Московский Авиационный Институт

(Национальный Исследовательский Университет)

Институт №8 “Компьютерные науки и прикладная математика”

Кафедра №806 “Вычислительная математика и программирование”

**Лабораторная работа №8 по курсу**

**«Операционные системы»**

Группа: М8О-203Б-23

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Оценка: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Постановка задачи**

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

**Что такое strace?**

**Протокол выполнения**

unix@DESKTOP-MPQDBS2:~/labs/osLabs/build/lab4$ strace ./PC3

execve("./PC3", ["./PC3"], 0x7fffc42eb0d0 /\* 29 vars \*/) = 0

brk(NULL) = 0x7fffde012000

arch\_prctl(0x3001 /\* ARCH\_??? \*/, 0x7fffe548fb90) = -1 EINVAL (Invalid argument)

mmap(NULL, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f5bdfbf0000

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=21347, ...}, AT\_EMPTY\_PATH) = 0

mmap(NULL, 21347, PROT\_READ, MAP\_PRIVATE, 3, 0) = 0x7f5bdfbaa000

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

newfstatat(3, "", {st\_mode=S\_IFREG|0644, st\_size=2260296, ...}, AT\_EMPTY\_PATH) = 0

mmap(NULL, 2275520, PROT\_READ, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0x7f5bdf970000

mprotect(0x7f5bdfa0a000, 1576960, PROT\_NONE) = 0

mmap(0x7f5bdfa0a000, 1118208, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x9a000) = 0x7f5bdfa0a000

mmap(0x7f5bdfb1b000, 454656, PROT\_READ, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x1ab000) = 0x7f5bdfb1b000

mmap(0x7f5bdfb8b000, 57344, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x21a000) = 0x7f5bdfb8b000

mmap(0x7f5bdfb99000, 10432, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_ANONYMOUS, -1, 0) = 0x7f5bdfb99000

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

newfstatat(3, "", {st\_mode=S\_IFREG|0644, st\_size=125488, ...}, AT\_EMPTY\_PATH) = 0

mmap(NULL, 127720, PROT\_READ, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0x7f5bdf950000

mmap(0x7f5bdf953000, 94208, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x3000) = 0x7f5bdf953000

mmap(0x7f5bdf96a000, 16384, PROT\_READ, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x1a000) = 0x7f5bdf96a000

mmap(0x7f5bdf96e000, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x1d000) = 0x7f5bdf96e000

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\0P\237\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 \0\0\0\5\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\0\0\0\0\0\0"..., 48, 848) = 48

pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0I\17\357\204\3$\f\221\2039x\324\224\323\236S"..., 68, 896) = 68

newfstatat(3, "", {st\_mode=S\_IFREG|0755, st\_size=2220400, ...}, 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, 2264656, PROT\_READ, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0x7f5bdf720000

mprotect(0x7f5bdf748000, 2023424, PROT\_NONE) = 0

mmap(0x7f5bdf748000, 1658880, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x28000) = 0x7f5bdf748000

mmap(0x7f5bdf8dd000, 360448, PROT\_READ, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x1bd000) = 0x7f5bdf8dd000

mmap(0x7f5bdf936000, 24576, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x215000) = 0x7f5bdf936000

mmap(0x7f5bdf93c000, 52816, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_ANONYMOUS, -1, 0) = 0x7f5bdf93c000

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=940560, ...}, AT\_EMPTY\_PATH) = 0

mmap(NULL, 942344, PROT\_READ, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0x7f5bdf630000

mmap(0x7f5bdf63e000, 507904, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0xe000) = 0x7f5bdf63e000

mmap(0x7f5bdf6ba000, 372736, PROT\_READ, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x8a000) = 0x7f5bdf6ba000

mmap(0x7f5bdf715000, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0xe4000) = 0x7f5bdf715000

close(3) = 0

mmap(NULL, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f5bdfba0000

arch\_prctl(ARCH\_SET\_FS, 0x7f5bdfba13c0) = 0

set\_tid\_address(0x7f5bdfba1690) = 7726

set\_robust\_list(0x7f5bdfba16a0, 24) = 0

rseq(0x7f5bdfba1d60, 0x20, 0, 0x53053053) = -1 ENOSYS (Function not implemented)

mprotect(0x7f5bdf936000, 16384, PROT\_READ) = 0

mprotect(0x7f5bdf715000, 4096, PROT\_READ) = 0

mprotect(0x7f5bdf96e000, 4096, PROT\_READ) = 0

mmap(NULL, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f5bdf620000

mprotect(0x7f5bdfb8b000, 45056, PROT\_READ) = 0

mprotect(0x7f5bdfbf9000, 4096, PROT\_READ) = 0

mprotect(0x7f5bdfbe8000, 8192, PROT\_READ) = 0

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

munmap(0x7f5bdfbaa000, 21347) = 0

getrandom("\xf5\xff\x46\x25\x78\x39\xe3\xda", 8, GRND\_NONBLOCK) = 8

brk(NULL) = 0x7fffde012000

brk(0x7fffde033000) = 0x7fffde033000

futex(0x7f5bdfb9977c, FUTEX\_WAKE\_PRIVATE, 2147483647) = 0

newfstatat(1, "", {st\_mode=S\_IFCHR|0620, st\_rdev=makedev(0x88, 0), ...}, AT\_EMPTY\_PATH) = 0

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 (/ex"..., 57Введите строку (/exit для выхода): ) = 57

newfstatat(0, "", {st\_mode=S\_IFCHR|0620, st\_rdev=makedev(0x88, 0), ...}, AT\_EMPTY\_PATH) = 0

read(0, 0x7fffde0242c0, 1024) = ? ERESTARTSYS (To be restarted if SA\_RESTART is set)

--- SIGWINCH {si\_signo=SIGWINCH, si\_code=SI\_KERNEL} ---

read(0, 0x7fffde0242c0, 1024) = ? ERESTARTSYS (To be restarted if SA\_RESTART is set)

--- SIGWINCH {si\_signo=SIGWINCH, si\_code=SI\_KERNEL} ---

read(0, 0x7fffde0242c0, 1024) = ? ERESTARTSYS (To be restarted if SA\_RESTART is set)

--- SIGWINCH {si\_signo=SIGWINCH, si\_code=SI\_KERNEL} ---

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--- SIGWINCH {si\_signo=SIGWINCH, si\_code=SI\_KERNEL} ---

read(0, 0x7fffde0242c0, 1024) = ? ERESTARTSYS (To be restarted if SA\_RESTART is set)

--- SIGWINCH {si\_signo=SIGWINCH, si\_code=SI\_KERNEL} ---

--- SIGWINCH {si\_signo=SIGWINCH, si\_code=SI\_KERNEL} ---

read(0, 0x7fffde0242c0, 1024) = ? ERESTARTSYS (To be restarted if SA\_RESTART is set)

--- SIGWINCH {si\_signo=SIGWINCH, si\_code=SI\_KERNEL} ---

read(0, 0x7fffde0242c0, 1024) = ? ERESTARTSYS (To be restarted if SA\_RESTART is set)

--- SIGWINCH {si\_signo=SIGWINCH, si\_code=SI\_KERNEL} ---

read(0, 0x7fffde0242c0, 1024) = ? ERESTARTSYS (To be restarted if SA\_RESTART is set)

--- SIGWINCH {si\_signo=SIGWINCH, si\_code=SI\_KERNEL} ---

read(0, FFadad

"FFadad\n", 1024) = 7

openat(AT\_FDCWD, "/dev/shm/shared\_memory", O\_RDWR|O\_CREAT|O\_NOFOLLOW|O\_CLOEXEC, 0666) = 3

ftruncate(3, 1024) = 0

mmap(NULL, 1024, PROT\_READ|PROT\_WRITE, MAP\_SHARED, 3, 0) = 0x7f5bdfbf3000

close(3) = 0

clone(child\_stack=NULL, flags=CLONE\_CHILD\_CLEARTID|CLONE\_CHILD\_SETTID|SIGCHLD, child\_tidptr=0x7f5bdfba1690) = 8141

rt\_sigaction(SIGUSR1, {sa\_handler=0x7f5bdfbf6d3d, sa\_mask=[USR1], sa\_flags=SA\_RESTORER|SA\_RESTART, sa\_restorer=0x7f5bdf762520}, {sa\_handler=SIG\_DFL, sa\_mask=[], sa\_flags=SA\_RESTORER, sa\_restorer=0x7f26b4532520}, 8) = 0

openat(AT\_FDCWD, "output.txt", O\_WRONLY|O\_CREAT|O\_APPEND, 0666) = 3

lseek(3, 0, SEEK\_END) = 122

write(3, "FFadad\n", 7) = 7

close(3) = 0

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 (/ex"..., 57Введите строку (/exit для выхода): ) = 57

read(0, /exit

"/exit\n", 1024) = 6

openat(AT\_FDCWD, "/dev/shm/shared\_memory", O\_RDWR|O\_NOFOLLOW|O\_CLOEXEC) = 3

mmap(NULL, 1024, PROT\_READ|PROT\_WRITE, MAP\_SHARED, 3, 0) = 0x7f5bdfbf2000

munmap(0x7f5bdfbf2000, 1024) = 0

kill(8141, SIGUSR1) = 0

wait4(8141, NULL, 0, NULL) = 8141

--- SIGCHLD {si\_signo=SIGCHLD, si\_code=CLD\_EXITED, si\_pid=8141, si\_uid=1000, si\_status=0, si\_utime=0, si\_stime=0} ---

unlink("/dev/shm/shared\_memory") = -1 ENOENT (No such file or directory)

exit\_group(0) = ?

+++ exited with 0 +++

**Этапы работы**

### 1. ****Запуск программы****:

* Программа PC3 запускается с помощью системного вызова execve.

### 2. ****Инициализация памяти****:

* Программа выделяет память для своих нужд с помощью вызовов brk, mmap и mprotect.

### 3. ****Загрузка динамических библиотек****:

* Программа загружает необходимые библиотеки, такие как libstdc++.so.6, libgcc\_s.so.1, libc.so.6 и libm.so.6. Она открывает и читает эти библиотеки.

### 4. ****Настройка программы****:

* Программа настраивает архитектурно-зависимые параметры с помощью вызовов arch\_prctl, set\_tid\_address и set\_robust\_list.

### 5. ****Вывод сообщения пользователю****:

* Программа выводит сообщение на стандартный вывод: "Введите строку (/exit для выхода):".

### 6. ****Ожидание ввода пользователя****:

* Программа ожидает ввода пользователя с помощью вызова read. Ввод может прерываться сигналом SIGWINCH (изменение размера окна терминала).

### 7. ****Обработка ввода****:

* Пользователь вводит строку (например, "FFadad"). Программа открывает файл output.txt и записывает в него введенную строку.

### 8. ****Работа с разделяемой памятью****:

* Программа создает и использует разделяемую память (/dev/shm/shared\_memory) для обмена данными между процессами.

### 9. ****Создание дочернего процесса****:

* Программа создает дочерний процесс с помощью вызова clone для выполнения задач параллельно.

### 10. ****Завершение работы****:

* Пользователь вводит команду /exit. Программа завершает работу: отправляет сигнал SIGUSR1 дочернему процессу, ожидает его завершения и корректно завершает свою работу.

**Strace с флагами**unix@DESKTOP-MPQDBS2:~/labs/osLabs/build/lab4$ strace -e trace=open,read,write ./PC3

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

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

read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0P\237\2\0\0\0\0\0"..., 832) = 832

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

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 (/ex"..., 57Введите строку (/exit для выхода): ) = 57

read(0, Ldadakdak

"Ldadakdak\n", 1024) = 10

write(3, "Ldadakdak\n", 10) = 10

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 (/ex"..., 57Введите строку (/exit для выхода): ) = 57

read(0, Ldaldladla

"Ldaldladla\n", 1024) = 11

write(3, "Ldaldladla\n", 11) = 11

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 (/ex"..., 57Введите строку (/exit для выхода): ) = 57

read(0, llll

"llll\n", 1024) = 5

write(2, "Error: \321\201\321\202\321\200\320\276\320\272\320\260 \320\264\320\276\320\273\320\266\320\275\320\260"..., 86Error: строка должна начинаться с заглавной буквы) = 86

write(2, "\n", 1

) = 1

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 (/ex"..., 57Введите строку (/exit для выхода): ) = 57

read(0, /exit

"/exit\n", 1024) = 6

--- SIGCHLD {si\_signo=SIGCHLD, si\_code=CLD\_EXITED, si\_pid=8833, si\_uid=1000, si\_status=0, si\_utime=0, si\_stime=0} ---

+++ exited with 0 +++

write(1, "Result: 3.0677\n", 15) = 15

write(1, "Enter command: ", 15) = 15

read(0, "2\n", 1024) = 2

write(1, "Enter n: ", 9) = 9

read(0, "10\n", 1024) = 3

write(1, "Result: 3.04184\n", 16) = 16

write(1, "Enter command: ", 15) = 15

read(0, 0x55e5cea032c0, 1024) = ? ERESTARTSYS (To be restarted if SA\_RESTART is set)

--- SIGWINCH {si\_signo=SIGWINCH, si\_code=SI\_KERNEL} ---

read(0, "3\n", 1024) = 2

write(1, "Enter size: ", 12) = 12

read(0, "15\n", 1024) = 3

write(1, "Enter values separated by space:"..., 33) = 33

read(0, "1 2 3 4 5 6 7 8 9 10 11 12 13 14"..., 1024) = 36

write(1, "Sorting...\n", 11) = 11

write(1, "Result: 1 2 3 4 5 6 7 8 9 10 11 "..., 45) = 45

write(1, "Enter command: ", 15) = 15

read(0, "3\n", 1024) = 2

write(1, "Enter size: ", 12) = 12

read(0, "3\n", 1024) = 2

write(1, "Enter values separated by space:"..., 33) = 33

read(0, "3 2 1\n", 1024) = 6

write(1, "Sorting...\n", 11) = 11

write(1, "Result: 1 2 3 \n", 15) = 15

write(1, "Enter command: ", 15) = 15

read(0, "", 1024) = 0

brk(0x55e5cea34000) = 0x55e5cea34000

mmap(NULL, 135168, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f512d0f6000

brk(0x55e5cea25000) = 0x55e5cea25000

mmap(NULL, 266240, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f512d0b5000

munmap(0x7f512d0f6000, 135168) = 0

mmap(NULL, 528384, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f512d034000

munmap(0x7f512d0b5000, 266240) = 0

mmap(NULL, 1052672, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f512cf33000

munmap(0x7f512d034000, 528384) = 0

mmap(NULL, 2101248, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f512cd32000

munmap(0x7f512cf33000, 1052672) = 0

mmap(NULL, 4198400, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f512c931000

munmap(0x7f512cd32000, 2101248) = 0

mmap(NULL, 8392704, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f512c130000

munmap(0x7f512c931000, 4198400) = 0

mmap(NULL, 16781312, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f512b12f000

munmap(0x7f512c130000, 8392704) = 0

mmap(NULL, 33558528, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f512912e000

munmap(0x7f512b12f000, 16781312) = 0

mmap(NULL, 67112960, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f512512d000

munmap(0x7f512912e000, 33558528) = 0

mmap(NULL, 134221824, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f511d12c000

munmap(0x7f512512d000, 67112960) = 0

mmap(NULL, 268439552, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f510d12b000

munmap(0x7f511d12c000, 134221824) = 0

--- SIGINT {si\_signo=SIGINT, si\_code=SI\_KERNEL} ---

+++ killed by SIGINT +++

**Заключение**

Выполнив работу я получил навыки использование strace.