Московский Авиационный Институт

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Институт №8 "Компьютерные науки и прикладная математика"

Кафедра №806 "Вычислительная математика и программирование"

Лабораторная работа №5 по курсу

«Операционные системы»

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Постановка задачи

В рамках лабораторной работы требуется проанализировать работу пользовательских программ на уровне системных вызовов операционной системы. Для этого необходимо использовать утилиту strace и исследовать системные вызовы, возникающие при выполнении программ, разработанных в лабораторных работах. Анализ должен показать, каким образом операционная система обеспечивает выполнение программ, управление памятью, создание процессов и потоков, а также межпроцессное взаимодействие.

Цель работы:

Целью работы является изучение механизмов взаимодействия пользовательских программ с операционной системой на уровне системных вызовов, а также закрепление практических навыков анализа работы программ с использованием утилиты strace.

Общий метод и алгоритм решения

Для демонстрации системных вызовов будем использовать утилиту strace в операционной системе linux. Strace — это диагностическая, отладочная и обучающая утилита пользовательского пространства для Linux. Она используется для мониторинга и вмешательства во взаимодействия между процессами и ядром Linux, включая системные вызовы, доставку сигналов и изменение состояния процесса. Наиболее часто он используется для запуска программы и вывода списка системных вызовов, которые она выполняет. Это особенно полезно, когда программа часто аварийно завершает работу или ведет себя непредсказуемо.

Основные флаги:

-p PID - присоединиться к уже работающему процессу с указанным идентификатором.

-c - подсчитать статистику по системным вызовам (время, вызовы, ошибки) и вывести сводку

по завершении.

-f - трассировать также все дочерние процессы, созданные с помощью fork().

-e - фильтрация вывода

-o файл - вывести вывод трассировки в указанный файл вместо stderr.

-s размер - увеличить максимальную длину выводимых строк аргументов (по умолчанию

часто 32 символа).

-t - выводить время в формате ЧЧ:ММ:СС при каждом вызове.

-T - показывать время, затраченное на каждый системный вызов.

-y - подробно выводить информацию о файловых дескрипторах (пути к файлам, сокетам).

-v - более подробный (verbose) вывод для некоторых вызовов.

-h - вывести справку по использованию.

Протокол работы программы

Лабораторная работа №1

execve("./parent", ["./parent"], 0x7ffd796dc3c8 /* 25 vars */) = 0
brk(NULL) = 0x6407c586a000
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7b239c26b000

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=52259, ...}) = 0
mmap(NULL, 52259, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7b239c25e000
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\0\3\0>\0\1\0\0\0\220\243\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
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) = 0x7b239c000000
mmap(0x7b239c028000, 1605632, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x28000) = 0x7b239c028000
mmap(0x7b239c1b0000, 323584, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x1b0000) = 0x7b239c1b0000
mmap(0x7b239c1ff000, 24576, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1fe000) = 0x7b239c1ff000
mmap(0x7b239c205000, 52624, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7b239c205000
close(3) = 0
mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7b239c25b000
arch_prctl(ARCH_SET_FS, 0x7b239c25b740) = 0
set_tid_address(0x7b239c25ba10) = 436
set_robust_list(0x7b239c25ba20, 24) = 0
rseq(0x7b239c25c060, 0x20, 0, 0x53053053) = 0
mprotect(0x7b239c1ff000, 16384, PROT_READ) = 0
mprotect(0x6407b87e4000, 4096, PROT_READ) = 0
mprotect(0x7b239c2a3000, 8192, PROT_READ) = 0
prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
munmap(0x7b239c25e000, 52259) = 0
pipe2([3, 4], 0) = 0
pipe2([5, 6], 0) = 0
pipe2([7, 8], 0) = 0
clone(child_stack=NULL,
flags=CLONE_CHILD_CLEARTID|CLONE_CHILD_SETTID|SIGCHLD,
child_tidptr=0x7b239c25ba10) = 437
437 set_robust_list(0x7b239c25ba20, 24 <unfinished ...>
436 **clone(child_stack=NULL,**
flags=CLONE_CHILD_CLEARTID|CLONE_CHILD_SETTID|SIGCHLD <unfinished ...>
437 <... set_robust_list resumed>) = 0
436 **<... clone resumed>, child_tidptr=0x7b239c25ba10) = 438**
438 set_robust_list(0x7b239c25ba20, 24 <unfinished ...>
436 close(3 <unfinished ...>
437 **dup2(3, 0 <unfinished ...>**
436 <... close resumed>) = 0
437 <... dup2 resumed>) = 0
436 close(5 <unfinished ...>
438 <... set_robust_list resumed>) = 0
436 <... close resumed>) = 0
437 **dup2(6, 1 <unfinished ...>**
436 close(6 <unfinished ...>
438 **dup2(5, 0 <unfinished ...>**
436 <... close resumed>) = 0
437 <... dup2 resumed>) = 1

436 close(8 <unfinished ...>
438 <... dup2 resumed>) = 0
436 <... close resumed>) = 0
437 close(3 <unfinished ...>
436 fstat(1, <unfinished ...>
438 **dup2(8, 1 <unfinished ...>**
436 <... fstat resumed>{st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0), ...}) = 0
437 <... close resumed>) = 0
436 getrandom(<unfinished ...>
438 <... dup2 resumed>) = 1
436 <... getrandom resumed>"\xbf\x43\xa4\xc9\xe3\xd4\x75\xc2", 8, GRND_NONBLOCK) = 8
437 close(4 <unfinished ...>
436 brk(NULL <unfinished ...>
438 close(3 <unfinished ...>
436 <... brk resumed>) = 0x6407c586a000
437 <... close resumed>) = 0
436 brk(0x6407c588b000 <unfinished ...>
438 <... close resumed>) = 0
436 <... brk resumed>) = 0x6407c588b000
437 close(5 <unfinished ...>
436 write(1, "\320\222\320\262\320\265\320\264\320\270\321\202\320\265
\321\201\321\202\321\200\320\276\320\272\321\203:\n", 29 <unfinished ...>
438 close(4 <unfinished ...>
436 <... write resumed>) = 29
437 <... close resumed>) = 0
436 fstat(0, <unfinished ...>
438 <... close resumed>) = 0
436 <... fstat resumed>{st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0), ...}) = 0
437 close(6 <unfinished ...>
436 **read(0, <unfinished ...>**
438 close(5 <unfinished ...>
437 <... close resumed>) = 0
438 <... close resumed>) = 0
437 close(7 <unfinished ...>
438 close(6 <unfinished ...>
437 <... close resumed>) = 0
438 <... close resumed>) = 0
437 close(8 <unfinished ...>
438 close(7 <unfinished ...>
437 <... close resumed>) = 0
438 <... close resumed>) = 0
437 **execve("./child1", ["child1"], 0x7fff0d3f0a98 /* 25 vars / <unfinished ...>***
438 close(8) = 0
438 **execve("./child2", ["child2"], 0x7fff0d3f0a98 /* 25 vars */) = 0**
438 brk(NULL <unfinished ...>
437 <... execve resumed>) = 0
438 <... brk resumed>) = 0x5b4ad6732000
437 brk(NULL <unfinished ...>
438 mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0
<unfinished ...>
437 <... brk resumed>) = 0x56f2cacea000
438 <... mmap resumed>) = 0x7fc0814c4000
437 mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0
<unfinished ...>
438 access("/etc/ld.so.preload", R_OK <unfinished ...>

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437 <... mmap resumed>) = 0x704d8bdd4000
438 <... access resumed>) = -1 ENOENT (No such file or directory)
437 access("/etc/ld.so.preload", R_OK <unfinished ...>
438 openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC <unfinished ...>
437 <... access resumed>) = -1 ENOENT (No such file or directory)
438 <... openat resumed>) = 3
437 openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC <unfinished ...>
438 fstat(3, <unfinished ...>
437 <... openat resumed>) = 3
438 <... fstat resumed>{st_mode=S_IFREG|0644, st_size=52259, ...}) = 0
437 fstat(3, <unfinished ...>
438 mmap(NULL, 52259, PROT_READ, MAP_PRIVATE, 3, 0 <unfinished ...>
437 <... fstat resumed>{st_mode=S_IFREG|0644, st_size=52259, ...}) = 0
438 <... mmap resumed>) = 0x7fc0814b7000
437 mmap(NULL, 52259, PROT_READ, MAP_PRIVATE, 3, 0 <unfinished ...>
438 close(3 <unfinished ...>
437 <... mmap resumed>) = 0x704d8bdc7000
438 <... close resumed>) = 0
437 close(3 <unfinished ...>
438 openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC <unfinished ...>
437 <... close resumed>) = 0
438 <... openat resumed>) = 3
437 openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC <unfinished ...>
438 read(3, <unfinished ...>
437 <... openat resumed>) = 3
438 <... read resumed>"\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
437 read(3, <unfinished ...>
438 pread64(3, <unfinished ...>
437 <... read resumed>"\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
438 <... 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\0\0"...,  784, 64) = 784
437 pread64(3, <unfinished ...>
438 fstat(3, <unfinished ...>
437 <... 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\0\0"...,  784, 64) = 784
438 <... fstat resumed>{st_mode=S_IFREG|0755, st_size=2125328, ...}) = 0
437 fstat(3, <unfinished ...>
438 pread64(3, <unfinished ...>
437 <... fstat resumed>{st_mode=S_IFREG|0755, st_size=2125328, ...}) = 0
438 <... 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\0\0"...,  784, 64) = 784
437 pread64(3, <unfinished ...>
438 mmap(NULL, 2170256, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0 <unfinished ...>
437 <... 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\0\0"...,  784, 64) = 784
438 <... mmap resumed>) = 0x7fc081200000
437 mmap(NULL, 2170256, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0 <unfinished ...>
438 mmap(0x7fc081228000, 1605632, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x28000 <unfinished ...>
437 <... mmap resumed>) = 0x704d8ba00000
438 <... mmap resumed>) = 0x7fc081228000
437 mmap(0x704d8ba28000, 1605632, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x28000 <unfinished ...>
438 mmap(0x7fc0813b0000, 323584, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x1b0000 <unfinished ...>
```

437 <... mmap resumed>) = 0x704d8ba28000
438 <... mmap resumed>) = 0x7fc0813b0000
437 mmap(0x704d8bbb0000, 323584, PROT_READ,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1b0000 <unfinished ...>
438 mmap(0x7fc0813ff000, 24576, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1fe000 <unfinished ...>
437 <... mmap resumed>) = 0x704d8bbb0000
438 <... mmap resumed>) = 0x7fc0813ff000
437 mmap(0x704d8bbff000, 24576, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1fe000 <unfinished ...>
438 mmap(0x7fc081405000, 52624, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0 <unfinished ...>
437 <... mmap resumed>) = 0x704d8bbff000
438 <... mmap resumed>) = 0x7fc081405000
437 mmap(0x704d8bc05000, 52624, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0 <unfinished ...>
438 close(3 <unfinished ...>
437 <... mmap resumed>) = 0x704d8bc05000
438 <... close resumed>) = 0
437 close(3 <unfinished ...>
438 mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0
<unfinished ...>
437 <... close resumed>) = 0
438 <... mmap resumed>) = 0x7fc0814b4000
437 mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0
<unfinished ...>
438 arch_prctl(ARCH_SET_FS, 0x7fc0814b4740 <unfinished ...>
437 <... mmap resumed>) = 0x704d8bdc4000
438 <... arch_prctl resumed>) = 0
437 arch_prctl(ARCH_SET_FS, 0x704d8bdc4740 <unfinished ...>
438 set_tid_address(0x7fc0814b4a10 <unfinished ...>
437 <... arch_prctl resumed>) = 0
438 <... set_tid_address resumed>) = 438
437 set_tid_address(0x704d8bdc4a10 <unfinished ...>
438 set_robust_list(0x7fc0814b4a20, 24 <unfinished ...>
437 <... set_tid_address resumed>) = 437
438 <... set_robust_list resumed>) = 0
437 set_robust_list(0x704d8bdc4a20, 24 <unfinished ...>
438 rseq(0x7fc0814b5060, 0x20, 0, 0x53053053 <unfinished ...>
437 <... set_robust_list resumed>) = 0
438 <... rseq resumed>) = 0
437 rseq(0x704d8bdc5060, 0x20, 0, 0x53053053 <unfinished ...>
438 mprotect(0x7fc0813ff000, 16384, PROT_READ <unfinished ...>
437 <... rseq resumed>) = 0
438 <... mprotect resumed>) = 0
437 mprotect(0x704d8bbff000, 16384, PROT_READ <unfinished ...>
438 mprotect(0x5b4ac3130000, 4096, PROT_READ <unfinished ...>
437 <... mprotect resumed>) = 0
438 <... mprotect resumed>) = 0
437 mprotect(0x56f292c42000, 4096, PROT_READ <unfinished ...>
438 mprotect(0x7fc0814fc000, 8192, PROT_READ <unfinished ...>
437 <... mprotect resumed>) = 0
438 <... mprotect resumed>) = 0
437 mprotect(0x704d8be0c000, 8192, PROT_READ <unfinished ...>
438 prlimit64(0, RLIMIT_STACK, NULL, <unfinished ...>

437 <... mprotect resumed>) = 0
438 <... prlimit64 resumed>{rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
437 prlimit64(0, RLIMIT_STACK, NULL, <unfinished ...>
438 munmap(0x7fc0814b7000, 52259 <unfinished ...>
437 <... prlimit64 resumed>{rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
438 <... munmap resumed>) = 0
437 munmap(0x704d8bdc7000, 52259 <unfinished ...>
438 read(0, <unfinished ...>
437 <... munmap resumed>) = 0
437 read(0, <unfinished ...>
436 <... read resumed>"HELLO WORLD! hELLo WoRLD!\n", 1024) = 28
436 write(4, "HELLO WORLD! hELLo WoRLD!\n", 28) = 28
437 <... read resumed>"HELLO WORLD! hELLo WoRLD!\n", 4096) = 28
436 read(7, <unfinished ...>
437 write(1, "hello world! hello world!\n", 28 <unfinished ...>
438 <... read resumed>"hello world! hello world!\n", 4096) = 28
437 <... write resumed>) = 28
438 write(1, "hello world! hello world!\n", 26 <unfinished ...>
437 read(0, <unfinished ...>
436 <... read resumed>"h", 1) = 1
438 <... write resumed>) = 26
436 read(7, <unfinished ...>
438 read(0, <unfinished ...>
436 <... read resumed>"e", 1) = 1
436 read(7, "l", 1) = 1
436 read(7, "l", 1) = 1
436 read(7, "o", 1) = 1
436 read(7, " ", 1) = 1
436 read(7, "w", 1) = 1
436 read(7, "o", 1) = 1
436 read(7, "r", 1) = 1
436 read(7, "l", 1) = 1
436 read(7, "d", 1) = 1
436 read(7, "!", 1) = 1
436 read(7, " ", 1) = 1
436 read(7, "h", 1) = 1
436 read(7, "e", 1) = 1
436 read(7, "l", 1) = 1
436 read(7, "l", 1) = 1
436 read(7, "o", 1) = 1
436 read(7, " ", 1) = 1
436 read(7, "w", 1) = 1
436 read(7, "o", 1) = 1
436 read(7, "r", 1) = 1
436 read(7, "l", 1) = 1
436 read(7, "d", 1) = 1
436 read(7, "!", 1) = 1
436 read(7, "\n", 1) = 1
436 write(1, "hello world! hello world!\n", 26) = 26
436 read(0, "", 1024) = 0
436 close(4) = 0
437 <... read resumed>"", 4096) = 0
436 close(7 <unfinished ...>
437 exit_group(0 <unfinished ...>
436 <... close resumed>) = 0

437 <... exit_group resumed>) = ?
436 **wait4(437, <unfinished ...>**
438 <... read resumed>"", 4096) = 0
437 +++ exited with 0 +++
436 <... wait4 resumed>NULL, 0, NULL) = 437
438 exit_group(0 <unfinished ...>
436 --- SIGCHLD {si_signo=SIGCHLD, si_code=CLD_EXITED, si_pid=437, si_uid=1000, si_status=0, si_utime=0, si_stime=0} ---
438 <... exit_group resumed>) = ?
436 **wait4(438, <unfinished ...>**
438 +++ exited with 0 +++
436 <... wait4 resumed>NULL, 0, NULL) = 438
436 --- SIGCHLD {si_signo=SIGCHLD, si_code=CLD_EXITED, si_pid=438, si_uid=1000, si_status=0, si_utime=0, si_stime=0} ---
436 exit_group(0) = ?
436 +++ exited with 0 +++

Лабораторная работа № 2

```
    15:31:51.401012 execve("./lab2_determinant", ["./lab2_determinant", "4", "9"],
0x7fff40a5c6f0 /* 26 vars */) = 0

    15:31:51.407827 brk(NULL)                = 0x5e489cf30000

    15:31:51.408800 mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1,
0) = 0x7f009a54c000

    15:31:51.409933 access("/etc/ld.so.preload", R_OK) = -1 ENOENT (No such file or
directory)

    15:31:51.410799 openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3

    15:31:51.411814 fstat(3, {st_mode=S_IFREG|0644, st_size=59003, ...}) = 0

    15:31:51.412842 mmap(NULL, 59003, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f009a53d000

    15:31:51.413747 close(3)                 = 0

    15:31:51.414779 openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6",
O_RDONLY|O_CLOEXEC) = 3

    15:31:51.415511 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

    15:31:51.416474 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"..., 784, 64) = 784

    15:31:51.417320 fstat(3, {st_mode=S_IFREG|0755, st_size=2125328, ...}) = 0

    15:31:51.417889 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"..., 784, 64) = 784

    15:31:51.418470 mmap(NULL, 2170256, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) =
0x7f009a200000

    15:31:51.419047 mmap(0x7f009a228000, 1605632, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x28000) = 0x7f009a228000

    15:31:51.419686 mmap(0x7f009a3b0000, 323584, PROT_READ,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1b0000) = 0x7f009a3b0000
```

```
    15:31:51.420369 mmap(0x7f009a3ff000, 24576, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1fe000) = 0x7f009a3ff000

    15:31:51.420863 mmap(0x7f009a405000, 52624, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7f009a405000

    15:31:51.421349 close(3)                = 0

    15:31:51.421836 mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1,
0) = 0x7f009a53a000

    15:31:51.422296 arch_prctl(ARCH_SET_FS, 0x7f009a53a740) = 0

    15:31:51.422775 set_tid_address(0x7f009a53aa10) = 358

    15:31:51.423189 set_robust_list(0x7f009a53aa20, 24) = 0

    15:31:51.423662 rseq(0x7f009a53b060, 0x20, 0, 0x53053053) = 0

    15:31:51.424114 mprotect(0x7f009a3ff000, 16384, PROT_READ) = 0

    15:31:51.424601 mprotect(0x5e486c574000, 4096, PROT_READ) = 0

    15:31:51.425131 mprotect(0x7f009a584000, 8192, PROT_READ) = 0

    15:31:51.425575 prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024,
rlim_max=RLIM64_INFINITY}) = 0

    15:31:51.426059 munmap(0x7f009a53d000, 59003) = 0

    15:31:51.426544 getrandom("\xaa\x21\x20\xa3\x15\xa8\x29\x57", 8, GRND_NONBLOCK) = 8

    15:31:51.427002 brk(NULL)               = 0x5e489cf30000

    15:31:51.427448 brk(0x5e489cf51000)     = 0x5e489cf51000

    15:31:51.427928 rt_sigaction(SIGRT_1, {sa_handler=0x7f009a299530, sa_mask=[],
sa_flags=SA_RESTORER|SA_ONSTACK|SA_RESTART|SA_SIGINFO, sa_restorer=0x7f009a245330}, NULL, 8)
= 0

    15:31:51.428412 rt_sigprocmask(SIG_UNBLOCK, [RTMIN RT_1], NULL, 8) = 0

    15:31:51.429310 mmap(NULL, 8392704, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -
1, 0) = 0x7f00999ff000

    15:31:51.430008 mprotect(0x7f0099a00000, 8388608, PROT_READ|PROT_WRITE) = 0

    15:31:51.430539 rt_sigprocmask(SIG_BLOCK, ~[], [], 8) = 0

    15:31:51.431039
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_S
ETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7f009a1ff990,
parent_tid=0x7f009a1ff990, exit_signal=0, stack=0x7f00999ff000, stack_size=0x7fff80,
tls=0x7f009a1ff6c0}strace: Process 359 attached

 => {parent_tid=[359]}, 88) = 359

    [pid   358] 15:31:51.432041 rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

    [pid   359] 15:31:51.432546 rseq(0x7f009a1fffe0, 0x20, 0, 0x53053053 <unfinished ...>

    [pid   358] 15:31:51.432992 <... rt_sigprocmask resumed>NULL, 8) = 0

    [pid   359] 15:31:51.433205 <... rseq resumed>) = 0

    [pid   358] 15:31:51.433401 mmap(NULL, 8392704, PROT_NONE,
MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0 <unfinished ...>

    [pid   359] 15:31:51.433836 set_robust_list(0x7f009a1ff9a0, 24 <unfinished ...>
```

```
[pid    358] 15:31:51.434228 <... mmap resumed>) = 0x7f00991fe000

[pid    359] 15:31:51.434435 <... set_robust_list resumed>) = 0

[pid    358] 15:31:51.434650 mprotect(0x7f00991ff000, 8388608, PROT_READ|PROT_WRITE
<unfinished ...>

[pid    359] 15:31:51.435115 rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

[pid    358] 15:31:51.435589 <... mprotect resumed>) = 0

[pid    359] 15:31:51.435866 <... rt_sigprocmask resumed>NULL, 8) = 0

[pid    358] 15:31:51.436190 rt_sigprocmask(SIG_BLOCK, ~[], [], 8) = 0

[pid    358] 15:31:51.436547
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_S
ETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7f00999fe990,
parent_tid=0x7f00999fe990, exit_signal=0, stack=0x7f00991fe000, stack_size=0x7fff80,
tls=0x7f00999fe6c0} => {parent_tid=[360]}, 88) = 360

strace: Process 360 attached

[pid    358] 15:31:51.437452 rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

[pid    360] 15:31:51.437879 rseq(0x7f00999fefe0, 0x20, 0, 0x53053053 <unfinished ...>

[pid    358] 15:31:51.438249 <... rt_sigprocmask resumed>NULL, 8) = 0

[pid    360] 15:31:51.438388 <... rseq resumed>) = 0

[pid    358] 15:31:51.438607 mmap(NULL, 8392704, PROT_NONE,
MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0 <unfinished ...>

[pid    360] 15:31:51.438969 set_robust_list(0x7f00999fe9a0, 24 <unfinished ...>

[pid    358] 15:31:51.439279 <... mmap resumed>) = 0x7f00989fd000

[pid    360] 15:31:51.439400 <... set_robust_list resumed>) = 0

[pid    358] 15:31:51.439583 mprotect(0x7f00989fe000, 8388608, PROT_READ|PROT_WRITE) =
0

[pid    360] 15:31:51.439894 rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

[pid    358] 15:31:51.440132 rt_sigprocmask(SIG_BLOCK, ~[],  <unfinished ...>

[pid    360] 15:31:51.440401 <... rt_sigprocmask resumed>NULL, 8) = 0

[pid    358] 15:31:51.440522 <... rt_sigprocmask resumed>[], 8) = 0

[pid    358] 15:31:51.440719
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_S
ETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7f00991fd990,
parent_tid=0x7f00991fd990, exit_signal=0, stack=0x7f00989fd000, stack_size=0x7fff80,
tls=0x7f00991fd6c0}strace: Process 361 attached

 => {parent_tid=[361]}, 88) = 361

[pid    358] 15:31:51.441289 rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

[pid    361] 15:31:51.441619 rseq(0x7f00991fdfe0, 0x20, 0, 0x53053053 <unfinished ...>

[pid    358] 15:31:51.441855 <... rt_sigprocmask resumed>NULL, 8) = 0

[pid    361] 15:31:51.441977 <... rseq resumed>) = 0

[pid    358] 15:31:51.442127 mmap(NULL, 8392704, PROT_NONE,
MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0 <unfinished ...>
```

```
[pid    361] 15:31:51.442359 set_robust_list(0x7f00991fd9a0, 24 <unfinished ...>

[pid    358] 15:31:51.442585 <... mmap resumed>) = 0x7f00981fc000

[pid    361] 15:31:51.442704 <... set_robust_list resumed>) = 0

[pid    358] 15:31:51.442857 mprotect(0x7f00981fd000, 8388608, PROT_READ|PROT_WRITE
<unfinished ...>

[pid    361] 15:31:51.443083 rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

[pid    358] 15:31:51.443366 <... mprotect resumed>) = 0

[pid    361] 15:31:51.443516 <... rt_sigprocmask resumed>NULL, 8) = 0

[pid    358] 15:31:51.443648 rt_sigprocmask(SIG_BLOCK, ~[], [], 8) = 0

[pid    358] 15:31:51.443954
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_S
ETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0x7f00989fc990,
parent_tid=0x7f00989fc990, exit_signal=0, stack=0x7f00981fc000, stack_size=0x7fff80,
tls=0x7f00989fc6c0}strace: Process 362 attached

 => {parent_tid=[362]}, 88) = 362

[pid    362] 15:31:51.444498 rseq(0x7f00989fcfe0, 0x20, 0, 0x53053053 <unfinished ...>

[pid    358] 15:31:51.444733 rt_sigprocmask(SIG_SETMASK, [],  <unfinished ...>

[pid    362] 15:31:51.445157 <... rseq resumed>) = 0

[pid    358] 15:31:51.445337 <... rt_sigprocmask resumed>NULL, 8) = 0

[pid    362] 15:31:51.445479 set_robust_list(0x7f00989fc9a0, 24 <unfinished ...>

[pid    358] 15:31:51.445777 futex(0x7f009a1ff990,
FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 359, NULL, FUTEX_BITSET_MATCH_ANY <unfinished ...>

[pid    362] 15:31:51.446018 <... set_robust_list resumed>) = 0

[pid    362] 15:31:51.446160 rt_sigprocmask(SIG_SETMASK, [], NULL, 8) = 0

[pid    359] 15:31:51.454903 rt_sigprocmask(SIG_BLOCK, ~[RT_1], NULL, 8) = 0

[pid    359] 15:31:51.455899 madvise(0x7f00999ff000, 8368128, MADV_DONTNEED) = 0

[pid    359] 15:31:51.456694 exit(0)      = ?

[pid    358] 15:31:51.458020 <... futex resumed>) = 0

[pid    359] 15:31:51.458571 +++ exited with 0 +++

[pid    358] 15:31:51.459012 futex(0x7f00999fe990,
FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 360, NULL, FUTEX_BITSET_MATCH_ANY <unfinished ...>

[pid    360] 15:31:51.460227 rt_sigprocmask(SIG_BLOCK, ~[RT_1], NULL, 8) = 0

[pid    360] 15:31:51.461472 madvise(0x7f00991fe000, 8368128, MADV_DONTNEED) = 0

[pid    360] 15:31:51.462237 exit(0 <unfinished ...>

[pid    361] 15:31:51.463151 rt_sigprocmask(SIG_BLOCK, ~[RT_1],  <unfinished ...>

[pid    360] 15:31:51.463981 <... exit resumed>) = ?

[pid    361] 15:31:51.464469 <... rt_sigprocmask resumed>NULL, 8) = 0

[pid    358] 15:31:51.464880 <... futex resumed>) = 0

[pid    360] 15:31:51.465343 +++ exited with 0 +++
```

```
     [pid   358] 15:31:51.465637 futex(0x7f00991fd990,
FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 361, NULL, FUTEX_BITSET_MATCH_ANY <unfinished ...>

     [pid   361] 15:31:51.466386 madvise(0x7f00989fd000, 8368128, MADV_DONTNEED <unfinished
...>

     [pid   362] 15:31:51.467017 rt_sigprocmask(SIG_BLOCK, ~[RT_1],  <unfinished ...>

     [pid   361] 15:31:51.467624 <... madvise resumed>) = 0

     [pid   362] 15:31:51.467847 <... rt_sigprocmask resumed>NULL, 8) = 0

     [pid   361] 15:31:51.468138 exit(0 <unfinished ...>

     [pid   362] 15:31:51.468636 madvise(0x7f00981fc000, 8368128, MADV_DONTNEED <unfinished
...>

     [pid   361] 15:31:51.469186 <... exit resumed>) = ?

     [pid   362] 15:31:51.469464 <... madvise resumed>) = 0

     [pid   358] 15:31:51.469797 <... futex resumed>) = 0

     [pid   361] 15:31:51.470061 +++ exited with 0 +++

     [pid   358] 15:31:51.470320 futex(0x7f00989fc990,
FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 362, NULL, FUTEX_BITSET_MATCH_ANY <unfinished ...>

     [pid   362] 15:31:51.470722 exit(0)      = ?

     [pid   362] 15:31:51.471311 +++ exited with 0 +++

     15:31:51.471425 <... futex resumed>)     = 0

     15:31:51.471553 fstat(1, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x1), ...}) = 0

     15:31:51.471922 write(1, "Matrix size: 9\n", 15) = 15

     15:31:51.472610 write(1, "Determinant: -11889494.0000\n", 28) = 28

     15:31:51.473246 write(1, "Time: 0.043624 seconds\n", 23) = 23

     15:31:51.473608 write(1, "Threads used: 4 (max: 4)\n", 25) = 25

     15:31:51.473920 getpid()                = 358

     15:31:51.474212 write(1, "Process PID: 358\n", 17) = 17

     15:31:51.474494 exit_group(0)            = ?

     15:31:51.475083 +++ exited with 0 +++
```

Лабораторная работа №3
   execve("./parent", ["./parent"], 0x7ffc5aab30b8 /* 26 vars */) = 0
brk(NULL) = 0x59e89f8be000
**mmap(NULL, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x757482931000**
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=71671, ...}) = 0
mmap(NULL, 71671, PROT_READ, MAP_PRIVATE, 3, 0) = 0x75748291f000
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\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)
= 0x757482600000
mmap(0x757482628000, 1605632, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x28000) = 0x757482628000
mmap(0x7574827b0000, 323584, PROT_READ,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1b0000) =
0x7574827b0000
mmap(0x7574827ff000, 24576, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1fe000) = 0x7574827ff000
mmap(0x757482805000, 52624, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x757482805000
close(3) = 0
mmap(NULL, 12288, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x75748291c000
arch_prctl(ARCH_SET_FS, 0x75748291c740) = 0
set_tid_address(0x75748291ca10) = 723
set_robust_list(0x75748291ca20, 24) = 0
rseq(0x75748291d060, 0x20, 0, 0x53053053) = 0
mprotect(0x7574827ff000, 16384, PROT_READ) = 0
mprotect(0x59e86f858000, 4096, PROT_READ) = 0
mprotect(0x757482969000, 8192, PROT_READ) = 0
prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024,
rlim_max=RLIM64_INFINITY}) = 0
munmap(0x75748291f000, 71671) = 0
openat(AT_FDCWD, "shared.bin", O_RDWR|O_CREAT|O_TRUNC, 0600) = 3
ftruncate(3, 1028) = 0
mmap(NULL, 1028, PROT_READ|PROT_WRITE, MAP_SHARED, 3, 0) =
0x757482930000
close(3) = 0
rt_sigaction(SIGUSR2, {sa_handler=0x59e86f8567b0, sa_mask=[],
sa_flags=SA_RESTORER, sa_restorer=0x757482645330}, NULL, 8) = 0
clone(child_stack=NULL,

flags=CLONE_CHILD_CLEARTID|CLONE_CHILD_SETTID|SIGCHLD,
child_tidptr=0x75748291ca10) = 724
strace: Process 724 attached
[pid 723] **clone(child_stack=NULL,**
flags=CLONE_CHILD_CLEARTID|CLONE_CHILD_SETTID|SIGCHLD
<unfinished ...>
[pid 724] set_robust_list(0x75748291ca20, 24) = 0
[pid 724] ****execve("./child1", ["child1"], 0x7ffc7788dc08 /* 26 vars */strace: Process**
725 attached**
<unfinished ...>
[pid 723] **<... clone resumed>, child_tidptr=0x75748291ca10) = 725**
[pid 725] set_robust_list(0x75748291ca20, 24 <unfinished ...>
[pid 723] **clock_nanosleep(CLOCK_REALTIME, 0, {tv_sec=1, tv_nsec=0},**
<unfinished ...>
[pid 725] <... set_robust_list resumed>) = 0
[pid 725] ****execve("./child2", ["child2"], 0x7ffc7788dc08 /* 26 vars / *<unfinished ...>****
[pid 724] <... execve resumed>) = 0
[pid 724] brk(NULL) = 0x56b150021000
[pid 724] **mmap(NULL, 8192, PROT_READ|PROT_WRITE,**
MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7c341cbdc000
[pid 724] access("/etc/ld.so.preload", R_OK <unfinished ...>
[pid 725] <... execve resumed>) = 0
[pid 724] <... access resumed>) = -1 ENOENT (No such file or directory)
[pid 725] brk(NULL <unfinished ...>
[pid 724] **openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC**
<unfinished ...>
[pid 725] <... brk resumed>) = 0x651e90620000
[pid 724] <... openat resumed>) = 3
[pid 725] **mmap(NULL, 8192, PROT_READ|PROT_WRITE,**
MAP_PRIVATE|MAP_ANONYMOUS, -1, 0 <unfinished ...>
[pid 724] fstat(3, <unfinished ...>
[pid 725] <... mmap resumed>) = 0x7d68cca3d000
[pid 724] <... fstat resumed>{st_mode=S_IFREG|0644, st_size=71671, ...}) = 0
[pid 725] access("/etc/ld.so.preload", R_OK <unfinished ...>
[pid 724] **mmap(NULL, 71671, PROT_READ, MAP_PRIVATE, 3, 0 <unfinished ...>**
[pid 725] <... access resumed>) = -1 ENOENT (No such file or directory)
[pid 725] **openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC**
<unfinished ...>
[pid 724] <... mmap resumed>) = 0x7c341cbca000
[pid 725] <... openat resumed>) = 3
[pid 724] **close(3 <unfinished ...>**

[pid 725] fstat(3, <unfinished ...>

[pid 724] <... close resumed>) = 0

[pid 725] <... fstat resumed>{st_mode=S_IFREG|0644, st_size=71671, ...}) = 0

[pid 724] **openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6",**
O_RDONLY|O_CLOEXEC <unfinished ...>

[pid 725] **mmap(NULL, 71671, PROT_READ, MAP_PRIVATE, 3, 0 <unfinished ...>**

[pid 724] <... openat resumed>) = 3

[pid 725] <... mmap resumed>) = 0x7d68cca2b000

[pid 724] read(3, <unfinished ...>

[pid 725] **close(3 <unfinished ...>**

[pid 724] <... read
resumed>"\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 725] <... close resumed>) = 0

[pid 724] pread64(3, <unfinished ...>

[pid 725] **openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6",**
O_RDONLY|O_CLOEXEC <unfinished ...>

[pid 724] <... 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\0\0"..., 784, 64) =
784

[pid 725] <... openat resumed>) = 3

[pid 724] fstat(3, <unfinished ...>

[pid 725] read(3, <unfinished ...>

[pid 724] <... fstat resumed>{st_mode=S_IFREG|0755, st_size=2125328, ...}) = 0

[pid 725] <... read
resumed>"\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 724] pread64(3, <unfinished ...>

[pid 725] pread64(3, <unfinished ...>

[pid 724] <... 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\0\0"..., 784, 64) =
784

[pid 725] <... 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\0\0"..., 784, 64) =
784

[pid 725] fstat(3, <unfinished ...>

[pid 724] **mmap(NULL, 2170256, PROT_READ,**
MAP_PRIVATE|MAP_DENYWRITE, 3, 0 <unfinished ...>

[pid 725] <... fstat resumed>{st_mode=S_IFREG|0755, st_size=2125328, ...}) = 0

[pid 724] <... mmap resumed>) = 0x7c341c800000

[pid 725] pread64(3, <unfinished ...>

[pid 724] **mmap(0x7c341c828000, 1605632, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x28000 <unfinished ...>**

[pid 725] <... pread64 resumed>"\6\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 724] <... mmap resumed>) = 0x7c341c828000

[pid 725] **mmap(NULL, 2170256, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0 <unfinished ...>**

[pid 724] **mmap(0x7c341c9b0000, 323584, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1b0000 <unfinished ...>**

[pid 725] <... mmap resumed>) = 0x7d68cc800000

[pid 724] <... mmap resumed>) = 0x7c341c9b0000

[pid 725] **mmap(0x7d68cc828000, 1605632, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x28000 <unfinished ...>**

[pid 724] **mmap(0x7c341c9ff000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1fe000 <unfinished ...>**

[pid 725] <... mmap resumed>) = 0x7d68cc828000

[pid 724] <... mmap resumed>) = 0x7c341c9ff000

[pid 725] **mmap(0x7d68cc9b0000, 323584, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1b0000 <unfinished ...>**

[pid 724] **mmap(0x7c341ca05000, 52624, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0 <unfinished ...>**

[pid 725] <... mmap resumed>) = 0x7d68cc9b0000

[pid 724] <... mmap resumed>) = 0x7c341ca05000

[pid 725] **mmap(0x7d68cc9ff000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1fe000 <unfinished ...>**

[pid 724] **close(3 <unfinished ...>**

[pid 725] <... mmap resumed>) = 0x7d68cc9ff000

[pid 724] <... close resumed>) = 0

[pid 725] **mmap(0x7d68cca05000, 52624, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0 <unfinished ...>**

[pid 724] **mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0 <unfinished ...>**

[pid 725] <... mmap resumed>) = 0x7d68cca05000

[pid 724] <... mmap resumed>) = 0x7c341cbc7000

[pid 725] **close(3 <unfinished ...>**

[pid 724] **arch_prctl(ARCH_SET_FS, 0x7c341cbc7740 <unfinished ...>**

[pid 725] <... close resumed>) = 0

[pid 724] <... arch_prctl resumed>) = 0

[pid 725] **mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0 <unfinished ...>**

[pid 724] set_tid_address(0x7c341cbc7a10 <unfinished ...>

[pid 725] <... mmap resumed>) = 0x7d68cca28000

[pid 724] <... set_tid_address resumed>) = 724

[pid 725] **arch_prctl(ARCH_SET_FS, 0x7d68cca28740 <unfinished ...>**

[pid 724] set_robust_list(0x7c341cbc7a20, 24 <unfinished ...>

[pid 725] <... arch_prctl resumed>) = 0

[pid 724] <... set_robust_list resumed>) = 0

[pid 725] set_tid_address(0x7d68cca28a10 <unfinished ...>

[pid 724] rseq(0x7c341cbc8060, 0x20, 0, 0x53053053 <unfinished ...>

[pid 725] <... set_tid_address resumed>) = 725

[pid 724] <... rseq resumed>) = 0

[pid 725] set_robust_list(0x7d68cca28a20, 24 <unfinished ...>

[pid 724] **mprotect(0x7c341c9ff000, 16384, PROT_READ <unfinished ...>**

[pid 725] <... set_robust_list resumed>) = 0

[pid 724] <... mprotect resumed>) = 0

[pid 725] rseq(0x7d68cca29060, 0x20, 0, 0x53053053 <unfinished ...>

[pid 724] mprotect(0x56b1332c4000, 4096, PROT_READ <unfinished ...>

[pid 725] <... rseq resumed>) = 0

[pid 724] <... mprotect resumed>) = 0

[pid 725] **mprotect(0x7d68cc9ff000, 16384, PROT_READ <unfinished ...>**

[pid 724] mprotect(0x7c341cc14000, 8192, PROT_READ <unfinished ...>

[pid 725] <... mprotect resumed>) = 0

[pid 724] <... mprotect resumed>) = 0

[pid 725] mprotect(0x651e552f2000, 4096, PROT_READ <unfinished ...>

[pid 724] prlimit64(0, RLIMIT_STACK, NULL, <unfinished ...>

[pid 725] <... mprotect resumed>) = 0

[pid 724] <... prlimit64 resumed>{rlim_cur=8192*1024,
rlim_max=RLIM64_INFINITY}) = 0

[pid 725] mprotect(0x7d68cca75000, 8192, PROT_READ <unfinished ...>

[pid 724] **munmap(0x7c341cbca000, 71671 <unfinished ...>**

[pid 725] <... mprotect resumed>) = 0

[pid 724] <... munmap resumed>) = 0

[pid 725] prlimit64(0, RLIMIT_STACK, NULL, <unfinished ...>

[pid 724] **openat(AT_FDCWD, "shared.bin", O_RDWR <unfinished ...>**

[pid 725] <... prlimit64 resumed>{rlim_cur=8192*1024,
rlim_max=RLIM64_INFINITY}) = 0

[pid 725] **munmap(0x7d68cca2b000, 71671) = 0**

[pid 725] **openat(AT_FDCWD, "shared.bin", O_RDWR) = 3**

[pid 724] <... openat resumed>) = 3

[pid 725] **mmap(NULL, 1028, PROT_READ|PROT_WRITE, MAP_SHARED, 3, 0
<unfinished ...>**

[pid 724] **mmap(NULL, 1028, PROT_READ|PROT_WRITE, MAP_SHARED, 3, 0 <unfinished ...>**

[pid 725] <... mmap resumed>) = 0x7d68cca3c000

[pid 724] <... mmap resumed>) = 0x7c341cbdb000

[pid 725] **close(3 <unfinished ...>**

[pid 724] **close(3 <unfinished ...>**

[pid 725] <... close resumed>) = 0

[pid 724] <... close resumed>) = 0

[pid 725] **rt_sigaction(SIGUSR1, {sa_handler=0x651e552f04d0, sa_mask=[], sa_flags=SA_RESTORER, sa_restorer=0x7d68cc845330}, <unfinished ...>**

[pid 724] **rt_sigaction(SIGUSR1, {sa_handler=0x56b1332c24c0, sa_mask=[], sa_flags=SA_RESTORER, sa_restorer=0x7c341c845330}, <unfinished ...>**

[pid 725] <... rt_sigaction resumed>NULL, 8) = 0

[pid 724] <... rt_sigaction resumed>NULL, 8) = 0

[pid 725] **getppid(<unfinished ...>**

[pid 724] **getppid(<unfinished ...>**

[pid 725] <... getppid resumed>) = 723

[pid 724] <... getppid resumed>) = 723

[pid 725] **pause(<unfinished ...>**

[pid 724] **pause(<unfinished ...>**

[pid 723] <... clock_nanosleep resumed>0x7ffc7788d5b0) = 0

[pid 723] fstat(1, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x2), ...}) = 0

[pid 723] getrandom("\xa7\x96\xe8\x6a\xd1\x46\x99\x70", 8, GRND_NONBLOCK) = 8

[pid 723] brk(NULL) = 0x59e89f8be000

[pid 723] brk(0x59e89f8df000) = 0x59e89f8df000

[pid 723] **write(1, "Enter lines (Ctrl+D to finish):\n", 32) = 32**

[pid 723] fstat(0, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x2), ...}) = 0

[pid 723] **read(0, "HeLlo woRlD!\n", 1024) = 13**

[pid 723] **kill(724, SIGUSR1) = 0**

[pid 724] <... pause resumed>) = ? ERESTARTNOHAND (To be restarted if no handler)

[pid 723] **pause(<unfinished ...>**

[pid 724] --- SIGUSR1 {si_signo=SIGUSR1, si_code=SI_USER, si_pid=723, si_uid=1000} ---

[pid 724] **rt_sigreturn({mask=[]}) = -1 EINTR (Interrupted system call)**

[pid 724] **kill(723, SIGUSR2 <unfinished ...>**

[pid 723] <... pause resumed>) = ? ERESTARTNOHAND (To be restarted if no handler)

[pid 724] <... kill resumed>) = 0

[pid 723] --- SIGUSR2 {si_signo=SIGUSR2, si_code=SI_USER, si_pid=724, si_uid=1000} ---

[pid 724] **pause(<unfinished ...>**

[pid 723] **rt_sigreturn({mask=[]}) = -1 EINTR (Interrupted system call)**

[pid 723] **kill(725, SIGUSR1) = 0**

[pid 725] <... pause resumed>) = ? ERESTARTNOHAND (To be restarted if no handler)

[pid 723] **pause(<unfinished ...>**

[pid 725] --- SIGUSR1 {si_signo=SIGUSR1, si_code=SI_USER, si_pid=723, si_uid=1000} ---

[pid 725] **rt_sigreturn({mask=[]}) = -1 EINTR (Interrupted system call)**

[pid 725] **kill(723, SIGUSR2) = 0**

[pid 723] <... pause resumed>) = ? ERESTARTNOHAND (To be restarted if no handler)

[pid 725] **pause(<unfinished ...>**

[pid 723] --- SIGUSR2 {si_signo=SIGUSR2, si_code=SI_USER, si_pid=725, si_uid=1000} ---

[pid 723] **rt_sigreturn({mask=[]}) = -1 EINTR (Interrupted system call)**

[pid 723] **write(1, "hello world!\n", 13) = 13**

[pid 723] **read(0, "", 1024) = 0**

[pid 723] **kill(724, SIGUSR1) = 0**

[pid 724] <... pause resumed>) = ? ERESTARTNOHAND (To be restarted if no handler)

[pid 723] **kill(725, SIGUSR1 <unfinished ...>**

[pid 724] --- SIGUSR1 {si_signo=SIGUSR1, si_code=SI_USER, si_pid=723, si_uid=1000} ---

[pid 723] <... kill resumed>) = 0

[pid 725] <... pause resumed>) = ? ERESTARTNOHAND (To be restarted if no handler)

[pid 723] **wait4(724, <unfinished ...>**

[pid 724] rt_sigreturn({mask=[]} <unfinished ...>

[pid 725] --- SIGUSR1 {si_signo=SIGUSR1, si_code=SI_USER, si_pid=723, si_uid=1000} ---

[pid 724] <... rt_sigreturn resumed>) = -1 EINTR (Interrupted system call)

[pid 725] rt_sigreturn({mask=[]} <unfinished ...>

[pid 724] **munmap(0x7c341cbdb000, 1028 <unfinished ...>**

[pid 725] <... rt_sigreturn resumed>) = -1 EINTR (Interrupted system call)

[pid 724] <... munmap resumed>) = 0

[pid 725] **munmap(0x7d68cca3c000, 1028 <unfinished ...>**

[pid 724] **exit_group(0 <unfinished ...>**

[pid 725] <... munmap resumed>) = 0

[pid 724] <... exit_group resumed>) = ?

[pid 725] **exit_group(0) = ?**

[pid 724] +++ exited with 0 +++

[pid 723] **<... wait4 resumed>[{WIFEXITED(s) && WEXITSTATUS(s) == 0}], 0, NULL) = 724**

[pid 725] +++ exited with 0 +++

--- SIGCHLD {si_signo=SIGCHLD, si_code=CLD_EXITED, si_pid=724, si_uid=1000, si_status=0, si_utime=0, si_stime=0} ---

wait4(725, [{WIFEXITED(s) && WEXITSTATUS(s) == 0}], 0, NULL) = 725

munmap(0x757482930000, 1028) = 0

exit_group(0) = ?

+++ exited with 0 +++

Лабораторная работа №4

160 15:03:09.943847 execve("./prog_static", ["./prog_static"], 0x7ffc3a140e28 /* 28 vars */) = 0 <0.006940>

160 15:03:09.952265 brk(NULL) = 0x572f9a252000 <0.000254>

160 15:03:09.953835 mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f70a7a35000 <0.000149>

160 15:03:09.955341 access("/etc/ld.so.preload", R_OK) = -1 ENOENT (No such file or directory) <0.000079>

160 15:03:09.956396 openat(AT_FDCWD, "./glibc-hwcaps/x86-64-v3/ libimpl1.so ", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory) <0.000705>

160 15:03:09.958250 openat(AT_FDCWD, "./glibc-hwcaps/x86-64-v2/ libimpl1.so ", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory) <0.000442>

160 15:03:09.960984 openat(AT_FDCWD, "./libimpl1.so", O_RDONLY|O_CLOEXEC) = 3 <0.001567>

160 15:03:09.963606 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\0\0@\0\0\0\0\0\0\0@5\0\0\0\0\0\0\0\0\0@\0 8\0\v\0@\0\36\0\35\0\1\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@\5\0\0\0\0\0\0@\5\0\0\ 0\0\0\0\0\20\0\0\0\0\0\0\1\0\0\0\5\0\0\0\20\0\0\0\0\0\0\20\0\0\0\0\0\0\20\0\0\0\0\0\241\1\0\0\0\0\0\ 241\1\0\0\0\0\0\0\20\0\0\0\0\0\0\1\0\0\0\4\0\0\0 \0\0\0\0\0\0 \0\0\0\0\0\0"..., 832) = 832 <0.000664>

160 15:03:09.965399 fstat(3, {st_mode=S_IFREG|0777, st_size=15552, ...}) = 0 <0.000564>

160 15:03:09.967091 getcwd("/mnt/c/Users/Son/OS_LABS/OS_LABS/lab4/src", 128) = 42 <0.000068>

160 15:03:09.968261 mmap(NULL, 16408, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f70a7a30000 <0.000074>

160 15:03:09.969276 mmap(0x7f70a7a31000, 4096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1000) = 0x7f70a7a31000 <0.000088>

160 15:03:09.970415 mmap(0x7f70a7a32000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f70a7a32000 <0.000072>

160 15:03:09.971358 mmap(0x7f70a7a33000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f70a7a33000 <0.000095>

160 15:03:09.973066 close(3) = 0 <0.000066>

160 15:03:09.974102 openat(AT_FDCWD, "./glibc-hwcaps/x86-64-v3/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory) <0.000890>

... (аналогичные вызовы для libc.so.6 и libm.so.6) ...

160 15:03:10.032982 prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0 <0.000087>

160 15:03:10.033909 munmap(0x7f70a7a1e000, 71671) = 0 <0.000108>

160 15:03:10.036035 fstat(0, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x1), ...}) = 0 <0.000071>

160 15:03:10.036735 getrandom("\xe1\x9d\x9c\x55\xd1\xd5\x90\xb4", 8, GRND_NONBLOCK) = 8 <0.000077>

160 15:03:10.037334 brk(NULL) = 0x572f9a252000 <0.000065>

160 15:03:10.038088 brk(0x572f9a273000) = 0x572f9a273000 <0.000060>

160 15:03:10.038672 read(0, "1 24 18\n", 1024) = 8 <3.514842>

160 15:03:13.554585 fstat(1, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x1), ...}) = 0 <0.000080>

160 15:03:13.556050 write(1, "6\n", 2) = 2 <0.000151>

160 15:03:13.557489 read(0, "2 10\n", 1024) = 5 <2.726724>

160 15:03:16.285873 write(1, "2.593742\n", 9) = 9 <0.000239>

160 15:03:16.287137 read(0, "", 1024) = 0 <1.304689>

160 15:03:17.593636 exit_group(0) = ?

160 15:03:17.596548 +++ exited with 0 +++

Динамическая версия (prog_dynamic):

182 15:03:25.865626 execve("./prog_dynamic", ["./prog_dynamic", "dynamic"], 0x7fff90508080 /* 28 vars */) = 0 <0.006122>

182 15:03:25.873513 brk(NULL) = 0x618ac06ff000 <0.000067>

182 15:03:25.875161 mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x77d58b448000 <0.000091>

... (загрузка libc.so.6) ...

182 15:03:25.921942 **openat(AT_FDCWD, "./ libimp1.so ", O_RDONLY|O_CLOEXEC) = 3 <0.001787>**

182 15:03:25.924610 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@\0\0\0\0\0\0\0@5\0\0\0\0\0\0\0\0\0\0@\08\0\v\0@\0\36\0\35\0\1\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\0@\5\0\0\0\0\0@\5\0\0\0\0\0\20\0\0\0\0\0\1\0\0\5\0\0\0\20\0\0\0\0\0\0\20\0\0\0\0\0\20\0\0\0\0\0\0\241\1\0\0\0\0\0\241\1\0\0\0\0\0\20\0\0\0\0\0\1\0\0\4\0\0\0\0 \0\0\0\0\0\0 \0\0\0\0\0\0"..., 832) = 832 <0.000688>

182 15:03:25.926763 fstat(3, {st_mode=S_IFREG|0777, st_size=15552, ...}) = 0 <0.001055>

182 15:03:25.928817 getcwd("/mnt/c/Users/Son/OS_LABS/OS_LABS/lab4/src", 128) = 42 <0.000163>

182 15:03:25.930052 mmap(NULL, 16408, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x77d58b443000 <0.000098>

182 15:03:25.931146 mmap(0x77d58b444000, 4096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1000) = 0x77d58b444000 <0.000064>

182 15:03:25.931875 mmap(0x77d58b445000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x77d58b445000 <0.000055>

182 15:03:25.932568 mmap(0x77d58b446000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x77d58b446000 <0.000055>

182 15:03:25.933514 close(3) = 0 <0.000054>

... (загрузка limb.so.6) ...

182 15:03:25.943938 openat(AT_FDCWD, "./libimp2.so", O_RDONLY|O_CLOEXEC) = 3 <0.000876>

182 15:03:25.945383 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@\0\0\0\0\0\0\0\3504\0\0\0\0\0\0\0\0\0\0@\08\0\v\0@\0\32\0\31\0\1\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\0310\4\0\0\0\0\0\0310\4\0\0\0\0\0\0\20\0\0\0\0\0\1\0\0\5\0\0\0\20\0\0\0\0\0\20\0\0\0\0\0\0\20\0\0\0\0\0\0301\1\0\0\0\0\0\0301\1\0\0\0\0\0\20\0\0\0\0\0\1\0\0\4\0\0\0\0 \0\0\0\0\0\0 \0\0\0\0\0\0"..., 832) = 832 <0.000247>

182 15:03:25.946108 fstat(3, {st_mode=S_IFREG|0777, st_size=15208, ...}) = 0 <0.000327>

182 15:03:25.946807 getcwd("/mnt/c/Users/Son/OS_LABS/OS_LABS/lab4/src", 128) = 42 <0.000055>

182 15:03:25.947231 mmap(NULL, 16400, PROT_READ,

MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x77d58b43e000 <0.000061>
182 15:03:25.947643 mmap(0x77d58b43f000, 4096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1000) = 0x77d58b43f000 <0.000067>
182 15:03:25.948061 mmap(0x77d58b440000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x77d58b440000 <0.000061>
182 15:03:25.948473 mmap(0x77d58b441000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x77d58b441000 <0.000060>
182 15:03:25.949098 close(3) = 0 <0.000088>
182 15:03:25.949650 mprotect(0x77d58b441000, 4096, PROT_READ) = 0 <0.000060>
182 15:03:25.950210 fstat(0, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x1), ...}) = 0 <0.000099>
182 15:03:25.954697 read(0, "1 24 18\n", 1024) = 8 <2.337602>
182 15:03:28.294643 fstat(1, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x1), ...}) = 0 <0.000279>
182 15:03:28.297122 write(1, "6\n", 2) = 2 <0.000218>
182 15:03:28.298965 read(0, "0\n", 1024) = 2 <3.484956>
182 15:03:31.785632 read(0, "2 10\n", 1024) = 5 <1.421596>
182 15:03:33.209055 write(1, "2.718282\n", 9) = 9 <0.000217>
182 15:03:33.210699 read(0, "", 1024) = 0 <2.072687>
182 15:03:35.284621 munmap(0x77d58b443000, 16408) = 0 <0.000558>
182 15:03:35.285778 munmap(0x77d58b117000, 950296) = 0 <0.000092>
182 15:03:35.286562 munmap(0x77d58b43e000, 16400) = 0 <0.000569>
182 15:03:35.288057 exit_group(0) = ?
182 15:03:35.289187 +++ exited with 0 +++

Вывод

В ходе выполнения лабораторной работы были получены навыки по диагностики работы программного обеспечения. Это было рассмотрено на примере команды strace. Полученные навыки помогают лучше понять, как программы взаимодействуют с операционной системой.