Московский Авиационный Институт

(Национальный Исследовательский Университет)

Институт №8 “Компьютерные науки и прикладная математика”

Кафедра №806 “Вычислительная математика и программирование”

Лабораторная работа №5 по курсу

«Операционные системы»

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Оценка: _____

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Цель работы

Приобретение практических навыков диагностики работы программного обеспечения.

Общий метод и алгоритм решения

Основным инструментом для анализа системных вызовов в Linux является утилита **strace.** Это мощная диагностическая и отладочная утилита в Linux, предназначенная для мониторинга взаимодействия между процессами пользовательск ого пространства и ядром операционной системы. Её основная задача — перехват и запись системных вызовов, которые являются фундаментальным интерфейсом для запроса услуг ядра, таких как операции с файлами, управление памятью, работа с сетью и управление процессами.

Принцип работы strace основан на использовании механизма **ptrace** (process trace), что позволяет утилите "присоединиться" к целевому процессу и перехватывать каждый его запрос к ядру. Это делает strace незаменимым инструментом не только для системных администраторов и разработчиков при отладке падающих или ведущих себя нестабильно программ, но и для глубокого понимания того, как приложения взаимодействуют с операционной системой на низком уровне.

Базовое использование утилиты предполагает простой запуск целевой программы под strace, после чего в терминал начинают выводиться все совершаемые ей системные вызовы в реальном времени. Однако для более глубокого и детализированного анализа strace предоставляет богатый набор ключей (флагов), позволяющих настроить вывод информации.

Основные флаги:

-f – отслеживает дочерние процессы, если они будут созданы

-r – выводить временную метку для каждого системного вызова

-T – выводит длительность выполнения системного вызова

Протокол работы программы

Лабораторная работа №1

```
echo -e "test.txt\n10 2 5 3" | strace -f ./parent
execve("./parent", ["./parent"], 0x7ffc7064ef48 /* 36 vars */) = 0
brk(NULL)               = 0x5746819ac000
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x741ec8dae000
access("/etc/ld.so.preload", R_OK)   = -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=19827, ...}) = 0
mmap(NULL, 19827, PROT_READ, MAP_PRIVATE, 3, 0) = 0x741ec8da9000
close(3)                = 0
openat(AT_FDCWD, "/lib/x86_64-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>\0\1\0\0\0\220\243\2\0\0\0\0"..., 832) = 832
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, 64) = 784
fstat(3, {st_mode=S_IFREG|0755, st_size=2125328, ...}) = 0
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, 64) = 784
mmap(NULL, 2170256, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x741ec8a00000
mmap(0x741ec8a28000, 1605632, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x28000) = 0x741ec8a28000
mmap(0x741ec8bb0000, 323584, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1b0000) =
0x741ec8bb0000
mmap(0x741ec8bff000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x1fe000) = 0x741ec8bff000
mmap(0x741ec8c05000, 52624, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) =
0x741ec8c05000
close(3)                = 0
```

```
mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x741ec8da6000
arch_prctl(ARCH_SET_FS, 0x741ec8da6740) = 0
set_tid_address(0x741ec8da6a10)     = 54158
set_robust_list(0x741ec8da6a20, 24)   = 0
rseq(0x741ec8da7060, 0x20, 0, 0x53053053) = 0
mprotect(0x741ec8bff000, 16384, PROT_READ) = 0
mprotect(0x5746789af000, 4096, PROT_READ) = 0
mprotect(0x741ec8de6000, 8192, PROT_READ) = 0
prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
munmap(0x741ec8da9000, 19827)      = 0
pipe2([3, 4], 0)           = 0
pipe2([5, 6], 0)           = 0
fstat(0, {st_mode=S_IFIFO|0600, st_size=0, ...}) = 0
getrandom("\x00\x77\x67\x57\x33\x74\x42\x4b", 8, GRND_NONBLOCK) = 8
brk(NULL)                = 0x5746819ac000
brk(0x5746819cd000)          = 0x5746819cd000
read(0, "test.txt\n10 2 5 3\n", 4096)  = 18
read(0, "", 4096)            = 0
clone(child_stack=NULL, flags=CLONE_CHILD_CLEARTID|CLONE_CHILD_SETTID|SIGCHLDstrace: Process 54159
attached
, child_tidptr=0x741ec8da6a10) = 54159
[pid 54159] set_robust_list(0x741ec8da6a20, 24 <unfinished ...>
[pid 54158] close(6 <unfinished ...>
[pid 54159] <... set_robust_list resumed>) = 0
[pid 54158] <... close resumed>)    = 0
[pid 54158] close(3 <unfinished ...>
[pid 54159] close(4 <unfinished ...>
[pid 54158] <... close resumed>)    = 0
[pid 54159] <... close resumed>)    = 0
[pid 54158] write(4, "test.txt\n\0\333\310\36t\0\0\t\0\0\0\0\0\0\0Q\4\334\310\36t\0\0"..., 1000 <unfinished ...>
[pid 54159] close(5 <unfinished ...>
[pid 54158] <... write resumed>)    = 1000
[pid 54159] <... close resumed>)    = 0
[pid 54158] write(4, "\4\0\0\0", 4 <unfinished ...>
[pid 54159] dup2(3, 0 <unfinished ...>
[pid 54158] <... write resumed>)    = 4
[pid 54159] <... dup2 resumed>)     = 0
[pid 54158] write(4, "\0\0 A", 4 <unfinished ...>
[pid 54159] dup2(6, 1 <unfinished ...>
[pid 54158] <... write resumed>)    = 4
[pid 54159] <... dup2 resumed>)     = 1
[pid 54158] write(4, "\0\0\0@", 4 <unfinished ...>
[pid 54159] close(3 <unfinished ...>
[pid 54158] <... write resumed>)    = 4
[pid 54159] <... close resumed>)    = 0
[pid 54158] write(4, "\0\0\240@", 4 <unfinished ...>
[pid 54159] close(6 <unfinished ...>
[pid 54158] <... write resumed>)    = 4
[pid 54159] <... close resumed>)    = 0
[pid 54158] write(4, "\0\0@@", 4 <unfinished ...>
[pid 54159] execve("./child", ["child"], 0x7ffcd36a2438 /* 36 vars */ <unfinished ...>
[pid 54158] <... write resumed>)    = 4
[pid 54158] close(4)          = 0
[pid 54158] wait4(-1, <unfinished ...>
[pid 54159] <... execve resumed>)    = 0
[pid 54159] brk(NULL)          = 0x6072b8771000
[pid 54159] mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7cca383de000
[pid 54159] access("/etc/ld.so.preload", R_OK) = -1 ENOENT (No such file or directory)
[pid 54159] openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3
[pid 54159] fstat(3, {st_mode=S_IFREG|0644, st_size=19827, ...}) = 0
[pid 54159] mmap(NULL, 19827, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7cca383d9000
[pid 54159] close(3)          = 0
[pid 54159] openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3
[pid 54159] 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
[pid 54159] 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\0\0"..., 784, 64) = 784
[pid 54159] fstat(3, {st_mode=S_IFREG|0755, st_size=2125328, ...}) = 0
[pid 54159] 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\0\0"..., 784, 64) = 784
[pid 54159] mmap(NULL, 2170256, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7cca38000000
[pid 54159] mmap(0x7cca38028000, 1605632, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x28000) = 0x7cca38028000
[pid 54159] mmap(0x7cca381b0000, 323584, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
```

```
mmap(0x7cca38028000, 1605632, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x28000) = 0x7cca38028000
[pid 54159] mmap(0x7cca381b0000, 323584, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1b0000) = 0x7cca381b0000
[pid 54159] mmap(0x7cca381ff000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1fe000) = 0x7cca381ff000
[pid 54159] mmap(0x7cca38205000, 52624, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7cca38205000
[pid 54159] close(3)          = 0
[pid 54159] mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7cca383d6000
[pid 54159] arch_prctl(ARCH_SET_FS, 0x7cca383d6740) = 0
[pid 54159] set_tid_address(0x7cca383d6a10) = 54159
[pid 54159] set_robust_list(0x7cca383d6a20, 24) = 0
[pid 54159] rseq(0x7cca383d7060, 0x20, 0, 0x53053053) = 0
[pid 54159] mprotect(0x7cca381ff000, 16384, PROT_READ) = 0
[pid 54159] mprotect(0x6072849ca000, 4096, PROT_READ) = 0
[pid 54159] mprotect(0x7cca38416000, 8192, PROT_READ) = 0
[pid 54159] prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
[pid 54159] munmap(0x7cca383d9000, 19827) = 0
[pid 54159] read(0, "test.txt\n\0\333\310\36t\0\0\t\0\0\0\0\0\0\0Q\4\334\310\36t\0\0"..., 1000) = 1000
[pid 54159] read(0, "\4\0\0\0", 4)   = 4
[pid 54159] read(0, "\0\0 A", 4)    = 4
[pid 54159] read(0, "\0\0\0@", 4)    = 4
[pid 54159] read(0, "\0\0\240@", 4)   = 4
[pid 54159] read(0, "\0\0@@", 4)    = 4
[pid 54159] getrandom("\x25\x84\x2e\x3b\x51\xfd\x92\xb3", 8, GRND_NONBLOCK) = 8
[pid 54159] brk(NULL)          = 0x6072b8771000
[pid 54159] brk(0x6072b8792000)     = 0x6072b8792000
[pid 54159] openat(AT_FDCWD, "test.txt", O_WRONLY|O_CREAT|O_TRUNC, 0666) = 3
[pid 54159] fstat(3, {st_mode=S_IFREG|0644, st_size=0, ...}) = 0
[pid 54159] write(3, "5.000000\n", 9)  = 9
[pid 54159] write(3, "2.000000\n", 9)  = 9
[pid 54159] write(3, "3.333333\n", 9)  = 9
[pid 54159] close(3)          = 0
[pid 54159] exit_group(0)        = ?
[pid 54159] +++ exited with 0 +++
<... wait4 resumed>[{WIFEXITED(s) && WEXITSTATUS(s) == 0}], 0, NULL) = 54159
--- SIGCHLD {si_signo=SIGCHLD, si_code=CLD_EXITED, si_pid=54159, si_uid=1000, si_status=0, si_utime=0, si_stime=0} ---
close(5)              = 0
exit_group(0)             = ?
+++ exited with 0 +++
```

Лабораторная работа №2

```
echo -e "3 2\n2 1 -1 8\n-3 -1 2 -11\n-2 1 2 -3" | strace -f ./gauss_solver 2>&1 | tail -100
[pid 58211] mmap(NULL, 134217728, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0 <unfinished ...>
[pid 58210] rt_sigprocmask(SIG_BLOCK, ~[], <unfinished ...>
[pid 58211] <... mmap resumed>)     = 0x71d1c27fe000
[pid 58210] <... rt_sigprocmask resumed>[], 8) = 0
[pid 58211] munmap(0x71d1c27fe000, 25174016 <unfinished ...>
[pid 58210] clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x71d1caffe990, parent_tid=0x71d1caffe990, exit_signal=0, stack=0x71d1ca7fe000, stack_size=0x7fff80, tls=0x71d1caffe6c0} <unfinished ...>
[pid 58211] <... munmap resumed>)    = 0
[pid 58211] munmap(0x71d1c8000000, 41934848strace: Process 58212 attached
) = 0
```

```
[pid 58210] <... clone3 resumed> => {parent_tid=[58212]}, 88) = 58212
[pid 58212] rseq(0x71d1caffefe0, 0x20, 0, 0x53053053 <unfinished ...>
[pid 58210] rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>
[pid 58211] mprotect(0x71d1c4000000, 135168, PROT_READ|PROT_WRITE <unfinished ...>
[pid 58210] <... rt_sigprocmask resumed>NULL, 8) = 0
[pid 58212] <... rseq resumed>)     = 0
[pid 58210] futex(0x71d1cb7ff990, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 58211, NULL,
FUTEX_BITSET_MATCH_ANY <unfinished ...>
[pid 58211] <... mprotect resumed>)   = 0
[pid 58212] set_robust_list(0x71d1caffe9a0, 24 <unfinished ...>
[pid 58211] rt_sigprocmask(SIG_BLOCK, ~[RT_1], <unfinished ...>
[pid 58212] <... set_robust_list resumed>) = 0
[pid 58211] <... rt_sigprocmask resumed>NULL, 8) = 0
[pid 58212] rt_sigprocmask(SIG_SETMASK, [], NULL, 8) = 0
[pid 58211] madvise(0x71d1cafff000, 8368128, MADV_DONTNEED <unfinished ...>
[pid 58212] rt_sigprocmask(SIG_BLOCK, ~[RT_1], <unfinished ...>
[pid 58211] <... madvise resumed>)   = 0
[pid 58212] <... rt_sigprocmask resumed>NULL, 8) = 0
[pid 58211] exit(0 <unfinished ...>
[pid 58212] madvise(0x71d1ca7fe000, 8368128, MADV_DONTNEED <unfinished ...>
[pid 58211] <... exit resumed>)     = ?
[pid 58212] <... madvise resumed>)   = 0
[pid 58211] +++ exited with 0 +++
[pid 58210] <... futex resumed>)    = 0
[pid 58210] futex(0x71d1caffe990, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 58212, NULL,
FUTEX_BITSET_MATCH_ANY <unfinished ...>
[pid 58212] exit(0)          = ?
[pid 58212] +++ exited with 0 +++
<... futex resumed>)         = 0
rt_sigprocmask(SIG_BLOCK, ~[], [], 8)  = 0
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLO
NE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x71d1caffe990,
parent_tid=0x71d1caffe990, exit_signal=0, stack=0x71d1ca7fe000, stack_size=0x7fff80, tls=0x71d1caffe6c0}strace:
Process 58213 attached
 => {parent_tid=[58213]}, 88) = 58213
[pid 58213] rseq(0x71d1caffefe0, 0x20, 0, 0x53053053 <unfinished ...>
[pid 58210] rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>
[pid 58213] <... rseq resumed>)     = 0
[pid 58210] <... rt_sigprocmask resumed>NULL, 8) = 0
[pid 58213] set_robust_list(0x71d1caffe9a0, 24 <unfinished ...>
[pid 58210] futex(0x71d1caffe990, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 58213, NULL,
FUTEX_BITSET_MATCH_ANY <unfinished ...>
[pid 58213] <... set_robust_list resumed>) = 0
[pid 58213] rt_sigprocmask(SIG_SETMASK, [], NULL, 8) = 0
[pid 58213] rt_sigprocmask(SIG_BLOCK, ~[RT_1], NULL, 8) = 0
[pid 58213] madvise(0x71d1ca7fe000, 8368128, MADV_DONTNEED) = 0
[pid 58213] exit(0)          = ?
[pid 58210] <... futex resumed>)    = 0
[pid 58213] +++ exited with 0 +++
rt_sigprocmask(SIG_BLOCK, ~[], [], 8)  = 0
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLO
NE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x71d1caffe990,
parent_tid=0x71d1caffe990, exit_signal=0, stack=0x71d1ca7fe000, stack_size=0x7fff80, tls=0x71d1caffe6c0}strace:
Process 58214 attached
 => {parent_tid=[58214]}, 88) = 58214
[pid 58214] rseq(0x71d1caffefe0, 0x20, 0, 0x53053053 <unfinished ...>
[pid 58210] rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>
[pid 58214] <... rseq resumed>)     = 0
[pid 58210] <... rt_sigprocmask resumed>NULL, 8) = 0
[pid 58214] set_robust_list(0x71d1caffe9a0, 24 <unfinished ...>
[pid 58210] rt_sigprocmask(SIG_BLOCK, ~[], <unfinished ...>
[pid 58214] <... set_robust_list resumed>) = 0
[pid 58210] <... rt_sigprocmask resumed>[], 8) = 0
[pid 58214] rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>
[pid 58210]
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLO
NE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x71d1cb7ff990,
parent_tid=0x71d1cb7ff990, exit_signal=0, stack=0x71d1cafff000, stack_size=0x7fff80, tls=0x71d1cb7ff6c0}
<unfinished ...>
[pid 58214] <... rt_sigprocmask resumed>NULL, 8) = 0
strace: Process 58215 attached
[pid 58214] rt_sigprocmask(SIG_BLOCK, ~[RT_1], <unfinished ...>
[pid 58210] <... clone3 resumed> => {parent_tid=[58215]}, 88) = 58215
```

```
[pid 58215] madvise(0x71d1cafff000, 8368128, MADV_DONTNEED) = 0
[pid 58215] exit(0)          = ?
[pid 58210] <... futex resumed>)    = 0
[pid 58215] +++ exited with 0 +++
write(1, "\320\222\320\262\320\265\320\264\320\270\321\202\320\265
\321\200\320\260\320\267\320\274\320\265\321\200 \321\201\320\270"..., 248Введите размер системы и
количество потоков: Введите матрицу коэффициентов и правые части:
Решение системы:
x[0] = 2.000000
x[1] = 3.000000
x[2] = -1.000000
) = 248
lseek(0, -1, SEEK_CUR)        = -1 ESPIPE (Illegal seek)
exit_group(0)             = ?
+++ exited with 0 +++
```

Лабораторная работа

```
echo -e "results.txt\n10 2 5 3" | strace -f ./main
execve("./main", ["./main"], 0x7ffc02e4aeb8 /* 36 vars */) = 0
brk(NULL)               = 0x62747544a000
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x76991e7fe000
access("/etc/ld.so.preload", R_OK)   = -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=19827, ...}) = 0
mmap(NULL, 19827, PROT_READ, MAP_PRIVATE, 3, 0) = 0x76991e7f9000
close(3)              = 0
openat(AT_FDCWD, "/lib/x86_64-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>\0\1\0\0\0\220\243\2\0\0\0\0"..., 832) = 832
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, 64) = 784
fstat(3, {st_mode=S_IFREG|0755, st_size=2125328, ...}) = 0
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, 64) = 784
mmap(NULL, 2170256, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x76991e400000
mmap(0x76991e428000, 1605632, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x28000) = 0x76991e428000
mmap(0x76991e5b0000, 323584, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1b0000)
= 0x76991e5b0000
mmap(0x76991e5ff000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x1fe000) = 0x76991e5ff000
mmap(0x76991e605000, 52624, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x76991e605000
close(3)              = 0
mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x76991e7f6000
arch_prctl(ARCH_SET_FS, 0x76991e7f6740) = 0
set_tid_address(0x76991e7f6a10)     = 61932
set_robust_list(0x76991e7f6a20, 24)   = 0
rseq(0x76991e7f7060, 0x20, 0, 0x53053053) = 0
mprotect(0x76991e5ff000, 16384, PROT_READ) = 0
mprotect(0x62745a9c1000, 4096, PROT_READ) = 0
mprotect(0x76991e836000, 8192, PROT_READ) = 0
prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
munmap(0x76991e7f9000, 19827)      = 0
openat(AT_FDCWD, "/dev/shm/my_shared_memory", O_RDWR|O_CREAT|O_NOFOLLOW|O_CLOEXEC, 0666)
= 3
ftruncate(3, 544)           = 0
mmap(NULL, 544, PROT_READ|PROT_WRITE, MAP_SHARED, 3, 0) = 0x76991e7fd000
fstat(0, {st_mode=S_IFIFO|0600, st_size=0, ...}) = 0
getrandom("\x41\x0b\x6f\x9c\x4a\x6d\x8c\x27", 8, GRND_NONBLOCK) = 8
brk(NULL)               = 0x62747544a000
brk(0x62747546b000)           = 0x62747546b000
read(0, "results.txt\n10 2 5 3\n", 4096) = 21
read(0, "", 4096)           = 0
clone(child_stack=NULL, flags=CLONE_CHILD_CLEARTID|CLONE_CHILD_SETTID|SIGCHLDstrace: Process
61933 attached
, child_tidptr=0x76991e7f6a10) = 61933
[pid 61933] set_robust_list(0x76991e7f6a20, 24 <unfinished ...>
[pid 61932] futex(0x76991e7fd1f8, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 0, NULL,
FUTEX_BITSET_MATCH_ANY <unfinished ...>
[pid 61933] <... set_robust_list resumed>) = 0
[pid 61933] openat(AT_FDCWD, "results.txt", O_WRONLY|O_CREAT|O_TRUNC, 0666) = 4
[pid 61933] fstat(4, {st_mode=S_IFREG|0644, st_size=0, ...}) = 0
[pid 61933] write(4, "1.000000\n", 9) = 9
```

```
[pid 61933] openat(AT_FDCWD, "results.txt", O_WRONLY|O_CREAT|O_TRUNC, 0666) = 4
[pid 61933] fstat(4, {st_mode=S_IFREG|0644, st_size=0, ...}) = 0
[pid 61933] write(4, "1.000000\n", 9)  = 9
[pid 61933] write(4, "5.000000\n", 9)  = 9
[pid 61933] write(4, "2.000000\n", 9)  = 9
[pid 61933] write(4, "3.333333\n", 9)  = 9
[pid 61933] close(4)          = 0
[pid 61933] futex(0x76991e7fd1f8, FUTEX_WAKE, 1 <unfinished ...>
[pid 61932] <... futex resumed>)    = 0
[pid 61933] <... futex resumed>)    = 1
[pid 61932] wait4(-1, <unfinished ...>
[pid 61933] exit_group(0)        = ?
[pid 61933] +++ exited with 0 +++
<... wait4 resumed>[{WIFEXITED(s) && WEXITSTATUS(s) == 0}], 0, NULL) = 61933
--- SIGCHLD {si_signo=SIGCHLD, si_code=CLD_EXITED, si_pid=61933, si_uid=1000, si_status=0, si_utime=0,
si_stime=0} ---
munmap(0x76991e7fd000, 544)       = 0
close(3)                = 0
unlink("/dev/shm/my_shared_memory")   = 0
exit_group(0)               = ?
+++ exited with 0 +++
```

Лабораторная работа №4

```
strace -f ./program2
execve("./program2", ["./program2"], 0x7ffc3db04c98 /* 36 vars */) = 0
brk(NULL) = 0x60f2afe0b000
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7a8d06a2e000
access("/etc/ld.so.preload", R_OK) = -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=19827, ...}) = 0
mmap(NULL, 19827, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7a8d06a29000
close(3) = 0
openat(AT_FDCWD, "/lib/x86_64-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>\0\1\0\0\0\220\243\2\0\0\0\0"..., 832) = 832
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"..., 784, 64) = 784
fstat(3, {st_mode=S_IFREG|0755, st_size=2125328, ...}) = 0
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"..., 784, 64) = 784

mmap(NULL, 2170256, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7a8d06800000
mmap(0x7a8d06828000, 1605632, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x28000) = 0x7a8d06828000
mmap(0x7a8d069b0000, 323584, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1b0000) =
0x7a8d069b0000
mmap(0x7a8d069ff000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x1fe000)
= 0x7a8d069ff000
mmap(0x7a8d06a05000, 52624, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1,
0) =
0x7a8d06a05000
close(3) = 0
mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7a8d06a26000
arch_prctl(ARCH_SET_FS, 0x7a8d06a26740) = 0
set_tid_address(0x7a8d06a26a10) = 48579
set_robust_list(0x7a8d06a26a20, 24) = 0
rseq(0x7a8d06a27060, 0x20, 0, 0x53053053) = 0
mprotect(0x7a8d069ff000, 16384, PROT_READ) = 0
mprotect(0x60f29678b000, 4096, PROT_READ) = 0
mprotect(0x7a8d06a66000, 8192, PROT_READ) = 0
prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
munmap(0x7a8d06a29000, 19827) = 0
fstat(1, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x4), ...}) = 0
getrandom("\xdb\x25\x55\x92\x6b\x09\xe9\xa3", 8, GRND_NONBLOCK) = 8
brk(NULL) = 0x60f2afe0b000
brk(0x60f2afe2c000) = 0x60f2afe2c000
write(1, "\320\237\321\200\320\276\320\263\321\200\320\260\320\274\320\274\320\260\321\201
\320\267\320\260\320\263\321\200\321\203"..., 97Программа с загрузкой библиотек во время выполнения
) = 97
write(1, "\320\224\320\276\321\201\321\202\321\203\320\277\320\275\321\213\320\265
\320\272\320\276\320\274\320\260\320\275\320\264\321"..., 35Доступные команды:
```

```
write(1, "\320\224\320\276\321\201\321\202\321\203\320\277\320\275\321\213\320\265
\320\272\320\276\320\274\320\260\320\275\320\264\321"..., 35Доступные команды:
) = 35
write(1, " 0 -
\320\277\320\265\321\200\320\265\320\272\320\273\321\216\321\207\320\270\321\202\321\214\321\200\320"...,

68 0 - переключить реализацию (сейчас: 1)
) = 68
write(1, " 1 K - \320\262\321\213\321\207\320\270\321\201\320\273\320\265\320\275\320\270\320\265Pi "..., 59 1 K -
вычисление Pi с длиной ряда K
) = 59
write(1, " 2 N - \320\277\320\265\321\200\320\265\320\262\320\276\320\264 \321\207\320\270\321\201\320\273\320"..., 67
2
N - перевод числа N в другую систему
) = 67
write(1, " exit - \320\262\321\213\321\205\320\276\320\264 \320\270\320\267 \320\277\321\200\320\276\320"..., 44 exit -
выход из программы
) = 44
write(1, "\n", 1
) = 1



openat(AT_FDCWD, "./libmath1.so", O_RDONLY|O_CLOEXEC) = 3
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\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0755, st_size=15584, ...}) = 0
getcwd("/home/lolol/projects/6laba/4lab/src", 128) = 36
mmap(NULL, 16408, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x780648aab000
mmap(0x780648aac000, 4096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x1000)
= 0x780648aac000
mmap(0x780648aad000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) =
0x780648aad000
mmap(0x780648aae000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x2000) = 0x780648aae000
close(3) = 0
mprotect(0x780648aae000, 4096, PROT_READ) = 0
fstat(0, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x4), ...}) = 0
write(1, "> ", 2> ) = 2
read(0,
```

Вывод

В ходе выполнения лабораторной работы были получены практические навыки диагностики работы программного обеспечения на уровне взаимодействия с ядром операционной системы. На примере команды **strace** была изучена методология отслеживания системных вызовов, которые служат основным интерфейсом между пользовательскими процессами и службами ядра Linux.

Практическое применение утилиты позволило наглядно исследовать, как программы выполняют операции с файлами, управляют памятью, взаимодействуют с сетью и создают дочерние процессы. Особую ценность представляет возможность анализировать не только успешные вызовы, но и ошибки (коды возврата), что критически важно для отладки некорректно работающего программного обеспечения.