CS342

HOMEWORK 1

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CS342-002

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INSTALLATION CHOICES AND EXPERIENCES:

As prescribed, I downloaded and installed Ubuntu Desktop 64-bit 20.04 LTS on a virtual machine using VirtualBox 6.1 for MacOS. I rarely use Ubuntu due to the availability of Bash Terminal in MacOS. I didn't particularly face ay challenges as I watched tutorials provided on the web to compete the prices of downloading and installing, however I had to follow through to change various settings on the VirtualBox with an allocation of a virtual hard drive of 64GB size (dynamic) as I thought that would be the necessary size, and since it can't be altered afterwards I allocated a good amount to not run into complications.
Ultimately, the experience of downloading and installing the OS and making it run was straight forward for the most part. Virtual Machines perform quite well given enough RAM (although I provided 1GB initially but changed it in settings to assess performance at different levels).

NAMES OF 10 LINUX COMMANDS:

1. cd
2. cat
3. mkdir
4. ls
5. cp
6. curl
7. echo
8. exit
9. chmod
10. gzip

THE LOCATION OF KERNEL EXECUTABLE:

Pathname: /boot/vmlinuz-5.8.0-41-generic
Version of running Kernel: 5.8.0-41-generic

SUBDIRECTORIES IN THE KERNEL SOURCE CODE:

arch/ block/ certs/ crypto/ Documentation/ drivers/ LICENSES/

DEFINITION OF SYSTEM CALL TABLE:

Location: arch/x86/entry/syscalls/syscall_64.tbl
3: close
35: sched_yield
110: sysinfo

210: fremovexattr

STRACE COMMAND:

strace ls:

```
execve("/usr/bin/ls", ["ls"], 0x7ffcc32a9430 /* 58 vars */) = 0
brk(NULL)                               = 0x55931feff000
arch_prctl(0x3001 /* ARCH_??? */, 0x7fff70c88490) = -1 EINVAL (Invalid argument)
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
fstat(3, {st_mode=S_IFREG|0644, st_size=66933, ...}) = 0
mmap(NULL, 66933, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f14a60bb000
close(3)                                = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libselinux.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@p\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=163200, ...}) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f14a60b9000
mmap(NULL, 174600, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f14a608e000
mprotect(0x7f14a6094000, 135168, PROT_NONE) = 0
mmap(0x7f14a6094000, 102400, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x6000) = 0x7f14a6094000
mmap(0x7f14a60ad000, 28672, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1f000) = 0x7f14a60ad000
mmap(0x7f14a60b5000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x26000) = 0x7f14a60b5000
mmap(0x7f14a60b7000, 6664, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7f14a60b7000
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\0\360q\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\20\0\0\0\5\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\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\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\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) = 0x7f14a5e9c000
mprotect(0x7f14a5ec1000, 1847296, PROT_NONE) = 0
mmap(0x7f14a5ec1000, 1540096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x25000) = 0x7f14a5ec1000
mmap(0x7f14a6039000, 303104, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x19d000) = 0x7f14a6039000
mmap(0x7f14a6084000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1e7000) = 0x7f14a6084000
mmap(0x7f14a608a000, 13528, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7f14a608a000
close(3)                                = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libpcre2-8.so.0", 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\340\"\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=584392, ...}) = 0
mmap(NULL, 586536, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f14a5e0c000
mmap(0x7f14a5e0e000, 409600, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f14a5e0e000
mmap(0x7f14a5e72000, 163840, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x66000) = 0x7f14a5e72000
mmap(0x7f14a5e9a000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x8d000) = 0x7f14a5e9a000
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\0\3\0>\0\1\0\0\0 \22\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=18816, ...}) = 0
mmap(NULL, 20752, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f14a5e06000
mmap(0x7f14a5e07000, 8192, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1000) = 0x7f14a5e07000
mmap(0x7f14a5e09000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x3000) = 0x7f14a5e09000
mmap(0x7f14a5e0a000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x3000) = 0x7f14a5e0a000
close(3)                                = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libpthread.so.0", 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\220\201\0\0\0\0\0\0"..., 832) = 832
pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\345Ga\367\265T\320\374\301V)Yf]\223\337"..., 68, 824) = 68
fstat(3, {st_mode=S_IFREG|0755, st_size=157224, ...}) = 0
pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\345Ga\367\265T\320\374\301V)Yf]\223\337"..., 68, 824) = 68
mmap(NULL, 140408, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f14a5de3000
mmap(0x7f14a5dea000, 69632, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x7000) = 0x7f14a5dea000
mmap(0x7f14a5dfb000, 20480, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x18000) = 0x7f14a5dfb000
mmap(0x7f14a5e00000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1c000) = 0x7f14a5e00000
mmap(0x7f14a5e02000, 13432, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7f14a5e02000
close(3)                                = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f14a5de1000
arch_prctl(ARCH_SET_FS, 0x7f14a5de2400) = 0
mprotect(0x7f14a6084000, 12288, PROT_READ) = 0
mprotect(0x7f14a5e00000, 4096, PROT_READ) = 0
mprotect(0x7f14a5e0a000, 4096, PROT_READ) = 0
mprotect(0x7f14a5e9a000, 4096, PROT_READ) = 0
mprotect(0x7f14a60b5000, 4096, PROT_READ) = 0
mprotect(0x55931e1b6000, 4096, PROT_READ) = 0
mprotect(0x7f14a60f9000, 4096, PROT_READ) = 0
munmap(0x7f14a60bb000, 66933)           = 0
set_tid_address(0x7f14a5de26d0)         = 1712
set_robust_list(0x7f14a5de26e0, 24)     = 0
rt_sigaction(SIGRTMIN, {sa_handler=0x7f14a5deabf0, sa_mask=[], sa_flags=SA_RESTORER|SA_SIGINFO, sa_restorer=0x7f14a5df83c0},
NULL, 8) = 0
rt_sigaction(SIGRT_1, {sa_handler=0x7f14a5deac90, sa_mask=[], sa_flags=SA_RESTORER|SA_RESTART|SA_SIGINFO,
sa_restorer=0x7f14a5df83c0}, NULL, 8) = 0
rt_sigprocmask(SIG_UNBLOCK, [RTMIN RT_1], NULL, 8) = 0
prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
```

```
statfs("/sys/fs/selinux", 0x7fff70c883e0) = -1 ENOENT (No such file or directory)
statfs("/selinux", 0x7fff70c883e0)      = -1 ENOENT (No such file or directory)
brk(NULL)                               = 0x55931feff000
brk(0x55931ff20000)                     = 0x55931ff20000
openat(AT_FDCWD, "/proc/filesystems", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0444, st_size=0, ...}) = 0
read(3, "nodev\tsysfs\nnodev\ttmpfs\nnodev\tbd"..., 1024) = 360
read(3, "", 1024)                       = 0
close(3)                                = 0
access("/etc/selinux/config", F_OK)     = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/lib/locale/locale-archive", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0644, st_size=14883008, ...}) = 0
mmap(NULL, 14883008, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f14a4faf000
close(3)                                = 0
ioctl(1, TCGETS, {B38400 opost isig icanon echo ...}) = 0
ioctl(1, TIOCGWINSZ, {ws_row=24, ws_col=80, ws_xpixel=0, ws_ypixel=0}) = 0
openat(AT_FDCWD, ".", O_RDONLY|O_NONBLOCK|O_CLOEXEC|O_DIRECTORY) = 3
fstat(3, {st_mode=S_IFDIR|0755, st_size=4096, ...}) = 0
getdents64(3, /* 26 entries */, 32768)  = 912
getdents64(3, /* 0 entries */, 32768)   = 0
close(3)                                = 0
fstat(1, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0), ...}) = 0
write(1, "Desktop  Documents  Downloads  M"..., 72Desktop  Documents  Downloads  Music  Pictures    Public    Templates  Videos
) = 72
close(1)                                = 0
close(2)                                = 0
exit_group(0)                           = ?
+++ exited with 0 +++
```

strace cp:

```
execve("/usr/bin/cp", ["cp"], 0x7ffde4154ae0 /* 58 vars */) = 0
brk(NULL)                               = 0x55744b5cb000
arch_prctl(0x3001 /* ARCH_??? */, 0x7fff15e50040) = -1 EINVAL (Invalid argument)
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
fstat(3, {st_mode=S_IFREG|0644, st_size=66933, ...}) = 0
mmap(NULL, 66933, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f62f3a72000
close(3)                                = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libselinux.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@p\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=163200, ...}) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f62f3a70000
mmap(NULL, 174600, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f62f3a45000
mprotect(0x7f62f3a4b000, 135168, PROT_NONE) = 0
mmap(0x7f62f3a4b000, 102400, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x6000) = 0x7f62f3a4b000
mmap(0x7f62f3a64000, 28672, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1f000) = 0x7f62f3a64000
mmap(0x7f62f3a6c000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x26000) = 0x7f62f3a6c000
mmap(0x7f62f3a6e000, 6664, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7f62f3a6e000
close(3)                                = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libacl.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\360$\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=39088, ...}) = 0
mmap(NULL, 41120, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f62f3a3a000
mmap(0x7f62f3a3c000, 20480, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f62f3a3c000
mmap(0x7f62f3a41000, 8192, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x7000) = 0x7f62f3a41000
mmap(0x7f62f3a43000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x8000) = 0x7f62f3a43000
close(3)                                = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libattr.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"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=26696, ...}) = 0
mmap(NULL, 28696, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f62f3a32000
mmap(0x7f62f3a34000, 12288, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f62f3a34000
mmap(0x7f62f3a37000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x5000) = 0x7f62f3a37000
mmap(0x7f62f3a38000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x5000) = 0x7f62f3a38000
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\0\360q\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\20\0\0\0\5\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\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\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\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) = 0x7f62f3840000
mprotect(0x7f62f3865000, 1847296, PROT_NONE) = 0
mmap(0x7f62f3865000, 1540096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x25000) = 0x7f62f3865000
mmap(0x7f62f39dd000, 303104, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x19d000) = 0x7f62f39dd000
mmap(0x7f62f3a28000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1e7000) = 0x7f62f3a28000
mmap(0x7f62f3a2e000, 13528, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7f62f3a2e000
close(3)                                = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libpcre2-8.so.0", 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\340\"\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=584392, ...}) = 0
mmap(NULL, 586536, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f62f37b0000
mmap(0x7f62f37b2000, 409600, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) = 0x7f62f37b2000
mmap(0x7f62f3816000, 163840, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x66000) = 0x7f62f3816000
mmap(0x7f62f383e000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x8d000) = 0x7f62f383e000
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\0\3\0>\0\1\0\0\0 \22\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=18816, ...}) = 0
mmap(NULL, 20752, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f62f37aa000
mmap(0x7f62f37ab000, 8192, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1000) = 0x7f62f37ab000
mmap(0x7f62f37ad000, 4096, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x3000) = 0x7f62f37ad000
mmap(0x7f62f37ae000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x3000) = 0x7f62f37ae000
close(3)                                = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libpthread.so.0", 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\220\201\0\0\0\0\0\0"..., 832) = 832
pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\345Ga\367\265T\320\374\301V)Yf]\223\337"..., 68, 824) = 68
fstat(3, {st_mode=S_IFREG|0755, st_size=157224, ...}) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f62f37a8000
pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\345Ga\367\265T\320\374\301V)Yf]\223\337"..., 68, 824) = 68
mmap(NULL, 140408, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f62f3785000
mmap(0x7f62f378c000, 69632, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x7000) = 0x7f62f378c000
mmap(0x7f62f379d000, 20480, PROT_READ, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x18000) = 0x7f62f379d000
mmap(0x7f62f37a2000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1c000) = 0x7f62f37a2000
mmap(0x7f62f37a4000, 13432, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7f62f37a4000
close(3)                                = 0
mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f62f3782000
arch_prctl(ARCH_SET_FS, 0x7f62f3782800) = 0
mprotect(0x7f62f3a28000, 12288, PROT_READ) = 0
mprotect(0x7f62f37a2000, 4096, PROT_READ) = 0
mprotect(0x7f62f37ae000, 4096, PROT_READ) = 0
mprotect(0x7f62f383e000, 4096, PROT_READ) = 0
mprotect(0x7f62f3a38000, 4096, PROT_READ) = 0
mprotect(0x7f62f3a43000, 4096, PROT_READ) = 0
mprotect(0x7f62f3a6c000, 4096, PROT_READ) = 0
mprotect(0x55744b514000, 4096, PROT_READ) = 0
mprotect(0x7f62f3ab0000, 4096, PROT_READ) = 0
munmap(0x7f62f3a72000, 66933)           = 0
set_tid_address(0x7f62f3782ad0)         = 1754
set_robust_list(0x7f62f3782ae0, 24)     = 0
rt_sigaction(SIGRTMIN, {sa_handler=0x7f62f378cbf0, sa_mask=[], sa_flags=SA_RESTORER|SA_SIGINFO, sa_restorer=0x7f62f379a3c0},
NULL, 8) = 0
rt_sigaction(SIGRT_1, {sa_handler=0x7f62f378cc90, sa_mask=[], sa_flags=SA_RESTORER|SA_RESTART|SA_SIGINFO,
sa_restorer=0x7f62f379a3c0}, NULL, 8) = 0
rt_sigprocmask(SIG_UNBLOCK, [RTMIN RT_1], NULL, 8) = 0
prlimit64(0, RLIMIT_STACK, NULL, {rlim_cur=8192*1024, rlim_max=RLIM64_INFINITY}) = 0
statfs("/sys/fs/selinux", 0x7fff15e4ff90) = -1 ENOENT (No such file or directory)
statfs("/selinux", 0x7fff15e4ff90)      = -1 ENOENT (No such file or directory)
brk(NULL)                               = 0x55744b5cb000
brk(0x55744b5ec000)                     = 0x55744b5ec000
openat(AT_FDCWD, "/proc/filesystems", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0444, st_size=0, ...}) = 0
read(3, "nodev\tsysfs\nnodev\ttmpfs\nnodev\tbd"..., 1024) = 360
read(3, "", 1024)                       = 0
close(3)                                = 0
access("/etc/selinux/config", F_OK)     = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/lib/locale/locale-archive", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0644, st_size=14883008, ...}) = 0
mmap(NULL, 14883008, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f62f2950000
close(3)                                = 0
geteuid()                               = 1000
openat(AT_FDCWD, "/usr/share/locale/locale.alias", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0644, st_size=2996, ...}) = 0
read(3, "# Locale name alias data base.\n#"..., 4096) = 2996
read(3, "", 4096)                       = 0
close(3)                                = 0
openat(AT_FDCWD, "/usr/share/locale/en_US.UTF-8/LC_MESSAGES/coreutils.mo", O_RDONLY) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale/en_US.utf8/LC_MESSAGES/coreutils.mo", O_RDONLY) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale/en_US/LC_MESSAGES/coreutils.mo", O_RDONLY) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale/en.UTF-8/LC_MESSAGES/coreutils.mo", O_RDONLY) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale/en.utf8/LC_MESSAGES/coreutils.mo", O_RDONLY) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale/en/LC_MESSAGES/coreutils.mo", O_RDONLY) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale-langpack/en_US.UTF-8/LC_MESSAGES/coreutils.mo", O_RDONLY) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "/usr/share/locale-langpack/en_US.utf8/LC_MESSAGES/coreutils.mo", O_RDONLY) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "/usr/share/locale-langpack/en_US/LC_MESSAGES/coreutils.mo", O_RDONLY) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale-langpack/en.UTF-8/LC_MESSAGES/coreutils.mo", O_RDONLY) = -1 ENOENT (No such file or
directory)
openat(AT_FDCWD, "/usr/share/locale-langpack/en.utf8/LC_MESSAGES/coreutils.mo", O_RDONLY) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/usr/share/locale-langpack/en/LC_MESSAGES/coreutils.mo", O_RDONLY) = 3
fstat(3, {st_mode=S_IFREG|0644, st_size=613, ...}) = 0
mmap(NULL, 613, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f62f3aaf000
close(3)                                = 0
write(2, "cp: ", 4cp: )                     = 4
write(2, "missing file operand", 20missing file operand)    = 20
write(2, "\n", 1
)                       = 1
write(2, "Try 'cp --help' for more informa"..., 38Try 'cp --help' for more information.
) = 38
lseek(0, 0, SEEK_CUR)                   = -1 ESPIPE (Illegal seek)
close(0)                                = 0
close(1)                                = 0
close(2)                                = 0
exit_group(1)                           = ?
+++ exited with 1 +++
```

TIME COMMAND:

Explanation:

command in Linux is used to execute a command and prints a summary of real-time, user CPU time and system CPU time spent by executing a command when it terminates. 'real' time is the time elapsed wall clock time taken by a command to get executed, while 'user' and 'sys' time are the number of CPU seconds that command uses in user and kernel mode respectively.

(The following commands are given while being at the desktop)

Command: ~/Desktop$ time ls

Output:

```
linux-5.10.13

real	0m0.002s
user	0m0.001s
sys	0m0.000s
```

Command: ~$ time sleep 3

Output:

```
real	0m3.005s
user	0m0.001s
sys	0m0.000s
```

THE C PROGRAM:

// Online C compiler to run C program online

// Online C++ compiler to run C++ program online

```c
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
#include <stdbool.h>
#include <sys/time.h>
#include <time.h>

int getmseconds( const struct timeval *start, const struct timeval *end){
  long microseconds = end->tv_usec - start->tv_usec;
  long seconds = (end->tv_sec - start->tv_sec) * 1000000;
  return (microseconds + seconds);
}
```

```
struct node {
   int data;
   struct node *next;
};

struct node *head = NULL;
struct node *tail = NULL;

void addNode(int item)
{
  struct node *temp = (struct node*)malloc(sizeof(struct node));
  temp->data = item;
  temp->next = NULL;

  if(head == NULL)
  {
     head = temp;
     tail = temp;
  }
  else
  {
    tail->next = temp;
    tail = tail->next; //pointing to the last node entered
    }
}

int main()
{
    struct timeval start, end;
    gettimeofday(&start, NULL);
    for ( int i = 0; i < 10000; i++)
    {
        addNode(rand());
    }

    gettimeofday(&end, NULL);
    printf("%d microseconds\n", getmseconds(&start,&end));

    return 0;
}
```

Output of the above program varies and can be assessed with the MakeFile included in the folder.