

CS342 Operating Systems

Fall 2019

Homework #1



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21502040

- **Installation Choices and Experiences**

I installed Linux in a virtual machine created in my computer. I used VirtualBox as my virtualization software because I already knew the interface of VirtualBox and how to use it. The main reason why I chose to use VM instead of installing Linux on bare hardware is I did not want to take risk of loosing my data. I don't have an extra disk for backuping my data. Also I already get used to work on Windows for years, so did not want to change my habits directly.

When I was first creating the virtual machine in VirtualBox, the 64 bits versions of the Linux were not visible. Then I updated VirtualBox into latest version and problem fixed.

I allocated 50% of my memory (2 GB) and 50% of my CPU for the virtual machine. In addition to that I seperated 15GB from my harddisk for Ubuntu VM.

After completing the setup of VM, I get an error from VirtualBox in my first try to run Ubuntu. The error was (**VERR_NEM_MISSING_KERNEL_API**). **VT-x is not available (VERR_VMX_NO_VMX)**. With an internet search I discovered that this error causes because of the Hyper-V. I was installed Docker on my computer before and it was enabled Hyper-V in my computer I learnt that Hyper-V causes conflict with VM. So I disabled the Hyper-V from the terminal and ran Ubuntu successfully.

Because of the technical specs of my computer Ubuntu runs pretty slow and it freezes sometimes but at least it works successfully.

- **10 Linux Commands That I Learned**

- **pwd** – this command shows the working directory
- **mkdir** – creates new directory
- **rmdir** – removes an existing directory
- **cd** – change directory command which allows to visit other folders
- **ls** – show the files in the directory which we are in
- **touch** – creates new file
- **move** – moves a file to the an another file, also can be used for renaming
- **cat** – displays content of a file
- **clear** – simply clears the Linux CLI
- **chmod** – makes a file executable

- Kernel executable is located in */boot*.

Version of my running kernel is *5.0.0-31-generic*.

- The subdirectories of kernel source code are :
 - arch
 - block
 - certs
 - crypto
 - Documentation
 - drivers
 - fs
 - include
 - init
 - ipc
 - kernel
 - lib
 - LICENSES
 - mm
 - net
 - samples
 - scripts
 - security
 - sound
 - tools
 - usr
 - virt

```
berkyildiz@berkyildiz-VirtualBox:~/Documents/linux-5.3.4$ ls
arch      CREDITS    fs         Kbuild     LICENSES   net        security   virt
block     crypto     include    Kconfig    MAINTAINERS  README    sound
certs     Documentation  init      kernel     Makefile    samples   tools
COPYING   drivers    ipc        lib         mm          scripts   usr
```

Figure 1: Subdirectories of source code

- **The System Call Table**

Pathname for the definiton of the system call table:

~/linux-5.3.4/include/uapi/asm-generic/unistd.h

System Call Numbers	System Call Names
5	setxattr
43	statfs
123	getaffinity
220	clone

- **Sample Output For strace Command – *strace ls***

```

execve("/bin/cp", ["cp"], 0x7ffe28834ea0 /* 62 vars */) =
0
brk(NULL)                                     = 0x55b3a8556000
access("/etc/ld.so.nohwcap", F_OK)           = -1 ENOENT (No
such file or directory)
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=81495, ...}) = 0
mmap(NULL, 81495, PROT_READ, MAP_PRIVATE, 3, 0) =
0x7f67e8c12000
close(3)                                     = 0
access("/etc/ld.so.nohwcap", F_OK)           = -1 ENOENT (No
such file or directory)
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\20b\0\0\0
\0\0\0"... , 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=154832, ...}) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f67e8c10000
mmap(NULL, 2259152, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f67e87d7000
mprotect(0x7f67e87fc000, 2093056, PROT_NONE) = 0
mmap(0x7f67e89fb000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x24000) =
0x7f67e89fb000
mmap(0x7f67e89fd000, 6352, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) =
0x7f67e89fd000
close(3)                                     = 0
access("/etc/ld.so.nohwcap", F_OK)           = -1 ENOENT (No
such file or directory)
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\340\33\0\
0\0\0\0"... , 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=31232, ...}) = 0

```

```

mmap(NULL, 2126336, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f67e85cf000
mprotect(0x7f67e85d6000, 2093056, PROT_NONE) = 0
mmap(0x7f67e87d5000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x6000) =
0x7f67e87d5000
close(3) = 0
access("/etc/ld.so.nohwcap", F_OK) = -1 ENOENT (No
such file or directory)
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\260\20\0\
0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=18680, ...}) = 0
mmap(NULL, 2113752, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f67e83ca000
mprotect(0x7f67e83ce000, 2093056, PROT_NONE) = 0
mmap(0x7f67e85cd000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x3000) =
0x7f67e85cd000
close(3) = 0
access("/etc/ld.so.nohwcap", F_OK) = -1 ENOENT (No
such file or directory)
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\260\34\2\
0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0755, st_size=2030544, ...}) =
0
mmap(NULL, 4131552, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f67e7fd9000
mprotect(0x7f67e81c0000, 2097152, PROT_NONE) = 0
mmap(0x7f67e83c0000, 24576, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1e7000) =
0x7f67e83c0000
mmap(0x7f67e83c6000, 15072, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) =
0x7f67e83c6000
close(3) = 0
access("/etc/ld.so.nohwcap", F_OK) = -1 ENOENT (No
such file or directory)

```

```

openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libpcres.so.3",
O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0
\25\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=464824, ...}) = 0
mmap(NULL, 2560264, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f67e7d67000
mprotect(0x7f67e7dd7000, 2097152, PROT_NONE) = 0
mmap(0x7f67e7fd7000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x70000) =
0x7f67e7fd7000
close(3) = 0
access("/etc/ld.so.nohwcap", F_OK) = -1 ENOENT (No
such file or directory)
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\0\0\3\0>\0\1\0\0\0\0P\16\0\0\0
\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=14560, ...}) = 0
mmap(NULL, 2109712, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f67e7b63000
mprotect(0x7f67e7b66000, 2093056, PROT_NONE) = 0
mmap(0x7f67e7d65000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x2000) =
0x7f67e7d65000
close(3) = 0
access("/etc/ld.so.nohwcap", F_OK) = -1 ENOENT (No
such file or directory)
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\0\0\3\0>\0\1\0\0\0000b\0\0\0
\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0755, st_size=144976, ...}) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f67e8c0e000
mmap(NULL, 2221184, PROT_READ|PROT_EXEC,
MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f67e7944000
mprotect(0x7f67e795e000, 2093056, PROT_NONE) = 0
mmap(0x7f67e7b5d000, 8192, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x19000) =
0x7f67e7b5d000

```

```

mmap(0x7f67e7b5f000, 13440, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) =
0x7f67e7b5f000
close(3) = 0
mmap(NULL, 12288, PROT_READ|PROT_WRITE,
MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f67e8c0b000
arch_prctl(ARCH_SET_FS, 0x7f67e8c0b800) = 0
mprotect(0x7f67e83c0000, 16384, PROT_READ) = 0
mprotect(0x7f67e7b5d000, 4096, PROT_READ) = 0
mprotect(0x7f67e7d65000, 4096, PROT_READ) = 0
mprotect(0x7f67e7fd7000, 4096, PROT_READ) = 0
mprotect(0x7f67e85cd000, 4096, PROT_READ) = 0
mprotect(0x7f67e87d5000, 4096, PROT_READ) = 0
mprotect(0x7f67e89fb000, 4096, PROT_READ) = 0
mprotect(0x55b3a703a000, 4096, PROT_READ) = 0
mprotect(0x7f67e8c26000, 4096, PROT_READ) = 0
munmap(0x7f67e8c12000, 81495) = 0
set_tid_address(0x7f67e8c0bad0) = 12717
set_robust_list(0x7f67e8c0bae0, 24) = 0
rt_sigaction(SIGRTMIN, {sa_handler=0x7f67e7949cb0,
sa_mask=[], sa_flags=SA_RESTORER|SA_SIGINFO,
sa_restorer=0x7f67e7956890}, NULL, 8) = 0
rt_sigaction(SIGRT_1, {sa_handler=0x7f67e7949d50,
sa_mask=[], sa_flags=SA_RESTORER|SA_RESTART|SA_SIGINFO,
sa_restorer=0x7f67e7956890}, 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", 0x7ffc2ab15470) = -1 ENOENT (No
such file or directory)
statfs("/selinux", 0x7ffc2ab15470) = -1 ENOENT (No
such file or directory)
brk(NULL) = 0x55b3a8556000
brk(0x55b3a8577000) = 0x55b3a8577000
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\trootfs\nnodev\ttr"... , 1024)
= 383
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=11731760, ...}) =
0
mmap(NULL, 11731760, PROT_READ, MAP_PRIVATE, 3, 0) =
0x7f67e6e13000
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=2995, ...}) = 0
read(3, "# Locale name alias data base.\n#"... , 4096) =
2995
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=578, ...}) = 0
mmap(NULL, 578, PROT_READ, MAP_PRIVATE, 3, 0) =
0x7f67e8c25000
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

real: time from beginning to end of the call

user: CPU time spent in user mode

sys: CPU time spent in kernel mode

	real	user	sys
ls	0,003s	0.000s	0.003s
date	0,003s	0,002s	0,000s
cp	0,004s	0,004s	0,000s
cd	0,000s	0,000s	0,000s
mkdir	0,005s	0,003s	0,000s
touch	0,002s	0,002s	0,000s

Table 1: Results of time command in seconds

- **Timing Experiments For Syscalls**

I conducted time experiments 2 times for getpid(), 6 times for open(), 3 times for write(), 6 times for close(), 3 times for read() and 2 times for mkdir().

The tables below show the cost of these syscalls in milliseconds.

getpid()	Cost
Condition 1	5
Condition 2	1

Table 2: Costs of getpid() in milliseconds

open()	Cost
Condition 1 (create empty file)	75
Condition 2 (file which has 12 chars)	11
Condition 3 (create empty file)	32
Condition 4 (file which has 70 chars)	7
Condition 5 (create empty file)	44
Condition 6 (file which has 560 chars)	8

Table 3: Costs of open() in milliseconds

write()	Cost
Condition 1 (write 12 chars to empty file)	33
Condition 2 (write 70 chars to empty file)	20
Condition 3 (write 560 chars to empty file)	20

Table 4: Costs of write() in milliseconds

close()	Cost
Condition 1 (close empty file)	7
Condition 2 (close file which has 12 chars)	4
Condition 3 (close empty file)	6
Condition 4 (close file which has 70 chars)	3
Condition 5 (close empty file)	7
Condition 6 (close file which has 560 chars)	4

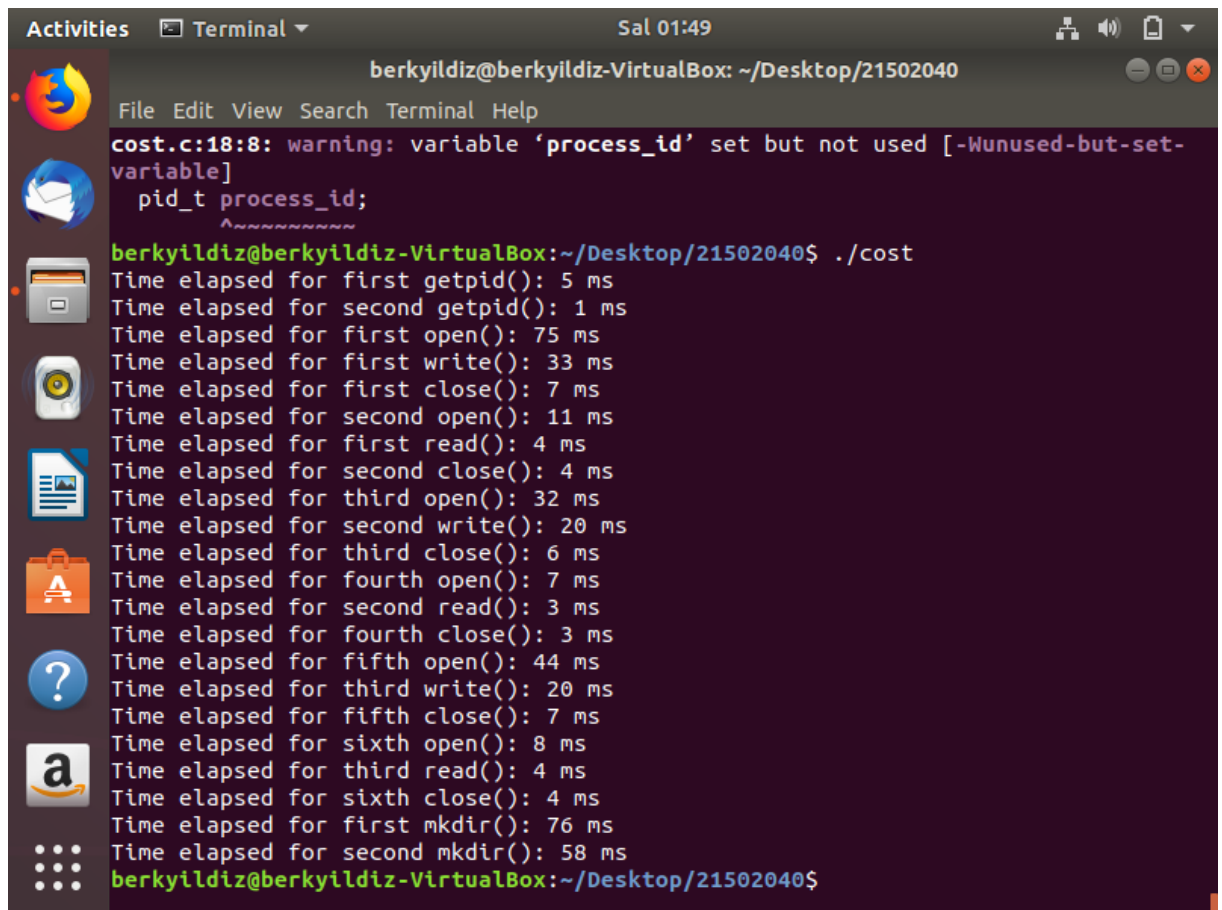
Table 5: Costs of close() in milliseconds

read()	Cost
Condition 1 (read 12 chars)	4
Condition 2 (read 70 chars)	3
Condition 3 (read 70 chars)	4

Table 6: Costs of read() in milliseconds

mkdir()	Cost
Condition 1	76
Condition 2	58

Table 7: Costs of mkdir() in milliseconds



```
berkyildiz@berkyildiz-VirtualBox: ~/Desktop/21502040
cost.c:18:8: warning: variable 'process_id' set but not used [-Wunused-but-set-variable]
    pid_t process_id;
    ^
berkyildiz@berkyildiz-VirtualBox:~/Desktop/21502040$ ./cost
Time elapsed for first getpid(): 5 ms
Time elapsed for second getpid(): 1 ms
Time elapsed for first open(): 75 ms
Time elapsed for first write(): 33 ms
Time elapsed for first close(): 7 ms
Time elapsed for second open(): 11 ms
Time elapsed for first read(): 4 ms
Time elapsed for second close(): 4 ms
Time elapsed for third open(): 32 ms
Time elapsed for second write(): 20 ms
Time elapsed for third close(): 6 ms
Time elapsed for fourth open(): 7 ms
Time elapsed for second read(): 3 ms
Time elapsed for fourth close(): 3 ms
Time elapsed for fifth open(): 44 ms
Time elapsed for third write(): 20 ms
Time elapsed for fifth close(): 7 ms
Time elapsed for sixth open(): 8 ms
Time elapsed for third read(): 4 ms
Time elapsed for sixth close(): 4 ms
Time elapsed for first mkdir(): 76 ms
Time elapsed for second mkdir(): 58 ms
berkyildiz@berkyildiz-VirtualBox:~/Desktop/21502040$
```

Figure 2: Output of cost.c

- **Source Code of *cost.c***

```
#include <sys/time.h>
#include <time.h>
#include <stdlib.h>
#include <stdio.h>
#include <unistd.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>

int main(void)
{

    struct timeval time_begin;
    struct timeval time_end;

    /*Calculation for first getpid()*/
    gettimeofday(&time_begin, 0);
    pid_t process_id;
```

```

process_id = getpid();

gettimeofday(&time_end, 0);
long elapsed = time_end.tv_usec - time_begin.tv_usec;

printf("Time elapsed for first getpid():
%ld",elapsed);
printf(" ms\n");
/*End of calculation for first getpid()*/

/*Calculation for second getpid()*/
gettimeofday(&time_begin, 0);
pid_t process_id2;
process_id2 = getpid();

gettimeofday(&time_end, 0);
elapsed = time_end.tv_usec - time_begin.tv_usec;

printf("Time elapsed for second getpid():
%ld",elapsed);
printf(" ms\n");
/*End of calculation for second getpid()*/

/*Calculation for first open()*/
int fd1;
int fd2;
int fd3;
char buf[14];
char buf2[72];
char buf3[562];

gettimeofday(&time_begin, 0);
fd1 = open("myfile.txt", O_CREAT | O_WRONLY, 0600);

if(fd1 == -1)
{
    printf("open() failed.\n");
    exit(1);
}

gettimeofday(&time_end, 0);
elapsed = time_end.tv_usec - time_begin.tv_usec;

printf("Time elapsed for first open(): %ld",elapsed);

```

```

printf(" ms\n");
/*End of calculation for first open()*/

/*Calculation for first write()*/
gettimeofday(&time_begin, 0);
write(fdl, "Hello World!\n", 13);

gettimeofday(&time_end, 0);
elapsed = time_end.tv_usec - time_begin.tv_usec;

printf("Time elapsed for first write():
%ld",elapsed);
printf(" ms\n");
/*End of calculation for first write()*/

/*Calculation for first close()*/
gettimeofday(&time_begin, 0);
close(fdl);

gettimeofday(&time_end, 0);
elapsed = time_end.tv_usec - time_begin.tv_usec;

printf("Time elapsed for first close():
%ld",elapsed);
printf(" ms\n");
/*End of calculation for first close()*/

/*Calculation for second open()*/
gettimeofday(&time_begin, 0);

fdl = open("myfile.txt", O_RDONLY);
if(fdl == -1)
{
    printf("open() and read() failed.\n");
    exit(1);
}

gettimeofday(&time_end, 0);
elapsed = time_end.tv_usec - time_begin.tv_usec;

printf("Time elapsed for second open():
%ld",elapsed);
printf(" ms\n");

```

```

/*End of calculation for second open()*/

/*Calculation for first read()*/
gettimeofday(&time_begin, 0);

read(fd1, buf, 13);

gettimeofday(&time_end, 0);
elapsed = time_end.tv_usec - time_begin.tv_usec;

printf("Time elapsed for first read(): %ld",elapsed);
printf(" ms\n");
/*End of calculation for first read()*/

/*Calculation for second close()*/
gettimeofday(&time_begin, 0);
close(fd1);

gettimeofday(&time_end, 0);
elapsed = time_end.tv_usec - time_begin.tv_usec;

printf("Time elapsed for second close():
%ld",elapsed);
printf(" ms\n");
/*End of calculation for second close()*/

/*-----End of file 1-----*/

/*Calculation for third open()*/

gettimeofday(&time_begin, 0);
fd2 = open("myfile2.txt", O_CREAT | O_WRONLY, 0600);

if(fd2 == -1)
{
    printf("open() failed.\n");
    exit(1);
}

gettimeofday(&time_end, 0);
elapsed = time_end.tv_usec - time_begin.tv_usec;

```

```

printf("Time elapsed for third open(): %ld",elapsed);
printf(" ms\n");
/*End of calculation for third open()*/

/*Calculation for second write()*/
gettimeofday(&time_begin, 0);
write(fd2,
"12345678901234567890123456789012345678901234567890123456
78901234567890\n", 71);

gettimeofday(&time_end, 0);
elapsed = time_end.tv_usec - time_begin.tv_usec;

printf("Time elapsed for second write():
%ld",elapsed);
printf(" ms\n");
/*End of calculation for second write()*/

/*Calculation for third close()*/
gettimeofday(&time_begin, 0);
close(fd2);

gettimeofday(&time_end, 0);
elapsed = time_end.tv_usec - time_begin.tv_usec;

printf("Time elapsed for third close():
%ld",elapsed);
printf(" ms\n");
/*End of calculation for third close()*/

/*Calculation for fourth open()*/
gettimeofday(&time_begin, 0);

fd2 = open("myfile2.txt", O_RDONLY);
if(fd2 == -1)
{
    printf("open() and read() failed.\n");
    exit(1);
}

gettimeofday(&time_end, 0);
elapsed = time_end.tv_usec - time_begin.tv_usec;

```

```

    printf("Time elapsed for fourth open():
%ld",elapsed);
    printf(" ms\n");
    /*End of calculation for fourth open()*/

/*Calculation for second read()*/
    gettimeofday(&time_begin, 0);

    read(fd2, buf2, 71);

    gettimeofday(&time_end, 0);
    elapsed = time_end.tv_usec - time_begin.tv_usec;

    printf("Time elapsed for second read():
%ld",elapsed);
    printf(" ms\n");
    /*End of calculation for second read()*/

/*Calculation for fourth close()*/
    gettimeofday(&time_begin, 0);
    close(fd2);

    gettimeofday(&time_end, 0);
    elapsed = time_end.tv_usec - time_begin.tv_usec;

    printf("Time elapsed for fourth close():
%ld",elapsed);
    printf(" ms\n");
    /*End of calculation for fourth close()*/

/*-----End of 2-----*/

/*Calculation for fifth open()*/

    gettimeofday(&time_begin, 0);
    fd3 = open("myfile3.txt", O_CREAT | O_WRONLY, 0600);

    if(fd3 == -1)

```



```

    {
        printf("open() failed.\n");
        exit(1);
    }

    gettimeofday(&time_end, 0);
    elapsed = time_end.tv_usec - time_begin.tv_usec;

    printf("Time elapsed for fifth open(): %ld", elapsed);
    printf(" ms\n");
    /*End of calculation for fifth open()*/

    /*Calculation for third write()*/
    gettimeofday(&time_begin, 0);
    write(fd3,
"123456789012345678901234567890123456789012345678901234567890123456
7890123456789012345678901234567890123456789012345678901234567890123
4567890123456789012345678901234567890123456789012345678901234567890
1234567890123456789012345678901234567890123456789012345678901234567
8901234567890123456789012345678901234567890123456789012345678901234
5678901234567890123456789012345678901234567890123456789012345678901
2345678901234567890123456789012345678901234567890123456789012345678
9012345678901234567890123456789012345678901234567890123456789012345
6789012345678901234567890123456789012345678901234567890123456789012
3456789012345678901234567890123456789012345678901234567890\n",
561);

    gettimeofday(&time_end, 0);
    elapsed = time_end.tv_usec - time_begin.tv_usec;

    printf("Time elapsed for third write():
%ld", elapsed);
    printf(" ms\n");
    /*End of calculation for third write()*/

    /*Calculation for fifth close()*/
    gettimeofday(&time_begin, 0);
    close(fd3);

    gettimeofday(&time_end, 0);
    elapsed = time_end.tv_usec - time_begin.tv_usec;

```

```

    printf("Time elapsed for fifth close():
%ld",elapsed);
    printf(" ms\n");
    /*End of calculation for fifth close()*/

/*Calculation for sixth open()*/
gettimeofday(&time_begin, 0);

fd3 = open("myfile3.txt", O_RDONLY);
if(fd3 == -1)
{
    printf("open() and read() failed.\n");
    exit(1);
}

gettimeofday(&time_end, 0);
elapsed = time_end.tv_usec - time_begin.tv_usec;

printf("Time elapsed for sixth open(): %ld",elapsed);
printf(" ms\n");
/*End of calculation for sixth open()*/

/*Calculation for third read()*/
gettimeofday(&time_begin, 0);

read(fd3, buf3, 561);

gettimeofday(&time_end, 0);
elapsed = time_end.tv_usec - time_begin.tv_usec;

printf("Time elapsed for third read(): %ld",elapsed);
printf(" ms\n");
/*End of calculation for third read()*/

/*Calculation for sixth close()*/
gettimeofday(&time_begin, 0);
close(fd3);

gettimeofday(&time_end, 0);
elapsed = time_end.tv_usec - time_begin.tv_usec;

printf("Time elapsed for sixth close():
%ld",elapsed);
printf(" ms\n");

```

```

    /*End of calculation for sixth close()*/

    /*-----End of file 3----- /

    /*Calculation for first mkdir()*/
    gettimeofday(&time_begin, 0);

    mkdir("newFolder", 0777);
    gettimeofday(&time_end, 0);
    elapsed = time_end.tv_usec - time_begin.tv_usec;

    printf("Time elapsed for first mkdir():
%ld",elapsed);
    printf(" ms\n");
    /*End of calculation for first mkdir()*/

    /*Calculation for second mkdir()*/
    gettimeofday(&time_begin, 0);

    mkdir("newFolder2", 0777);
    gettimeofday(&time_end, 0);
    elapsed = time_end.tv_usec - time_begin.tv_usec;

    printf("Time elapsed for second mkdir():
%ld",elapsed);
    printf(" ms\n");
    /*End of calculation for second mkdir()*/

return 0;
}

```