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**Лабораторная работа №1 по курсу**  
**«Операционные системы»**

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Дата: 29.09.25

Москва, 2025

# 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<newline>». 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 prospath[1024];
```

```
    {
```

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

```
        write(STDOUT_FILENO, msg, sizeof(msg) - 1);
```

```
        ssize_t n = read(STDIN_FILENO, prospath, sizeof(prospath) - 1);
```

```
        if (n <= 0) {
```

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

```
            write(STDERR_FILENO, msg, sizeof(msg) - 1);
```

```
            exit(EXIT_FAILURE);
```

```
        }
```

```
        prospath[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:

The screenshot shows a Linux desktop environment with a terminal window and a file editor. The terminal window displays the following commands and output:

```

tru@tru: ~/Downloads$ gcc client.c -o client
tru@tru: ~/Downloads$ gcc server.c -o server
tru@tru: ~/Downloads$ ./client
input file: clean.txt
tru@tru: ~/Downloads$ ./client
input file: input.txt
40
1
0
17
450
-86
tru@tru: ~/Downloads$ ./client
input file: input_err.txt
error: invalid input
error: division by zero
error: not enough arguments
error: invalid input
6
tru@tru: ~/Downloads$

```

The file editor shows the contents of two files:

**clean.txt**

```

1

```

**input.txt**

```

1 1000 5 5
2 1 1 1 1 1
3 0 10 10
4 102 2 3
5 2222222222 2222 222
6 -344 2 2

```

**input\_err.txt**

```

1 22aaa 1 1
2 100 0 1
3
4 aaa bbb ccc
5 40 2 3

```

## 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)
```

```
newfstatat(AT_FDCWD, "/home/tru/catkin_ws/devel/lib/aarch64/atomics", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)
```

```
openat(AT_FDCWD, "/home/tru/catkin_ws/devel/lib/aarch64/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)
```

```
newfstatat(AT_FDCWD, "/home/tru/catkin_ws/devel/lib/aarch64", 0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)
```

```
openat(AT_FDCWD, "/home/tru/catkin_ws/devel/lib/atomics/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)
```

```
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)

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

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)
```

```
newfstatat(AT_FDCWD, "/home/tru/catkin_ws/install/lib/mavlink_sitl_gazebo/plugins/aarch64",  
0xffffed9f0070, 0) = -1 ENOENT (No such file or directory)
```

```
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\3\0\267\0\1\0\0\0`\17\2\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(0xaaad9161000, 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\n0 10 10\n102 2"..., 4096) = 63**

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

**[pid 33744] write(4, "1000 5 5\n1 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"], 0xffffd9f1458 /\* 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", 0xffff2eaab40, 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\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(0xaaac1f31000, 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\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.