Московский Авиационный Институт

(Национальный Исследовательский Университет)

Институт №8 “Компьютерные науки и прикладная математика”

Кафедра №806 “Вычислительная математика и программирование”

**Лабораторная работа №1 по курсу**

**«Операционные системы»**

Группа: М8О-214БВ-24

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**Постановка задачи**

**Вариант 8.**

Родительский процесс создает дочерний процесс. Первой строчкой пользователь в консоль родительского процесса вводит имя файла, которое будет использовано для открытия файла с таким именем на чтение. Стандартный поток ввода дочернего процесса переопределяется открытым файлом. Дочерний процесс читает команды из стандартного потока ввода. Стандартный поток вывода дочернего процесса перенаправляется в pipe1. Родительский процесс читает из pipe1 и прочитанное выводит в свой стандартный поток вывода. Родительский и дочерний процесс должны быть представлены разными программами.

В файле записаны команды вида:«число число число<endline>». Дочерний процесс производит деление первого числа команда, на последующие числа в команде, а результат выводит в стандартный поток вывода. Если происходит деление на 0, то тогда дочерний и родительский процесс завершают свою работу. Проверка деления на 0 должна осуществляться на стороне дочернего процесса. Числа имеют тип int. Количество чисел может быть произвольным.

**Общий метод и алгоритм решения**

**Использованные системные вызовы:**

* **pid\_t fork(void)** – создает дочерний процесс.
* **int pipe(int \*fd)** – создает неименованный канал для межпроцессорного взаимодействия.
* **ssize\_t write(int fd, void \*buf, size\_t count**)– записывает файлы из буфера в файловый дескриптор.
* **ssize\_t read(int fd, void \*buf, size\_t count)** – читает файлы из файлового дескриптора в буфер.
* **int open(const char \*pathname, int flags, mode\_t mode)** – открывает\создает файл.
* **int close(int fd)** – закрывает файл.
* **int dup2(int oldfd, int newfd)** – переназначение файлового дескриптора
* **int execl(const char \*path, const char \*arg0, ..., NULL)** – запуск другой программы, замещая текущий процесс.
* **pid\_t wait(int \*status)** – ожидание завершения дочернего процесса.
* **void exit (int status)** – завершения выполнения процесса и возвращение статуса.

**Алгоритм решения:**

Создается родительский процесс, запрашивающий имя файла и открывающий его на чтение. Содержимое файла отправляет дочернему процессу, который выполняет следующие задачи: обработка строк, парсинг чисел, операция деления чисел. Если встречается деление на ноль, дочерний процесс выводит сообщение об ошибке, уведомляя родителя через пайп. В остальных случаях результат деления отправляется родителю через второй пайп, который выводит его на экран. Таким образом, родитель и дочерний процесс обмениваются данными и выводят результаты построчно, обеспечивая корректное завершение при ошибках.

**Код программы**

**client.c**

#include <unistd.h>

#include <stdlib.h>

#include <sys/wait.h>

#include <stdint.h>

#include <fcntl.h>

#include <stdio.h>

int main(int argc, char \*argv[]) {

char progpath[1024];

{

const char msg[] = "input file: ";

write(STDOUT\_FILENO, msg, sizeof(msg) - 1);

ssize\_t n = read(STDIN\_FILENO, progpath, sizeof(progpath) - 1);

if (n <= 0) {

const char msg[] = "error: can't read the file\n";

write(STDERR\_FILENO, msg, sizeof(msg) - 1);

exit(EXIT\_FAILURE);

}

progpath[n - 1] = '\0';

}

//open pipes

int client\_to\_server[2];

if (pipe(client\_to\_server) == -1) {

const char msg[] = "error: can't make the pipe\n";

write(STDERR\_FILENO, msg, sizeof(msg) - 1);

exit(EXIT\_FAILURE);

}

int server\_to\_client[2];

if (pipe(server\_to\_client) == -1) {

const char msg[] = "error: can't make the pipe\n";

write(STDERR\_FILENO, msg, sizeof(msg) - 1);

exit(EXIT\_FAILURE);

}

//make process

pid\_t pid = fork();

switch(pid) {

case -1: {

const char msg[] = "error: can't make a new process\n";

write(STDERR\_FILENO, msg, sizeof(msg) - 1);

exit(EXIT\_FAILURE);

} break;

case 0: {

//child process

close(client\_to\_server[1]);

close(server\_to\_client[0]);

dup2(client\_to\_server[0], STDIN\_FILENO);

close(client\_to\_server[0]);

dup2(server\_to\_client[1], STDOUT\_FILENO);

close(server\_to\_client[1]);

execl("./server", "server", NULL);

const char msg[] = "error: can't exec\n";

write(STDERR\_FILENO, msg, sizeof(msg) - 1);

exit(EXIT\_FAILURE);

} break;

default: {

//parent process

close(client\_to\_server[0]);

close(server\_to\_client[1]);

int file = open(progpath, O\_RDONLY);

if (file == -1) {

const char msg[] = "error: can't open file\n";

write(STDERR\_FILENO, msg, sizeof(msg) - 1);

exit(EXIT\_FAILURE);

}

char buf[4096];

ssize\_t n;

while ((n = read(file, buf, sizeof(buf)))) {

write(client\_to\_server[1], buf, n);

}

close(file);

close(client\_to\_server[1]);

//request from child

while ((n = read(server\_to\_client[0], buf, sizeof(buf)))) {

write(STDOUT\_FILENO, buf, n);

}

close(server\_to\_client[0]);

wait(NULL);

} break;

}

return 0;

}

**server.c**

#include <stdlib.h>

#include <unistd.h>

#include <ctype.h>

#include <string.h>

#include <stdio.h>

int main() {

char buf[4096];

ssize\_t n;

size\_t pos = 0;

while ((n = read(STDIN\_FILENO, buf + pos, sizeof(buf) - pos - 1)) > 0) {

pos += n;

buf[pos] = '\0';

char \*cur\_line = buf;

char \*tmp\_line;

while ((tmp\_line = strchr(cur\_line, '\n'))) {

\*tmp\_line = '\0';

int result = 0;

int div\_seen = 0;

int count = 0;

int division\_by\_zero = 0;

int invalid\_input = 0;

//parsing int

char \*p = cur\_line;

while (\*p) {

while (\*p && isspace((unsigned char)\*p)) {

p++;

}

if (!\*p) {

break;

}

int is\_neg = 1;

if (\*p == '-') {

is\_neg = -1;

p++;

}

if (!isdigit((unsigned char)\*p)) {

invalid\_input = 1;

break;

}

int num = 0;

int digit\_found = 0;

while (\*p && isdigit((unsigned char)\*p)) {

num = num \* 10 + (\*p - '0');

p++;

digit\_found = 1;

}

if (!digit\_found) {

while (\*p && !isspace((unsigned char)\*p)) p++;

continue;

}

num \*= is\_neg;

count++;

if (!div\_seen) {

result = num;

div\_seen = 1;

} else {

if (num == 0) {

division\_by\_zero = 1;

break;

}

result /= num;

}

while (\*p && !isspace((unsigned char)\*p)) {

invalid\_input = 1;

break;

}

if (invalid\_input) {

break;

}

}

if (invalid\_input) {

const char msg[] = "error: invalid input\n";

write(STDERR\_FILENO, msg, sizeof(msg) - 1);

} else if (division\_by\_zero) {

const char msg[] = "error: division by zero\n";

write(STDERR\_FILENO, msg, sizeof(msg) - 1);

} else if (count < 3) {

const char msg[] = "error: not enough arguments\n";

write(STDERR\_FILENO, msg, sizeof(msg) - 1);

} else {

char out[64];

int len = snprintf(out, sizeof(out), "%d\n", result);

write(STDOUT\_FILENO, out, len);

}

cur\_line = tmp\_line + 1;

}

pos = strlen(cur\_line);

memmove(buf, cur\_line, pos);

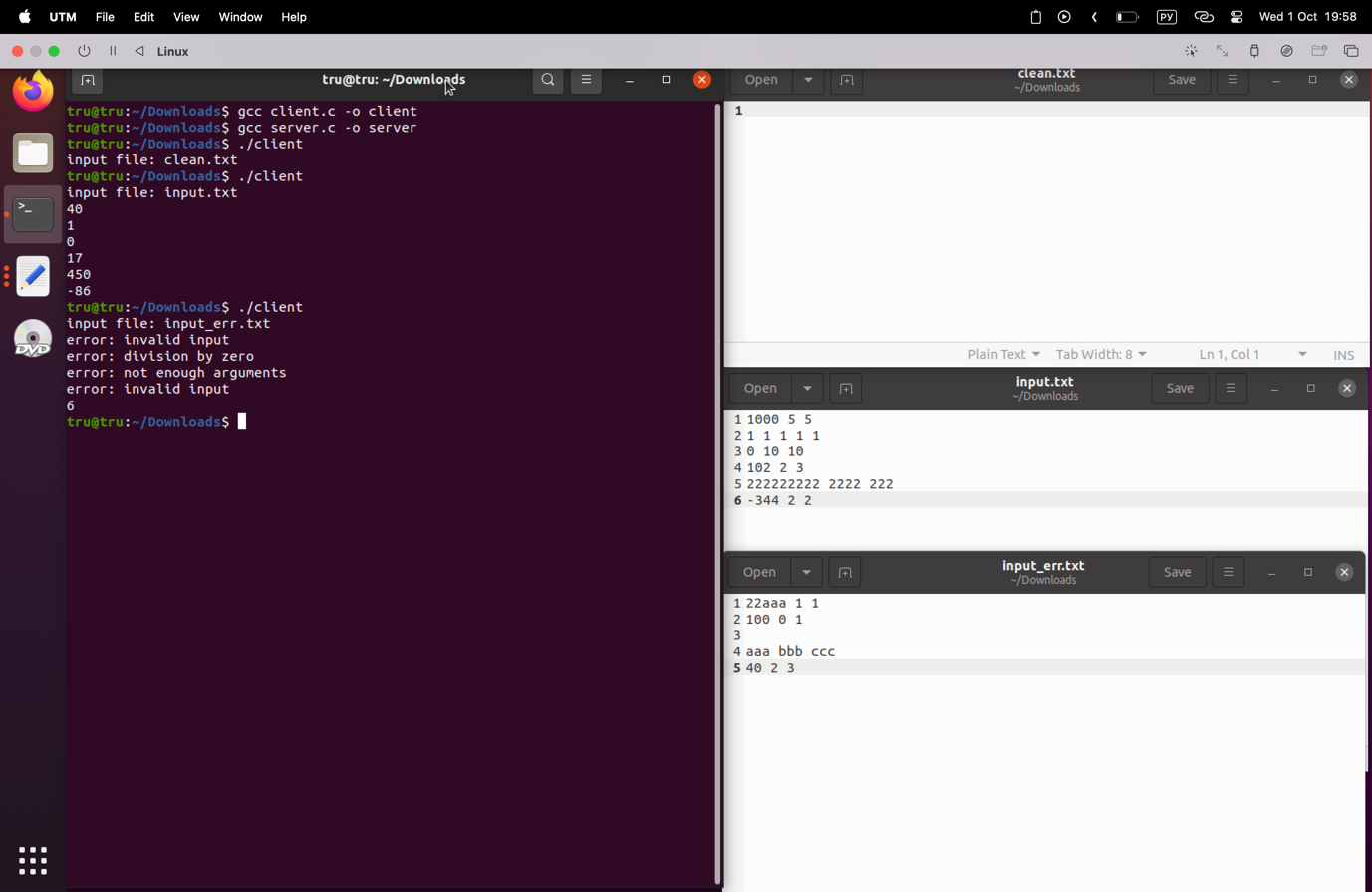
}

return 0;

}

**Протокол работы программы**

**Тесты:**

****

**Strace:**

tru@tru:~/Downloads$ strace -f ./client

execve("./client", ["./client"], 0xffffd190feb8 /\* 73 vars \*/) = 0

brk(NULL) = 0xaaab0c45d000

mmap(NULL, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0xffffb8a7a000

faccessat(AT\_FDCWD, "/etc/ld.so.preload", R\_OK) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls/aarch64/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls/aarch64/atomics", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls/aarch64/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls/aarch64", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls/atomics", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/aarch64/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

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newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/atomics", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib", {st\_mode=S\_IFDIR|0775, st\_size=12288, ...}, 0) = 0

openat(AT\_FDCWD, "/opt/ros/noetic/lib/tls/aarch64/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib/tls/aarch64/atomics", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/opt/ros/noetic/lib/tls/aarch64/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib/tls/aarch64", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/opt/ros/noetic/lib/tls/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib/tls/atomics", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/opt/ros/noetic/lib/tls/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib/tls", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/opt/ros/noetic/lib/aarch64/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib/aarch64/atomics", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

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newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib/aarch64", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/opt/ros/noetic/lib/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib/atomics", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/opt/ros/noetic/lib/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib", {st\_mode=S\_IFDIR|0755, st\_size=12288, ...}, 0) = 0

openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls/aarch64/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls/aarch64/atomics", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls/aarch64/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls/aarch64", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls/atomics", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/aarch64/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/aarch64/atomics", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/aarch64/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

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openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/atomics", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)

openat(AT\_FDCWD, "/etc/ld.so.cache", O\_RDONLY|O\_CLOEXEC) = 3

fstat(3, {st\_mode=S\_IFREG|0644, st\_size=244355, ...}) = 0

mmap(NULL, 244355, PROT\_READ, MAP\_PRIVATE, 3, 0) = 0xffffb8a12000

close(3) = 0

openat(AT\_FDCWD, "/lib/aarch64-linux-gnu/libc.so.6", O\_RDONLY|O\_CLOEXEC) = 3

read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0`\17\2\0\0\0\0\0"..., 832) = 832

fstat(3, {st\_mode=S\_IFREG|0755, st\_size=1450832, ...}) = 0

mmap(NULL, 1519552, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0xffffb889f000

mprotect(0xffffb89fa000, 61440, PROT\_NONE) = 0

mmap(0xffffb8a09000, 24576, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x15a000) = 0xffffb8a09000

mmap(0xffffb8a0f000, 12224, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_ANONYMOUS, -1, 0) = 0xffffb8a0f000

close(3) = 0

mprotect(0xffffb8a09000, 16384, PROT\_READ) = 0

mprotect(0xaaaad9161000, 4096, PROT\_READ) = 0

mprotect(0xffffb8a7f000, 4096, PROT\_READ) = 0

munmap(0xffffb8a12000, 244355) = 0

**write(1, "input file: ", 12input file: ) = 12**

**read(0, input.txt**

**"input.txt\n", 1023) = 10**

**pipe2([3, 4], 0) = 0**

**pipe2([5, 6], 0) = 0**

**clone(child\_stack=NULL, flags=CLONE\_CHILD\_CLEARTID|CLONE\_CHILD\_SETTID|SIGCHLD, child\_tidptr=0xffffb8a7ae00) = 33745**

**close(3strace: Process 33745 attached**

**) = 0**

[pid 33744] close(6 <unfinished ...>

[pid 33745] close(4) = 0

[pid 33744] <... close resumed>) = 0

[pid 33745] close(5 <unfinished ...>

[pid 33744] openat(AT\_FDCWD, "input.txt", O\_RDONLY <unfinished ...>

[pid 33745] <... close resumed>) = 0

[pid 33744] <... openat resumed>) = 3

**[pid 33745] dup3(3, 0, 0 <unfinished ...>**

**[pid 33744] read(3, "1000 5 5\n1 1 1 1 1\n0 10 10\n102 2"..., 4096) = 63**

[pid 33745] <... dup3 resumed>) = 0

**[pid 33744] write(4, "1000 5 5\n1 1 1 1 1\n0 10 10\n102 2"..., 63 <unfinished ...>**

[pid 33745] close(3 <unfinished ...>

[pid 33744] <... write resumed>) = 63

[pid 33745] <... close resumed>) = 0

[pid 33744] read(3, <unfinished ...>

**[pid 33745] dup3(6, 1, 0 <unfinished ...>**

**[pid 33744] <... read resumed>"", 4096) = 0**

[pid 33744] close(3 <unfinished ...>

[pid 33745] <... dup3 resumed>) = 1

[pid 33744] <... close resumed>) = 0

[pid 33745] close(6 <unfinished ...>

[pid 33744] close(4 <unfinished ...>

[pid 33745] <... close resumed>) = 0

[pid 33744] <... close resumed>) = 0

**[pid 33745] execve("./server", ["server"], 0xffffed9f1458 /\* 73 vars \*/ <unfinished ...>**

[pid 33744] read(5, <unfinished ...>

[pid 33745] <... execve resumed>) = 0

[pid 33745] brk(NULL) = 0xaaaaf4f39000

[pid 33745] mmap(NULL, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0xffffb92bd000

[pid 33745] faccessat(AT\_FDCWD, "/etc/ld.so.preload", R\_OK) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls/aarch64/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls/aarch64/atomics", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls/aarch64/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls/aarch64", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls/atomics", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/tls", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/aarch64/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/aarch64/atomics", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/aarch64/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/aarch64", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/atomics", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/devel/lib", {st\_mode=S\_IFDIR|0775, st\_size=12288, ...}, 0) = 0

[pid 33745] openat(AT\_FDCWD, "/opt/ros/noetic/lib/tls/aarch64/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib/tls/aarch64/atomics", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/opt/ros/noetic/lib/tls/aarch64/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib/tls/aarch64", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/opt/ros/noetic/lib/tls/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib/tls/atomics", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/opt/ros/noetic/lib/tls/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib/tls", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/opt/ros/noetic/lib/aarch64/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib/aarch64/atomics", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/opt/ros/noetic/lib/aarch64/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib/aarch64", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/opt/ros/noetic/lib/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib/atomics", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/opt/ros/noetic/lib/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/opt/ros/noetic/lib", {st\_mode=S\_IFDIR|0755, st\_size=12288, ...}, 0) = 0

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls/aarch64/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls/aarch64/atomics", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls/aarch64/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls/aarch64", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls/atomics", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/tls", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/aarch64/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/aarch64/atomics", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/aarch64/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/aarch64", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/atomics/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/atomics", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins/libc.so.6", O\_RDONLY|O\_CLOEXEC) = -1 ENOENT (No such file or directory)

[pid 33745] newfstatat(AT\_FDCWD, "/home/tru/catkin\_ws/install/lib/mavlink\_sitl\_gazebo/plugins", 0xfffff2eaab40, 0) = -1 ENOENT (No such file or directory)

[pid 33745] openat(AT\_FDCWD, "/etc/ld.so.cache", O\_RDONLY|O\_CLOEXEC) = 3

[pid 33745] fstat(3, {st\_mode=S\_IFREG|0644, st\_size=244355, ...}) = 0

[pid 33745] mmap(NULL, 244355, PROT\_READ, MAP\_PRIVATE, 3, 0) = 0xffffb9255000

[pid 33745] close(3) = 0

[pid 33745] openat(AT\_FDCWD, "/lib/aarch64-linux-gnu/libc.so.6", O\_RDONLY|O\_CLOEXEC) = 3

**[pid 33745] read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0`\17\2\0\0\0\0\0"..., 832) = 832**

[pid 33745] fstat(3, {st\_mode=S\_IFREG|0755, st\_size=1450832, ...}) = 0

[pid 33745] mmap(NULL, 1519552, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0xffffb90e2000

[pid 33745] mprotect(0xffffb923d000, 61440, PROT\_NONE) = 0

[pid 33745] mmap(0xffffb924c000, 24576, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x15a000) = 0xffffb924c000

[pid 33745] mmap(0xffffb9252000, 12224, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_ANONYMOUS, -1, 0) = 0xffffb9252000

[pid 33745] close(3) = 0

[pid 33745] mprotect(0xffffb924c000, 16384, PROT\_READ) = 0

[pid 33745] mprotect(0xaaaac1f31000, 4096, PROT\_READ) = 0

[pid 33745] mprotect(0xffffb92c2000, 4096, PROT\_READ) = 0

[pid 33745] munmap(0xffffb9255000, 244355) = 0

**[pid 33745] read(0, "1000 5 5\n1 1 1 1 1\n0 10 10\n102 2"..., 4095) = 63**

**[pid 33745] write(1, "40\n", 3) = 3**

[pid 33744] <... read resumed>"40\n", 4096) = 3

[pid 33745] write(1, "1\n", 2 <unfinished ...>

[pid 33744] write(1, "40\n", 3 <unfinished ...>

[pid 33745] <... write resumed>) = 2

40

[pid 33744] <... write resumed>) = 3

[pid 33745] write(1, "0\n", 2 <unfinished ...>

[pid 33744] read(5, <unfinished ...>

[pid 33745] <... write resumed>) = 2

[pid 33744] <... read resumed>"1\n0\n", 4096) = 4

**[pid 33744] write(1, "1\n0\n", 4 <unfinished ...>**

**[pid 33745] write(1, "17\n", 31**

**0**

**<unfinished ...>**

[pid 33744] <... write resumed>) = 4

[pid 33745] <... write resumed>) = 3

[pid 33744] read(5, <unfinished ...>

[pid 33745] write(1, "450\n", 4 <unfinished ...>

[pid 33744] <... read resumed>"17\n450\n", 4096) = 7

[pid 33745] <... write resumed>) = 4

**[pid 33744] write(1, "17\n450\n", 717**

**450**

**) = 7**

[pid 33745] write(1, "-86\n", 4 <unfinished ...>

[pid 33744] read(5, <unfinished ...>

[pid 33745] <... write resumed>) = 4

[pid 33744] <... read resumed>"-86\n", 4096) = 4

[pid 33745] read(0, "", 4095) = 0

**[pid 33744] write(1, "-86\n", 4 <unfinished ...>**

[pid 33745] exit\_group(0-86

<unfinished ...>

[pid 33744] <... write resumed>) = 4

[pid 33745] <... exit\_group resumed>) = ?

[pid 33744] read(5, <unfinished ...>

[pid 33745] +++ exited with 0 +++

<... read resumed>"", 4096) = 0

--- SIGCHLD {si\_signo=SIGCHLD, si\_code=CLD\_EXITED, si\_pid=33745, si\_uid=1000, si\_status=0, si\_utime=0, si\_stime=0} ---

close(5) = 0

wait4(-1, NULL, 0, NULL) = 33745

**exit\_group(0) = ?**

+++ exited with 0 +++

tru@tru:~/Downloads$

**Вывод**

В ходе лабораторной работы были изучены и применены основные системные вызовы для работы с процессами и межпроцессного взаимодействия в Linux. Реализована программа, демонстрирующая создание процессов, организацию каналов связи и перенаправление стандартных потоков. Для обработки входных данных были разработаны собственные алгоритмы разбора строк и преобразования чисел, учитывающие различные пробелы и разделители. Также обеспечено корректное закрытие файловых дескрипторов для предотвращения утечек.