

**МОСКОВСКИЙ АВИАЦИОННЫЙ ИНСТИТУТ
(НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ УНИВЕРСИТЕТ)**

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Кафедра 806 «Вычислительная математика и программирование»**

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

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Дата сдачи: 25.12.2025

Москва, 2025

Условие

Родительский процесс создает два дочерних процесса. Первой строкой пользователь в консоль родительского процесса вводит имя файла, которое будет использовано для открытия File с таким именем на запись для child1. Аналогично для второй строки и процесса child2. Родительский и дочерний процесс должны быть представлены разными программами. Родительский процесс принимает от пользователя строки произвольной длины и пересылает их в pipe1 или в pipe2 в зависимости от правила фильтрации. Процесс child1 и child2 производят работу над строками. Процессы пишут результаты своей работы в стандартный вывод.

Цель работы

Изучение механизмов создания процессов, организации межпроцессного взаимодействия через pipes и обработки данных в многопроцессной архитектуре.

Задание

Правило фильтрации: строки длины больше 10 отправляются в pipe2, четные в pipe1. Дочерние процессы удаляют все гласные из строк.

Вариант

17

Метод решения

Данная программа реализует многопроцессную обработку текстовых данных с использованием каналов (pipes) для межпроцессного взаимодействия. Основной алгоритм: родительский процесс читает строки из стандартного ввода и направляет строки длиной больше 10 второму дочернему процессу, меньше 10 - первому. Каждый дочерний процесс получает строки из своего канала, удаляет все гласные из строк их и записывает в указанный файл.

Ключевые компоненты:

ParentProcess - управляет каналами и дочерними процессами

Pipe - реализация каналов

ChildProcess - запускает дочерние процессы

ChildProcessor - обрабатывает данные в дочерних процессах

Системные вызовы:

Linux: pipe, fork, execl, read, write

Программа использует объектно-ориентированный подход с инкапсуляцией.

Описание программы

Программа реализует многопроцессную обработку текстовых данных через каналы (pipes). Родительский процесс читает строки из стандартного ввода и распределяет их между двумя дочерними процессами

Каждый дочерний процесс удаляет все гласные буквы и записывает результат в указанный файл.

Программа состоит из двух исполняемых файлов: `parent` и `child`.
`parent (src/parent.cpp)` — родительский процесс:
создаёт каналы (`Pipe`), порождает дочерние процессы (`fork/exec1`),
считывает строки до `END` и распределяет их по длине.
`child (src/child.cpp)` — дочерний процесс:
через `ChildProcess` читает данные из канала,
удаляет гласные с помощью `ChildProcessor`
и записывает результат в файл и на экран.

Результаты

Разработанная программа успешно реализует многопроцессную архитектуру для параллельной обработки текстовых данных.

В ходе решения были достигнуты следующие ключевые результаты:

Корректная работа системы межпроцессного взаимодействия

Реализованы два независимых канала передачи данных между родительским и дочерними процессами

Обеспечено четкое распределение строк по принципу больше/меньше 10

Достигнута синхронизация процессов через блокирующие операции чтения/записи

Реализована унифицированная абстракция для работы с каналами через класс `Pipe`

Выводы

В ходе лабораторной работы успешно разработана многопроцессная система обработки текстовых данных с использованием межпроцессного взаимодействия через каналы. Программа демонстрирует корректную работу на Unix системах.

Исходная программа

Листинг 1: src/parent.cpp — родительский процесс

```
1  #include <iostream>
2  #include <string>
3  #include <unistd.h>
4  #include <sys/wait.h>
5  #include <cstdlib>
6  #include "pipe.hpp"
7
8  int main()
9  {
10     std::string file1, file2;
11     std::getline(std::cin, file1);
12     std::getline(std::cin, file2);
13
14     Pipe pipe1;
15     Pipe pipe2;
16
17     pid_t pid1 = fork();
18     if (pid1 == 0)
19     {
20         pipe1.closeWrite();
21         pipe2.closeRead();
22         pipe2.closeWrite();
23         execl("./child", "./child", std::to_string(pipe1.getReadFd()).c_str(), file1.
24             c_str(), nullptr);
25         std::cerr << "Exec failed for child1" << std::endl;
26         exit(1);
27     }
28     else if (pid1 < 0)
29     {
30         std::cerr << "Fork failed for child1" << std::endl;
31         return 1;
32     }
33
34     pid_t pid2 = fork();
35     if (pid2 == 0)
36     {
37         pipe2.closeWrite();
38         pipe1.closeRead();
39         pipe1.closeWrite();
40         execl("./child", "./child", std::to_string(pipe2.getReadFd()).c_str(), file2.
41             c_str(), nullptr);
42         std::cerr << "Exec failed for child2" << std::endl;
43         exit(1);
44     }
45     else if (pid2 < 0)
46     {
47         std::cerr << "Fork failed for child2" << std::endl;
48         return 1;
49     }
50
51     pipe1.closeRead();
52     pipe2.closeRead();
53
54     std::string line;
```

```

53 | while (std::getline(std::cin, line))
54 | {
55 |     line += "\n";
56 |     if (line.length() - 1 > 10)
57 |     {
58 |         write(pipe2.getWriteFd(), line.c_str(), line.length());
59 |     }
60 |     else
61 |     {
62 |         write(pipe1.getWriteFd(), line.c_str(), line.length());
63 |     }
64 | }
65 |
66 | pipe1.closeWrite();
67 | pipe2.closeWrite();
68 |
69 | waitpid(pid1, nullptr, 0);
70 | waitpid(pid2, nullptr, 0);
71 |
72 | return 0;
73 | }

```

Листинг 2: src/child.cpp — точка входа дочернего процесса

```

1 | #include <iostream>
2 | #include <string>
3 | #include <cstdlib>
4 | #include "childProcess.hpp"
5 |
6 | int main(int argc, char *argv[])
7 | {
8 |     if (argc != 3)
9 |     {
10 |         std::cerr << "Usage: " << argv[0] << " <read_fd> <filename>" << std::endl;
11 |         return 1;
12 |     }
13 |
14 |     int read_fd = std::atoi(argv[1]);
15 |     std::string filename = argv[2];
16 |
17 |     ChildProcess child(read_fd, filename);
18 |     child.run();
19 |
20 |     return 0;
21 | }

```

Листинг 3: src/childProcess.cpp — обработка в child

```

1 | #include "childProcess.hpp"
2 | #include <iostream>
3 | #include <fstream>
4 | #include <string>
5 |
6 | ChildProcess::ChildProcess(int read_fd, const std::string &filename)
7 |     : read_fd_(read_fd), filename_(filename) {}

```

```

8
9 void ChildProcess::run()
10 {
11     std::ofstream file(filename_);
12     if (!file.is_open())
13     {
14         std::cerr << "Failed to open file: " << filename_ << std::endl;
15         close(read_fd_);
16         return;
17     }
18
19     std::string line;
20     char ch;
21     while (read(read_fd_, &ch, 1) == 1)
22     {
23         line += ch;
24         if (ch == '\n')
25         {
26             std::string processed = processor_.removeVowels(line);
27             std::cout << processed;
28             file << processed;
29             line.clear();
30         }
31     }
32     if (!line.empty())
33     {
34         std::string processed = processor_.removeVowels(line);
35         std::cout << processed;
36         file << processed;
37     }
38
39     file.close();
40     close(read_fd_);
41 }

```

Листинг 4: src/childProcessor.cpp — удаление гласных

```

1 #include "childProcessor.hpp"
2 #include <algorithm>
3 #include <cctype>
4
5 std::string ChildProcessor::removeVowels(const std::string &input)
6 {
7     std::string result = input;
8     std::string vowels = "aeiouAEIOU";
9     result.erase(std::remove_if(result.begin(), result.end(), [&](char c)
10                             { return vowels.find(c) != std::string::npos; }),
11                 result.end());
12     return result;
13 }

```

Листинг 5: src/pipe.cpp — обёртка над pipe()

```

1 #include "pipe.hpp"
2 #include <unistd.h>

```

```

3  | #include <iostream>
4  |
5  | Pipe::Pipe()
6  | {
7  |     fds_[0] = -1;
8  |     fds_[1] = -1;
9  |     if (pipe(fds_) == -1)
10 |     {
11 |         std::cerr << "Pipe creation failed" << std::endl;
12 |     }
13 | }
14 |
15 | Pipe::~Pipe()
16 | {
17 |     closeRead();
18 |     closeWrite();
19 | }
20 |
21 | int Pipe::getReadFd() const
22 | {
23 |     return fds_[0];
24 | }
25 |
26 | int Pipe::getWriteFd() const
27 | {
28 |     return fds_[1];
29 | }
30 |
31 | void Pipe::closeRead()
32 | {
33 |     if (fds_[0] != -1)
34 |     {
35 |         close(fds_[0]);
36 |         fds_[0] = -1;
37 |     }
38 | }
39 |
40 | void Pipe::closeWrite()
41 | {
42 |     if (fds_[1] != -1)
43 |     {
44 |         close(fds_[1]);
45 |         fds_[1] = -1;
46 |     }
47 | }

```

Системные вызовы

```

55532 execve("./parent",["./parent"],0x7ffd7d0a0d38 /* 42 vars */) = 0
55532 brk(NULL) = 0x5bdb92fb9000
55532 mmap(NULL,8192,PROT_READ|PROT_WRITE,MAP_PRIVATE|MAP_ANONYMOUS,-1,0) =
0x7c7bc6641000
55532 access("/etc/ld.so.preload",R_OK) = -1 ENOENT (No such file or directory)
55532 openat(AT_FDCWD,"/etc/ld.so.cache",O_RDONLY|O_CLOEXEC) = 3
55532 fstat(3,{st_mode=S_IFREG|0644,st_size=30415,...}) = 0
55532 mmap(NULL,30415,PROT_READ,MAP_PRIVATE,3,0) = 0x7c7bc6639000

```

```

55532 close(3) = 0
55532 openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libstdc++.so.6", O_RDONLY|O_CLOEXEC)
= 3
55532 read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\0\0\0\0\0\0"..., 832)
= 832
55532 fstat(3, {st_mode=S_IFREG|0644, st_size=2592224, ...}) = 0
55532 mmap(NULL, 2609472, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7c7bc6200000
55532 mmap(0x7c7bc629d000, 1343488, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0)
= 0x7c7bc629d000
55532 mmap(0x7c7bc63e5000, 552960, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0)
= 0x7c7bc63e5000
55532 mmap(0x7c7bc646c000, 57344, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0)
= 0x7c7bc646c000
55532 mmap(0x7c7bc647a000, 12608, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, 3, 0)
= 0x7c7bc647a000
55532 close(3) = 0
55532 openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libgcc_s.so.1", O_RDONLY|O_CLOEXEC)
= 3
55532 read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\0\0\0\0\0\0"..., 832)
= 832
55532 fstat(3, {st_mode=S_IFREG|0644, st_size=183024, ...}) = 0
55532 mmap(NULL, 185256, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7c7bc660b000
55532 mmap(0x7c7bc660f000, 147456, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0)
= 0x7c7bc660f000
55532 mmap(0x7c7bc6633000, 16384, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0)
= 0x7c7bc6633000
55532 mmap(0x7c7bc6637000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0)
= 0x7c7bc6637000
55532 close(3) = 0
55532 openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC)
= 3
55532 read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\220\243\2\0\0\0\0\0"..., 832)
= 832
55532 pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0"..., 784)
= 784
55532 fstat(3, {st_mode=S_IFREG|0755, st_size=2125328, ...}) = 0
55532 pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0"..., 784)
= 784
55532 mmap(NULL, 2170256, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7c7bc5e00000
55532 mmap(0x7c7bc5e28000, 1605632, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0)
= 0x7c7bc5e28000
55532 mmap(0x7c7bc5fb0000, 323584, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0)
= 0x7c7bc5fb0000
55532 mmap(0x7c7bc5fff000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0)
= 0x7c7bc5fff000
55532 mmap(0x7c7bc6005000, 52624, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, 3, 0)
= 0x7c7bc6005000
55532 close(3) = 0

```



```

55532 openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libm.so.6", O_RDONLY|O_CLOEXEC)
= 3
55532 read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\0\0\0\0\0\0"..., 832)
= 832
55532 fstat(3, {st_mode=S_IFREG|0644, st_size=952616, ...}) = 0
55532 mmap(NULL, 950296, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7c7bc6522000
55532 mmap(0x7c7bc6532000, 520192, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWR
= 0x7c7bc6532000
55532 mmap(0x7c7bc65b1000, 360448, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x8f
= 0x7c7bc65b1000
55532 mmap(0x7c7bc6609000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWR
= 0x7c7bc6609000
55532 close(3) = 0
55532 mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7c7bc6520000
55532 mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0)
= 0x7c7bc651d000
55532 arch_prctl(ARCH_SET_FS, 0x7c7bc651d740) = 0
55532 set_tid_address(0x7c7bc651da10) = 55532
55532 set_robust_list(0x7c7bc651da20, 24) = 0
55532 rseq(0x7c7bc651e060, 0x20, 0, 0x53053053) = 0
55532 mprotect(0x7c7bc5fff000, 16384, PROT_READ) = 0
55532 mprotect(0x7c7bc6609000, 4096, PROT_READ) = 0
55532 mprotect(0x7c7bc6637000, 4096, PROT_READ) = 0
55532 mprotect(0x7c7bc646c000, 45056, PROT_READ) = 0
55532 mprotect(0x5bdb5cddb000, 4096, PROT_READ) = 0
55532 mprotect(0x7c7bc6679000, 8192, PROT_READ) = 0
55532 prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY})
= 0
55532 munmap(0x7c7bc6639000, 30415) = 0
55532 futex(0x7c7bc647a7bc, FUTEX_WAKE_PRIVATE, 2147483647) = 0
55532 getrandom("\x34\x6e\x52\x38\xe7\xf\x6\xdd", 8, GRND_NONBLOCK) = 8
55532 brk(NULL) = 0x5bdb92fb9000
55532 brk(0x5bdb92fda000) = 0x5bdb92fda000
55532 fstat(0, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x4), ...}) = 0
55532 read(0, "", 1024) = 0
55532 pipe2([3, 4], 0) = 0
55532 pipe2([5, 6], 0) = 0
55532 clone(child_stack=NULL, flags=CLONE_CHILD_CLEARTID|CLONE_CHILD_SETTID|SIGCHLD, ch
= 55679
55532 clone(child_stack=NULL, flags=CLONE_CHILD_CLEARTID|CLONE_CHILD_SETTID|SIGCHLD
<unfinished ...>
55679 set_robust_list(0x7c7bc651da20, 24) = 0
55679 close(4 <unfinished ...>
55532 <... clone resumed>, child_tidptr=0x7c7bc651da10) = 55680
55680 set_robust_list(0x7c7bc651da20, 24 <unfinished ...>
55532 close(3 <unfinished ...>
55679 <... close resumed> = 0

```

```

55680 <... set_robust_list resumed>)      = 0
55532 <... close resumed>)                = 0
55679 close(5 <unfinished ...>
55680 close(6 <unfinished ...>
55532 close(5 <unfinished ...>
55679 <... close resumed>)                = 0
55532 <... close resumed>)                = 0
55680 <... close resumed>)                = 0
55532 close(4 <unfinished ...>
55679 close(6 <unfinished ...>
55680 close(3 <unfinished ...>
55532 <... close resumed>)                = 0
55680 <... close resumed>)                = 0
55679 <... close resumed>)                = 0
55532 close(6)                            = 0
55680 close(4 <unfinished ...>
55679 execve("./child",["./child","3",""],0x7ffd87d47708 /* 42 vars */ <unfinished
...>
55532 wait4(55679, <unfinished ...>
55680 <... close resumed>)                = 0
55680 execve("./child",["./child","5",""],0x7ffd87d47708 /* 42 vars */) = 0
55679 <... execve resumed>)                = 0
55680 brk(NULL <unfinished ...>
55679 brk(NULL <unfinished ...>
55680 <... brk resumed>)                  = 0x5929f5b5e000
55679 <... brk resumed>)                  = 0x6290049ce000
55680 mmap(NULL,8192,PROT_READ|PROT_WRITE,MAP_PRIVATE|MAP_ANONYMOUS,-1,0 <unfinished
...>
55679 mmap(NULL,8192,PROT_READ|PROT_WRITE,MAP_PRIVATE|MAP_ANONYMOUS,-1,0 <unfinished
...>
55680 <... mmap resumed>)                  = 0x731db2bb4000
55679 <... mmap resumed>)                  = 0x74a03c052000
55680 access("/etc/ld.so.preload",R_OK <unfinished ...>
55679 access("/etc/ld.so.preload",R_OK <unfinished ...>
55680 <... access resumed>)                  = -1 ENOENT (No such file or directory)
55679 <... access resumed>)                  = -1 ENOENT (No such file or directory)
55680 openat(AT_FDCWD,"/etc/ld.so.cache",O_RDONLY|O_CLOEXEC <unfinished ...>
55679 openat(AT_FDCWD,"/etc/ld.so.cache",O_RDONLY|O_CLOEXEC <unfinished ...>
55680 <... openat resumed>)                  = 3
55679 <... openat resumed>)                  = 4
55680 fstat(3, <unfinished ...>
55679 fstat(4, <unfinished ...>
55680 <... fstat resumed>{st_mode=S_IFREG|0644,st_size=30415,...}) = 0
55679 <... fstat resumed>{st_mode=S_IFREG|0644,st_size=30415,...}) = 0
55680 mmap(NULL,30415,PROT_READ,MAP_PRIVATE,3,0 <unfinished ...>
55679 mmap(NULL,30415,PROT_READ,MAP_PRIVATE,4,0 <unfinished ...>
55680 <... mmap resumed>)                    = 0x731db2bac000
55679 <... mmap resumed>)                    = 0x74a03c04a000

```

[illegible]

```
<unfinished ...>  
55680 close(3 <unfinished ...>  
55679 <... mmap resumed>) = 0x74a03be7a000  
55680 <... close resumed>) = 0  
55680 openat(AT_FDCWD,"/lib/x86_64-linux-gnu/libgcc_s.so.1",O_RDONLY|O_CLOEXEC  
<unfinished ...>  
55679 close(4 <unfinished ...>  
55680 <... openat resumed>) = 3  
55679 <... close resumed>) = 0  
55680 read(3, <unfinished ...>  
55679 openat(AT_FDCWD,"/lib/x86_64-linux-gnu/libgcc_s.so.1",O_RDONLY|O_CLOEXEC  
<unfinished ...>  
55680 <... read resumed>"\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\0\0\0\0\0\0\0  
= 832  
55680 fstat(3, <unfinished ...>  
55679 <... openat resumed>) = 4  
55680 <... fstat resumed>{st_mode=S_IFREG|0644,st_size=183024,...}) = 0  
55679 read(4, <unfinished ...>  
55680 mmap(NULL,185256,PROT_READ,MAP_PRIVATE|MAP_DENYWRITE,3,0 <unfinished  
...>  
55679 <... read resumed>"\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\0\0\0\0\0\0\0  
= 832  
55680 <... mmap resumed>) = 0x731db2b7e000  
55680 mmap(0x731db2b82000,147456,PROT_READ|PROT_EXEC,MAP_PRIVATE|MAP_FIXED|MAP_DENYWR  
<unfinished ...>  
55679 fstat(4, <unfinished ...>  
55680 <... mmap resumed>) = 0x731db2b82000  
55679 <... fstat resumed>{st_mode=S_IFREG|0644,st_size=183024,...}) = 0  
55680 mmap(0x731db2ba6000,16384,PROT_READ,MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,3,0x280  
<unfinished ...>  
55679 mmap(NULL,185256,PROT_READ,MAP_PRIVATE|MAP_DENYWRITE,4,0 <unfinished  
...>  
55680 <... mmap resumed>) = 0x731db2ba6000  
55680 mmap(0x731db2baa000,8192,PROT_READ|PROT_WRITE,MAP_PRIVATE|MAP_FIXED|MAP_DENYWRI  
<unfinished ...>  
55679 <... mmap resumed>) = 0x74a03c01c000  
55680 <... mmap resumed>) = 0x731db2baa000  
55679 mmap(0x74a03c020000,147456,PROT_READ|PROT_EXEC,MAP_PRIVATE|MAP_FIXED|MAP_DENYWR  
<unfinished ...>  
55680 close(3 <unfinished ...>  
55679 <... mmap resumed>) = 0x74a03c020000  
55680 <... close resumed>) = 0  
55679 mmap(0x74a03c044000,16384,PROT_READ,MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,4,0x280  
<unfinished ...>  
55680 openat(AT_FDCWD,"/lib/x86_64-linux-gnu/libc.so.6",O_RDONLY|O_CLOEXEC  
<unfinished ...>  
55679 <... mmap resumed>) = 0x74a03c044000  
55680 <... openat resumed>) = 3
```

```

55679 mmap(0x74a03c048000,8192,PROT_READ|PROT_WRITE,MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE
<unfinished ...>
55680 read(3, <unfinished ...>
55679 <... mmap resumed>) = 0x74a03c048000
55680 <... read resumed>"\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\220\243\2\0\0
= 832
55679 close(4 <unfinished ...>
55680 pread64(3, <unfinished ...>
55679 <... close resumed>) = 0
55680 <... pread64 resumed>"\6\0\0\0\4\0\0\0@ \0\0\0\0\0\0\0@ \0\0\0\0\0\0\0@ \0\0\0\0\0
= 784
55680 fstat(3, <unfinished ...>
55679 openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC
<unfinished ...>
55680 <... fstat resumed>{st_mode=S_IFREG|0755,st_size=2125328,...}) = 0
55679 <... openat resumed>) = 4
55680 pread64(3, <unfinished ...>
55679 read(4, <unfinished ...>
55680 <... pread64 resumed>"\6\0\0\0\4\0\0\0@ \0\0\0\0\0\0\0@ \0\0\0\0\0\0\0@ \0\0\0\0\0
= 784
55679 <... read resumed>"\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\220\243\2\0\0
= 832
55680 mmap(NULL,2170256,PROT_READ,MAP_PRIVATE|MAP_DENYWRITE,3,0 <unfinished
...>
55679 pread64(4, <unfinished ...>
55680 <... mmap resumed>) = 0x731db2400000
55679 <... pread64 resumed>"\6\0\0\0\4\0\0\0@ \0\0\0\0\0\0\0@ \0\0\0\0\0\0\0@ \0\0\0\0\0
= 784
55680 mmap(0x731db2428000,1605632,PROT_READ|PROT_EXEC,MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE
<unfinished ...>
55679 fstat(4,{st_mode=S_IFREG|0755,st_size=2125328,...}) = 0
55680 <... mmap resumed>) = 0x731db2428000
55679 pread64(4, <unfinished ...>
55680 mmap(0x731db25b0000,323584,PROT_READ,MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,3,0x1b
<unfinished ...>
55679 <... pread64 resumed>"\6\0\0\0\4\0\0\0@ \0\0\0\0\0\0\0@ \0\0\0\0\0\0\0@ \0\0\0\0\0
= 784
55680 <... mmap resumed>) = 0x731db25b0000
55679 mmap(NULL,2170256,PROT_READ,MAP_PRIVATE|MAP_DENYWRITE,4,0 <unfinished
...>
55680 mmap(0x731db25ff000,24576,PROT_READ|PROT_WRITE,MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE
<unfinished ...>
55679 <... mmap resumed>) = 0x74a03b800000
55680 <... mmap resumed>) = 0x731db25ff000
55679 mmap(0x74a03b828000,1605632,PROT_READ|PROT_EXEC,MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE
<unfinished ...>
55680 mmap(0x731db2605000,52624,PROT_READ|PROT_WRITE,MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS
<unfinished ...>

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```

55679 <... mmap resumed>) = 0x74a03b828000
55680 <... mmap resumed>) = 0x731db2605000
55679 mmap(0x74a03b9b0000,323584,PROT_READ,MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,4,0x1b
<unfinished ...>
55680 close(3 <unfinished ...>
55679 <... mmap resumed>) = 0x74a03b9b0000
55680 <... close resumed>) = 0
55679 mmap(0x74a03b9ff000,24576,PROT_READ|PROT_WRITE,MAP_PRIVATE|MAP_FIXED|MAP_DENYWR
<unfinished ...>
55680 openat(AT_FDCWD,"/lib/x86_64-linux-gnu/libm.so.6",O_RDONLY|O_CLOEXEC
<unfinished ...>
55679 <... mmap resumed>) = 0x74a03b9ff000
55680 <... openat resumed>) = 3
55679 mmap(0x74a03ba05000,52624,PROT_READ|PROT_WRITE,MAP_PRIVATE|MAP_FIXED|MAP_ANONYM
<unfinished ...>
55680 read(3, <unfinished ...>
55679 <... mmap resumed>) = 0x74a03ba05000
55680 <... read resumed>"\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\0\0\0\0\0\0\0
= 832
55679 close(4 <unfinished ...>
55680 fstat(3, <unfinished ...>
55679 <... close resumed>) = 0
55680 <... fstat resumed>{st_mode=S_IFREG|0644,st_size=952616,...}) = 0
55679 openat(AT_FDCWD,"/lib/x86_64-linux-gnu/libm.so.6",O_RDONLY|O_CLOEXEC
<unfinished ...>
55680 mmap(NULL,950296,PROT_READ,MAP_PRIVATE|MAP_DENYWRITE,3,0) = 0x731db2a95000
55679 <... openat resumed>) = 4
55680 mmap(0x731db2aa5000,520192,PROT_READ|PROT_EXEC,MAP_PRIVATE|MAP_FIXED|MAP_DENYWR
<unfinished ...>
55679 read(4, <unfinished ...>
55680 <... mmap resumed>) = 0x731db2aa5000
55679 <... read resumed>"\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\0\0\0\0\0\0\0
= 832
55680 mmap(0x731db2b24000,360448,PROT_READ,MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,3,0x8f
<unfinished ...>
55679 fstat(4, <unfinished ...>
55680 <... mmap resumed>) = 0x731db2b24000
55679 <... fstat resumed>{st_mode=S_IFREG|0644,st_size=952616,...}) = 0
55680 mmap(0x731db2b7c000,8192,PROT_READ|PROT_WRITE,MAP_PRIVATE|MAP_FIXED|MAP_DENYWRI
<unfinished ...>
55679 mmap(NULL,950296,PROT_READ,MAP_PRIVATE|MAP_DENYWRITE,4,0 <unfinished
...>
55680 <... mmap resumed>) = 0x731db2b7c000
55679 <... mmap resumed>) = 0x74a03bf33000
55680 close(3 <unfinished ...>
55679 mmap(0x74a03bf43000,520192,PROT_READ|PROT_EXEC,MAP_PRIVATE|MAP_FIXED|MAP_DENYWR
<unfinished ...>
55680 <... close resumed>) = 0

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55679 <... mmap resumed>) = 0x74a03bf43000
55680 mmap(NULL,8192,PROT_READ|PROT_WRITE,MAP_PRIVATE|MAP_ANONYMOUS,-1,0 <unfinished
...>
55679 mmap(0x74a03bfc2000,360448,PROT_READ,MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,4,0x8f
<unfinished ...>
55680 <... mmap resumed>) = 0x731db2a93000
55679 <... mmap resumed>) = 0x74a03bfc2000
55680 mmap(NULL,12288,PROT_READ|PROT_WRITE,MAP_PRIVATE|MAP_ANONYMOUS,-1,0 <unfinished
...>
55679 mmap(0x74a03c01a000,8192,PROT_READ|PROT_WRITE,MAP_PRIVATE|MAP_FIXED|MAP_DENYWRI
<unfinished ...>
55680 <... mmap resumed>) = 0x731db2a90000
55679 <... mmap resumed>) = 0x74a03c01a000
55680 arch_prctl(ARCH_SET_FS,0x731db2a90740 <unfinished ...>
55679 close(4 <unfinished ...>
55680 <... arch_prctl resumed>) = 0
55680 set_tid_address(0x731db2a90a10 <unfinished ...>
55679 <... close resumed>) = 0
55680 <... set_tid_address resumed>) = 55680
55679 mmap(NULL,8192,PROT_READ|PROT_WRITE,MAP_PRIVATE|MAP_ANONYMOUS,-1,0 <unfinished
...>
55680 set_robust_list(0x731db2a90a20,24) = 0
55679 <... mmap resumed>) = 0x74a03bf31000
55680 rseq(0x731db2a91060,0x20,0,0x53053053) = 0
55679 mmap(NULL,12288,PROT_READ|PROT_WRITE,MAP_PRIVATE|MAP_ANONYMOUS,-1,0 <unfinished
...>
55680 mprotect(0x731db25ff000,16384,PROT_READ <unfinished ...>
55679 <... mmap resumed>) = 0x74a03bf2e000
55680 <... mprotect resumed>) = 0
55679 arch_prctl(ARCH_SET_FS,0x74a03bf2e740 <unfinished ...>
55680 mprotect(0x731db2b7c000,4096,PROT_READ <unfinished ...>
55679 <... arch_prctl resumed>) = 0
55680 <... mprotect resumed>) = 0
55679 set_tid_address(0x74a03bf2ea10 <unfinished ...>
55680 mprotect(0x731db2baa000,4096,PROT_READ <unfinished ...>
55679 <... set_tid_address resumed>) = 55679
55680 <... mprotect resumed>) = 0
55679 set_robust_list(0x74a03bf2ea20,24) = 0
55679 rseq(0x74a03bf2f060,0x20,0,0x53053053) = 0
55680 mprotect(0x731db2a6c000,45056,PROT_READ <unfinished ...>
55679 mprotect(0x74a03b9ff000,16384,PROT_READ <unfinished ...>
55680 <... mprotect resumed>) = 0
55679 <... mprotect resumed>) = 0
55680 mprotect(0x5929ea6b2000,4096,PROT_READ <unfinished ...>
55679 mprotect(0x74a03c01a000,4096,PROT_READ <unfinished ...>
55680 <... mprotect resumed>) = 0
55679 <... mprotect resumed>) = 0
55680 mprotect(0x731db2bec000,8192,PROT_READ <unfinished ...>

```

```

55679 mprotect(0x74a03c048000,4096,PROT_READ <unfinished ...>
55680 <... mprotect resumed>) = 0
55679 <... mprotect resumed>) = 0
55680 prlimit64(0,RLIMIT_STACK,NULL,{rlim_cur=8192*1024,rlim_max=RLIM64_INFINITY})
= 0
55680 munmap(0x731db2bac000,30415) = 0
55679 mprotect(0x74a03be6c000,45056,PROT_READ <unfinished ...>
55680 futex(0x731db2a7a7bc,FUTEX_WAKE_PRIVATE,2147483647 <unfinished ...>
55679 <... mprotect resumed>) = 0
55680 <... futex resumed>) = 0
55679 mprotect(0x628ff30e8000,4096,PROT_READ <unfinished ...>
55680 getrandom( <unfinished ...>
55679 <... mprotect resumed>) = 0
55680 <... getrandom resumed>"\x26\x4a\x75\x16\x43\xa6\xb6\xdb",8,GRND_NONBLOCK)
= 8
55679 mprotect(0x74a03c08a000,8192,PROT_READ <unfinished ...>
55680 brk(NULL) = 0x5929f5b5e000
55679 <... mprotect resumed>) = 0
55680 brk(0x5929f5b7f000 <unfinished ...>
55679 prlimit64(0,RLIMIT_STACK,NULL, <unfinished ...>
55680 <... brk resumed>) = 0x5929f5b7f000
55679 <... prlimit64 resumed>{rlim_cur=8192*1024,rlim_max=RLIM64_INFINITY})
= 0
55680 openat(AT_FDCWD,"",O_WRONLY|O_CREAT|O_TRUNC,0666 <unfinished ...>
55679 munmap(0x74a03c04a000,30415 <unfinished ...>
55680 <... openat resumed>) = -1 ENOENT (No such file or directory)
55679 <... munmap resumed>) = 0
55680 write(2,"Failed to open file: ",21) = 21
55679 futex(0x74a03be7a7bc,FUTEX_WAKE_PRIVATE,2147483647 <unfinished ...>
55680 write(2,"\n",1 <unfinished ...>
55679 <... futex resumed>) = 0
55680 <... write resumed>) = 1
55679 getrandom( <unfinished ...>
55680 close(5 <unfinished ...>
55679 <... getrandom resumed>"\x59\xeb\x70\x5f\x8b\x9e\xc0\x6e",8,GRND_NONBLOCK)
= 8
55680 <... close resumed>) = 0
55679 brk(NULL) = 0x6290049ce000
55679 brk(0x6290049ef000 <unfinished ...>
55680 exit_group(0 <unfinished ...>
55679 <... brk resumed>) = 0x6290049ef000
55680 <... exit_group resumed>) = ?
55679 openat(AT_FDCWD,"",O_WRONLY|O_CREAT|O_TRUNC,0666 <unfinished ...>
55680 +++ exited with 0 +++
55532 <... wait4 resumed>NULL,0,NULL) = ? ERESTARTSYS (To be restarted if SA_RESTART
is set)
55679 <... openat resumed>) = -1 ENOENT (No such file or directory)
55532 ---SIGCHLD {si_signo=SIGCHLD,si_code=CLD_EXITED,si_pid=55680,si_uid=1000,si_sta

```

55532 wait4(55679, <unfinished ...>

55679 write(2,"Failed to open file: ",21) = 21

55679 write(2,"\n",1) = 1

55679 close(3) = 0

55679 exit_group(0) = ?

55679 +++ exited with 0 +++

55532 <... wait4 resumed>NULL,0,NULL) = 55679

55532 ---SIGCHLD {si_signo=SIGCHLD,si_code=CLD_EXITED,si_pid=55679,si_uid=1000,si_sta

55532 wait4(55680,NULL,0,NULL) = 55680

55532 exit_group(0) = ?

55532 +++ exited with 0 +++