Московский Авиационный Институт

(Национальный Исследовательский Университет)

Институт №8 “Компьютерные науки и прикладная математика”

Кафедра №806 “Вычислительная математика и программирование”

Лабораторная работа №6 по курсу

«Операционные системы»

Группа: М8О-209БВ-24

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Оценка: _____

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Постановка задачи

Цель работы:

Приобретение практических навыков диагностики работы программного обеспечения.

Задание:

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

Общий метод и алгоритм решения:

Strace - утилита командной строки для трассировки системных вызовов и сигналов в операционных системах Linux и других Unix-подобных системах. Её основное назначение - перехват и запись взаимодействия между пользовательским процессом и ядром операционной системы в реальном времени что полезно для отладки, анализа производительности и диагностики ошибок. Strace работает, используя механизм ядра ptrace (process trace), который позволяет одному процессу наблюдать и контролировать выполнение другого. При запуске с целевой программой strace перехватывает каждый системный вызов (например, открытие файла, запись в сеть, выделение памяти) на границе перехода из пользовательского пространства в пространство ядра и обратно. Это позволяет видеть не только факт вызова, но и его аргументы, возвращаемое значение и код ошибки (errno), если вызов завершился неудачно.

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

Lab_1:

1102 execve("./parent", ["./parent"], 0xfffffd166e18 /* 8 vars */) = 0**

1102 brk(NULL) = 0xaaaab3dfb000

1102 mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0xffffaeb92000

1102 faccessat(AT_FDCWD, "/etc/ld.so.preload", R_OK) = -1 ENOENT (No such file or directory)

1102 openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3

1102 fstat(3, {st_mode=S_IFREG|0644, st_size=8467, ...}) = 0

1102 mmap(NULL, 8467, PROT_READ, MAP_PRIVATE, 3, 0) = 0xffffaeb8f000

1102 close(3) = 0

1102 openat(AT_FDCWD, "/lib/aarch64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3

1102 read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\360\206\2\0\0\0\0\0"..., 832) = 832

1102 fstat(3, {st_mode=S_IFREG|0755, st_size=1722920, ...}) = 0

1102 mmap(NULL, 1892240, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_DENYWRITE, -1, 0) = 0xffffae98b000

1102 mmap(0xffffae990000, 1826704, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0) = 0xffffae990000

1102 munmap(0xffffae98b000, 20480) = 0

1102 munmap(0xffffaeb4e000, 44944) = 0

1102 mprotect(0xffffaeb29000, 81920, PROT_NONE) = 0

1102 mmap(0xffffaeb3d000, 20480, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x19d000) = 0xffffaeb3d000

1102 mmap(0xffffaeb42000, 49040, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0xffffaeb42000

1102 close(3) = 0

1102 set_tid_address(0xffffaeb92fb0) = 1102

1102 set_robust_list(0xffffaeb92fc0, 24) = 0

1102 rseq(0xffffaeb93600, 0x20, 0, 0xd428bc00) = 0

1102 mprotect(0xffffaeb3d000, 12288, PROT_READ) = 0

1102 mprotect(0xaaaab2e3f000, 4096, PROT_READ) = 0

1102 mprotect(0xffffaeb97000, 8192, PROT_READ) = 0

1102 prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0

1102 munmap(0xffffaeb8f000, 8467) = 0

1102 pipe2([3, 4], 0) = 0

1102 pipe2([5, 6], 0) = 0

1102 fstat(1, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0), ...}) = 0

1102 getrandom("\x0f\x0a\x07\x01\x7d\xce\x26\x08", 8, GRND_NONBLOCK) = 8

1102 brk(NULL) = 0xaaaab3dfb000

1102 brk(0xaaaab3e1c000) = 0xaaaab3e1c000

1102 fstat(0, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0), ...}) = 0

1102 write(1, "\320\222\320\262\320\265\320\264\320\270\321\202\320\265 \320\270\320\274\321\217 \321\204\320\260\320\271\320\273\320\260"..., 34) = 34

1102 read(0, "res.txt\n", 1024) = 8

1102 clone(child_stack=NULL, flags=CLONE_CHILD_CLEARTID|CLONE_CHILD_SETTID|SIGCHLD, child_tidptr=0xffffaeb92fb0) = 1103

1102 close(3) = 0

1103 set_robust_list(0xffffaeb92fc0, 24 <unfinished ...>

1102 close(6 <unfinished ...>

1103 <... set_robust_list resumed>) = 0

1102 <... close resumed>) = 0

1103 close(4 <unfinished ...>

1102 write(1, "\320\222\320\262\320\265\320\264\320\270\321\202\320\265 \321\207\320\270\321\201\320\273\320\276: ", 27 <unfinished ...>

1103 <... close resumed>) = 0

1102 <... write resumed>) = 27

1103 close(5 <unfinished ...>

1102 read(0, <unfinished ...>

1103 <... close resumed>) = 0

1103 dup3(3, 0, 0) = 0

1103 close(3) = 0

1103 dup3(6, 1, 0) = 1

1103 close(6) = 0

1103 execve("./child", ["child", "res.txt"], 0xffffc6fcd168 /* 8 vars */) = 0

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1103  brk(NULL)                         = 0xaaaae35e8000

1103  mmap(NULL, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0xffffba760000

1103  faccessat(AT_FDCWD, "/etc/ld.so.preload", R_OK) = -1 ENOENT (No such file or
directory)

1103  openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3

1103  fstat(3, {st_mode=S_IFREG|0644, st_size=8467, ...}) = 0

1103  mmap(NULL, 8467, PROT_READ, MAP_PRIVATE, 3, 0) = 0xffffba75d000

1103  close(3)                          = 0

1103  openat(AT_FDCWD, "/lib/aarch64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3

1103  read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\360\206\2\0\0\0\0"..., 832) =
832

1103  fstat(3, {st_mode=S_IFREG|0755, st_size=1722920, ...}) = 0

1103  mmap(NULL, 1892240, PROT_NONE,
MAP_PRIVATE|MAP_ANONYMOUS|MAP_DENYWRITE, -1, 0) = 0xffffba559000

1103  mmap(0xffffba560000, 1826704, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0) = 0xffffba560000

1103  munmap(0xffffba559000, 28672)     = 0

1103  munmap(0xffffba71e000, 36752)     = 0

1103  mprotect(0xffffba6f9000, 81920, PROT_NONE) = 0

1103  mmap(0xffffba70d000, 20480, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x19d000) = 0xffffba70d000

1103  mmap(0xffffba712000, 49040, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0xffffba712000

1103  close(3)                          = 0

1103  set_tid_address(0xffffba760fb0)   = 1103

1103  set_robust_list(0xffffba760fc0, 24) = 0

1103  rseq(0xffffba761600, 0x20, 0, 0xd428bc00) = 0

1103  mprotect(0xffffba70d000, 12288, PROT_READ) = 0

1103  mprotect(0xaaaac0dff000, 4096, PROT_READ) = 0

1103  mprotect(0xffffba765000, 8192, PROT_READ) = 0

1103  prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024,
rlim_max=RLIM64_INFINITY}) = 0

1103  munmap(0xffffba75d000, 8467)      = 0

1103  getrandom("\x31\x1a\x56\x04\x8a\xa3\x13\x6d", 8, GRND_NONBLOCK) = 8

1103  brk(NULL)                         = 0xaaaae35e8000
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1103 brk(0xaaaae3609000) = 0xaaaae3609000

1103 openat(AT_FDCWD, "res.txt", O_WRONLY|O_CREAT|O_TRUNC, 0666) = 3

1103 fstat(0, {st_mode=S_IFIFO|0600, st_size=0, ...}) = 0

1103 read(0, <unfinished ...>

1102 <... read resumed>"35\n", 1024) = 3

1102 wait4(1103, NULL, WNOHANG, NULL) = 0

1102 write(4, "35", 2) = 2

1103 <... read resumed>"35", 4096) = 2

1102 write(4, "\n", 1 <unfinished ...>

1103 read(0, <unfinished ...>

1102 <... write resumed>) = 1

1103 <... read resumed>"\n", 4096) = 1

1102 read(5, <unfinished ...>

1103 fstat(3, {st_mode=S_IFREG|0644, st_size=0, ...}) = 0

1103 write(3, "35\n", 3) = 3

1103 fstat(1, {st_mode=S_IFIFO|0600, st_size=0, ...}) = 0

1103 write(1, "OK\n", 3 <unfinished ...>

1102 <... read resumed>"OK\n", 10) = 3

1103 <... write resumed>) = 3

1102 write(1, "\320\222\320\262\320\265\320\264\320\270\321\202\320\265
\321\207\320\270\321\201\320\273\320\276: ", 27 <unfinished ...>

1103 read(0, <unfinished ...>

1102 <... write resumed>) = 27

1102 read(0, "9\n", 1024) = 2

1102 wait4(1103, NULL, WNOHANG, NULL) = 0

1102 write(4, "9", 1) = 1

1103 <... read resumed>"9", 4096) = 1

1102 write(4, "\n", 1 <unfinished ...>

1103 read(0, <unfinished ...>

1102 <... write resumed>) = 1

1103 <... read resumed>"\n", 4096) = 1

1102 read(5, <unfinished ...>

1103 write(3, "9\n", 2) = 2

1103 write(1, "OK\n", 3 <unfinished ...>

1102 <... read resumed>"OK\n", 10)   = 3

1103 <... write resumed>)   = 3

1102 write(1, "\320\222\320\262\320\265\320\264\320\270\321\202\320\265
\321\207\320\270\321\201\320\273\320\276: ", 27 <unfinished ...>

1103 read(0, <unfinished ...>

1102 <... write resumed>)   = 27

1102 read(0, "0\n", 1024)   = 2

1102 wait4(1103, NULL, WNOHANG, NULL) = 0

1102 write(4, "0", 1)   = 1

1103 <... read resumed>"0", 4096)   = 1

1102 write(4, "\n", 1 <unfinished ...>

1103 read(0, <unfinished ...>

1102 <... write resumed>)   = 1

1103 <... read resumed>"\n", 4096)   = 1

1102 read(5, <unfinished ...>

1103 write(3, "0\n", 2)   = 2

1103 write(1, "OK\n", 3 <unfinished ...>

1102 <... read resumed>"OK\n", 10)   = 3

1103 <... write resumed>)   = 3

1102 write(1, "\320\222\320\262\320\265\320\264\320\270\321\202\320\265
\321\207\320\270\321\201\320\273\320\276: ", 27 <unfinished ...>

1103 read(0, <unfinished ...>

1102 <... write resumed>)   = 27

1102 read(0, "-20\n", 1024)   = 4

1102 wait4(1103, NULL, WNOHANG, NULL) = 0

1102 write(4, "-20", 3)   = 3

1103 <... read resumed>"-20", 4096)   = 3

1102 write(4, "\n", 1 <unfinished ...>

1103 read(0, <unfinished ...>

1102 <... write resumed>)   = 1

1103 <... read resumed>"\n", 4096)   = 1

1102 read(5, <unfinished ...>

1103 write(3, "EXIT: -20\n", 10) = 10

1103 close(3) = 0

1103 write(1, "EXIT\n", 5 <unfinished ...>

1102 <... read resumed>"EXIT\n", 10) = 5

1103 <... write resumed>) = 5

1102 write(1, "\320\237\320\276\320\273\321\203\321\207\320\265\320\275 \321\201\320\270\320\263\320\275\320\260\320\273 \320\267\320\260"..., 49 <unfinished ...>

1103 exit_group(0 <unfinished ...>

1102 <... write resumed>) = 49

1103 <... exit_group resumed>) = ?

1102 close(4) = 0

1102 close(5 <unfinished ...>

1103 +++ exited with 0 +++

1102 <... close resumed>) = 0

1102 --- SIGCHLD {si_signo=SIGCHLD, si_code=CLD_EXITED, si_pid=1103, si_uid=0, si_status=0, si_utime=0, si_stime=0} ---

1102 wait4(-1, NULL, 0, NULL) = 1103

1102 write(1, "\320\240\320\276\320\264\320\270\321\202\320\265\320\273\321\214\321\201\320\272\320\270\320\271 \320\277\321\200\320\276\321"..., 57) = 57

1102 lseek(0, -1, SEEK_CUR) = -1 ESPIPE (Illegal seek)

1102 exit_group(0) = ?

1102 +++ exited with 0 +++

Lab_2:

1097 execve("./monte_carlo", ["./monte_carlo", "5.0", "10000000", "4"], 0xffffc7a1cb10 /* 8 vars */) = 0

1097 brk(NULL) = 0xaaaae9711000

1097 mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0xffffaee58000

1097 faccessat(AT_FDCWD, "/etc/ld.so.preload", R_OK) = -1 ENOENT (No such file or directory)

1097 openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3

1097 fstat(3, {st_mode=S_IFREG|0644, st_size=8467, ...}) = 0

1097 mmap(NULL, 8467, PROT_READ, MAP_PRIVATE, 3, 0) = 0xffffaee55000

1097 close(3) = 0

1097 openat(AT_FDCWD, "/lib/aarch64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3

1097 read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\360\206\2\0\0\0\0"..., 832) = 832

1097 fstat(3, {st_mode=S_IFREG|0755, st_size=1722920, ...}) = 0

1097 mmap(NULL, 1892240, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_DENYWRITE, -1, 0) = 0xffffaec51000

1097 mmap(0xffffaec60000, 1826704, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0) = 0xffffaec60000

1097 munmap(0xffffaec51000, 61440) = 0

1097 munmap(0xffffaee1e000, 3984) = 0

1097 mprotect(0xffffaedf9000, 81920, PROT_NONE) = 0

1097 mmap(0xffffaee0d000, 20480, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x19d000) = 0xffffaee0d000

1097 mmap(0xffffaee12000, 49040, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0xffffaee12000

1097 close(3) = 0

1097 set_tid_address(0xffffaee58fb0) = 1097

1097 set_robust_list(0xffffaee58fc0, 24) = 0

1097 rseq(0xffffaee59600, 0x20, 0, 0xd428bc00) = 0

1097 mprotect(0xffffaee0d000, 12288, PROT_READ) = 0

1097 mprotect(0xaaaad4acf000, 4096, PROT_READ) = 0

1097 mprotect(0xffffaee5d000, 8192, PROT_READ) = 0

1097 prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0

1097 munmap(0xffffaee55000, 8467) = 0

1097 fstat(1, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0), ...}) = 0

1097 getrandom("\x75\x07\xbf\x03\xc7\x73\x9c\x99", 8, GRND_NONBLOCK) = 8

1097 brk(NULL) = 0xaaaae9711000

1097 brk(0xaaaae9732000) = 0xaaaae9732000

1097 write(1, "\320\237\320\260\321\200\320\260\320\274\320\265\321\202\321\200\321\213:\n", 20) = 20

1097 write(1, "\320\240\320\260\320\264\320\270\321\203\321\201: 5.00\n", 19) = 19

1097 write(1, "\320\222\321\201\320\265\320\263\320\276\321\202\320\276\321\207\320\265\320\272: 10000000\n", 32) = 32

1097 write(1, "\320\234\320\260\320\272\321\201\320\270\320\274\321\203\320\274 \320\277\320\276\321\202\320\276\320\272\320\276\320\262:"..., 35) = 35

1097 clock_gettime(CLOCK_PROCESS_CPUTIME_ID, {tv_sec=0, tv_nsec=523832}) = 0

1097 rt_sigaction(SIGRT_1, {sa_handler=0xffffaece2840, sa_mask=[], sa_flags=SA_ONSTACK|SA_RESTART|SA_SIGINFO}, NULL, 8) = 0

1097 rt_sigprocmask(SIG_UNBLOCK, [RTMIN RT_1], NULL, 8) = 0

1097 mmap(NULL, 8454144, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0) = 0xffffae400000

1097 mprotect(0xffffae410000, 8388608, PROT_READ|PROT_WRITE) = 0

1097 rt_sigprocmask(SIG_BLOCK, ~[], [], 8) = 0

1097 clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0xffffaec0f270, parent_tid=0xffffaec0f270, exit_signal=0, stack=0xffffae400000, stack_size=0x80ea60, tls=0xffffaec0f8e0} => {parent_tid=[1098]}, 88) = 1098

1097 rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>

1098 rseq(0xffffaec0f8c0, 0x20, 0, 0xd428bc00 <unfinished ...>

1097 <... rt_sigprocmask resumed>NULL, 8) = 0

1098 <... rseq resumed>) = 0

1097 mmap(NULL, 8454144, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0 <unfinished ...>

1098 set_robust_list(0xffffaec0f280, 24 <unfinished ...>

1097 <... mmap resumed>) = 0xffffada00000

1098 <... set_robust_list resumed>) = 0

1097 mprotect(0xffffada10000, 8388608, PROT_READ|PROT_WRITE <unfinished ...>

1098 rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>

1097 <... mprotect resumed>) = 0

1098 <... rt_sigprocmask resumed>NULL, 8) = 0

1097 rt_sigprocmask(SIG_BLOCK, ~[], [], 8) = 0

1097 clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0xffffae20f270, parent_tid=0xffffae20f270, exit_signal=0, stack=0xffffada00000, stack_size=0x80ea60, tls=0xffffae20f8e0} => {parent_tid=[1099]}, 88) = 1099

1097 rt_sigprocmask(SIG_SETMASK, [], NULL, 8) = 0

1099 rseq(0xffffae20f8c0, 0x20, 0, 0xd428bc00 <unfinished ...>

1097 mmap(NULL, 8454144, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0 <unfinished ...>

1099 <... rseq resumed>) = 0

1097 <... mmap resumed>) = 0xffffad000000

1099 set_robust_list(0xffffae20f280, 24 <unfinished ...>

1097 mprotect(0xffffad010000, 8388608, PROT_READ|PROT_WRITE <unfinished ...>

1099 <... set_robust_list resumed>) = 0

1097 <... mprotect resumed>) = 0

1099 rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>

1097 rt_sigprocmask(SIG_BLOCK, ~[], <unfinished ...>

1099 <... rt_sigprocmask resumed>NULL, 8) = 0

1097 <... rt_sigprocmask resumed>[], 8) = 0

**1097
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0xffffad80f270, parent_tid=0xffffad80f270, exit_signal=0, stack=0xffffad000000, stack_size=0x80ea60, tls=0xffffad80f8e0} => {parent_tid=[1100]}, 88) = 1100**

1097 rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>

1100 rseq(0xffffad80f8c0, 0x20, 0, 0xd428bc00 <unfinished ...>

1097 <... rt_sigprocmask resumed>NULL, 8) = 0

1100 <... rseq resumed>) = 0

1097 mmap(NULL, 8454144, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_STACK, -1, 0 <unfinished ...>

1100 set_robust_list(0xffffad80f280, 24 <unfinished ...>

1097 <... mmap resumed>) = 0xffffac600000

1100 <... set_robust_list resumed>) = 0

1097 mprotect(0xffffac610000, 8388608, PROT_READ|PROT_WRITE <unfinished ...>

1100 rt_sigprocmask(SIG_SETMASK, [], <unfinished ...>

1097 <... mprotect resumed>) = 0

1100 <... rt_sigprocmask resumed>NULL, 8) = 0

1097 rt_sigprocmask(SIG_BLOCK, ~[], [], 8) = 0

**1097
clone3({flags=CLONE_VM|CLONE_FS|CLONE_FILES|CLONE_SIGHAND|CLONE_THREAD|CLONE_SYSVSEM|CLONE_SETTLS|CLONE_PARENT_SETTID|CLONE_CHILD_CLEARTID, child_tid=0xffffface0f270, parent_tid=0xffffface0f270, exit_signal=0, stack=0xffffac600000, stack_size=0x80ea60, tls=0xffffface0f8e0} => {parent_tid=[1101]}, 88) = 1101**

1097 rt_sigprocmask(SIG_SETMASK, [], NULL, 8) = 0

1101 rseq(0xffffface0f8c0, 0x20, 0, 0xd428bc00 <unfinished ...>

1097 futex(0xffffaec0f270, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 1098, NULL, FUTEX_BITSET_MATCH_ANY <unfinished ...>

1101 <... rseq resumed>) = 0

1101 set_robust_list(0xffffface0f280, 24) = 0

1101 rt_sigprocmask(SIG_SETMASK, [], NULL, 8) = 0

1098 rt_sigprocmask(SIG_BLOCK, ~[RT_1], NULL, 8) = 0

1098 madvise(0xffffae400000, 8314880, MADV_DONTNEED <unfinished ...>

1099 rt_sigprocmask(SIG_BLOCK, ~[RT_1], <unfinished ...>

1098 <... madvise resumed>) = 0

1099 <... rt_sigprocmask resumed>NULL, 8) = 0

1098 exit(0 <unfinished ...>

1099 madvise(0xffffada00000, 8314880, MADV_DONTNEED <unfinished ...>

1098 <... exit resumed>) = ?

1099 <... madvise resumed>) = 0

1097 <... futex resumed>) = 0

1098 +++ exited with 0 +++

1097 futex(0xffffae20f270, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 1099, NULL, FUTEX_BITSET_MATCH_ANY <unfinished ...>

1099 exit(0) = ?

1100 rt_sigprocmask(SIG_BLOCK, ~[RT_1], <unfinished ...>

1097 <... futex resumed>) = 0

1099 +++ exited with 0 +++

1097 futex(0xffffad80f270, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 1100, NULL, FUTEX_BITSET_MATCH_ANY <unfinished ...>

1100 <... rt_sigprocmask resumed>NULL, 8) = 0

1100 madvise(0xffffad000000, 8314880, MADV_DONTNEED) = 0

1100 exit(0) = ?

1097 <... futex resumed>) = 0

1100 +++ exited with 0 +++

1097 futex(0xffffface0f270, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 1101, NULL, FUTEX_BITSET_MATCH_ANY <unfinished ...>

1101 rt_sigprocmask(SIG_BLOCK, ~[RT_1], NULL, 8) = 0

1101 madvise(0xffffac600000, 8314880, MADV_DONTNEED) = 0

1101 exit(0) = ?

1097 <... futex resumed>) = 0

1101 +++ exited with 0 +++

1097 clock_gettime(CLOCK_PROCESS_CPUTIME_ID, {tv_sec=0, tv_nsec=124337250}) = 0

1097 write(1, "\n", 1) = 1

1097 write(1, "\320\240\320\265\320\267\321\203\320\273\321\214\321\202\320\260\321\202\321\213:\n", 22) = 22

1097 write(1, "\320\242\320\276\321\207\320\265\320\272 \320\262\320\275\321\203\321\202\321\200\320\270 \320\272\321\200\321\203\320\263"..., 44) = 44

1097 write(1, "\320\222\321\213\321\207\320\270\321\201\320\273\320\265\320\275\320\275\320\260\321\217 \320\277\320\273\320\276\321\211\320"..., 49) = 49

1097 write(1, "\320\242\320\265\320\276\321\200\320\265\321\202\320\270\321\207\320\265\321\201\320\272\320\260\321\217 \320\277\320\273\320"..., 53) = 53

1097 write(1, "\320\237\320\276\320\263\321\200\320\265\321\210\320\275\320\276\321\201\321\202\321\214: 0.0169%\n", 32) = 32

1097 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:"..., 52) = 52

1097 write(1, "\n", 1) = 1

1097 write(1, "\320\220\320\275\320\260\320\273\320\270\320\267 \320\277\321\200\320\276\320\270\320\267\320\262\320\276\320\264\320\270\321"..., 51) = 51

1097 write(1, "\320\230\321\201\320\277\320\276\320\273\321\214\320\267\320\276\320\262\320\260\320\275\320\276 \320\277\320\276\321\202\320"..., 43) = 43

1097 getpid() = 1097

1097 write(1, "ID \320\277\321\200\320\276\321\206\320\265\321\201\321\201\320\260: 1097\n", 26) = 26

1097 getpid() = 1097

1097 write(1, "\n\320\224\320\273\321\217 \320\277\321\200\320\276\321\201\320\274\320\276\321\202\321\200\320\260 \320\277\320\276\321"..., 73) = 73

1097 exit_group(0) = ?

1097 +++ exited with 0 +++

Lab_3:

1102 execve("./parent", ["./parent"], 0xffffdb09d888 /* 8 vars */) = 0

1102 brk(NULL) = 0xaaaae34fd000

1102 mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0xffff9cb18000

1102 faccessat(AT_FDCWD, "/etc/ld.so.preload", R_OK) = -1 ENOENT (No such file or directory)

1102 openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3

1102 fstat(3, {st_mode=S_IFREG|0644, st_size=8467, ...}) = 0

1102 mmap(NULL, 8467, PROT_READ, MAP_PRIVATE, 3, 0) = 0xffff9cb15000

1102 close(3) = 0

1102 openat(AT_FDCWD, "/lib/aarch64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3

1102 read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\360\206\2\0\0\0\0\0"..., 832) = 832

1102 fstat(3, {st_mode=S_IFREG|0755, st_size=1722920, ...}) = 0

1102 mmap(NULL, 1892240, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_DENYWRITE, -1, 0) = 0xffff9c911000

1102 mmap(0xffff9c920000, 1826704, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0) = 0xffff9c920000

1102 munmap(0xffff9c911000, 61440) = 0

1102 munmap(0xffff9cade000, 3984) = 0

1102 mprotect(0xffff9cab9000, 81920, PROT_NONE) = 0

1102 mmap(0xffff9cacd000, 20480, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x19d000) = 0xffff9cacd000

1102 mmap(0xffff9cad2000, 49040, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0xffff9cad2000

1102 close(3) = 0

1102 set_tid_address(0xffff9cb18fb0) = 1102

1102 set_robust_list(0xffff9cb18fc0, 24) = 0

1102 rseq(0xffff9cb19600, 0x20, 0, 0xd428bc00) = 0

1102 mprotect(0xffff9cacd000, 12288, PROT_READ) = 0

1102 mprotect(0xaaaab502f000, 4096, PROT_READ) = 0

1102 mprotect(0xffff9cb1d000, 8192, PROT_READ) = 0

1102 prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0

1102 munmap(0xffff9cb15000, 8467) = 0

1102 unlinkat(AT_FDCWD, "/dev/shm/sem.sem_parent", 0) = -1 ENOENT (No such file or directory)

1102 unlinkat(AT_FDCWD, "/dev/shm/sem.sem_child", 0) = -1 ENOENT (No such file or directory)

1102 openat(AT_FDCWD, "/dev/shm/sem.sem_parent", O_RDWR|O_NOFOLLOW|O_CLOEXEC) = -1 ENOENT (No such file or directory)

1102 getrandom("\x23\x62\xfe\x6a\x30\x9e\x4a\x8c", 8, GRND_NONBLOCK) = 8

1102 newfstatat(AT_FDCWD, "/dev/shm/sem.DnG8on", 0xffffec86c2b8, AT_SYMLINK_NOFOLLOW) = -1 ENOENT (No such file or directory)

1102 openat(AT_FDCWD, "/dev/shm/sem.DnG8on", O_RDWR|O_CREAT|O_EXCL|O_NOFOLLOW|O_CLOEXEC, 0666) = 3

1102 write(3, "\0\0\0\0\0\0\0\200\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0", 32) = 32

1102 mmap(NULL, 32, PROT_READ|PROT_WRITE, MAP_SHARED, 3, 0) = 0xffff9cb17000

1102 linkat(AT_FDCWD, "/dev/shm/sem.DnG8on", AT_FDCWD, "/dev/shm/sem.sem_parent", 0) = 0

1102 fstat(3, {st_mode=S_IFREG|0644, st_size=32, ...}) = 0

1102 getrandom("\x9b\xe0\x2b\x37\x09\xb1\xf2\xc7", 8, GRND_NONBLOCK) = 8

1102 brk(NULL) = 0xaaaae34fd000

1102 brk(0xaaaae351e000) = 0xaaaae351e000

1102 unlinkat(AT_FDCWD, "/dev/shm/sem.DnG8on", 0) = 0

1102 close(3) = 0

1102 openat(AT_FDCWD, "/dev/shm/sem.sem_child", O_RDWR|O_NOFOLLOW|O_CLOEXEC) = -1 ENOENT (No such file or directory)

1102 getrandom("\x3c\x29\x44\x86\x52\xea\xc1\x33", 8, GRND_NONBLOCK) = 8

1102 newfstatat(AT_FDCWD, "/dev/shm/sem.O6mjGh", 0xffffec86c2b8, AT_SYMLINK_NOFOLLOW) = -1 ENOENT (No such file or directory)

1102 openat(AT_FDCWD, "/dev/shm/sem.O6mjGh", O_RDWR|O_CREAT|O_EXCL|O_NOFOLLOW|O_CLOEXEC, 0666) = 3

1102 write(3, "\0\0\0\0\0\0\0\200\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0\0", 32) = 32

1102 mmap(NULL, 32, PROT_READ|PROT_WRITE, MAP_SHARED, 3, 0) = 0xffff9cb16000

1102 linkat(AT_FDCWD, "/dev/shm/sem.O6mjGh", AT_FDCWD, "/dev/shm/sem.sem_child", 0) = 0

1102 fstat(3, {st_mode=S_IFREG|0644, st_size=32, ...}) = 0

1102 unlinkat(AT_FDCWD, "/dev/shm/sem.O6mjGh", 0) = 0

1102 close(3) = 0

1102 unlinkat(AT_FDCWD, "/dev/shm/input_shm", 0) = -1 ENOENT (No such file or directory)

1102 unlinkat(AT_FDCWD, "/dev/shm/output_shm", 0) = -1 ENOENT (No such file or directory)

1102 openat(AT_FDCWD, "/dev/shm/input_shm", O_RDWR|O_CREAT|O_NOFOLLOW|O_CLOEXEC, 0666) = 3

1102 openat(AT_FDCWD, "/dev/shm/output_shm", O_RDWR|O_CREAT|O_NOFOLLOW|O_CLOEXEC, 0666) = 4

1102 ftruncate(3, 100) = 0

1102 ftruncate(4, 100) = 0

1102 mmap(NULL, 100, PROT_READ|PROT_WRITE, MAP_SHARED, 3, 0) = 0xffff9cb15000

1102 mmap(NULL, 100, PROT_READ|PROT_WRITE, MAP_SHARED, 4, 0) = 0xffff9cb14000

1102 fstat(1, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0), ...}) = 0

1102 fstat(0, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0), ...}) = 0

1102 write(1, "\320\222\320\262\320\265\320\264\320\270\321\202\320\265 \320\270\320\274\321\217 \321\204\320\260\320\271\320\273\320\260"..., 34) = 34

1102 read(0, "res.txt\n", 1024) = 8

1102 clone(child_stack=NULL, flags=CLONE_CHILD_CLEARTID|CLONE_CHILD_SETTID|SIGCHLD, child_tidptr=0xffff9cb18fb0) = 1103

1102 clock_nanosleep(CLOCK_REALTIME, 0, {tv_sec=1, tv_nsec=0}, <unfinished ...>

1103 set_robust_list(0xffff9cb18fc0, 24) = 0

1103 close(3) = 0

1103 close(4) = 0

1103 munmap(0xffff9cb17000, 32) = 0

1103 munmap(0xffff9cb16000, 32) = 0

1103 execve("./child", ["child", "res.txt"], 0xffffec86c8e8 /* 8 vars */) = 0

1103 brk(NULL) = 0xaaab03689000

1103 mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0xffff801f9000

1103 faccessat(AT_FDCWD, "/etc/ld.so.preload", R_OK) = -1 ENOENT (No such file or directory)

1103 openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3

1103 fstat(3, {st_mode=S_IFREG|0644, st_size=8467, ...}) = 0

1103 mmap(NULL, 8467, PROT_READ, MAP_PRIVATE, 3, 0) = 0xffff801f6000

1103 close(3) = 0

1103 openat(AT_FDCWD, "/lib/aarch64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3

1103 read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\360\206\2\0\0\0\0"..., 832) = 832

1103 fstat(3, {st_mode=S_IFREG|0755, st_size=1722920, ...}) = 0

1103 mmap(NULL, 1892240, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_DENYWRITE, -1, 0) = 0xffff7fff2000

1103 mmap(0xffff80000000, 1826704, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0) = 0xffff80000000

1103 munmap(0xffff7fff2000, 57344) = 0

1103 munmap(0xffff801be000, 8080) = 0

1103 mprotect(0xffff80199000, 81920, PROT_NONE) = 0

1103 mmap(0xffff801ad000, 20480, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x19d000) = 0xffff801ad000

1103 mmap(0xffff801b2000, 49040, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0xffff801b2000

1103 close(3) = 0

1103 set_tid_address(0xffff801f9fb0) = 1103

1103 set_robust_list(0xffff801f9fc0, 24) = 0

1103 rseq(0xffff801fa600, 0x20, 0, 0xd428bc00) = 0

1103 mprotect(0xffff801ad000, 12288, PROT_READ) = 0

1103 mprotect(0xaaaaca01f000, 4096, PROT_READ) = 0

1103 mprotect(0xffff801fe000, 8192, PROT_READ) = 0

1103 prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0

1103 munmap(0xffff801f6000, 8467) = 0

1103 getrandom("\x0a\xbe\xe4\xe2\x9e\xc6\xf0\x15", 8, GRND_NONBLOCK) = 8

1103 brk(NULL) = 0xaaab03689000

1103 brk(0xaaab036aa000) = 0xaaab036aa000

1103 openat(AT_FDCWD, "res.txt", O_WRONLY|O_CREAT|O_TRUNC, 0666) = 3

1103 openat(AT_FDCWD, "/dev/shm/sem.sem_parent", O_RDWR|O_NOFOLLOW|O_CLOEXEC) = 4

1103 fstat(4, {st_mode=S_IFREG|0644, st_size=32, ...}) = 0

1103 mmap(NULL, 32, PROT_READ|PROT_WRITE, MAP_SHARED, 4, 0) = 0xffff801f8000

1103 close(4) = 0

1103 openat(AT_FDCWD, "/dev/shm/sem.sem_child", O_RDWR|O_NOFOLLOW|O_CLOEXEC) = 4

1103 fstat(4, {st_mode=S_IFREG|0644, st_size=32, ...}) = 0

1103 mmap(NULL, 32, PROT_READ|PROT_WRITE, MAP_SHARED, 4, 0) = 0xffff801f7000

1103 close(4) = 0

1103 openat(AT_FDCWD, "/dev/shm/input_shm", O_RDWR|O_NOFOLLOW|O_CLOEXEC) = 4

1103 openat(AT_FDCWD, "/dev/shm/output_shm", O_RDWR|O_NOFOLLOW|O_CLOEXEC) = 5

1103 mmap(NULL, 100, PROT_READ|PROT_WRITE, MAP_SHARED, 4, 0) = 0xffff801f6000

1103 mmap(NULL, 100, PROT_READ|PROT_WRITE, MAP_SHARED, 5, 0) = 0xffff801f5000

1103 futex(0xffff801f8000, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 0, NULL, FUTEX_BITSET_MATCH_ANY <unfinished ...>

1102 <... clock_nanosleep resumed>0xffffec86c5e8) = 0

1102 write(1, "\320\222\320\262\320\265\320\264\320\270\321\202\320\265 \321\207\320\270\321\201\320\273\320\276: ", 27) = 27

1102 read(0, "40\n", 1024) = 3

1102 wait4(1103, NULL, WNOHANG, NULL) = 0

1102 futex(0xffff9cb17000, FUTEX_WAKE, 1) = 1

1103 <... futex resumed>) = 0

1102 futex(0xffff9cb16000, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 0, NULL, FUTEX_BITSET_MATCH_ANY <unfinished ...>

1103 fstat(3, {st_mode=S_IFREG|0644, st_size=0, ...}) = 0

1103 write(3, "40\n", 3) = 3

1103 futex(0xffff801f7000, FUTEX_WAKE, 1 <unfinished ...>

1102 <... futex resumed>) = 0

1103 <... futex resumed>) = 1

1102 write(1, "\320\222\320\262\320\265\320\264\320\270\321\202\320\265 \321\207\320\270\321\201\320\273\320\276: ", 27 <unfinished ...>

1103 futex(0xffff801f8000, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 0, NULL, FUTEX_BITSET_MATCH_ANY <unfinished ...>

1102 <... write resumed>) = 27

1102 read(0, "3002\n", 1024) = 5

1102 wait4(1103, NULL, WNOHANG, NULL) = 0

1102 futex(0xffff9cb17000, FUTEX_WAKE, 1) = 1

1103 <... futex resumed>) = 0

1102 futex(0xffff9cb16000, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 0, NULL, FUTEX_BITSET_MATCH_ANY <unfinished ...>

1103 write(3, "3002\n", 5) = 5

1103 futex(0xffff801f7000, FUTEX_WAKE, 1 <unfinished ...>

1102 <... futex resumed>) = 0

1103 <... futex resumed>) = 1

1102 write(1, "\320\222\320\262\320\265\320\264\320\270\321\202\320\265 \321\207\320\270\321\201\320\273\320\276: ", 27 <unfinished ...>

1103 futex(0xffff801f8000, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 0, NULL, FUTEX_BITSET_MATCH_ANY <unfinished ...>

1102 <... write resumed>) = 27

1102 read(0, "-1\n", 1024) = 3

1102 wait4(1103, NULL, WNOHANG, NULL) = 0

1102 futex(0xffff9cb17000, FUTEX_WAKE, 1) = 1

1103 <... futex resumed>) = 0

1102 futex(0xffff9cb16000, FUTEX_WAIT_BITSET|FUTEX_CLOCK_REALTIME, 0, NULL, FUTEX_BITSET_MATCH_ANY <unfinished ...>

1103 write(3, "EXIT: -1\n", 9) = 9

1103 close(3) = 0

1103 futex(0xffff801f7000, FUTEX_WAKE, 1 <unfinished ...>

1102 <... futex resumed>) = 0

1103 <... futex resumed>) = 1

1102 write(1, "\320\237\320\276\320\273\321\203\321\207\320\265\320\275 \321\201\320\270\320\263\320\275\320\260\320\273 \320\267\320\260"..., 49 <unfinished ...>

1103 munmap(0xffff801f6000, 100 <unfinished ...>

1102 <... write resumed>) = 49

1103 <... munmap resumed>) = 0

1102 wait4(-1, <unfinished ...>

1103 munmap(0xffff801f5000, 100) = 0

1103 close(4) = 0

1103 close(5) = 0

1103 munmap(0xffff801f8000, 32) = 0

1103 munmap(0xffff801f7000, 32) = 0

1103 exit_group(0) = ?

1103 +++ exited with 0 +++

1102 <... wait4 resumed>NULL, 0, NULL) = 1103

1102 --- SIGCHLD {si_signo=SIGCHLD, si_code=CLD_EXITED, si_pid=1103, si_uid=0, si_status=0, si_utime=0, si_stime=0} ---

1102 munmap(0xffff9cb15000, 100) = 0

1102 munmap(0xffff9cb14000, 100) = 0

1102 close(3) = 0

1102 close(4) = 0

1102 munmap(0xffff9cb17000, 32) = 0

1102 munmap(0xffff9cb16000, 32) = 0

1102 unlinkat(AT_FDCWD, "/dev/shm/sem.sem_parent", 0) = 0

1102 unlinkat(AT_FDCWD, "/dev/shm/sem.sem_child", 0) = 0

1102 unlinkat(AT_FDCWD, "/dev/shm/input_shm", 0) = 0

1102 unlinkat(AT_FDCWD, "/dev/shm/output_shm", 0) = 0

1102 write(1, "\320\240\320\276\320\264\320\270\321\202\320\265\320\273\321\214\321\201\320\272\320\270\320\271 \320\277\321\200\320\276\321"..., 57) = 57

1102 lseek(0, -1, SEEK_CUR) = -1 ESPIPE (Illegal seek)

1102 exit_group(0) = ?

1102 +++ exited with 0 +++

Lab_4:

Program1

1113 execve("./program1", ["./program1"], 0xffffd67732f8 /* 8 vars */) = 0

1113 brk(NULL) = 0xaaaabd14d000

1113 mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0xffff9a4c8000

1113 faccessat(AT_FDCWD, "/etc/ld.so.preload", R_OK) = -1 ENOENT (No such file or directory)

1113 openat(AT_FDCWD, "./libmath_impl1.so", O_RDONLY|O_CLOEXEC) = 3

1113 read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\0\0\0\0\0\0\0"..., 832) = 832

1113 fstat(3, {st_mode=S_IFREG|0755, st_size=69272, ...}) = 0

1113 mmap(NULL, 196640, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_DENYWRITE, -1, 0) = 0xffff9a45e000

1113 mmap(0xffff9a460000, 131104, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0) = 0xffff9a460000

1113 munmap(0xffff9a45e000, 8192) = 0

1113 mprotect(0xffff9a461000, 122880, PROT_NONE) = 0

1113 mmap(0xffff9a47f000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0xf000) = 0xffff9a47f000

1113 close(3) = 0

1113 openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3

1113 mmap(NULL, 8467, PROT_READ, MAP_PRIVATE, 3, 0) = 0xffff9a4c5000

1113 close(3) = 0

1113 openat(AT_FDCWD, "/lib/aarch64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3

1113 mmap(NULL, 1892240, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_DENYWRITE, -1, 0) = 0xffff9a292000

1113 mmap(0xffff9a2a0000, 1826704, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0) = 0xffff9a2a0000

1113 mprotect(0xffff9a439000, 81920, PROT_NONE) = 0

1113 mmap(0xffff9a44d000, 20480, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x19d000) = 0xffff9a44d000

1113 mmap(0xffff9a452000, 49040, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0xffff9a452000

1113 close(3) = 0

1113 mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0xffff9a4c3000

1113 write(1, "1 K - Pi(K)\n", 12) = 12

1113 write(1, "2 A B - Square(A,B)\n", 20) = 20

1113 write(1, "0 - exit\n", 9) = 9

1113 read(0, "1 100\n2 3 4\n0\n", 4096) = 14

1113 write(1, "> Pi: 3.131593\n", 15) = 15

1113 write(1, "> Square: 12.000000\n", 20) = 20

1113 exit_group(0) = ?

1113 +++ exited with 0 +++

Program2

1117 execve("./program2", ["./program2"], 0xffffe83a48e8 /* 8 vars */) = 0

1117 brk(NULL) = 0xaaaae896b000

1117 mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0xffffa06dc000

1117 faccessat(AT_FDCWD, "/etc/ld.so.preload", R_OK) = -1 ENOENT (No such file or directory)

1117 openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3

1117 fstat(3, {st_mode=S_IFREG|0644, st_size=8467, ...}) = 0

1117 mmap(NULL, 8467, PROT_READ, MAP_PRIVATE, 3, 0) = 0xffffa06d9000

1117 close(3) = 0

1117 openat(AT_FDCWD, "/lib/aarch64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3

1117 read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\360\206\2\0\0\0\0"..., 832) = 832

1117 fstat(3, {st_mode=S_IFREG|0755, st_size=1722920, ...}) = 0

1117 mmap(NULL, 1892240, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_DENYWRITE, -1, 0) = 0xffffa04d5000

1117 mmap(0xffffa04e0000, 1826704, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0) = 0xffffa04e0000

1117 munmap(0xffffa04d5000, 45056) = 0

1117 mprotect(0xffffa0679000, 81920, PROT_NONE) = 0

1117 mmap(0xffffa068d000, 20480, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x19d000) = 0xffffa068d000

1117 mmap(0xffffa0692000, 49040, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0xffffa0692000

1117 close(3) = 0

1117 munmap(0xffffa06d9000, 8467) = 0

1117 openat(AT_FDCWD, "./libmath_impl1.so", O_RDONLY|O_CLOEXEC) = 3

1117 read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\0\0\0\0\0\0\0"..., 832) = 832

1117 mmap(NULL, 196640, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_DENYWRITE, -1, 0) = 0xffffa04af000

1117 mmap(0xffffa04b0000, 131104, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0) = 0xffffa04b0000

1117 munmap(0xffffa04af000, 4096) = 0

1117 mprotect(0xffffa04b1000, 122880, PROT_NONE) = 0

1117 mmap(0xffffa04cf000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0xf000) = 0xffffa04cf000

1117 close(3) = 0

1117 mprotect(0xffffa04cf000, 4096, PROT_READ) = 0

1117 write(1, "1 K - Pi\n", 9) = 9

1117 write(1, "2 A B - Square\n", 15) = 15

1117 write(1, "0 - switch lib\n", 15) = 15

1117 write(1, "3 - exit\n", 9) = 9

1117 read(0, "1 10\n0\n1 100\n2 3 4\n0\n3\n", 4096) = 23

1117 write(1, "> Pi: = 3.041840 (lib 1)\n", 25) = 25

1117 munmap(0xffffa04b0000, 131104) = 0

1117 openat(AT_FDCWD, "./libmath_impl2.so", O_RDONLY|O_CLOEXEC) = 3

1117 read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\0\0\0\0\0\0\0"..., 832) = 832

1117 mmap(NULL, 196640, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_DENYWRITE, -1, 0) = 0xffffa04af000

1117 mmap(0xffffa04b0000, 131104, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0) = 0xffffa04b0000

1117 munmap(0xffffa04af000, 4096) = 0

1117 mprotect(0xffffa04b1000, 122880, PROT_NONE) = 0

1117 mmap(0xffffa04cf000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0xf000) = 0xffffa04cf000

1117 close(3) = 0

1117 mprotect(0xffffa04cf000, 4096, PROT_READ) = 0

1117 write(1, "> Switched to lib 2\n", 20) = 20

1117 write(1, "> Pi: = 3.133787 (lib 2)\n", 25) = 25

1117 write(1, "> Square: 6.000000 (lib 2)\n", 27) = 27

1117 munmap(0xffffa04b0000, 131104) = 0

1117 openat(AT_FDCWD, "./libmath_impl1.so", O_RDONLY|O_CLOEXEC) = 3

1117 read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\3\0\267\0\1\0\0\0\0\0\0\0\0\0\0"..., 832) = 832

1117 mmap(NULL, 196640, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS|MAP_DENYWRITE, -1, 0) = 0xffffa04af000

1117 mmap(0xffffa04b0000, 131104, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0) = 0xffffa04b0000

1117 munmap(0xffffa04af000, 4096) = 0

1117 mprotect(0xffffa04b1000, 122880, PROT_NONE) = 0

1117 mmap(0xffffa04cf000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0xf000) = 0xffffa04cf000

1117 close(3)   = 0

1117 mprotect(0xffffa04cf000, 4096, PROT_READ) = 0

1117 write(1, "> Switched to lib 1\n", 20) = 20

1117 munmap(0xffffa04b0000, 131104)   = 0

1117 write(1, "> ", 2)   = 2

1117 exit_group(0)   = ?

1117 +++ exited with 0 +++

Вывод

В ходе выполнения лабораторной работы №6 был проведён детальный анализ системных вызовов программ, разработанных в предыдущих четырёх лабораторных работах, с помощью утилиты strace. Это позволило наглядно увидеть, как высокоуровневые операции на языке Си (создание процессов, работа с каналами, разделяемой памятью, потоками и динамическими библиотеками) транслируются в низкоуровневые запросы к ядру операционной системы, такие как clone, pipe2, mmap, openat и munmap. Анализ подтвердил корректность реализации межпроцессного взаимодействия и управления ресурсами в каждой из рассмотренных программ, а также выявил характерные паттерны использования системных вызовов для разных механизмов коммуникации (pipes, shared memory) и многозадачности (процессы vs потоки).