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»

Группа: М8О-209БВ-24

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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

strace -f ./parent

```
execve("./parent", ["./parent"], 0x7ffdcb9e2d28 /* 31 vars */) = 0
brk(NULL)                               = 0x104d5000
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x76d445143000
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
newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=33091, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 33091, PROT_READ, MAP_PRIVATE, 3, 0) = 0x76d44513a000
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\20t\2\0\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
```

newfstatat(3, "", {st_mode=S_IFREG|0755, st_size=1926232, ...}, AT_EMPTY_PATH) = 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, 1974096, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x76d444f58000
mmap(0x76d444f7e000, 1400832, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x26000) = 0x76d444f7e000
mmap(0x76d4450d4000, 339968, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x17c000) = 0x76d4450d4000
mmap(0x76d445127000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1cf000) = 0x76d445127000
mmap(0x76d44512d000, 53072, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x76d44512d000
close(3) = 0
mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x76d444f55000
arch_prctl(ARCH_SET_FS, 0x76d444f55740) = 0
set_tid_address(0x76d444f55a10) = 5695
set_robust_list(0x76d444f55a20, 24) = 0
rseq(0x76d444f56060, 0x20, 0, 0x53053053) = 0
mprotect(0x76d445127000, 16384, PROT_READ) = 0
mprotect(0x403000, 4096, PROT_READ) = 0
mprotect(0x76d445176000, 8192, PROT_READ) = 0
prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
munmap(0x76d44513a000, 33091) = 0
pipe2([3, 4], 0) = 0
pipe2([5, 6], 0) = 0
newfstatat(0, "", {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0), ...}, AT_EMPTY_PATH) = 0
getrandom("\xca\xd5\xc0\x2c\x81\xe1\x93\x23", 8, GRND_NONBLOCK) = 8
brk(NULL) = 0x104d5000
brk(0x104f6000) = 0x104f6000
read(0, test.txt
"test.txt\n", 1024) = 9
read(0, 1.2 4.3268 83.25 0.36
"1.2 4.3268 83.25 0.36\n", 1024) = 22
read(0, "", 1024) = 0
clone(child_stack=NULL,
flags=CLONE_CHILD_CLEARTID|CLONE_CHILD_SETTID|SIGCHLDstrace:
Process 6043 attached
, child_tidptr=0x76d444f55a10) = 6043
[pid 6043] set_robust_list(0x76d444f55a20, 24 <unfinished ...>
[pid 5695] close(6 <unfinished ...>
[pid 6043] <... set_robust_list resumed>) = 0
[pid 5695] <... close resumed>) = 0
[pid 6043] close(4 <unfinished ...>

[pid 5695] close(3) = 0
[pid 6043] <... close resumed>) = 0
[pid 5695] write(4, "test.txt\n\0\24E\324v\0\0`\267\225\222\377\177\0\0\1\0\0\0\324v\0\0"..., 1000 <unfinished ...>
[pid 6043] close(5 <unfinished ...>
[pid 5695] <... write resumed>) = 1000
[pid 6043] <... close resumed>) = 0
[pid 5695] write(4, "\4\0\0\0", 4) = 4
[pid 6043] dup2(3, 0 <unfinished ...>
[pid 5695] write(4, "\232\231\231?", 4 <unfinished ...>
[pid 6043] <... dup2 resumed>) = 0
[pid 5695] <... write resumed>) = 4
[pid 6043] dup2(6, 1 <unfinished ...>
[pid 5695] write(4, "%u\212@", 4 <unfinished ...>
[pid 6043] <... dup2 resumed>) = 1
[pid 5695] <... write resumed>) = 4
[pid 6043] close(3 <unfinished ...>
[pid 5695] write(4, "\0\200\246B", 4 <unfinished ...>
[pid 6043] <... close resumed>) = 0
[pid 5695] <... write resumed>) = 4
[pid 6043] close(6 <unfinished ...>
[pid 5695] write(4, "\354Q\270>", 4) = 4
[pid 6043] <... close resumed>) = 0
[pid 5695] close(4 <unfinished ...>
[pid 6043] execve("./child", ["child"], 0x7fff9295bb38 /* 31 vars */ <unfinished ...>
[pid 5695] <... close resumed>) = 0
[pid 5695] wait4(-1, <unfinished ...>
[pid 6043] <... execve resumed>) = 0
[pid 6043] brk(NULL) = 0x2a368000
[pid 6043] mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7600cd7f4000
[pid 6043] access("/etc/ld.so.preload", R_OK) = -1 ENOENT (No such file or directory)
[pid 6043] openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3
[pid 6043] newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=33091, ...}, AT_EMPTY_PATH) = 0
[pid 6043] mmap(NULL, 33091, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7600cd7eb000
[pid 6043] close(3) = 0
[pid 6043] openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3
[pid 6043] read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\20t\2\0\0\0\0"..., 832) = 832
[pid 6043] 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
[pid 6043] newfstatat(3, "", {st_mode=S_IFREG|0755, st_size=1926232, ...}, AT_EMPTY_PATH) = 0
[pid 6043] 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

[pid 6043] mmap(NULL, 1974096, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7600cd609000
[pid 6043] mmap(0x7600cd62f000, 1400832, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x26000) = 0x7600cd62f000
[pid 6043] mmap(0x7600cd785000, 339968, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x17c000) = 0x7600cd785000
[pid 6043] mmap(0x7600cd7d8000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1cf000) = 0x7600cd7d8000
[pid 6043] mmap(0x7600cd7de000, 53072, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7600cd7de000
[pid 6043] close(3) = 0
[pid 6043] mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7600cd606000
[pid 6043] arch_prctl(ARCH_SET_FS, 0x7600cd606740) = 0
[pid 6043] set_tid_address(0x7600cd606a10) = 6043
[pid 6043] set_robust_list(0x7600cd606a20, 24) = 0
[pid 6043] rseq(0x7600cd607060, 0x20, 0, 0x53053053) = 0
[pid 6043] mprotect(0x7600cd7d8000, 16384, PROT_READ) = 0
[pid 6043] mprotect(0x403000, 4096, PROT_READ) = 0
[pid 6043] mprotect(0x7600cd827000, 8192, PROT_READ) = 0
[pid 6043] prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
[pid 6043] munmap(0x7600cd7eb000, 33091) = 0
[pid 6043] read(0, "test.txt\n\0\24E\324v\0\0`\267\225\222\377\177\0\0\1\0\0\0\324v\0\0"..., 1000) = 1000
[pid 6043] read(0, "\4\0\0\0", 4) = 4
[pid 6043] read(0, "\232\231\231?", 4) = 4
[pid 6043] read(0, "%u\212@", 4) = 4
[pid 6043] read(0, "\0\200\246B", 4) = 4
[pid 6043] read(0, "\354Q\270>", 4) = 4
[pid 6043] getrandom("\x97\x0d\xaf\xe0\xce\x08\x5a\xad", 8, GRND_NONBLOCK) = 8
[pid 6043] brk(NULL) = 0x2a368000
[pid 6043] brk(0x2a389000) = 0x2a389000
[pid 6043] openat(AT_FDCWD, "test.txt", O_WRONLY|O_CREAT|O_TRUNC, 0666) = 3
[pid 6043] newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=0, ...}, AT_EMPTY_PATH) = 0
[pid 6043] write(3, "0.277341\n", 9) = 9
[pid 6043] write(3, "0.014414\n", 9) = 9
[pid 6043] write(3, "3.333333\n", 9) = 9
[pid 6043] close(3) = 0
[pid 6043] exit_group(0) = ?
[pid 6043] +++ exited with 0 +++
<... wait4 resumed>[{WIFEXITED(s) && WEXITSTATUS(s) == 0}], 0, NULL) = 6043
--- SIGCHLD {si_signo=SIGCHLD, si_code=CLD_EXITED, si_pid=6043, si_uid=0, si_status=0, si_utime=0, si_stime=1 /* 0.01 s */} ---
close(5) = 0
exit_group(0) = ?

+++ exited with 0 +++

Лабораторная работа №2

strace -f ./main 4
execve("./main", ["./main", "4"], 0x7ffff4ae8ec0 /* 31 vars */) = 0
brk(NULL) = 0x18b14000
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x72a1ac6de000
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
newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=33091, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 33091, PROT_READ, MAP_PRIVATE, 3, 0) = 0x72a1ac6d5000
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\20t\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
newfstatat(3, "", {st_mode=S_IFREG|0755, st_size=1926232, ...}, AT_EMPTY_PATH) = 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, 1974096, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x72a1ac4f3000
mmap(0x72a1ac519000, 1400832, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x26000) = 0x72a1ac519000
mmap(0x72a1ac66f000, 339968, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x17c000) = 0x72a1ac66f000
mmap(0x72a1ac6c2000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1cf000) = 0x72a1ac6c2000
mmap(0x72a1ac6c8000, 53072, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x72a1ac6c8000
close(3) = 0
mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x72a1ac4f0000
arch_prctl(ARCH_SET_FS, 0x72a1ac4f0740) = 0
set_tid_address(0x72a1ac4f0a10) = 4951
set_robust_list(0x72a1ac4f0a20, 24) = 0
rseq(0x72a1ac4f1060, 0x20, 0, 0x53053053) = 0
mprotect(0x72a1ac6c2000, 16384, PROT_READ) = 0

mprotect(0x403000, 4096, PROT_READ) = 0
mprotect(0x72a1ac711000, 8192, PROT_READ) = 0
prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
munmap(0x72a1ac6d5000, 33091) = 0

rt_sigaction(SIGRT_1, {sa_handler=0x72a1ac579720, sa_mask=[], sa_flags=SA_RESTORER|SA_ONSTACK|SA_RESTART|SA_SIGINFO, sa_restorer=0x72a1ac52f050}, NULL, 8) = 0
rt_sigprocmask(SIG_UNBLOCK, [RTMIN RT_1], NULL, 8) = 0
mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0) = 0x72a1abcef000
mprotect(0x72a1abcf0000, 8388608, PROT_READ|PROT_WRITE) = 0
getrandom("\xcd\x61\xb4\x5f\x21\xbd\xaf\xb6", 8, GRND_NONBLOCK) = 8
brk(NULL) = 0x18b14000
brk(0x18b35000) = 0x18b35000
rt_sigprocmask(SIG_BLOCK, ~[], [], 8) = 0
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x72a1ac4ef990, parent_tid=0x72a1ac4ef990, exit_signal=0, stack=0x72a1abcef000, stack_size=0x7fff80, tls=0x72a1ac4ef6c0}, 88) = -1 ENOSYS (Function not implemented)
clone(child_stack=0x72a1ac4eef70, flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTIDstrace: Process 4952 attached
, parent_tid=[4952], tls=0x72a1ac4ef6c0, child_tidptr=0x72a1ac4ef990) = 4952
[pid 4951] rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>
[pid 4952] rseq(0x72a1ac4effe0, 0x20, 0, 0x53053053 <unfinished ...>
[pid 4951] <... rt_sigprocmask resumed>NULL, 8) = 0
[pid 4952] <... rseq resumed>) = 0
[pid 4951] mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0 <unfinished ...>
[pid 4952] set_robust_list(0x72a1ac4ef9a0, 24 <unfinished ...>
[pid 4951] <... mmap resumed>) = 0x72a1ab4ee000
[pid 4952] <... set_robust_list resumed>) = 0
[pid 4951] mprotect(0x72a1ab4ef000, 8388608, PROT_READ|PROT_WRITE <unfinished ...>
[pid 4952] rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>
[pid 4951] <... mprotect resumed>) = 0
[pid 4952] <... rt_sigprocmask resumed>NULL, 8) = 0
[pid 4951] rt_sigprocmask(SIG_BLOCK, ~[], [], 8) = 0

[pid 4951] clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x72a1abcee990, parent_tid=0x72a1abcee990, exit_signal=0, stack=0x72a1ab4ee000, stack_size=0x7fff80, tls=0x72a1abcee6c0}, 88) = -1 ENOSYS (Function not implemented)
[pid 4951] clone(child_stack=0x72a1abcedf70, flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTIDstrace: Process 4953 attached

, parent_tid=[4953], tls=0x72a1abcee6c0, child_tidptr=0x72a1abcee990) = 4953
[pid 4953] rseq(0x72a1abceefe0, 0x20, 0, 0x53053053 <unfinished ...>
[pid 4951] rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>
[pid 4953] <... rseq resumed>) = 0
[pid 4951] <... rt_sigprocmask resumed>NULL, 8) = 0
[pid 4953] set_robust_list(0x72a1abcee9a0, 24 <unfinished ...>
[pid 4951] mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0 <unfinished ...>
[pid 4953] <... set_robust_list resumed>) = 0
[pid 4951] <... mmap resumed>) = 0x72a1aaced000
[pid 4953] rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>
[pid 4951] mprotect(0x72a1aacee000, 8388608, PROT_READ|PROT_WRITE <unfinished ...>
[pid 4953] <... rt_sigprocmask resumed>NULL, 8) = 0
[pid 4951] <... mprotect resumed>) = 0
[pid 4951] rt_sigprocmask(SIG_BLOCK, ~[], [], 8) = 0
[pid 4951] clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x72a1ab4ed990, parent_tid=0x72a1ab4ed990, exit_signal=0, stack=0x72a1aaced000, stack_size=0x7fff80, tls=0x72a1ab4ed6c0}, 88) = -1 ENOSYS (Function not implemented)
[pid 4951] clone(child_stack=0x72a1ab4ecf70, flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTIDstrace: Process 4954 attached
, parent_tid=[4954], tls=0x72a1ab4ed6c0, child_tidptr=0x72a1ab4ed990) = 4954
[pid 4954] rseq(0x72a1ab4edfe0, 0x20, 0, 0x53053053 <unfinished ...>
[pid 4951] rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>
[pid 4954] <... rseq resumed>) = 0
[pid 4951] <... rt_sigprocmask resumed>NULL, 8) = 0
[pid 4954] set_robust_list(0x72a1ab4ed9a0, 24 <unfinished ...>
[pid 4951] mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0 <unfinished ...>
[pid 4954] <... set_robust_list resumed>) = 0
[pid 4951] <... mmap resumed>) = 0x72a1aa4ec000
[pid 4954] rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>
[pid 4951] mprotect(0x72a1aa4ed000, 8388608, PROT_READ|PROT_WRITE <unfinished ...>
[pid 4954] <... rt_sigprocmask resumed>NULL, 8) = 0
[pid 4951] <... mprotect resumed>) = 0
[pid 4951] rt_sigprocmask(SIG_BLOCK, ~[], [], 8) = 0

[pid 4951] clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x72a1aacec990, parent_tid=0x72a1aacec990, exit_signal=0, stack=0x72a1aa4ec000, stack_size=0x7fff80, tls=0x72a1aacec6c0}, 88) = -1 ENOSYS (Function not implemented)
[pid 4951] clone(child_stack=0x72a1aacebf70, flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTIDstrace: Process 4955 attached
, parent_tid=[4955], tls=0x72a1aacec6c0, child_tidptr=0x72a1aacec990) = 4955
[pid 4951] rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>
[pid 4955] rseq(0x72a1aacecfe0, 0x20, 0, 0x53053053 <unfinished ...>
[pid 4951] <... rt_sigprocmask resumed>NULL, 8) = 0
[pid 4955] <... rseq resumed>) = 0
[pid 4951] futex(0x72a1ac4ef990, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 4952, NULL, FUTEX_BITSET_MATCH_ANY <unfinished ...>
[pid 4955] set_robust_list(0x72a1aacec9a0, 24) = 0
[pid 4955] rt_sigprocmask(SIG_SETMASK, [], NULL, 8) = 0
[pid 4953] rt_sigprocmask(SIG_BLOCK, ~[RT_1], NULL, 8) = 0
[pid 4953] madvise(0x72a1ab4ee000, 8368128, MADV_DONTNEED) = 0
[pid 4953] exit(0) = ?
[pid 4953] +++ exited with 0 +++
[pid 4955] rt_sigprocmask(SIG_BLOCK, ~[RT_1], NULL, 8) = 0
[pid 4955] madvise(0x72a1aa4ec000, 8368128, MADV_DONTNEED) = 0
[pid 4955] exit(0) = ?
[pid 4955] +++ exited with 0 +++
[pid 4954] rt_sigprocmask(SIG_BLOCK, ~[RT_1], NULL, 8) = 0
[pid 4954] madvise(0x72a1aaced000, 8368128, MADV_DONTNEED) = 0
[pid 4954] exit(0) = ?
[pid 4952] rt_sigprocmask(SIG_BLOCK, ~[RT_1], <unfinished ...>
[pid 4954] +++ exited with 0 +++
[pid 4952] <... rt_sigprocmask resumed>NULL, 8) = 0
[pid 4952] madvise(0x72a1abcef000, 8368128, MADV_DONTNEED) = 0
[pid 4952] exit(0) = ?
[pid 4951] <... futex resumed>) = 0
[pid 4952] +++ exited with 0 +++
newfstatat(1, "", {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x1), ...}, AT_EMPTY_PATH) = 0
write(1, "\320\222\321\200\320\265\320\274\321\217\320\262\321\213\320\277\320\276\320\273\320\275\320\265\320\275\320\270\321\217 "..., 95Время выполнения программы с 4 потоками: 0.107280 секунд
) = 95
exit_group(0) = ?
+++ exited with 0 +++

Лабораторная работа №3

strace -f ./main

execve("./main", ["./main"], 0x7ffebd0711d8 /* 31 vars */) = 0

brk(NULL) = 0x3b7d0000

mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7ddfa96db000

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

newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=33091, ...}, AT_EMPTY_PATH) = 0

mmap(NULL, 33091, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7ddfa96d2000

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\20t\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

newfstatat(3, "", {st_mode=S_IFREG|0755, st_size=1926232, ...}, AT_EMPTY_PATH) = 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, 1974096, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7ddfa94f0000

mmap(0x7ddfa9516000, 1400832, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x26000) = 0x7ddfa9516000

mmap(0x7ddfa966c000, 339968, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x17c000) = 0x7ddfa966c000

mmap(0x7ddfa96bf000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1cf000) = 0x7ddfa96bf000

mmap(0x7ddfa96c5000, 53072, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7ddfa96c5000

close(3) = 0

mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7ddfa94ed000

arch_prctl(ARCH_SET_FS, 0x7ddfa94ed740) = 0

set_tid_address(0x7ddfa94eda10) = 29426

set_robust_list(0x7ddfa94eda20, 24) = 0

rseq(0x7ddfa94ee060, 0x20, 0, 0x53053053) = 0

mprotect(0x7ddfa96bf000, 16384, PROT_READ) = 0

mprotect(0x403000, 4096, PROT_READ) = 0

mprotect(0x7ddfa970e000, 8192, PROT_READ) = 0

prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0

munmap(0x7ddfa96d2000, 33091) = 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) = 0x7ddfa96da000

newfstatat(0, "", {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0), ...}, AT_EMPTY_PATH) = 0

```
getrandom("\x2f\xec\xa1\x7f\xf9\x78\x2c\xb8", 8, GRND_NONBLOCK) = 8
brk(NULL)                               = 0x3b7d0000
brk(0x3b7f1000)                         = 0x3b7f1000
read(0, file.txt
"file.txt\n", 1024)             = 9
read(0, 1 2 3 3 4 5 6 7 8 9 9 10
"1 2 3 3 4 5 6 7 8 9 9 10\n", 1024) = 25
read(0, "", 1024)                       = 0
clone(child_stack=NULL,
flags=CLONE_CHILD_CLEARTID|CLONE_CHILD_SETTID|SIGCHLDstrace:
Process 29626 attached
, child_tidptr=0x7ddfa94eda10) = 29626
[pid 29626] set_robust_list(0x7ddfa94eda20, 24 <unfinished ...>
[pid                                    29426]                                  futex(0x7ddfa96da1f8,
FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME,                 0,                 NULL,
FUTEX_BITSET_MATCH_ANY <unfinished ...>
[pid 29626] <... set_robust_list resumed>) = 0
[pid 29626] openat(AT_FDCWD, "file.txt", O_WRONLY|O_CREAT|O_TRUNC, 0666) = 4
[pid 29626] newfstatat(4, "", {st_mode=S_IFREG|0644, st_size=0, ...}, AT_EMPTY_PATH)
= 0
[pid 29626] write(4, "1.000000\n", 9)   = 9
[pid 29626] write(4, "0.500000\n", 9)   = 9
[pid 29626] write(4, "0.333333\n", 9)   = 9
[pid 29626] write(4, "0.333333\n", 9)   = 9
[pid 29626] write(4, "0.250000\n", 9)   = 9
[pid 29626] write(4, "0.200000\n", 9)   = 9
[pid 29626] write(4, "0.166667\n", 9)   = 9
[pid 29626] write(4, "0.142857\n", 9)   = 9
[pid 29626] write(4, "0.125000\n", 9)   = 9
[pid 29626] write(4, "0.111111\n", 9)   = 9
[pid 29626] write(4, "0.111111\n", 9)   = 9
[pid 29626] write(4, "0.100000\n", 9)   = 9
[pid 29626] close(4)                    = 0
[pid 29626] futex(0x7ddfa96da1f8, FUTEX_WAKE, 1 <unfinished ...>
[pid 29426] <... futex resumed>)        = 0
[pid 29626] <... futex resumed>)        = 1
[pid 29426] wait4(-1,  <unfinished ...>
[pid 29626] exit_group(0)               = ?
[pid 29626] +++ exited with 0 +++
<... wait4 resumed>[{WIFEXITED(s) && WEXITSTATUS(s) == 0}], 0, NULL) = 29626
--- SIGCHLD {si_signo=SIGCHLD, si_code=CLD_EXITED, si_pid=29626, si_uid=0,
si_status=0, si_utime=0, si_stime=0} ---
munmap(0x7ddfa96da000, 544)             = 0
close(3)                                = 0
unlink("/dev/shm/my_shared_memory")     = 0
exit_group(0)                           = ?
+++ exited with 0 +++
```

Лабораторная работа №4

strace -f ./prog2

```
execve("./prog2", ["./prog2"], 0x7ffeca910078 /* 31 vars */) = 0
brk(NULL)                               = 0x36708000
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x707d7c2ac000
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
newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=33091, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 33091, PROT_READ, MAP_PRIVATE, 3, 0) = 0x707d7c2a3000
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\20t\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
newfstatat(3, "", {st_mode=S_IFREG|0755, st_size=1926232, ...}, AT_EMPTY_PATH) = 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, 1974096, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x707d7c0c1000
mmap(0x707d7c0e7000, 1400832, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x26000) = 0x707d7c0e7000
mmap(0x707d7c23d000, 339968, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x17c000) = 0x707d7c23d000
mmap(0x707d7c290000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1cf000) = 0x707d7c290000
mmap(0x707d7c296000, 53072, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x707d7c296000
close(3)                                = 0
mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x707d7c0be000
arch_prctl(ARCH_SET_FS, 0x707d7c0be740) = 0
set_tid_address(0x707d7c0bea10)         = 7211
set_robust_list(0x707d7c0bea20, 24)     = 0
rseq(0x707d7c0bf060, 0x20, 0, 0x53053053) = 0
mprotect(0x707d7c290000, 16384, PROT_READ) = 0
mprotect(0x403000, 4096, PROT_READ)     = 0
mprotect(0x707d7c2df000, 8192, PROT_READ) = 0
prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
munmap(0x707d7c2a3000, 33091)           = 0
newfstatat(1, "", {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0), ...}, AT_EMPTY_PATH) = 0
getrandom("\x30\xfe\xab\x58\x75\xfb\x6b\x36", 8, GRND_NONBLOCK) = 8
```

brk(NULL) = 0x36708000
brk(0x36729000) = 0x36729000
write(1, "\320\227\320\260\320\263\321\200\321\203\320\266\320\260\320\265\320\274\320\261\320\270\320\261\320\273\320\270\320\276\321"..., 54Загружаем библиотеку ./libimpl1.so
) = 54
openat(AT_FDCWD, "./libimpl1.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
newfstatat(3, "", {st_mode=S_IFREG|0755, st_size=15312, ...}, AT_EMPTY_PATH) = 0
getcwd("/workspaces/lab1/lab4/src", 128) = 26
mmap(NULL, 16408, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x707d7c2a7000
mmap(0x707d7c2a8000, 4096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1000) = 0x707d7c2a8000
mmap(0x707d7c2a9000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x707d7c2a9000
mmap(0x707d7c2aa000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x707d7c2aa000
close(3) = 0
openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3
newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=33091, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 33091, PROT_READ, MAP_PRIVATE, 3, 0) = 0x707d7c0b5000
close(3) = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libm.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\0\0\0\0\0\0\0\0"..., 832) = 832
newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=911904, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 913680, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x707d7bfd5000
mmap(0x707d7bfe5000, 475136, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x10000) = 0x707d7bfe5000
mmap(0x707d7c059000, 368640, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x84000) = 0x707d7c059000
mmap(0x707d7c0b3000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0xdd000) = 0x707d7c0b3000
close(3) = 0
mprotect(0x707d7c0b3000, 4096, PROT_READ) = 0
mprotect(0x707d7c2aa000, 4096, PROT_READ) = 0
munmap(0x707d7c0b5000, 33091) = 0
write(1, "\320\237\321\200\320\276\320\263\321\200\320\260\320\274\320\274\320\260 2: \320\224\320\270\320\275\320\260\320\274"..., 83Программа 2: Динамическая загрузка библиотек
) = 83
write(1, "\320\232\320\276\320\274\320\260\320\275\320\264\321\213:\n", 16Команды:
) = 16

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"..., 80 0 - переключить реализацию (libimpl1.so <-> libimpl2.so)
) = 80
write(1, " 1 A B e - \320\262\321\213\321\207\320\270\321\201\320\273\320\270\321\202\321\214 \320"..., 85 1 A B e - вычислить интеграл sin(x) от A до B с шагом e
) = 85
write(1, " 2 N x1 x2 ... xN - \320\276\321\202\321\201\320\276\321\200\321"..., 87 2 N x1 x2 ... xN - отсортировать массив из N элементов
) = 87
write(1, " q - \320\262\321\213\321\205\320\276\320\264\n", 17 q - выход
) = 17
write(1, "\n", 1
) = 1
newfstatat(0, "", {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0), ...}, AT_EMPTY_PATH) = 0
write(1, "> ", 2>) = 2
read(0, 1 2 10 0.01
"1 2 10 0.01\n", 1024) = 12
write(1, "\320\240\320\265\320\267\321\203\320\273\321\214\321\202\320\260\321\202(\320\261\320\270\320\261\320\273\320\270\320\276"..., 54Результат (библиотека 1): 0.430189
) = 54
write(1, "> ", 2>) = 2
read(0, 0
"0\n", 1024) = 2
munmap(0x707d7c2a7000, 16408) = 0
munmap(0x707d7bfd5000, 913680) = 0
write(1, "\320\237\320\265\321\200\320\265\320\272\320\273\321\216\321\207\320\260\320\265\320\274 \320\275\320\260 \320\261\320\270"..., 63Переключаем на библиотеку ./libimpl2.so
) = 63
openat(AT_FDCWD, "./libimpl2.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
newfstatat(3, "", {st_mode=S_IFREG|0755, st_size=15416, ...}, AT_EMPTY_PATH) = 0
getcwd("/workspaces/lab1/lab4/src", 128) = 26
mmap(NULL, 16408, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x707d7c2a7000
mmap(0x707d7c2a8000, 4096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1000) = 0x707d7c2a8000
mmap(0x707d7c2a9000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x707d7c2a9000
mmap(0x707d7c2aa000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x707d7c2aa000
close(3) = 0
openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3

newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=33091, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 33091, PROT_READ, MAP_PRIVATE, 3, 0) = 0x707d7c0b5000
close(3) = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libm.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\0\0\0\0\0\0\0\0"..., 832) = 832
newfstatat(3, "", {st_mode=S_IFREG|0644, st_size=911904, ...}, AT_EMPTY_PATH) = 0
mmap(NULL, 913680, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x707d7bfd5000
mmap(0x707d7bfe5000, 475136, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x10000) = 0x707d7bfe5000
mmap(0x707d7c059000, 368640, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x84000) = 0x707d7c059000
mmap(0x707d7c0b3000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0xdd000) = 0x707d7c0b3000
close(3) = 0
mprotect(0x707d7c0b3000, 4096, PROT_READ) = 0
mprotect(0x707d7c2aa000, 4096, PROT_READ) = 0
munmap(0x707d7c0b5000, 33091) = 0
write(1, "> ", 2>) = 2
read(0, 1 2 10 0.01
"1 2 10 0.01\n", 1024) = 12
write(1, "\320\240\320\265\320\267\321\203\320\273\321\214\321\202\320\260\321\202(\320\261\320\270\320\261\320\273\320\270\320\276"..., 54Результат (библиотека 2): 0.422921
) = 54
write(1, "> ", 2>) = 2
read(0, ^C0x36709dc0, 1024) = ? ERESTARTSYS (To be restarted if SA_RESTART is set)
strace: Process 7211 detached

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.