingExe = setExeNumber();
152     return;
153 }
154
155 /*
156 *
157 * PURPOSE : Allocate a new item in the list
158 * PARAMS : Task* actualTask -> pointer of the last task of the list
159 * PARAMS : int idT -> the id of the new task
160 * RETURN : Task* -> pointer of the new last task of the list
161 *
162 */
163 Task* newTaskElement(Task *actualTask, int idT) {
164     actualTask->ID = idT;
165     setTaskName(actualTask);
166     actualTask->priority = setPriority();
167     actualTask->remainingExe = setExeNumber();
168     (*actualTask).nextTask = malloc(sizeof(Task));
169     return (*actualTask).nextTask;
170 }
171
172 /*
173 *
174 * PURPOSE : Print a single Task
175 * PARAMS : Task* thisTask -> pointer of the task to print
176 * RETURN : void
177 *
178 */
179 void printTask(Task *thisTask) {
180     printf("| %d + %d + %s + %d | \n\r",
181         thisTask->ID, thisTask->priority, thisTask->nameTask,
182         thisTask->remainingExe);
183     printf(SEPARATOR);

```

```

184 }
185
186 /*
187 *
188 * PURPOSE : Print the list of the task
189 * PARAMS : Task* first -> printing start from this task
190 * RETURN : void
191 *
192 */
193 void printListTasks(Task *first) {
194     printf(SEPARATOR);
195     printf("| ID + PRIORITY + TASK NAME + REMAINING EXEC |\\n\\r");
196     printf(SEPARATOR);
197     Task* tmp = first;
198     while (tmp->ID != 0) {
199         printTask(tmp);
200         tmp = (*tmp).nextTask;
201     }
202 }
203
204 /*
205 *
206 * PURPOSE : Delete a Task
207 * PARAMS : Task* first -> pointer of the first task of the list
208 * PARAMS : Task* thisTask -> pointer of the task to delete
209 * RETURN : Task* -> return the pointer of the first task of the list
210 *
211 */
212 Task* deleteTask(Task *first, Task *thisTask) {
213     if (thisTask != NULL) {
214         Task *tmpTask = first;
215         if (thisTask == first) {
216             tmpTask = thisTask->nextTask;
217             thisTask->ID = thisTask->priority = thisTask->remainingExe = 0;
218             strcpy(thisTask->nameTask, "\\0");
219             thisTask->nextTask = NULL;
220             return tmpTask;
221         } else {
222             while (tmpTask->nextTask == NULL) {
223                 if (tmpTask->nextTask == thisTask) {
224                     tmpTask->nextTask = thisTask->nextTask;
225                     thisTask->ID = thisTask->priority = thisTask->remainingExe =
226                     0;
227                     strcpy(thisTask->nameTask, "\\0");
228                     thisTask->nextTask = NULL;
229                     return first;
230                 }
231                 tmpTask = tmpTask->nextTask;
232             }
233         }
234     }
235     printf("There is no task to delete!\\n\\r");
236     return first;
237 }
238
239 /*
240 *
241 * PURPOSE : Execute a Task
242 * PARAMS : Task* thisTask -> pointer of the task to execute
243 * RETURN : Task* -> return the number of the remaining execution
244 *
245 */
246 int executeTask(Task *thisTask) {
247     if (thisTask != NULL) {
248         thisTask->remainingExe -= 1;
249         return thisTask->remainingExe;
250     } else if (thisTask->remainingExe == 0) {
251         printf("This task has no more executions to be done\\n\\r");
252         return 0;
253     }
254     printf("There is no task to execute!\\n\\r");
255     return 0;
256 }

```

---

## Listing 2: Task Manager

```

1 #include <string.h>
2 #include <stdio.h>
3 #include <stdlib.h>
4 #include "taskmanager.h"
5
6 int getChoice(void);
7 char switchPolicy(char pol);
8 Task* sortListByPriority(Task*);
9 Task* sortListByExecution(Task*);
10 Task* swapTask(Task*, Task*, Task*);
11
12 int main() {
13     int idTraker = 1;
14     int flag = 1;
15     char policy = 'p';
16     Task *firstTask = malloc(sizeof(Task));
17     Task *lastTask = NULL; // the last Task is always empty
18     printf(POINTSHEAD);
19     printf("                This is a process scheduler\n\r");
20     printf(POINTSHEAD);
21     while (flag == 1) {
22         Task *tmpTask;
23         switch (getChoice()) {
24             case 0:
25                 printf("Bye!\n\r");
26                 return 0;
27             case 1:
28                 if (firstTask->ID == 0) {
29                     lastTask = newTaskElement(firstTask, idTraker);
30                 } else {
31                     lastTask = newTaskElement(lastTask, idTraker);
32                     if (policy == 'p') {
33                         firstTask = sortListByPriority(firstTask);
34                     } else if (policy == 'e') {
35                         firstTask = sortListByExecution(firstTask);
36                     }
37                 }
38                 idTraker += 1;
39                 break;
40             case 2:
41                 printf("\n\rHow many execution do you want to do: ");
42                 scanf("%d", &flag);
43                 while (flag != 0) {
44                     if (executeTask(firstTask) == 0) {
45                         firstTask = deleteTask(firstTask, firstTask);
46                     }
47                     flag -= 1;
48                 }
49                 flag = 1;
50                 printf("\n\r");
51                 break;
52             case 3:
53                 if (!isEmptyTaskList(firstTask)) {
54                     tmpTask = selectTask(firstTask);
55                     if (executeTask(tmpTask) == 0) {
56                         firstTask = deleteTask(firstTask, tmpTask);
57                     }
58                 }
59                 break;
60             case 4:
61                 firstTask = deleteTask(firstTask, selectTask(firstTask));
62                 break;
63             case 5:
64                 modifyPriority(firstTask);
65                 if (policy == 'p') {
66                     firstTask = sortListByPriority(firstTask);
67                 }
68                 break;
69             case 6:
70                 policy = switchPolicy(policy);

```



```

71     if (policy == 'p') {
72         firstTask = sortListByPriority(firstTask);
73     } else if (policy == 'e') {
74         firstTask = sortListByExecution(firstTask);
75     }
76     break;
77 case 7:
78     modifyExecNumb(firstTask);
79     if (policy == 'e') {
80         firstTask = sortListByExecution(firstTask);
81     }
82     break;
83 default:
84     flag = 0;
85     break;
86 }
87 if (!isEmptyTaskList(firstTask)) {
88     printf("\n\rScheduling Policy: ");
89     if (policy == 'p') {
90         printf("PRIORITY \n\r");
91     } else if (policy == 'e') {
92         printf("REMAINING EXECUTIONS \n\r");
93     }
94     printListTasks(firstTask);
95 } else {
96     printf("\n\rList is empty! Please insert a task first...\n\r");
97 }
98 }
99 return 0;
100 }
101
102 /*
103 *
104 * PURPOSE : Print menu and get the choice
105 * RETURN  : int -> choice of the menu
106 *
107 */
108 int getChoice() {
109     printf("\n\rPlease select an option:\n\r");
110     printf(" 0) Exit\n\r 1) Create a new task\n\r 2) Execute the task on the top of the\n\r");
111     printf(" 3) Execute a task\n\r 4) Delete a task\n\r 5) Modify the PRIORITY of a task\n\r");
112     ;
113     printf(" 6) Switch policy (default : PRIORITY)\n\r 7) Modify the REMAINING EXECUTIONS of a\n\r");
114     printf(" task");
115     int res = 0;
116     printf("\n\r> ");
117     scanf("%i", &res);
118     return res;
119 }
120
121 /*
122 *
123 * PURPOSE : Switch the policy of the scheduler
124 * PARAMS  : char pol -> actual policy of the scheduler
125 * RETURN  : char -> new policy of the scheduler
126 *
127 */
128 char switchPolicy(char pol) {
129     printf("\n\rYou switched the policy of scheduling from ");
130     if (pol == 'p') {
131         printf("PRIORITY to REMAINING EXECUTIONS\n\r");
132         return 'e';
133     } else if (pol == 'e') {
134         printf("REMAINING EXECUTIONS to PRIORITY \n\r");
135         return 'p';
136     }
137     return 'p';
138 }
139
140 /*

```

```

141 *
142 * PURPOSE : Sort list by priority (highest priority , task most important)
143 * PARAMS : Task* headTask -> pointer of the first task of the list
144 * RETURN : Task* -> new pointer of first (head) task
145 *
146 */
147 Task* sortListByPriority(Task *headTask) {
148     Task *tempTask = headTask;
149     Task *previousTempTask = tempTask;
150     int flag = 0;
151     while (!flag) {
152         flag = 1;
153         tempTask = headTask;
154         previousTempTask = tempTask;
155         while (tempTask->ID != 0) {
156             if (tempTask->priority < tempTask->nextTask->priority) {
157                 if (tempTask == headTask) {
158                     headTask = swapTask(headTask, tempTask, tempTask->nextTask);
159                 } else {
160                     previousTempTask = swapTask(previousTempTask, tempTask,
161                                                 tempTask->nextTask);
162                 }
163                 flag = 0;
164             }
165             previousTempTask = tempTask;
166             tempTask = tempTask->nextTask;
167         }
168     }
169     return headTask;
170 }
171
172 /*
173 *
174 * PURPOSE : Sort list by priority (lowest remaining execution , task most important)
175 * PARAMS : Task* headTask -> pointer of the first task of the list
176 * RETURN : Task* -> new pointer of first (head) task
177 *
178 */
179 Task* sortListByExecution(Task* headTask) {
180     Task *tempTask = headTask;
181     Task *previousTempTask = tempTask;
182     int flag = 0;
183     while (!flag) {
184         flag = 1;
185         tempTask = headTask;
186         previousTempTask = tempTask;
187         while (tempTask->ID != 0) {
188             if ((tempTask->remainingExe > tempTask->nextTask->remainingExe)
189                 && (tempTask->nextTask->remainingExe != 0)) {
190                 if (tempTask == headTask) {
191                     headTask = swapTask(headTask, headTask, headTask->nextTask);
192                 } else {
193                     previousTempTask = swapTask(previousTempTask, tempTask,
194                                                 tempTask->nextTask);
195                 }
196                 flag = 0;
197             }
198             previousTempTask = tempTask;
199             tempTask = tempTask->nextTask;
200         }
201     }
202     return headTask;
203 }
204
205 /*
206 *
207 * PURPOSE : Swap two task
208 * PARAMS : Task* previousTask -> pointer of the first task of the list
209 * PARAMS : Task* taskSwap1 -> pointer of first task to swap
210 * PARAMS : Task* taskSwap2 -> pointer of second task to swap
211 * RETURN : Task* -> pointer of the previous task
212 *
213 */

```

```
214 Task* swapTask(Task *previousTask, Task *taskSwap1, Task *taskSwap2) {
215     if (previousTask != taskSwap1) {
216         previousTask->nextTask = taskSwap2;
217         taskSwap1->nextTask = taskSwap2->nextTask;
218         taskSwap2->nextTask = taskSwap1;
219         return previousTask;
220     }
221     taskSwap1->nextTask = taskSwap2->nextTask;
222     taskSwap2->nextTask = taskSwap1;
223     return taskSwap2;
224 }
```

Listing 3: scheduler.c

## 2 Secondo Esercizio

### Esecutore di comandi

#### 2.1 Descrizione dell'implementazione

L'obiettivo del secondo esercizio é quello di creare un esecutore di comandi UNIX che scriva, sequenzialmente o parallelamente, l'output dell'esecuzione su di un file.

Tutte le funzionalità del programma sono incluse all'interno della libreria *functions.h5* e fanno uso a loro volta della libreria *unistd.h*. La funzione *initDataFolder()* si occupa di creare la cartella ed inserirvi il file di output. Essa viene generata all'interno della directory *"../commandexe/data/[pid]"* dove il *pid* é il process ID del chiamante in questione, ritornato dal *getpid()*. Il comando inserito dall'utente viene poi eseguito attraverso una *popen()*, la quale apre uno stream di scrittura/lettura su di una pipe, inserendovi l'output del comando. La funzione *execCommandAndLog(char,int)* genera due *char[]*, rispettivamente il *path* ed il *filename*, quest'ultimo viene nominato attraverso il pid e l'indice di esecuzione, come richiesto dalla specifica di implementazione. Viene poi eseguito il comando ed il log dell'output: l'esecuzione viene affidata ancora una volta ad una *popen()* mentre la scrittura dell'output viene eseguita mediante le usuali funzioni dello *stdin* attraverso il descrittore di file generato precedentemente. Il codice viene eseguito nel *cmd.c4*, all'interno del quale vi é un ciclo while che itera fino a quando non viene inserita la stringa vuota dall'utente.

#### 2.2 Codice

```
1 #include <stdio.h>
2 #include <stdlib.h>
3 #include <string.h>
4 #include <unistd.h>
5 #include "functions.h"
6
7 #define MAX_CMD_LEN 100
8
9 int main() {
10     int k = 1;
11     initDataFolder();
12     while (1) {
13         char cmd[MAX_CMD_LEN] = "";
14         printf("\nEnter the %d-cmd: ", k);
15
16         //read chars until \n
17         scanf("%[^\n]", cmd);
18         getchar();
19         printf("Cmd entered : %s\n", cmd);
20         if (strlen(cmd) == 0) {
21             printf("Bye!\n");
22             exit(1);
23         }
24         execCommandAndLog(cmd, k);
25         k = k + 1;
26     }
27
28     return (0);
29 }
```

Listing 4: cmd.c

```
1 /*
2 *
3 * PURPOSE : Create the data folder to store outputs
4 *
5 * RETURN : void
6 *
7 */
8 int initDataFolder() {
9     char cmd[30];
10     FILE *fp;
11     sprintf(cmd, "%s%i", "mkdir -p ../commandexe/data/", getpid());
12     fp = popen(cmd, "r");
```

```

13     if (fp == NULL) {
14         printf("[Error] - Error initialing process folder\n");
15         exit(1);
16     }
17     return 0;
18 }
19
20 /*
21 *
22 * PURPOSE : Function that execute the c command and log the output in ../commandexe/data
23             /[pid]/out.[index]
24 *
25 * PARAMS : char* -> command string
26 * PARAMS : int -> index of out.[index] log
27 * RETURN : int -> 0
28 */
29 int execCommandAndLog(char* c, int index) {
30     FILE *fp;
31     char path[1035];
32     char filename[7];
33
34     sprintf(filename, "data/%i/%s.%i", getpid(), "out", index);
35     FILE *f = fopen(filename, "w");
36     if (f == NULL) {
37         printf("[Error] - Error opening file!\n");
38         exit(1);
39     }
40
41     // command open to read
42     sprintf(c, "%s %s", c, "2>&1");
43     fp = popen(c, "r");
44
45     if (fp == NULL) {
46         fprintf(f, "[Error] - Error executing the command\n");
47     }
48
49     // read the output a line at a time - output it.
50     while (fgets(path, sizeof(path) - 1, fp) != NULL) {
51         fprintf(f, "%s", path);
52     }
53
54     // closing files
55     pclose(fp);
56     fclose(f);
57
58     return 0;
59 }

```

Listing 5: functions.h

## 3 Terzo Esercizio

### Message passing

#### 3.1 Descrizione dell'implementazione

L'obiettivo del terzo esercizio é l'implementazione di un client e un server che comunicano tramite pipe con nome ed eseguono routine dipendentemente dal tipo di richiesta.

Inizialmente viene eseguito il *server.c*<sup>12</sup> che racchiude le sue funzionalità nei file inclusi *functions.server.h*<sup>8</sup> e *listmanage.h*<sup>9</sup>. Il client invece include la libreria *functions.client.h*<sup>7</sup>. Sia *client.c* che *server.c* condividono due librerie, rispettivamente *functions.inc.h*<sup>10</sup> e *config.h*<sup>6</sup>.

Una volta mandato in esecuzione, il server aspetta comandi dal client in linea con il formato del protocollo definito. Il protocollo definito per permettere la comunicazione tra client e server é composto da una stringa in cui le informazioni sono separate da spazio. Il server quindi si preoccupa di splittare la stringa ricevuta per avere tutte le informazioni della richiesta. Ogni richiesta é composta da una prima informazione che identifica l'ID del comando (1-5), la seconda invece l'ID del client richiedente. L'unica eccezione é fatta dal comando n°3 che oltre a queste due informazioni segue con l'ID del client destinatario e il messaggio da inviare. Abbiamo definito che l'ID di ogni client corrisponde al suo PID. Per ogni funzionalità é definito il formato per richiederla e un esempio:

1. Connessione, con la quale il client si registra presso il server. → "1 [pid\_richiedente]" → "1 5555"
2. Richiesta elenco ID dei client registrati, con la quale si richiede al server l'elenco dei client attualmente registrati. → "1 [pid\_richiedente]" → "1 5555"
3. Invio di un messaggio testuale a un altro client o a un insieme di client (specificandone l'ID). → "1 [pid\_richiedente] [pid\_destinatario] [messaggio]" → "1 5555 4444 Questo é un messaggio da recapitare"
4. Disconnessione, con la quale il client richiede la cancellazione della registrazione presso il server. → "1 [pid\_richiedente]" → "1 5555"
5. Uscita dal programma. → "1 [pid\_richiedente]" → "1 5555"

#### Infrastrutture e segnali previsti:

La comunicazione tra client e server per richiedere l'esecuzione di una routine avviene tramite la pipe con nome "data/pipe" (definita nel *config.h*<sup>6</sup>). Il server quando riceve una richiesta di connessione o di disconnessione aggiorna la sua lista concatenata nella quale si mantiene i client connessi. Le funzioni per interagire con questa lista sono definite in *listmanage.h*.

Quando il server ha la necessità di inviare informazioni ad uno specifico client si crea una pipe "data/[PID\_DEST]", scrive sulla pipe e segnala l'evento al relativo client tramite segnale **SIGUSR1**. Il segnale **SIGUSR2** invece é inviato dal server ad un client quando quest'ultimo ha richiesto l'invio di un messaggio ad un client non connesso al server. Un altro segnale intercettato sia dal client che dal server é il **SIGINT**. Quando questo segnale viene intercettato da un client, esso si disconnette dal server prima di terminare mentre in caso sia intercettato dal server fa terminare tutti i client connessi inviandogli lo stesso segnale **SIGINT**.

#### 3.2 Codice

```
1 #define DEBUG 1 //debug mode
2 #define CMD_PIPE_NAME "data/pipe" //path to store the main named pipe
3 #define PIPES_PATH "data/" //path to store clients pipes
4 #define MAX_MSG_LEN 100
5 #define MAX_PID_LEN 100
```

Listing 6: config.h

```
1 /*
2 *
3 * PURPOSE : Show menu options
4 *
5 * RETURN : void
```

```

6  *
7  */
8  void menu() {
9      int menuChoice;
10
11      printf("Menu 1\n");
12      printf("~~~~~\n");
13      printf("1. Connect to server.\n");
14      printf("2. Get clients connected to server.\n");
15      printf("3. Write to client/s.\n");
16      printf("4. Disconnect from server.\n");
17      printf("5. Exit.\n");
18      scanf("%d", &menuChoice);
19      printf("\n");
20      switch ( menuChoice ) {
21          case 1:
22              connect();
23              break;
24          case 2:
25              getClientsID();
26              break;
27          case 3:
28              sendMessage();
29              break;
30          case 4:
31              disconnect();
32              break;
33          case 5:
34              disconnect();
35              clientExit();
36              break;
37          default:
38              printf("Please.. is not a joke. \n");
39      }
40
41      printf("\n");
42      menu();
43  }
44
45  /*
46  *
47  * PURPOSE : Connect to server
48  *
49  * RETURN : void
50  *
51  */
52  void connect() {
53      if (connected == 1) {
54          printf("%s\n", "Already connected");
55          return;
56      }
57
58      printf("%s\n", "Connected");
59
60      char str[7];
61
62      sprintf(str, "1 %d", getpid()); // puts string into buffer
63
64      write(fd, str, sizeof(str));
65
66      connected = 1;
67
68      return;
69  }
70
71  /*
72  *
73  * PURPOSE : Request the list of the clients connected to the server
74  *
75  * RETURN : void
76  *
77  */
78  void getClientsID() {

```

```

79     char str[7];
80     char *s_pid;
81
82     sprintf(s_pid, "%d", getpid());
83     sprintf(str, "2 %s", s_pid); // puts string into buffer
84
85     write(fd, str, sizeof(str));
86
87     return;
88 }
89
90 /*
91 *
92 * PURPOSE : Clear old chars on a stream
93 *
94 * RETURN : void
95 *
96 */
97 void clear_stream(FILE *in){
98     int ch;
99
100    clearerr(in);
101
102    do
103        ch =getc(in);
104    while (ch != '\n' && ch != EOF);
105
106    clearerr(in);
107 }
108
109 /*
110 *
111 * PURPOSE : Get the lenght of an int
112 *
113 * PARAMS : int -> int to measure
114 * RETURN : int -> lenght of the int passed
115 *
116 */
117 int get_int_len(int value){
118     int l=1;
119     while(value>9){ l++; value/=10; }
120     return l;
121 }
122
123 /*
124 *
125 * PURPOSE : Send message to client(s) menu
126 *
127 * RETURN : void
128 *
129 */
130 void sendMessage(){
131     char msg[MAX_MSG_LEN];
132     int confirm;
133     int i = 1;
134
135     //read the string message from STDIN
136     clear_stream(stdin);
137     printf("\nEnter the message: ");
138     scanf("%[^\\n]s", msg);
139
140     //output the message to the STDOUT
141     printf("Message entered : %s\\n", msg);
142
143     //message confirm
144     printf("\\nPress 1 to confirm, others to delete the message.. ");
145     if (scanf("%d", &confirm)==1 && confirm==1){
146         //confirmed
147         if (DEBUG)
148             printf("%s\\n", "Start sending..");
149
150         int k = 1;
151         int pid;

```



```

152
153     while (1) {
154         printf("\nEnter the %dth pid destination (letters to return to Menu): ", k);
155
156         if (scanf("%d", &pid)==1){
157             if (DEBUG)
158                 printf("[DEBUG] pid entered: %d\n", pid);
159
160             //send to pid
161             int size = 5 + get_int_len(getpid()) + get_int_len(pid) + strlen(msg);
162             char str[size];
163
164             if (DEBUG)
165                 printf("[DEBUG] str size: %d\n", size);
166
167             sprintf(str, "3 %d %d %s", getpid(), pid, msg); // puts string into
buffer
168
169             if (DEBUG)
170                 printf("[DEBUG] string to send: '%s'\n", str);
171
172             write(fd, str, sizeof(str));
173
174
175             k = k + 1;
176         } else {
177             clear_stream(stdin);
178             break;
179         }
180     }
181
182     if (DEBUG)
183         printf("%s\n", "[DEBUG] End sending");
184
185 } else {
186     clear_stream(stdin);
187     printf("%s\n", "Message aborted");
188 }
189
190
191 return;
192 }
193
194 /*
195 *
196 * PURPOSE : Disconnect from the server
197 *
198 * RETURN : void
199 *
200 */
201 void disconnect() {
202     if (connected == 0) {
203         printf("%s\n", "Already disconnected");
204         return;
205     }
206
207     printf("%s\n", "Client disconnected");
208
209     char str[7];
210
211     sprintf(str, "4 %d", getpid()); // puts string into buffer
212
213     write(fd, str, sizeof(str));
214
215     connected = 0;
216
217     return;
218 }
219
220 /*
221 *
222 * PURPOSE : Function to exit from client execution
223 *

```

```

224 * RETURN : void
225 *
226 */
227 void clientExit () {
228     close (fd);
229     printf ("%s\n", "Bye");
230     exit (0);
231 }
232
233 /*
234 *
235 * PURPOSE : Manage SIGINT signal (CTRL+C)
236 *
237 * PARAMS : int -> signal number
238 * RETURN : void
239 *
240 */
241 void sigHandler_1 (int signumber) {
242     if (signumber == SIGINT) {
243         printf ("\n{SIGNAL}\n");
244
245         if (DEBUG)
246             printf ("    [DEBUG] SIGINT caught\n");
247
248         printf ("/{SIGNAL}\n");
249         disconnect ();
250         clientExit ();
251     }
252     return;
253 }
254
255 /*
256 *
257 * PURPOSE : Manage SIGUSR1 signal. When a SIGUSR1 is caught the client read from its
258             named pipe
259 *
260 * PARAMS : int -> signal number
261 * RETURN : void
262 *
263 */
264 void sigHandler_2 (int signumber) {
265     if (signumber == SIGUSR1) {
266         printf ("\n{SIGNAL}\n");
267         if (DEBUG)
268             printf ("    [DEBUG] SIGUSR1 caught\n");
269
270         //READ RESPONSE FROM PROCESS PIPE
271         char s_pid[10];
272         int fd_client;
273         char pipeName[20];
274         char response[100];
275         char *p_pipeName;
276
277         sprintf (s_pid, "%d", getpid());
278
279         p_pipeName = concat (PIPES_PATH, s_pid);
280
281         // sprintf (p_pipeName, "%s %s", PIPES_PATH, s_pid);
282
283         strcpy (pipeName, p_pipeName); /* BANG!!! */
284         fd_client = open (pipeName, O_RDWR); /* Open it for writing */
285
286         if (DEBUG)
287             printf ("    [DEBUG] Reading from: %s ... \n", pipeName);
288
289         readLine (fd_client, response);
290         printf ("    Received: %s\n", response);
291
292         close (fd_client);
293
294         char c[50];
295

```

```

296     sprintf(c, "rm -f %s", pipeName);
297     FILE *fp = popen(c, "r");
298
299     // closing files
300     pclose(fp);
301     printf("{/SIGNAL}\n");
302
303 }
304 }
305
306 /*
307 *
308 * PURPOSE : Manage SIGUSR2 signal. When a SIGUSR2 is caught the client had tried to send
309             a message to a non existing client
310 *
311 * PARAMS : int -> signal number
312 * RETURN : void
313 */
314 void sigHandler_3(int signumber){
315
316     if(signumber == SIGUSR2) {
317         printf("\n{SIGNAL}\n");
318
319         if (DEBUG)
320             printf("    [DEBUG] SIGUSR2 caught.\n");
321
322         printf("    Pid not found.\n");
323
324         printf("{/SIGNAL}\n");
325     }
326 }

```

Listing 7: functions.client.h

```

1  /*
2  *
3  * PURPOSE : Create the data folder to store named pipes
4  *
5  * RETURN : void
6  *
7  */
8  int initDataFolder() {
9      FILE *fp;
10
11      fp = popen("mkdir -p data/", "r");
12      if (fp == NULL) {
13          printf("[Error] - Error initialing process folder\n");
14          exit(1);
15      }
16
17      pclose(fp);
18
19      return 0;
20 }
21
22 /*
23 *
24 * PURPOSE : Manage SIGINT signal (CTRL+C)
25 *
26 * PARAMS : int -> signal number
27 * RETURN : void
28 *
29 */
30 void sigHandler_1(int signumber) {
31     if(signumber == SIGINT){
32         printf("\n{SIGNAL}\n");
33         if (DEBUG)
34             printf("    [DEBUG] SIGINT caught\n");
35
36         int killed;
37         remove(CMD_PIPE_NAME);

```

```

38     // here we have to insert a while to send SIGINT to all clients to disconnect to
    this server
39     killed = clients_killer(n);
40     if(DEBUG)
41         printf(" [DEBUG] killed %d clients\n", killed);
42         printf("{/SIGNAL}\n");
43     exit(0);
44 }
45 return;
46 }
47
48 /*
49 *
50 * PURPOSE : Send text to a pid client. Create a named pipe with the destination pid value
    , write the text and send.
51 *
52 * PARAMS : char* -> destination pid
53 * PARAMS : char* -> string to send
54 * RETURN : void
55 *
56 */
57 void sendTextToClient(char* pid, char* p_textToSend){
58     char pipeName[20];
59     char* p_pipeName;
60     int fd_client;
61     char c_textToSend[ strlen(p_textToSend)+1];
62
63     strcpy(c_textToSend, p_textToSend);
64
65     p_pipeName = (char*) malloc(strlen(PIPES_PATH)+strlen(pid)+1);
66     p_pipeName = concat(PIPES_PATH, pid);
67     strcpy(pipeName, p_pipeName); /* BANG!!! */
68     mknod(pipeName, S_IFIFO|0666, 0); /* Create named pipe */
69     if(DEBUG)
70         printf("[DEBUG] Writing '%s' (size: %lu) to '%s'\n", c_textToSend, sizeof(
            c_textToSend), pipeName);
71     fd_client = open(pipeName, O_RDWR); /* Open it for writing */
72
73     int res = write(fd_client, c_textToSend, sizeof(c_textToSend));
74     if(DEBUG)
75         printf("[DEBUG] Written %d elements\n", res);
76     // close(fd_client); /* Close pipe */
77
78 }

```

Listing 8: functions.server.h

```

1 //struct
2 struct node{
3     char data[10];
4     struct node *next;
5 }*head;
6
7
8 /*
9 *
10 * PURPOSE : Get the number of clients connected
11 *
12 * RETURN : int -> number of clients in the list
13 *
14 */
15 int clients_count(){
16     struct node *n;
17     int c=0;
18     n=head;
19     while(n!=NULL){
20         n=n->next;
21         c++;
22     }
23     return c;
24 }
25
26 /*

```

```

27 *
28 * PURPOSE : Append a node to the end of the concat list
29 *
30 * PARAMS : char *pid -> pid to add in the list
31 * RETURN : void
32 *
33 */
34 void clients_append(char* pid){
35     struct node *temp,*right;
36     temp= (struct node *)malloc(sizeof(struct node));
37     strcpy(temp->data, pid);
38
39     right=(struct node *)head;
40     while(right->next != NULL)
41         right=right->next;
42
43     right->next =temp;
44     right=temp;
45     right->next=NULL;
46 }
47
48 /*
49 *
50 * PURPOSE : Add the first node in the concat list
51 *
52 * PARAMS : char *pid -> pid to add in the list
53 * RETURN : void
54 *
55 */
56 void clients_add( char* num ){
57     struct node *temp;
58     temp=(struct node *)malloc(sizeof(struct node));
59     strcpy(temp->data, num);
60     // temp->data=num;
61     if (head== NULL){
62         head=temp;
63         head->next=NULL;
64     }
65     else{
66         temp->next=head;
67         head=temp;
68     }
69 }
70
71 /*
72 *
73 * PURPOSE : Add the (i+1)-node in the concat list
74 *
75 * PARAMS : char *pid -> pid to add in the list
76 * RETURN : void
77 *
78 */
79 void clients_addafter(char* num, int loc){
80     int i;
81     struct node *temp,*left,*right;
82     right=head;
83     for(i=1;i<loc;i++){
84         left=right;
85         right=right->next;
86     }
87     temp=(struct node *)malloc(sizeof(struct node));
88     // temp->data=num;
89     strcpy(temp->data, num);
90
91     left->next=temp;
92     left=temp;
93     left->next=right;
94 }
95
96 /*
97 *
98 * PURPOSE : Insert a pid in the concat list
99 *

```

```

100 * PARAMS : char *pid -> pid to add in the list
101 * RETURN : void
102 *
103 */
104 void clients_insert(char* pid){
105     int c=0;
106     struct node *temp;
107     temp=head;
108     if(temp==NULL){
109         // printf("%s\n", "ok");
110         clients_add(pid);
111     }
112     else{
113         while(temp!=NULL){
114             if(temp->data<pid)
115                 c++;
116             temp=temp->next;
117         }
118         if(c==0)
119             clients_add(pid);
120         else if(c<clients_count())
121             clients_addafter(pid,++c);
122         else
123             clients_append(pid);
124     }
125 }
126
127 /*
128 *
129 * PURPOSE : Search a client in the concat list
130 *
131 * PARAMS : char *pid -> pid to add in the list
132 * RETURN : void
133 *
134 */
135 int clients_search(char* pid){
136     struct node *temp, *prev;
137     temp=head;
138     while(temp!=NULL){
139         if(strcmp(temp->data,pid)==0)
140             return 1;
141
142         prev=temp;
143         temp= temp->next;
144     }
145
146     return 0;
147 }
148
149 /*
150 *
151 * PURPOSE : Remove a client in the concat list
152 *
153 * PARAMS : char *pid -> pid to remove
154 * RETURN : int -> 1 if removed, 0 otherwise
155 *
156 */
157 int clients_delete(char* num){
158     struct node *temp, *prev;
159     temp=head;
160     while(temp!=NULL){
161         if(strcmp(temp->data,num)==0){
162             if(temp==head){
163                 head=temp->next;
164                 free(temp);
165                 return 1;
166             }
167             else{
168                 prev->next=temp->next;
169                 free(temp);
170                 return 1;
171             }
172         }

```

```

173         else{
174             prev=temp;
175             temp= temp->next;
176         }
177     }
178     return 0;
179 }
180
181 /*
182 *
183 * PURPOSE : Get the pid list of the clients connected
184 *
185 * PARAMS : struct node *r
186 * RETURN : char* -> string of clients connected
187 *
188 */
189 char* clients_display(struct node *r){
190     char* clients = NULL;
191     char* toAdd;
192
193     clients = malloc(0);
194
195     r=head;
196     if(r==NULL)
197         return "No Clients Connected";
198
199     while(r!=NULL){
200         toAdd = &(r->data)[0];
201         sprintf(clients, "%s %s", clients, toAdd);
202         r=r->next;
203     }
204
205     return clients;
206 }
207
208 /*
209 *
210 * PURPOSE : Kill all clients connected to the server sending them a SIGINT signal
211 *
212 * PARAMS : struct node *r
213 * RETURN : int -> number of clients killed
214 *
215 */
216 int clients_killer(struct node *r){
217     int pid;
218     int clientsKilled=0;
219
220     r=head;
221     if(r==NULL)
222         return 0;
223
224     while(r!=NULL){
225         pid = atoi(r->data);
226         if(DEBUG)
227             printf("[DEBUG] pid to kill: %d\n",pid);
228
229         kill(pid,SIGINT);
230         clientsKilled += 1;
231         r=r->next;
232     }
233
234     return clientsKilled;
235 }

```

Listing 9: listmanage.h

```

1  /*
2  *
3  * PURPOSE : Concat two strings
4  *
5  * PARAMS : char* s1 -> first string
6  * PARAMS : char* s2 -> second string
7  * RETURN : char* -> string concatenated

```

```

8  *
9  */
10 char* concat(const char *s1, const char *s2){
11     int i_s1 = 0;
12     int i_s2 = 0;
13
14     if(&(s1)[0] != NULL)
15         i_s1 = strlen(s1);
16
17     if(&(s2)[0] != NULL)
18         i_s2 = strlen(s2);
19
20     char *result = malloc(i_s1+i_s2+1); //+1 for the zero-terminator
21
22     //in real code you would check for errors in malloc here
23     if(&(s1)[0] != NULL)
24         strcpy(result, s1);
25
26     if(&(s2)[0] != NULL)
27         strcat(result, s2);
28
29     return result;
30 }
31
32 /*
33 *
34 * PURPOSE : read a line from a file and write it in str
35 *
36 * PARAMS : int fd -> file descriptor
37 * PARAMS : char* str -> where the line read will go
38 * RETURN : int -> 1 if ok, 0 end-of-input
39 *
40 */
41 int readLine(int fd, char *str) {
42     /* Read a single '\0'-terminated line into str from fd */
43     /* Return 0 when the end-of-input is reached and 1 otherwise */
44     int n;
45     do { /* Read characters until '\0' or end-of-input */
46         n = read (fd, str, 1); /* Read one character */
47     } while (n > 0 && *str++ != '\0');
48     return (n > 0); /* Return false if end-of-input */
49 }

```

Listing 10: functions.inc.h

```

1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <fcntl.h>
4  #include <sys/stat.h>
5  #include <sys/types.h>
6  #include <unistd.h>
7  #include <string.h>
8  #include <stdio.h>
9  #include <stdlib.h>
10 #include <signal.h>
11 #include <math.h>
12 #include "config.h"
13
14 int connected = 0;
15 char * myfifo = CMD_PIPE_NAME;
16 int fd;
17
18 void menu();
19 void connect();
20 void getClientsID();
21 void sendMessage();
22 void disconnect();
23 void clientExit();
24 void ex_program(int);
25 void sigHandler_1(int);
26 void sigHandler_2(int);
27 void sigHandler_3(int);
28

```



```

29 #include "functions.inc.h"
30 #include "functions.client.h"
31
32 int main(){
33     if(DEBUG)
34         printf("[DEBUG] pid: %d\n", getpid());
35
36     signal(SIGINT, sigHandler_1);
37     signal(SIGUSR1, sigHandler_2);
38     signal(SIGUSR2, sigHandler_3);
39
40     fd = open(myfifo, O_WRONLY);
41
42     if(fd==-1){
43         printf("%s\n", "[ERR]: server is not running");
44         return 0;
45     }
46
47     printf("Hello. Welcome to the client.\n");
48     printf("Press RETURN key to continue...\n");
49     getchar();
50     menu();
51
52     return 0;
53 }

```

Listing 11: client.c

```

1 #include <stdio.h>
2 #include <stdlib.h>
3 #include <fcntl.h>
4 #include <sys/stat.h>
5 #include <sys/types.h>
6 #include <unistd.h>
7 #include <string.h>
8 #include <stdio.h>
9 #include <stdlib.h>
10 #include <signal.h>
11 #include "config.h"
12
13 struct node *n;
14
15 int initDataFolder(void);
16 void sigHandler_1(int);
17 void sendTextToClient(char*, char*);
18
19 #include "functions.inc.h"
20 #include "listmanage.h"
21 #include "functions.server.h"
22
23 int main(){
24     initDataFolder();
25
26     signal(SIGINT, sigHandler_1);
27
28     int i_fd;
29     int i_pid_m;
30     int i_pid_d;
31
32     char cmd[100];
33     char pid[10];
34
35     char* p_pid_m;
36     char* p_pid_d;
37     char* p_msg;
38     char* p_clientsList;
39     char* p_token;
40
41     //init clients list
42     head=NULL;
43
44     int res = mknod(CMD_PIPE_NAME, S_IFIFO|0666, 0); /* Create named pipe */
45     if(res!=0){

```

```

46     printf("%s\n", "[ERR] Problem creating pipe");
47     return 1;
48 }
49
50 i_fd = open(CMD_PIPE_NAME, O_RDONLY); /* Open it for reading */
51 if(i_fd==1){
52     printf("%s\n", "[ERR] Problem reading pipe");
53     return 1;
54 }
55
56 if(DEBUG)
57     printf("[DEBUG] Reading from pipe %s ..\n\n", CMD_PIPE_NAME);
58
59 while (readLine(i_fd, cmd)){
60     /* Receiving messages */
61     if(DEBUG)
62         printf("[DEBUG] Received: %s\n", cmd);
63
64     char* cmd_detected = strtok(cmd, " ");
65     // printf("%s\n", cmd_detected);
66     char* p_pid_m = strtok(NULL, " ");
67     // printf("%s\n", p_pid_m);
68
69
70     strcpy(pid, p_pid_m); /* BANG!!! */
71     i_pid_m = atoi(pid);
72
73     if(DEBUG)
74         printf("[DEBUG] cmd->%s | pid_m->%s\n", cmd_detected, p_pid_m);
75
76     switch (cmd_detected[0]) {
77         case '1':
78             clients_insert(pid);
79             break;
80         case '2':
81             p_clientsList = clients_display(n);
82
83             sendTextToClient(pid, p_clientsList);
84
85             if(DEBUG)
86                 printf("[DEBUG] SIGUSR1 TO PID %d\n", i_pid_m);
87
88             //notify client through SIGNAL SIGUSR1
89             kill(i_pid_m, SIGUSR1);
90             break;
91         case '3':
92
93             p_pid_d = strtok(NULL, " ");
94             p_msg = strtok(NULL, " ");
95
96             while(p_token = strtok(NULL, " "))
97                 sprintf(p_msg, "%s %s", p_msg, p_token);
98
99
100             if(DEBUG){
101                 printf("[DEBUG] pid_d->%s\n", p_pid_d);
102                 printf("[DEBUG] msg received: %s\n", p_msg);
103             }
104
105
106             if (clients_search(p_pid_d)==1){
107                 //if the client is connected, send the message
108                 i_pid_d = atoi(p_pid_d);
109
110                 sendTextToClient(p_pid_d, p_msg);
111                 //notify client through SIGNAL SIGUSR1
112                 kill(i_pid_d, SIGUSR1);
113             } else {
114                 //otherwise notify the client who request to send this message
115                 if(DEBUG)
116                     printf("[DEBUG] Client %s is not connected\n", p_pid_d);
117
118                 //send SIGUSR2 to client

```

```

119         kill(i_pid_m, SIGUSR2);
120
121     }
122
123     break;
124     case '4':
125     case '5':
126         clients_delete(pid);
127         break;
128     }
129
130     printf("\n\r");
131 }
132
133 if (DEBUG)
134     printf("%s\n", "End..");
135
136 close (i_fd); /* Close pipe */
137 remove(CMD_PIPE_NAME);
138 }

```

Listing 12: server.c

## 4 Evidenza del corretto funzionamento

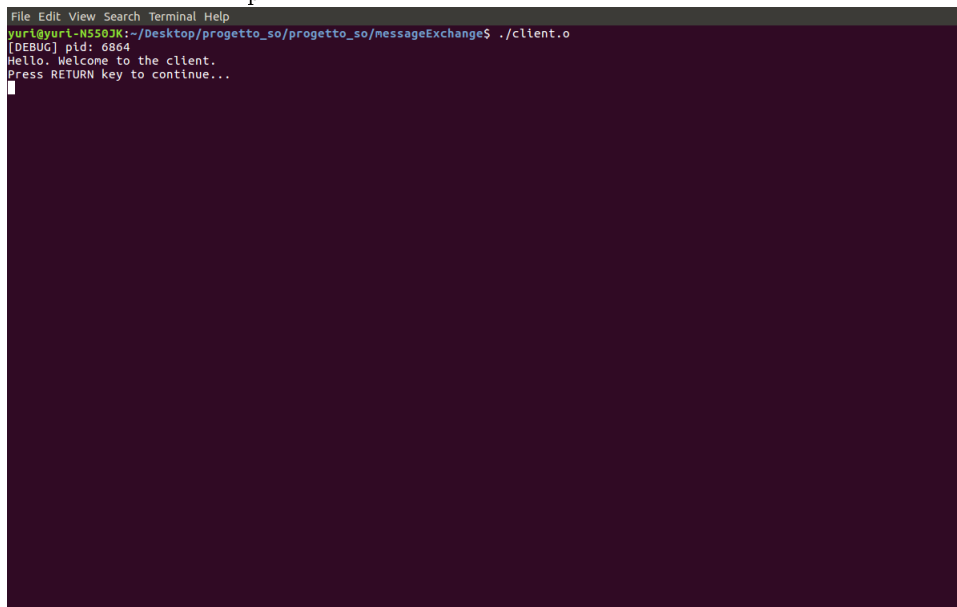
### 4.1 Esercizio 1

#### 4.1.1 Stress Test

### 4.2 Esercizio 2

### 4.3 Esercizio 3

- lancio del client con pid 6864



```

File Edit View Search Terminal Help
yuri@yuri-N550JK:~/Desktop/progetto_so/progetto_so/messageExchange$ ./client.o
(DEBUG) pid: 6864
Hello. Welcome to the client.
Press RETURN key to continue...

```

- comparsa del menu

```
File Edit View Search Terminal Help
yuri@yuri-N550JK:~/Desktop/progetto_so/progetto_so/messageExchange$ ./client.o
[DEBUG] pid: 6864
Hello. Welcome to the client.
Press RETURN key to continue...

Menu 1
~~~~~
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
```

- connessione del client 6864 al server

```
File Edit View Search Terminal Help
yuri@yuri-N550JK:~/Desktop/progetto_so/progetto_so/messageExchange$ ./client.o
[DEBUG] pid: 6864
Hello. Welcome to the client.
Press RETURN key to continue...

Menu 1
~~~~~
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
1

Connected

Menu 1
~~~~~
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
█
```

- connessione del client 6932 al server

```
File Edit View Search Terminal Help
yuri@yuri-N550JK:~/Desktop/progetto_so/progetto_so/messageExchange$ ./client.o
[DEBUG] pid: 6932
Hello. Welcome to the client.
Press RETURN key to continue...

Menu 1
~~~~~
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
1

Connected

Menu 1
~~~~~
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
█
```

```

File Modifica Visualizza Cerca Terminale Aiuto
mabrt@pabulinus:~/git/progetto_so/progetto_so/procScheduler$ ./scheduler.out
.....
This is a process scheduler
.....
Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 1

Name this task (max 8 chars) : task1

Insert the priority (ascending order): 5

Insert the number of remaning executions : 70

Scheduling Policy: PRIORITY
+-----+
| ID + PRIORITY + TASK NAME + REMAINING EXEC |
+-----+
| 1 + 5 + task1 + 70 |
+-----+

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
>

```

(a) inserimento

```

File Modifica Visualizza Cerca Terminale Aiuto
Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 1

Name this task (max 8 chars) : troppicaratteri
The name of the task must be less than 8
Name this task (max 8 chars) : task2

Insert the priority (ascending order): -5
Error! It must be a number between 1 and 9
Insert the priority (ascending order): 15
Error! It must be a number between 1 and 9
Insert the priority (ascending order): 8

Insert the number of remaning executions : -50
Error! It must be a number between 1 and 99.
Insert the number of remaning executions : 150
Error! It must be a number between 1 and 99.
Insert the number of remaning executions : 50

Scheduling Policy: PRIORITY
+-----+
| ID + PRIORITY + TASK NAME + REMAINING EXEC |
+-----+
| 2 + 8 + task2 + 50 |
+-----+
| 1 + 5 + task1 + 70 |
+-----+

```

(b) inserimento con errore

```

File Modifica Visualizza Cerca Terminale Aiuto
+-----+
| 2 + 8 + task2 + 50 |
+-----+
| 1 + 5 + task1 + 70 |
+-----+

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 1

Name this task (max 8 chars) : task3

Insert the priority (ascending order): 7

Insert the number of remaning executions : 30

Scheduling Policy: PRIORITY
+-----+
| ID + PRIORITY + TASK NAME + REMAINING EXEC |
+-----+
| 2 + 8 + task2 + 50 |
| 3 + 7 + task3 + 30 |
| 1 + 5 + task1 + 70 |
+-----+

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
>

```

(c) inserimento e ordinamento

Figure 1: Creazione di un nuovo task

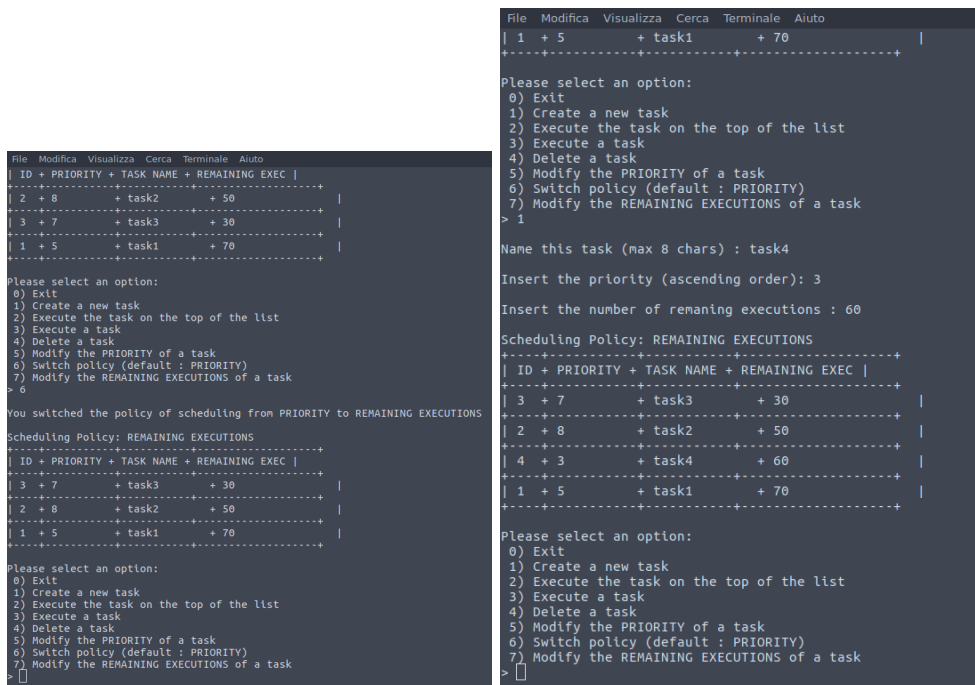


Figure 2: Mantenimento dell'ordinamento della lista dei task e modifica ai parametri

```

File Modifica Visualizza Cerca Terminale Aiuto
Scheduling Policy: PRIORITY
+-----+
| ID + PRIORITY + TASK NAME + REMAINING EXEC |
+-----+
| 2 + 8 + task2 + 50 |
+-----+
| 1 + 5 + task1 + 70 |
+-----+
| 4 + 3 + task4 + 60 |
+-----+
| 3 + 2 + task3 + 30 |
+-----+

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 3
Select the task...
Insert the ID : 4

Scheduling Policy: PRIORITY
+-----+
| ID + PRIORITY + TASK NAME + REMAINING EXEC |
+-----+
| 2 + 8 + task2 + 50 |
+-----+
| 1 + 5 + task1 + 70 |
+-----+
| 4 + 3 + task4 + 59 |
+-----+
| 3 + 2 + task3 + 30 |
+-----+

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 2

```

(a) singola esecuzione di un task

```

File Modifica Visualizza Cerca Terminale Aiuto
Scheduling Policy: PRIORITY
+-----+
| ID + PRIORITY + TASK NAME + REMAINING EXEC |
+-----+
| 2 + 8 + task2 + 50 |
+-----+
| 1 + 5 + task1 + 70 |
+-----+
| 4 + 3 + task4 + 59 |
+-----+
| 3 + 2 + task3 + 30 |
+-----+

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 2

How many execution do you want to do: 150

Scheduling Policy: PRIORITY
+-----+
| ID + PRIORITY + TASK NAME + REMAINING EXEC |
+-----+
| 4 + 3 + task4 + 29 |
+-----+
| 3 + 2 + task3 + 30 |
+-----+

```

(b) 150 esecuzioni dei task in testa

```

Scheduling Policy: PRIORITY
+-----+
| ID + PRIORITY + TASK NAME + REMAINING EXEC |
+-----+
| 5 + 8 + task5 + 40 |
+-----+
| 3 + 2 + task3 + 30 |
+-----+
| 6 + 1 + task6 + 90 |
+-----+

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 2

How many execution do you want to do: 160

List is empty! Please insert a task first...

```

(c) esecuzione di tutti i task

Figure 3: Esecuzioni varie dei task



```

Scheduling Policy: PRIORITY
+-----+-----+-----+-----+
| ID + PRIORITY + TASK NAME + REMAINING EXEC |
+-----+-----+-----+-----+
| 4 + 3 + task4 + 29 |
+-----+-----+-----+-----+
| 3 + 2 + task3 + 30 |
+-----+-----+-----+-----+

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 4
Select the task...
Insert the ID : 4

Scheduling Policy: PRIORITY
+-----+-----+-----+-----+
| ID + PRIORITY + TASK NAME + REMAINING EXEC |
+-----+-----+-----+-----+
| 3 + 2 + task3 + 30 |
+-----+-----+-----+-----+

```

(a) eliminazione di tutti i task

```

List is empty! Please insert a task first...

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 0
Bye!
wabri@Fabullinus:~/git/progetto_so/progetto_so/procScheduler$

```

(b) uscita dal programma

Figure 4: Eliminazione dei task ed uscita dal programma

```

File Modifica Visualizza Cerca Terminale Aiuto
wabri@Fabullinus:~/git/progetto_so/progetto_so/procScheduler$ ./scheduler.out

This is a process scheduler

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 2
How many execution do you want to do: 100

List is empty! Please insert a task first...

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
>

```

(a) esecuzione a lista vuota

```

List is empty! Please insert a task first...

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 3

List is empty! Please insert a task first...

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
>

```

(b) esecuzione per ID a lista vuota

```

List is empty! Please insert a task first...

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 4
Select the task...
Insert the ID : 10
Error! No tasks with this ID!
There is no task to delete!

List is empty! Please insert a task first...

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
>

```

(c) eliminazione per ID a lista vuota

Figure 5: Esecuzioni a lista vuota

```

List is empty! Please insert a task first...

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 5
Select the task...
Insert the ID : 1

Error! No tasks with this ID!

List is empty! Please insert a task first...

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 

```

(a) modifica della priorità a lista vuota

```

List is empty! Please insert a task first...

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 7
Select the task...
Insert the ID : 4

Error! No tasks with this ID!

List is empty! Please insert a task first...

Please select an option:
0) Exit
1) Create a new task
2) Execute the task on the top of the list
3) Execute a task
4) Delete a task
5) Modify the PRIORITY of a task
6) Switch policy (default : PRIORITY)
7) Modify the REMAINING EXECUTIONS of a task
> 

```

(b) modifica del n.esec. a lista vuota

Figure 6: Modifiche a lista vuota

```
yuri@yuri-N550JK:~/Desktop/progetto_so/progetto_so/commandexe$ ./cmd.o
Enter the 1-cmd: █
```

(a) esecuzioni di `ls`

```
yuri@yuri-N550JK:~/Desktop/progetto_so/progetto_so/commandexe$ ./cmd.o
Enter the 1-cmd: ls
Cmd entered : ls
Enter the 2-cmd: █
```

(b) esecuzioni di `df -h`

```
yuri@yuri-N550JK:~/Desktop/progetto_so/progetto_so/commandexe$ ./cmd.o

Enter the 1-cmd: ls
Cmd entered : ls

Enter the 2-cmd: df -h
Cmd entered : df -h

Enter the 3-cmd: █
```

(a) esecuzioni di `free`

```
yuri@yuri-N550JK:~/Desktop/progetto_so/progetto_so/commandexe$ ./cmd.o

Enter the 1-cmd: ls
Cmd entered : ls

Enter the 2-cmd: df -h
Cmd entered : df -h

Enter the 3-cmd: free
Cmd entered : free

Enter the 4-cmd: █
```

(b) uscita dal programma

```
File Edit View Search Terminal Help
yuri@yuri-NS50JK:~/Desktop/progetto_so/progetto_so/messageExchange$ ./server.o
[DEBUG] Reading from pipe data/pipe ..
[DEBUG] Received: 1 6864
[DEBUG] cmd->1 | pid_n->6864
[DEBUG] Received: 1 6932
[DEBUG] cmd->1 | pid_n->6932
```

(a) Connessioni dei client 6864 e 6932 lato server

```
File Edit View Search Terminal Help
yuri@yuri-NS50JK:~/Desktop/progetto_so/progetto_so/messageExchange$ ./client.o
[DEBUG] pid: 6932
Hello, Welcome to the client.
Press RETURN key to continue...

Menu 1
-----
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
1
Connected

Menu 1
-----
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
2
2

Menu 1
-----
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
5

[DEBUG] SIGUSR1 caught
[DEBUG] Reading from: data/6932 ...
Received: 6864 6932
[/SIGUSR1]
```

(b) Richiesta da parte di 6932 dei client connessi

```
File Edit View Search Terminal Help
yuri@yuri-NS50JK:~/Desktop/progetto_so/progetto_so/messageExchange$ ./server.o
[DEBUG] Reading from pipe data/pipe ..
[DEBUG] Received: 1 6864
[DEBUG] cmd->1 | pid_n->6864
[DEBUG] Received: 1 6932
[DEBUG] cmd->1 | pid_n->6932
[DEBUG] Received: 2 6932
[DEBUG] cmd->2 | pid_n->6932
[DEBUG] Writing ' 6864 6932' (size: 11) to 'data/6932'
[DEBUG] Written 11 elements
[DEBUG] SIGUSR1 TO PID 6932
```

(c) Risposta del server a 6932

Figure 9: Connessioni e richiesta dei client connessi

```
File Edit View Search Terminal Help
5. Exit.
1
Connected
Menu 1
-----
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
2
Menu 1
-----
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
3
{[SIGNAL]
  [DEBUG] SIGUSR1 caught
  [DEBUG] Reading from: data/6932 ...
    Received: 6864 6932
  [/SIGNAL]
}
3
Enter the message: Questo è un messaggio da inviare.
Message entered : Questo è un messaggio da inviare.
Press 1 to confirm, others to delete the message.. 1
Start sending..
Enter the 1th pid destination (letters to return to Menu): 6864
[DEBUG] pid entered: 6864
[DEBUG] str size: 47
[DEBUG] string to send: '3 6932 6864 Questo è un messaggio da inviare.'
Enter the 2th pid destination (letters to return to Menu):
```

(a) 6932 invia un messaggio a 6864

```
File Edit View Search Terminal Help
yuri@yuri-NS50JK:~/Desktop/progetto_so/progetto_so/messageExchange$ ./server.o
[DEBUG] Reading from pipe data/pipe ..
[DEBUG] Received: 1 6864
[DEBUG] cmd->1 | pid_n->6864
[DEBUG] Received: 1 6932
[DEBUG] cmd->1 | pid_n->6932
[DEBUG] Received: 2 6932
[DEBUG] cmd->2 | pid_n->6932
[DEBUG] Writing '6864 6932' (size: 11) to 'data/6932'
[DEBUG] Written 11 elements
[DEBUG] SIGUSR1 TO PID 6932
[DEBUG] Received: 3 6932 6864 Questo è un messaggio da inviare.
[DEBUG] cmd->3 | pid_n->6932
[DEBUG] pid_d->6864
[DEBUG] msg received: Questo è un messaggio da inviare.
[DEBUG] Writing 'Questo è un messaggio da inviare.' (size: 35) to 'data/6864'
[DEBUG] Written 35 elements

```

(b) Risposta del server alla richiesta di 6932

```
File Edit View Search Terminal Help
yuri@yuri-NS50JK:~/Desktop/progetto_so/progetto_so/messageExchange$ ./client.o
[DEBUG] pid: 6864
Hello. Welcome to the client.
Press RETURN key to continue...
Menu 1
-----
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
1
Connected
Menu 1
-----
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
1
{[SIGNAL]
  [DEBUG] SIGUSR1 caught
  [DEBUG] Reading from: data/6864 ...
    Received: Questo è un messaggio da inviare.
  [/SIGNAL]
}
```

(c) Ricezione del messaggio da parte di 6864

Figure 10: Message passing

```
File Edit View Search Terminal Help
4. Disconnect from server.
5. Exit.
2

Menu 1
-----
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.

{[SIGNAL]
  [DEBUG] SIGUSR1 caught
  [DEBUG] Reading from: data/6932 ...
  Received: 6864 6932
}[SIGNAL]
3

Enter the message: Questo è un messaggio da inviare.
Message entered : Questo è un messaggio da inviare.

Press 1 to confirm, others to delete the message.. 1
Start sending..

Enter the 1th pid destination (letters to return to Menü): 6864
[DEBUG] pid entered: 6864
[DEBUG] str size: 47
[DEBUG] string to send: '3 6932 6864 Questo è un messaggio da inviare.'

Enter the 2th pid destination (letters to return to Menü): 123
[DEBUG] pid entered: 123
[DEBUG] str size: 46
[DEBUG] string to send: '3 6932 123 Questo è un messaggio da inviare.'

Enter the 3th pid destination (letters to return to Menü):
{[SIGNAL]
  [DEBUG] SIGUSR2 caught.
  Pid not found.
}[SIGNAL]
```

(a) Gestione dell'errore nell'invio di un messaggio ad un client inesistente

```
File Edit View Search Terminal Help
yuri@yuri-NS50JK:~/Desktop/progetto_so/progetto_so/messageExchange$ ./server.o
[DEBUG] Reading from pipe data/pipe ..

[DEBUG] Received: 1 6864
[DEBUG] cmd->1 | pid_n->6864

[DEBUG] Received: 1 6932
[DEBUG] cmd->1 | pid_n->6932

[DEBUG] Received: 2 6932
[DEBUG] cmd->2 | pid_n->6932
[DEBUG] Writing ' 6864 6932' (size: 11) to 'data/6932'
[DEBUG] Written 11 elements
[DEBUG] SIGUSR1 TO PID 6932

[DEBUG] Received: 3 6932 6864 Questo è un messaggio da inviare.
[DEBUG] cmd->3 | pid_n->6932
[DEBUG] pid_d->6864
[DEBUG] msg received: Questo è un messaggio da inviare.
[DEBUG] Writing 'Questo è un messaggio da inviare.' (size: 35) to 'data/6864'
[DEBUG] Written 35 elements

[DEBUG] Received: 3 6932 123 Questo è un messaggio da inviare.
[DEBUG] cmd->3 | pid_n->6932
[DEBUG] pid_d->123
[DEBUG] msg received: Questo è un messaggio da inviare.
[DEBUG] Client 123 is not connected
```

(b) Gestione dell'errore nell'invio di un messaggio ad un client inesistente lato server

Figure 11: Errori

```

File Edit View Search Terminal Help
yuri@yuri-NS50JK:~/Desktop/progetto_so/messageExchange$ ./client.o
[DEBUG] pid: 6864
Hello, Welcome to the client.
Press RETURN key to continue...

Menu 1
-----
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
1
Connected

Menu 1
-----
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
4
[DEBUG] SIGUSR1 caught
[DEBUG] Reading from: data/6864 ...
Received: Questo è un messaggio da inviare.
[/SIGUSR1]
4
Client disconnected

Menu 1
-----
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
5

```

(a) Disconnessione di 6864 dal server

```

File Edit View Search Terminal Help
yuri@yuri-NS50JK:~/Desktop/progetto_so/messageExchange$ ./server.o
[DEBUG] Reading from pipe data/pipe ..

[DEBUG] Received: 1 6864
[DEBUG] cmd->1 | pid_n->6864

[DEBUG] Received: 1 6932
[DEBUG] cmd->1 | pid_n->6932

[DEBUG] Received: 2 6932
[DEBUG] cmd->2 | pid_n->6932
[DEBUG] Writing ' 6864 6932' (size: 11) to 'data/6932'
[DEBUG] Written 11 elements
[DEBUG] SIGUSR1 TO PID 6932

[DEBUG] Received: 3 6932 6864 Questo è un messaggio da inviare.
[DEBUG] cmd->3 | pid_n->6932
[DEBUG] pid_d->6864
[DEBUG] msg received: Questo è un messaggio da inviare.
[DEBUG] Writing 'Questo è un messaggio da inviare.' (size: 35) to 'data/6864'
[DEBUG] Written 35 elements

[DEBUG] Received: 3 6932 123 Questo è un messaggio da inviare.
[DEBUG] cmd->3 | pid_n->6932
[DEBUG] pid_d->123
[DEBUG] msg received: Questo è un messaggio da inviare.
[DEBUG] client 123 is not connected

[DEBUG] Received: 4 6864
[DEBUG] cmd->4 | pid_n->6864

```

(b) Risposta del server

```

File Edit View Search Terminal Help
Connected

Menu 1
-----
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
4
[DEBUG] SIGUSR1 caught
[DEBUG] Reading from: data/6864 ...
Received: Questo è un messaggio da inviare.
[/SIGUSR1]
4
Client disconnected

Menu 1
-----
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
2

Menu 1
-----
1. Connect to server.
2. Get clients connected to server.
3. Write to client/s.
4. Disconnect from server.
5. Exit.
3
[DEBUG] SIGUSR1 caught
[DEBUG] Reading from: data/6864 ...
Received: 6932
[/SIGUSR1]

```

(c) Richiesta dei client connessi al server

Figure 12: Disconnessione



```

File Edit View Search Terminal Help
[DEBUG] cmd->1 | pid_n->6932

[DEBUG] Received: 2 6932
[DEBUG] cmd->2 | pid_n->6932
[DEBUG] Writing ' 6864 6932' (size: 11) to 'data/6932'
[DEBUG] Written 11 elements
[DEBUG] SIGUSR1 TO PID 6932

[DEBUG] Received: 3 6932 6864 Questo è un messaggio da inviare.
[DEBUG] cmd->3 | pid_n->6932
[DEBUG] pid_d->6864
[DEBUG] msg received: Questo è un messaggio da inviare.
[DEBUG] Writing 'Questo è un messaggio da inviare.' (size: 35) to 'data/6864'
[DEBUG] Written 35 elements

[DEBUG] Received: 3 6932 123 Questo è un messaggio da inviare.
[DEBUG] cmd->3 | pid_n->6932
[DEBUG] pid_d->123
[DEBUG] msg received: Questo è un messaggio da inviare.
[DEBUG] Client 123 is not connected

[DEBUG] Received: 4 6864
[DEBUG] cmd->4 | pid_n->6864

[DEBUG] Received: 3 6932 2 Questo è un messaggio da inviare.
[DEBUG] cmd->3 | pid_n->6932
[DEBUG] pid_d->2
[DEBUG] msg received: Questo è un messaggio da inviare.
[DEBUG] Client 2 is not connected

[DEBUG] Received: 2 6864
[DEBUG] cmd->2 | pid_n->6864
[DEBUG] Writing ' 6932' (size: 6) to 'data/6864'
[DEBUG] Written 6 elements
[DEBUG] SIGUSR1 TO PID 6864

^C
{SIGNAL}
[DEBUG] SIGINT caught
[DEBUG] pid to kill: 6932
[DEBUG] killed 1 clients
{/SIGNAL}
yuri@yuri-N550JK:~/Desktop/progetto_so/progetto_so/messageExchange$

```

(a)

```

File Edit View Search Terminal Help Impostazioni delle notifiche
Received: 6864 6932
{/SIGNAL}
3
Enter the message: Questo è un messaggio da inviare.
Message entered : Questo è un messaggio da inviare.

Press 1 to confirm, others to delete the message.. 1
Start sending..

Enter the 1th pid destination (letters to return to Menü): 6864
[DEBUG] pid entered: 6864
[DEBUG] str size: 47
[DEBUG] string to send: '3 6932 6864 Questo è un messaggio da inviare.'

Enter the 2th pid destination (letters to return to Menü): 123
[DEBUG] pid entered: 123
[DEBUG] str size: 46
[DEBUG] string to send: '3 6932 123 Questo è un messaggio da inviare.'

Enter the 3th pid destination (letters to return to Menü):
{SIGNAL}
[DEBUG] SIGUSR2 caught.
Pid not found.
{/SIGNAL}
2
[DEBUG] pid entered: 2
[DEBUG] str size: 44
[DEBUG] string to send: '3 6932 2 Questo è un messaggio da inviare.'

Enter the 4th pid destination (letters to return to Menü):
{SIGNAL}
[DEBUG] SIGUSR2 caught.
Pid not found.
{/SIGNAL}

{SIGNAL}
[DEBUG] SIGINT caught
{/SIGNAL}
Client disconnected
Bye
yuri@yuri-N550JK:~/Desktop/progetto_so/progetto_so/messageExchange$

```

(b)

Figure 13: Errori