CS 481

Programming Assignment 1

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# Problem 1

## Part A

This call failed because the system call “open("OSclass", O\_RDONLY) = -1 ENOENT (No such file or directory)” failed.

System calls:

1. execve
2. write
3. access
4. mmap
5. open

## Part B

This time the system call “open” succeeded and was followed by a “close” system call before moving on to writing the output.

1. fopen is not a system call, it correlates with the system call “open”.
2. printf is not a system call, it correlates with the system call “write”.

# Problem 2

Output: strace whoami

execve("/usr/bin/whoami", ["whoami"], [/\* 19 vars \*/]) = 0

brk(0) = 0x1c56000

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

mmap(NULL, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f0095afc000

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

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

fstat(3, {st\_mode=S\_IFREG|0644, st\_size=152067, ...}) = 0

mmap(NULL, 152067, PROT\_READ, MAP\_PRIVATE, 3, 0) = 0x7f0095ad6000

close(3) = 0

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

open("/lib/x86\_64-linux-gnu/libc.so.6", 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\0P \2\0\0\0\0\0"..., 832) = 832

fstat(3, {st\_mode=S\_IFREG|0755, st\_size=1840928, ...}) = 0

mmap(NULL, 3949248, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0x7f0095517000

mprotect(0x7f00956d1000, 2097152, PROT\_NONE) = 0

mmap(0x7f00958d1000, 24576, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x1ba000) = 0x7f00958d1000

mmap(0x7f00958d7000, 17088, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_ANONYMOUS, -1, 0) = 0x7f00958d7000

close(3) = 0

mmap(NULL, 4096, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f0095ad5000

mmap(NULL, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f0095ad3000

arch\_prctl(ARCH\_SET\_FS, 0x7f0095ad3740) = 0

mprotect(0x7f00958d1000, 16384, PROT\_READ) = 0

mprotect(0x605000, 4096, PROT\_READ) = 0

mprotect(0x7f0095afe000, 4096, PROT\_READ) = 0

munmap(0x7f0095ad6000, 152067) = 0

brk(0) = 0x1c56000

brk(0x1c77000) = 0x1c77000

open("/usr/lib/locale/locale-archive", O\_RDONLY|O\_CLOEXEC) = 3

fstat(3, {st\_mode=S\_IFREG|0644, st\_size=7216688, ...}) = 0

mmap(NULL, 7216688, PROT\_READ, MAP\_PRIVATE, 3, 0) = 0x7f0094e35000

close(3) = 0

geteuid() = 4424

socket(PF\_LOCAL, SOCK\_STREAM|SOCK\_CLOEXEC|SOCK\_NONBLOCK, 0) = 3

connect(3, {sa\_family=AF\_LOCAL, sun\_path="/var/run/nscd/socket"}, 110) = 0

sendto(3, "\2\0\0\0\v\0\0\0\7\0\0\0passwd\0", 19, MSG\_NOSIGNAL, NULL, 0) = 19

poll([{fd=3, events=POLLIN|POLLERR|POLLHUP}], 1, 5000) = 1 ([{fd=3, revents=POLLIN|POLLHUP}])

recvmsg(3, {msg\_name(0)=NULL, msg\_iov(2)=[{"passwd\0", 7}, {"\310O\3\0\0\0\0\0", 8}], msg\_controllen=20, {cmsg\_len=20, cmsg\_level=SOL\_SOCKET, cmsg\_type=SCM\_RIGHTS, {4}}, msg\_flags=MSG\_CMSG\_CLOEXEC}, MSG\_CMSG\_CLOEXEC) = 15

mmap(NULL, 217032, PROT\_READ, MAP\_SHARED, 4, 0) = 0x7f0095a9e000

close(4) = 0

close(3) = 0

fstat(1, {st\_mode=S\_IFCHR|0620, st\_rdev=makedev(136, 5), ...}) = 0

mmap(NULL, 4096, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -1, 0) = 0x7f0095afb000

write(1, "alexebaker\n", 11alexebaker

) = 11

close(1) = 0

munmap(0x7f0095afb000, 4096) = 0

close(2) = 0

exit\_group(0) = ?

+++ exited with 0 +++

Syscalls:

* execve
  + Executes a file passed to it
  + Parameters
    - const char \*filename
      * Path to the file to execute
    - char \*const argv[]
      * Arguments to be passed to the program
    - char \*const envp[]
      * environment variables passed to the program
  + Returns
    - Does not return on success, on error, returns -1 and sets errno
* mmap
  + Creates a new mapping for files or devices in the virtual address space for the process
  + Parameters
    - void \*addr
      * starting address of the mapping. If left to NULL, the the kernel will choose
    - size\_t length
      * length of the mapping
    - int prot
      * the memory protection of the mapping
    - int flags
      * determines if updates to the mapping are visible to other processes
    - inf fd
      * file descriptor of the file being read
    - off\_t offset
      * offset of the file with the file descriptor fd
  + Returns
    - Pointer to the mapped value if successful, -1 if the mapping failed
* open
  + open and possible create a file
  + Parameters
    - const char \*pathname
      * path to the file to open
    - int flags
      * one of the following access modes: O\_RDONLY, O\_WRONLY, O\_RDWR
  + Returns
    - File descriptor for the opened file, or -1 if it failed and sets errno appropriately
* fstat
  + Returns information about a file
  + Parameters
    - int fd
      * File descriptor of the file to get information for
    - struct stat \*buf
      * buffer to write file information to
  + Returns
    - 0 on success, -1 if an error occurred and sets errno appropriately

# Problem 3

Output: strace -c ls

% time seconds usecs/call calls errors syscall

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26.85 0.000178 8 23 mmap

14.48 0.000096 11 9 open

14.48 0.000096 7 14 mprotect

10.71 0.000071 9 8 read

6.33 0.000042 14 3 munmap

5.88 0.000039 5 8 8 access

4.37 0.000029 15 2 2 statfs

4.22 0.000028 2 12 close

3.32 0.000022 2 10 fstat

2.71 0.000018 18 1 openat

1.96 0.000013 13 1 write

1.66 0.000011 6 2 getdents

1.21 0.000008 3 3 brk

0.90 0.000006 3 2 ioctl

0.75 0.000005 5 1 execve

0.15 0.000001 1 1 arch\_prctl

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100.00 0.000663 100 10 total

Most Frequent:

1. mmap: 23
   1. avg: 28 μs
   2. min: 22 μs
   3. max: 61 μs
2. mprotect: 14
   1. avg: 27 μs
   2. min: 25 μs
   3. max: 30 μs
3. close: 12
   1. avg: 119 μs
   2. min: 18 μs
   3. max: 643 μs
4. fstat: 10
   1. avg: 110 μs
   2. min: 17 μs
   3. max: 923 μs
5. open: 9
   1. avg: 33 μs
   2. min: 29 μs
   3. max: 41 μs

# Problem 4

## Part A

Commands:

* Library Functions:
  + opendir(".")
* System Calls:
  + openat(AT\_FDCWD, ".", O\_RDONLY|O\_NONBLOCK|O\_DIRECTORY|O\_CLOEXEC) = 3

## Part B

Commands:

* Library Functions:
  + readdir(0xaa4c20)
* System Calls:
  + getdents(3, /\* 41 entries \*/, 32768) = 1320
  + getdents(3, /\* 0 entries \*/, 32768) = 0

## Part C

Commands:

* Library Functions:
  + strcoll()
  + fwrite\_unlocked()
* System Calls
  + write(1, "Desktop Documents Downloads M"..., 88Desktop Documents Downloads Music Pictures Public public\_html Templates Videos vim) = 88