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Факультет информационных технологий и прикладной математики

Кафедра вычислительной математики и программирования

Лабораторная работа №1 по курсу

«Операционные системы»

Системные вызовы

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Дата: \_\_\_\_\_\_\_\_\_\_

Подпись: \_\_\_\_\_\_\_\_\_\_

Москва, 2020.

Постановка задачи

**Цель работы**

Приобретение практических навыков диагностики работы программного обеспечения.

**Задание**

При выполнении последующих лабораторных работ необходимо продемонстрировать ключевые системные вызовы, которые в них используются и то, что их использование соответствует варианту ЛР.

**Результат команды**

strace ./b.out

execve("./b.out", ["./b.out"], 0x7ffd815f2960 /\* 61 vars \*/) = 0

brk(NULL) = 0x5625fab14000

arch\_prctl(0x3001 /\* ARCH\_??? \*/, 0x7ffce6485580) = -1 EINVAL (Invalid argument)

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=69789, ...}) = 0

mmap(NULL, 69789, PROT\_READ, MAP\_PRIVATE, 3, 0) = 0x7f1f5394d000

close(3) = 0

openat(AT\_FDCWD, "/usr/local/lib/libzmq.so.5", 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\240\206\1\0\0\0\0\0"..., 832) = 832

fstat(3, {st\_mode=S\_IFREG|0755, st\_size=16922168, ...}) = 0

mmap(NULL, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f1f5394b000

mmap(NULL, 701976, PROT\_READ, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0x7f1f5389f000

mmap(0x7f1f538b6000, 438272, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x17000) = 0x7f1f538b6000

mmap(0x7f1f53921000, 135168, PROT\_READ, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x82000) = 0x7f1f53921000

mmap(0x7f1f53942000, 36864, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0xa2000) = 0x7f1f53942000

close(3) = 0

openat(AT\_FDCWD, "/lib/x86\_64-linux-gnu/libpthread.so.0", 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\220\201\0\0\0\0\0\0"..., 832) = 832

pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0O\305\3743\364B\2216\244\224\306@\261\23\327o"..., 68, 824) = 68

fstat(3, {st\_mode=S\_IFREG|0755, st\_size=157224, ...}) = 0

pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0O\305\3743\364B\2216\244\224\306@\261\23\327o"..., 68, 824) = 68

mmap(NULL, 140408, PROT\_READ, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0x7f1f5387c000

mmap(0x7f1f53883000, 69632, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x7000) = 0x7f1f53883000

mmap(0x7f1f53894000, 20480, PROT\_READ, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x18000) = 0x7f1f53894000

mmap(0x7f1f53899000, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x1c000) = 0x7f1f53899000

mmap(0x7f1f5389b000, 13432, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_ANONYMOUS, -1, 0) = 0x7f1f5389b000

close(3) = 0

openat(AT\_FDCWD, "/lib/x86\_64-linux-gnu/libstdc++.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\240\341\t\0\0\0\0\0"..., 832) = 832

fstat(3, {st\_mode=S\_IFREG|0644, st\_size=1952928, ...}) = 0

mmap(NULL, 1968128, PROT\_READ, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0x7f1f5369b000

mprotect(0x7f1f53731000, 1286144, PROT\_NONE) = 0

mmap(0x7f1f53731000, 983040, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x96000) = 0x7f1f53731000

mmap(0x7f1f53821000, 299008, PROT\_READ, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x186000) = 0x7f1f53821000

mmap(0x7f1f5386b000, 57344, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x1cf000) = 0x7f1f5386b000

mmap(0x7f1f53879000, 10240, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_ANONYMOUS, -1, 0) = 0x7f1f53879000

close(3) = 0

openat(AT\_FDCWD, "/lib/x86\_64-linux-gnu/libgcc\_s.so.1", 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\3405\0\0\0\0\0\0"..., 832) = 832

fstat(3, {st\_mode=S\_IFREG|0644, st\_size=104984, ...}) = 0

mmap(NULL, 107592, PROT\_READ, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0x7f1f53680000

mmap(0x7f1f53683000, 73728, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x3000) = 0x7f1f53683000

mmap(0x7f1f53695000, 16384, PROT\_READ, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x15000) = 0x7f1f53695000

mmap(0x7f1f53699000, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x18000) = 0x7f1f53699000

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\360q\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

pread64(3, "\4\0\0\0\20\0\0\0\5\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\0\0\0\0\0\0", 32, 848) = 32

pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\363\377?\332\200\270\27\304d\245n\355Y\377\t\334"..., 68, 880) = 68

fstat(3, {st\_mode=S\_IFREG|0755, st\_size=2029224, ...}) = 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

pread64(3, "\4\0\0\0\20\0\0\0\5\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\0\0\0\0\0\0", 32, 848) = 32

pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\363\377?\332\200\270\27\304d\245n\355Y\377\t\334"..., 68, 880) = 68

mmap(NULL, 2036952, PROT\_READ, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0x7f1f5348e000

mprotect(0x7f1f534b3000, 1847296, PROT\_NONE) = 0

mmap(0x7f1f534b3000, 1540096, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x25000) = 0x7f1f534b3000

mmap(0x7f1f5362b000, 303104, PROT\_READ, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x19d000) = 0x7f1f5362b000

mmap(0x7f1f53676000, 24576, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x1e7000) = 0x7f1f53676000

mmap(0x7f1f5367c000, 13528, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_ANONYMOUS, -1, 0) = 0x7f1f5367c000

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\300\363\0\0\0\0\0\0"..., 832) = 832

fstat(3, {st\_mode=S\_IFREG|0644, st\_size=1369352, ...}) = 0

mmap(NULL, 1368336, PROT\_READ, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0x7f1f5333f000

mmap(0x7f1f5334e000, 684032, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0xf000) = 0x7f1f5334e000

mmap(0x7f1f533f5000, 618496, PROT\_READ, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0xb6000) = 0x7f1f533f5000

mmap(0x7f1f5348c000, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x14c000) = 0x7f1f5348c000

close(3) = 0

mmap(NULL, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f1f5333d000

mmap(NULL, 12288, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f1f5333a000

arch\_prctl(ARCH\_SET\_FS, 0x7f1f5333a740) = 0

mprotect(0x7f1f53676000, 12288, PROT\_READ) = 0

mprotect(0x7f1f5348c000, 4096, PROT\_READ) = 0

mprotect(0x7f1f53699000, 4096, PROT\_READ) = 0

mprotect(0x7f1f5386b000, 45056, PROT\_READ) = 0

mprotect(0x7f1f53899000, 4096, PROT\_READ) = 0

mprotect(0x7f1f53942000, 32768, PROT\_READ) = 0

mprotect(0x5625f91b8000, 4096, PROT\_READ) = 0

mprotect(0x7f1f5398c000, 4096, PROT\_READ) = 0

munmap(0x7f1f5394d000, 69789) = 0

set\_tid\_address(0x7f1f5333aa10) = 213257

set\_robust\_list(0x7f1f5333aa20, 24) = 0

rt\_sigaction(SIGRTMIN, {sa\_handler=0x7f1f53883bf0, sa\_mask=[], sa\_flags=SA\_RESTORER|SA\_SIGINFO, sa\_restorer=0x7f1f538913c0}, NULL, 8) = 0

rt\_sigaction(SIGRT\_1, {sa\_handler=0x7f1f53883c90, sa\_mask=[], sa\_flags=SA\_RESTORER|SA\_RESTART|SA\_SIGINFO, sa\_restorer=0x7f1f538913c0}, NULL, 8) = 0

rt\_sigprocmask(SIG\_UNBLOCK, [RTMIN RT\_1], NULL, 8) = 0

prlimit64(0, RLIMIT\_STACK, NULL, {rlim\_cur=8192\*1024, rlim\_max=RLIM64\_INFINITY}) = 0

brk(NULL) = 0x5625fab14000

brk(0x5625fab35000) = 0x5625fab35000

futex(0x7f1f538796bc, FUTEX\_WAKE\_PRIVATE, 2147483647) = 0

futex(0x7f1f538796c8, FUTEX\_WAKE\_PRIVATE, 2147483647) = 0

eventfd2(0, EFD\_CLOEXEC) = 3

fcntl(3, F\_GETFL) = 0x2 (flags O\_RDWR)

fcntl(3, F\_SETFL, O\_RDWR|O\_NONBLOCK) = 0

fcntl(3, F\_GETFL) = 0x802 (flags O\_RDWR|O\_NONBLOCK)

fcntl(3, F\_SETFL, O\_RDWR|O\_NONBLOCK) = 0

eventfd2(0, EFD\_CLOEXEC) = 4

fcntl(4, F\_GETFL) = 0x2 (flags O\_RDWR)

fcntl(4, F\_SETFL, O\_RDWR|O\_NONBLOCK) = 0

fcntl(4, F\_GETFL) = 0x802 (flags O\_RDWR|O\_NONBLOCK)

fcntl(4, F\_SETFL, O\_RDWR|O\_NONBLOCK) = 0

epoll\_create1(EPOLL\_CLOEXEC) = 5

epoll\_ctl(5, EPOLL\_CTL\_ADD, 4, {0, {u32=4206009568, u64=94721119788256}}) = 0

epoll\_ctl(5, EPOLL\_CTL\_MOD, 4, {EPOLLIN, {u32=4206009568, u64=94721119788256}}) = 0

mmap(NULL, 8392704, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f1f52b39000

mprotect(0x7f1f52b3a000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f1f53338fb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLONE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID, parent\_tid=[213258], tls=0x7f1f53339700, child\_tidptr=0x7f1f533399d0) = 213258

eventfd2(0, EFD\_CLOEXEC) = 6

fcntl(6, F\_GETFL) = 0x2 (flags O\_RDWR)

fcntl(6, F\_SETFL, O\_RDWR|O\_NONBLOCK) = 0

fcntl(6, F\_GETFL) = 0x802 (flags O\_RDWR|O\_NONBLOCK)

fcntl(6, F\_SETFL, O\_RDWR|O\_NONBLOCK) = 0

epoll\_create1(EPOLL\_CLOEXEC) = 7

epoll\_ctl(7, EPOLL\_CTL\_ADD, 6, {0, {u32=4206011584, u64=94721119790272}}) = 0

epoll\_ctl(7, EPOLL\_CTL\_MOD, 6, {EPOLLIN, {u32=4206011584, u64=94721119790272}}) = 0

mmap(NULL, 8392704, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f1f52338000

mprotect(0x7f1f52339000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f1f52b37fb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLONE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID, parent\_tid=[213259], tls=0x7f1f52b38700, child\_tidptr=0x7f1f52b389d0) = 213259

eventfd2(0, EFD\_CLOEXEC) = 8

fcntl(8, F\_GETFL) = 0x2 (flags O\_RDWR)

fcntl(8, F\_SETFL, O\_RDWR|O\_NONBLOCK) = 0

fcntl(8, F\_GETFL) = 0x802 (flags O\_RDWR|O\_NONBLOCK)

fcntl(8, F\_SETFL, O\_RDWR|O\_NONBLOCK) = 0

poll([{fd=8, events=POLLIN}], 1, 0) = 0 (Timeout)

socket(AF\_INET, SOCK\_STREAM|SOCK\_CLOEXEC, IPPROTO\_TCP) = 9

setsockopt(9, SOL\_SOCKET, SO\_REUSEADDR, [1], 4) = 0

bind(9, {sa\_family=AF\_INET, sin\_port=htons(0), sin\_addr=inet\_addr("0.0.0.0")}, 16) = 0

listen(9, 100) = 0

getsockname(9, {sa\_family=AF\_INET, sin\_port=htons(38665), sin\_addr=inet\_addr("0.0.0.0")}, [128->16]) = 0

getsockname(9, {sa\_family=AF\_INET, sin\_port=htons(38665), sin\_addr=inet\_addr("0.0.0.0")}, [128->16]) = 0

write(6, "\1\0\0\0\0\0\0\0", 8) = 8

write(8, "\1\0\0\0\0\0\0\0", 8) = 8

clone(child\_stack=NULL, flags=CLONE\_CHILD\_CLEARTID|CLONE\_CHILD\_SETTID|SIGCHLD, child\_tidptr=0x7f1f5333aa10) = 213260

poll([{fd=8, events=POLLIN}], 1, -1) = 1 ([{fd=8, revents=POLLIN}])

read(8, "\1\0\0\0\0\0\0\0", 8) = 8

poll([{fd=8, events=POLLIN}], 1, 0) = 0 (Timeout)

poll([{fd=8, events=POLLIN}], 1, -1) = 1 ([{fd=8, revents=POLLIN}])

read(8, "\1\0\0\0\0\0\0\0", 8) = 8

poll([{fd=8, events=POLLIN}], 1, 0) = 0 (Timeout)

poll([{fd=8, events=POLLIN}], 1, -1) = 1 ([{fd=8, revents=POLLIN}])

read(8, "\1\0\0\0\0\0\0\0", 8) = 8

poll([{fd=8, events=POLLIN}], 1, 0) = 0 (Timeout)

poll([{fd=8, events=POLLIN}], 1, -1bruh

C: bruh

) = 1 ([{fd=8, revents=POLLIN}])

read(8,

"\1\0\0\0\0\0\0\0", 8) = 8

poll([{fd=8, events=POLLIN}], 1, 0A: Yes

) = 0 (Timeout)

fstat(1, {st\_mode=S\_IFCHR|0620, st\_rdev=makedev(0x88, 0x1), ...}) = 0

write(1, "B: A sent 5 symbols\n", 20B: A sent 5 symbols

) = 20

write(1, "B: C reeived 5 symbols\n", 23B: C reeived 5 symbols

) = 23

poll([{fd=8, events=POLLIN}], 1, -1A ended

C:

N

C ended

) = 1 ([{fd=8, revents=POLLIN}])

read(8, "\1\0\0\0\0\0\0\0", 8) = 8

poll([{fd=8, events=POLLIN}], 1, 0) = 0 (Timeout)

write(1, "B ended\n", 8B ended

) = 8

write(4, "\1\0\0\0\0\0\0\0", 8) = 8

write(4, "\1\0\0\0\0\0\0\0", 8) = 8

--- SIGCHLD {si\_signo=SIGCHLD, si\_code=CLD\_EXITED, si\_pid=213260, si\_uid=1000, si\_status=0, si\_utime=0, si\_stime=0} ---

poll([{fd=3, events=POLLIN}], 1, -1) = 1 ([{fd=3, revents=POLLIN}])

read(3, "\1\0\0\0\0\0\0\0", 8) = 8

write(6, "\1\0\0\0\0\0\0\0", 8) = 8

close(7) = 0

close(6) = 0

close(5) = 0

close(4) = 0

close(3) = 0

exit\_group(0) = ?

+++ exited with 0 +++

**Системные вызовы**

execve("./b.out", ["./b.out"], 0x7ffd815f2960 /\* 61 vars \*/) = 0

вызвать процесс с аргументами и переменными окружения

brk(NULL) = 0x5625fab14000

Обеспечение памяти для процесса

access("/etc/ld.so.preload", R\_OK) = -1 ENOENT (No such file or directory)

Проверяет, доступен ли файл

openat(AT\_FDCWD, "/etc/ld.so.cache", O\_RDONLY|O\_CLOEXEC) = 3

открыть файл и получить его дескриптор

fstat(3, {st\_mode=S\_IFREG|0644, st\_size=69789, ...}) = 0

Получить информация о файле, пользуясь его дескриптором

mmap(NULL, 69789, PROT\_READ, MAP\_PRIVATE, 3, 0) = 0x7f1f5394d000

отображает файл на память

close(3) = 0

закрывает файл по дескриптору

read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\240\206\1\0\0\0\0\0"..., 832) = 832

считывает в файл, указанный дескриптором, возвращает количество считанных байтов

pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0O\305\3743\364B\2216\244\224\306@\261\23\327o"..., 68, 824) = 68

как read(4), но не меняет сдвиг (4-ый аргумент)

mprotect(0x7f1f53731000, 1286144, PROT\_NONE) = 0

установить защиту памяти

munmap(0x7f1f5394d000, 69789) = 0

освободить отображенную память

clone(child\_stack=0x7f1f53338fb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLONE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID, parent\_tid=[213258], tls=0x7f1f53339700, child\_tidptr=0x7f1f533399d0) = 213258

создаёт копию текущего процесса, возвращает ИД нового процесса

socket(AF\_INET, SOCK\_STREAM|SOCK\_CLOEXEC, IPPROTO\_TCP) = 9

создаёт непривязанный разъем, и возвращает файловый дескриптор, который используется для работы с узлом

setsockopt(9, SOL\_SOCKET, SO\_REUSEADDR, [1], 4) = 0

Меняет свойства разъема

bind(9, {sa\_family=AF\_INET, sin\_port=htons(0), sin\_addr=inet\_addr("0.0.0.0")}, 16) = 0

listen(9, 100) = 0

привязывает разъему адрес

write(6, "\1\0\0\0\0\0\0\0", 8) = 8

написать в файл по дескриптору байты, и вернуть число записанных байтов

**Вывод**

Вызывая strace, становится видно, сколько работы спрятано за простыми командами C и C++. Скорее всего, использование их напрямую – не лучшая идея.