

CS 481

PROGRAMMING ASSIGNMENT 1

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Problem 1

Part A

This call failed because the system call “open(“OSclass”, O_RDONLY)” failed. = -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}, {"\3100\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
 - `int 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
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
100.00	0.000663		100	10	total

Most Frequent:

1. mmap: 23
 - a. avg: 28 μ s
 - b. min: 22 μ s
 - c. max: 61 μ s
2. mprotect: 14
 - a. avg: 27 μ s
 - b. min: 25 μ s
 - c. max: 30 μ s
3. close: 12
 - a. avg: 119 μ s
 - b. min: 18 μ s
 - c. max: 643 μ s
4. fstat: 10
 - a. avg: 110 μ s
 - b. min: 17 μ s
 - c. max: 923 μ s

5. open: 9
 - a. avg: 33 μ s
 - b. min: 29 μ s
 - c. max: 41 μ s

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`