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Факультет информационных технологий и прикладной математики
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Лабораторная работа №1 по курсу
«Операционные системы»

Тема работы
“Использование утилиты strace”

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Репозиторий

https://github.com/klitnaya/OS/tree/main/os_laba1/doc

Постановка задачи

Задача: подробно рассказать о каждом системном вызове, отображенном утилитой strace. Разбор системных вызовов осуществляется на примере пятой лабораторной работы курса “Операционные системы”.

Демонстрация работы с утилитой strace и подробное объяснение каждого системного вызова

Исходный код strace:

```
execve("./m2", ["/m2"], 0x7ffe2b236cf0 /* 20 vars */) = 0
brk(NULL)                               = 0x558b49c37000
arch_prctl(0x3001 /* ARCH_??? */, 0x7ffe504578c0) = -1 EINVAL (Invalid argument)
access("/etc/ld.so.preload", R_OK)      = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/tls/x86_64/x86_64/libdl.so.2", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/tls/x86_64/libdl.so.2", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/tls/x86_64/libdl.so.2", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/tls/libdl.so.2", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/x86_64/x86_64/libdl.so.2", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/x86_64/libdl.so.2", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/x86_64/libdl.so.2", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/libdl.so.2", O_RDONLY|O_CLOEXEC) = -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=32071, ... }) = 0
mmap(NULL, 32071, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f44d39a7000
close(3)                                = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libdl.so.2", O_RDONLY|O_CLOEXEC) = 3
```

```

read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\22\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=18816, ...}) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7f44d39a5000
mmap(NULL, 20752, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f44d399f000
mmap(0x7f44d39a0000, 8192, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1000) = 0x7f44d39a0000
mmap(0x7f44d39a2000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x3000) = 0x7f44d39a2000
mmap(0x7f44d39a3000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x3000) = 0x7f44d39a3000
close(3) = 0
openat(AT_FDCWD, "./tls/x86_64/x86_64/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT
(No such file or directory)
openat(AT_FDCWD, "./tls/x86_64/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No
such file or directory)
openat(AT_FDCWD, "./tls/x86_64/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No
such file or directory)
openat(AT_FDCWD, "./tls/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "./x86_64/x86_64/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT
(No such file or directory)
openat(AT_FDCWD, "./x86_64/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such
file or directory)
openat(AT_FDCWD, "./x86_64/libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such
file or directory)
openat(AT_FDCWD, "./libstdc++.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)
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\3\0>\0\1\0\0\0`\341\t\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=1956992, ...}) = 0
mmap(NULL, 1972224, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f44d37bd000
mprotect(0x7f44d3853000, 1290240, PROT_NONE) = 0
mmap(0x7f44d3853000, 987136, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x96000) = 0x7f44d3853000
mmap(0x7f44d3944000, 299008, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x187000) = 0x7f44d3944000
mmap(0x7f44d398e000, 57344, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1d0000) = 0x7f44d398e000

```

```

mmap(0x7f44d399c000, 10240, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7f44d399c000

close(3) = 0

openat(AT_FDCWD, "/tls/x86_64/x86_64/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No
such file or directory)

openat(AT_FDCWD, "/tls/x86_64/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file
or directory)

openat(AT_FDCWD, "/tls/x86_64/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file
or directory)

openat(AT_FDCWD, "/tls/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)

openat(AT_FDCWD, "/x86_64/x86_64/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such
file or directory)

openat(AT_FDCWD, "/x86_64/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)

openat(AT_FDCWD, "/x86_64/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)

openat(AT_FDCWD, "/libc.so.6", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)

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\3\0>\0\1\0\0\0\360q\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"..., 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", 32, 848) = 32

pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\t\233\222%\274\260\320\31\331\326\10\204\276X>\263"...,
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"..., 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", 32, 848) = 32

pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\t\233\222%\274\260\320\31\331\326\10\204\276X>\263"...,
68, 880) = 68

mmap(NULL, 2036952, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f44d35cb000

mprotect(0x7f44d35f0000, 1847296, PROT_NONE) = 0

mmap(0x7f44d35f0000, 1540096, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x25000) = 0x7f44d35f0000

mmap(0x7f44d3768000, 303104, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0x19d000) = 0x7f44d3768000

mmap(0x7f44d37b3000, 24576, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1e7000) = 0x7f44d37b3000

```

```

mmap(0x7f44d37b9000, 13528, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7f44d37b9000

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\3\0>\0\1\0\0\0\300\363\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) = 0x7f44d347c000

mmap(0x7f44d348b000, 684032, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0xf000) = 0x7f44d348b000

mmap(0x7f44d3532000, 618496, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE,
3, 0xb6000) = 0x7f44d3532000

mmap(0x7f44d35c9000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x14c000) = 0x7f44d35c9000

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\3\0>\0\1\0\0\0\3405\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) = 0x7f44d3461000

mmap(0x7f44d3464000, 73728, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x3000) = 0x7f44d3464000

mmap(0x7f44d3476000, 16384, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x15000) = 0x7f44d3476000

mmap(0x7f44d347a000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x18000) = 0x7f44d347a000

close(3) = 0

mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7f44d345f000

mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) =
0x7f44d345c000

arch_prctl(ARCH_SET_FS, 0x7f44d345c740) = 0

mprotect(0x7f44d37b3000, 12288, PROT_READ) = 0

mprotect(0x7f44d347a000, 4096, PROT_READ) = 0

mprotect(0x7f44d35c9000, 4096, PROT_READ) = 0

mprotect(0x7f44d398e000, 45056, PROT_READ) = 0

mprotect(0x7f44d39a3000, 4096, PROT_READ) = 0

mprotect(0x558b49944000, 4096, PROT_READ) = 0

mprotect(0x7f44d39dc000, 4096, PROT_READ) = 0

```

```

munmap(0x7f44d39a7000, 32071) = 0
brk(NULL) = 0x558b49c37000
brk(0x558b49c58000) = 0x558b49c58000
fstat(1, {st_mode=S_IFCHR|0600, st_rdev=makedev(0x88, 0), ...}) = 0
write(1, "Enter the start library:\n", 25) = 25
write(1, "\t1 for first library\n", 21) = 21
write(1, "\t2 for second library\n", 22) = 22
fstat(0, {st_mode=S_IFCHR|0600, st_rdev=makedev(0x88, 0), ...}) = 0
read(0, "1\n", 1024) = 2
openat(AT_FDCWD, "/tls/x86_64/x86_64/libd1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No
such file or directory)
openat(AT_FDCWD, "/tls/x86_64/libd1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file
or directory)
openat(AT_FDCWD, "/tls/x86_64/libd1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file
or directory)
openat(AT_FDCWD, "/tls/libd1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "/x86_64/x86_64/libd1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such
file or directory)
openat(AT_FDCWD, "/x86_64/libd1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "/x86_64/libd1.so", O_RDONLY|O_CLOEXEC) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "/libd1.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\200\20\0\0\0\0\0"... , 832) = 832
fstat(3, {st_mode=S_IFREG|0777, st_size=16184, ...}) = 0
getcwd("/mnt/c/Users/\320\235\320\260\321\201\321\202\321\217", 128) = 24
mmap(NULL, 16440, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f44d39aa000
mmap(0x7f44d39ab000, 4096, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1000) = 0x7f44d39ab000
mmap(0x7f44d39ac000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3,
0x2000) = 0x7f44d39ac000
mmap(0x7f44d39ad000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f44d39ad000
close(3) = 0
mprotect(0x7f44d39ad000, 4096, PROT_READ) = 0
write(1, "Please read the nexst ruls? befo"..., 86) = 86

```

```

write(1, "\t1 for calculating the SinIntegr"..., 37) = 37
write(1, "\t2 for calculating the Derivativ"..., 36) = 36
write(1, "Please enter your command: ", 27) = 27
read(0, "2\n", 1024)          = 2
read(0, "1\n", 1024)          = 2
read(0, "2\n", 1024)          = 2
write(1, "Derivative(1,2)=-0.765147\n", 26) = 26
write(1, "Please enter your command: ", 27) = 27
read(0, "1\n", 1024)          = 2
read(0, "2 3 5\n", 1024)      = 6
write(1, "SinIntegral(2,3,5)=4.54649\n", 27) = 27
write(1, "Please enter your command: ", 27) = 27
read(0, "-1\n", 1024)         = 3
write(1, "You had to enter only 0, 1 or 2!"..., 33) = 33
write(1, "Please enter your command: ", 27) = 27
read(0, "", 1024)              = 0
munmap(0x7f44d39aa000, 16440)  = 0
exit_group(0)                  = ?
+++ exited with 0 +++

```

Разберем подробнее:

`execve(...)` - запускает программу

`brk(...)` - устанавливает конец сегмента данных в значение `NULL`

`access(...)` - проверяет права доступа к файлу, возвращает -1 как код ошибки

`openat(...)` - открывает файл, имеет в качестве возвращаемого значения файловый дескриптор

`fstat(...)` - собирает информацию из файла

`mmap(...)` - отображает файл на память

`mprotect(...)` - контролирует доступ к памяти

`close(...)` - закрывает файловый дескриптор

`read(...)` - считывает из файлового дескриптора

`arch_prctl(...)` - устанавливает специфичное для архитектуры значение ядра

`munmap(...)` - освобождает память, отведенную для отображения файла

`write(...)` - пишет в консоль

`pread64(...)` - читает из файлового дескриптора

`getcwd(...)` - получить текущую рабочую директорию

Выводы

В данной лабораторной работе я углублённо разобрал strace и вновь убедился, что это довольно полезная утилита, которая позволяет узнать всё до мелочей о работе своей программы.