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1. I had already linux installed in my machine. I created a 100GB partition from my D disk and am using linux for one years. I think the most important commands are ls to go back into directories, cd to open a directory, mv to move a file, mkdir to create a directory, rmdir to delete a directory, rm to remove a file, pwd to see what is your current directory, top to see task manager, touch to create a file, sudo to install a software.
2. Source code of my kernel is in /sys/kernel/, executable of my kernel is in /boot/ directory, and its version is `4.15.0-43-generic`.
3. I downloaded the linux-4.14.98 version source code. Subdirectories changed after I open README file. The final subdirectories were arch, block, certs, COPYING, CREDITS, crypto, Documentation, drivers, firmware, fs, include, init, ipc, Kbuild, Kconfig, kernel, lib, MAINTAINERS, Makefile, mm, net, README, samples, scripts, security,sound,tools,usr,virt.
4. I found the system call table in /linux-4.14.98/arch/x86/entry/syscalls/
   a. 5 common fstat sys_newfstat
   b. 43 common accept sys_accept
   c. 123 common setfsgid sys_setfsgid
   d. 220 common semtimedop sys_semtimedop
5. Output of strace clear is:

```
barisc@barisc-N550JK:~$ strace clear
execve("/usr/bin/clear", ["clear"], 0x7ffcfe1f6610 /* 65 vars */) = 0
brk(NULL)                               = 0x55920fbef000
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=142349, ...}) = 0
mmap(NULL, 142349, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7feff5ffa000
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/libtinfo.so.5", O_RDONLY|
O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\3\0>\
0\1\0\0\0\220\311\0\0\0\0\0\0"..., 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=170784, ...}) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1,
0) = 0x7feff5ff8000
mmap(NULL, 2267936, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3,
0) = 0x7feff5bcc000
mprotect(0x7feff5bf1000, 2097152, PROT_NONE) = 0
```

```
mmap(0x7feff5df1000, 20480, PROT_READ|PROT_WRITE, MAP_PRIVATE|
MAP_FIXED|MAP_DENYWRITE, 3, 0x25000) = 0x7feff5df1000
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) = 0x7feff57db000
mprotect(0x7feff59c2000, 2097152, PROT_NONE) = 0
mmap(0x7feff5bc2000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|
MAP_FIXED|MAP_DENYWRITE, 3, 0x1e7000) = 0x7feff5bc2000
mmap(0x7feff5bc8000, 15072, PROT_READ|PROT_WRITE, MAP_PRIVATE|
MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7feff5bc8000
close(3)                                = 0
mmap(NULL, 12288, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1,
0) = 0x7feff5ff5000
arch_prctl(ARCH_SET_FS, 0x7feff5ff5740) = 0
mprotect(0x7feff5bc2000, 16384, PROT_READ) = 0
mprotect(0x7feff5df1000, 16384, PROT_READ) = 0
mprotect(0x55920e12e000, 4096, PROT_READ) = 0
mprotect(0x7feff601d000, 4096, PROT_READ) = 0
munmap(0x7feff5ffa000, 142349)          = 0
ioctl(2, TCGETS, {B38400 opost isig icanon echo ...}) = 0
brk(NULL)                               = 0x55920fbef000
brk(0x55920fc10000)                     = 0x55920fc10000
stat("/home/barisc/.terminfo", 0x55920fbef440) = -1 ENOENT (No such
file or directory)
stat("/etc/terminfo", {st_mode=S_IFDIR|0755, st_size=4096, ...}) = 0
stat("/lib/terminfo", {st_mode=S_IFDIR|0755, st_size=4096, ...}) = 0
stat("/usr/share/terminfo", {st_mode=S_IFDIR|0755, st_size=4096, ...})
= 0
access("/etc/terminfo/x/xterm-256color", R_OK) = -1 ENOENT (No such
file or directory)
access("/lib/terminfo/x/xterm-256color", R_OK) = 0
openat(AT_FDCWD, "/lib/terminfo/x/xterm-256color", O_RDONLY) = 3
fstat(3, {st_mode=S_IFREG|0644, st_size=3525, ...}) = 0
read(3, "\32\1%\0&\0\17\0\235\1\2\6xterm-256color|xterm"..., 4096) =
3525
read(3, "", 4096)                       = 0
close(3)                                = 0
ioctl(2, TCGETS, {B38400 opost isig icanon echo ...}) = 0
ioctl(2, TCGETS, {B38400 opost isig icanon echo ...}) = 0
ioctl(2, TCGETS, {B38400 opost isig icanon echo ...}) = 0
```

```
ioctl(2, TCGETS, {B38400 opost isig icanon echo ...}) = 0
ioctl(2, TIOCGWINSZ, {ws_row=56, ws_col=237, ws_xpixel=0,
ws_ypixel=0}) = 0
fstat(1, {st_mode=S_IFCHR|0600, st_rdev=makedev(136, 0), ...}) = 0
)       = 11
exit_group(0)                           = ?
+++ exited with 0 +++
```

6.

- **real** is the time from start to finish of the call.
- **user** is the amount of CPU time spent in user mode.
- **sys** is the amount of CPU time spent in kernel mode.

a.
```
barisc@barisc-N550JK:~/Downloads$ time ls
idea-IU-182.4505.22  linux-4.14.98  OpenVPN

real    0m0,003s
user    0m0,000s
sys     0m0,003s
```

b.
```
time mkdir Hop

real    0m0,002s
user    0m0,002s
sys     0m0,000s
```

c.
```
time cd Hop

real    0m0,000s
user    0m0,000s
sys     0m0,000s
```

7.

Source code:

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

int main() {
   struct timeval stop1, start1, stop2, start2, stop3, start3, stop4, start4, stop5,
start5;
```

```
    int fd, sz;
    char *c = (char *) calloc(100, sizeof(char));
    char *j = (char *) calloc(1000, sizeof(char));

    //First Trial
    printf("------------------------First Trial------------------------\n");
    gettimeofday(&start1, NULL);
    creat("hop.txt", S_IRUSR | S_IRGRP | S_IROTH); //This will create a file.
    gettimeofday(&stop1, NULL);
    printf("Time ellapsed for creat : %ld\n", stop1.tv_usec - start1.tv_usec);

    //Second Trial
    printf("------------------------Second Trial------------------------\n");
    creat("hop1.txt", S_IRUSR | S_IRGRP | S_IROTH); //This will create a file.
    fd = open("hop1.txt", O_RDWR | O_EXCL); //This will open the created file.
    gettimeofday(&start2, NULL);
    printf("opened the fd = % d\n", fd);
    write(fd, "hello baris\n", 11); //Write hello baris
    close(fd);
    gettimeofday(&stop2, NULL);
    printf("Time ellapsed for write : %ld\n", stop2.tv_usec - start2.tv_usec);

    fd = open("hop1.txt",O_RDWR | O_EXCL); //This will open the created file.
    gettimeofday(&start3, NULL);
    sz = read(fd, c, 11); //Read hello baris.
    c[sz] = '\0';
    printf("Those bytes are as follows: %s\n", c); //Readed chars.
    close(fd);
    gettimeofday(&stop3, NULL);
    printf("Time ellapsed for read : %ld\n", stop3.tv_usec - start3.tv_usec);

    //Third Trial
    printf("------------------------Third Trial------------------------\n");
    creat("hop2.txt", S_IRUSR | S_IRGRP | S_IROTH); //This will create a new file.
    fd = open("hop2.txt",O_RDWR | O_EXCL | O_APPEND | O_TRUNC); //This will open
the created file.
    gettimeofday(&start4, NULL);
    for (int i = 0; i < 1000; i++){ //Write 1000 a.
        write(fd, "a", 1);
        if ( i % 100 == 0){ //Calculate write in every 100 iteration.
            gettimeofday(&stop4, NULL);
            printf("Time ellapsed for write for %i number: %ld\n", i, stop4.tv_usec -
start4.tv_usec);

            gettimeofday(&start5, NULL);
            sz = read(fd, j, i);  //Read 100i chars.
            gettimeofday(&stop5, NULL);
```

```
        printf("Time ellapsed for read for %i number: %ld\n", i, stop5.tv_usec -
start5.tv_usec);
     }
   }
   close(fd);
}
```

Example Outputs:

```
-------------------------First Trial-------------------------
Time ellapsed for creat : 428
-------------------------Second Trial-------------------------
opened the fd =  5
Time ellapsed for write : 90
Those bytes are as follows: hello baris
Time ellapsed for read : 52
-------------------------Third Trial-------------------------
Time ellapsed for write for 0 number: 45
Time ellapsed for read for 0 number: 1
Time ellapsed for write for 100 number: 4026
Time ellapsed for read for 100 number: 34
Time ellapsed for write for 200 number: 7265
Time ellapsed for read for 200 number: 12
Time ellapsed for write for 300 number: 10719
Time ellapsed for read for 300 number: 16
Time ellapsed for write for 400 number: 14370
Time ellapsed for read for 400 number: 12
Time ellapsed for write for 500 number: 16747
Time ellapsed for read for 500 number: 8
Time ellapsed for write for 600 number: 18811
Time ellapsed for read for 600 number: 8
Time ellapsed for write for 700 number: 20944
Time ellapsed for read for 700 number: 7
Time ellapsed for write for 800 number: 23117
Time ellapsed for read for 800 number: 7
Time ellapsed for write for 900 number: 25272
Time ellapsed for read for 900 number: 8
```

Discussion on Results:

From the first trial, I realized creating a file with creat is very costly compared to other calls. In the second trial, I wrote 11 charachers in a text file, read them and print them. In this trial I realized even though writing in a file is costly, reading them is very efficient. Although I got 52 miliseconds, reading part took 0 miliseconds and priting the characters took 52 miliseconds. In the last trial, I tried only reading a file (not printing it), and it took 8 miliseconds for 900 characters. Writing is still very costly, considering it also includes for loop.

8. I read.