

I have majorly involved in user program making including write, read calls to device and from device.

```

1 #include <fcntl.h>
2 #include <stdio.h>
3 #include <unistd.h>
4
5 int main(){
6     // To store the message to be encrypted and decrypted
7     char buffer[100];
8     //fd -> File Descriptor    n-> Length of the message
9     int fd,n=1;
10
11     printf("Enter message : ");
12     scanf("%s",buffer);
13     while(buffer[n++] != '\0');
14     n--;
15
16     fd=open("/dev/enc_device",O_RDWR);
17     if(fd<0){
18         printf("Cannot open Encryption char device file\n");
19         return 0;
20     }
21     //Write to device
22     write(fd,buffer,n);
23     // Read from device to user
24     read(fd,buffer,n);
25     printf("The encoded message is \"%s\"\n",buffer);
26     close(fd);
27
28     fd=open("/dev/dec_device",O_RDWR);
29     if(fd<0){
30         printf("Cannot open Decryption char device file\n");
31         return 0;
32     }
33     //Write to device
34     write(fd,buffer,n);
35     //Read from device to user
36     read(fd,buffer,n);
37     printf("The decoded message is \"%s\"\n",buffer);
38     close(fd);
39 }
40
41
42
43

```

This is the whole code corresponding to user program. I have included three header files

#include<stdio.h>

For basic functionalities like printf, scanf, main() function etc., Every c program written for user purpose would include this library.

#include<fcntl.h>

For declaration of read, write functions. (This is not mandatory but if we don't include them then this shows warnings while executing read, write, close functions as shown in the screenshot)

```

printk(KERN_INFO "Message: %s\n", encrypted_message);
return length;
}

int close_file(struct inode *pinode, struct file *pfile)
{
    printk(KERN_ALERT "Inside the %s function\n", __FUNCTION__);
    return 0;
}

struct file_operations file_ops = {
    .owner      = THIS_MODULE,
    .open       = open_file,
    .read       = read_file,
    .write      = write_file,
    .release    = close_file,
};

int char_module_init(void)
{
    printk(KERN_ALERT "Inside the %s function\n", __FUNCTION__);
    register_chrdev(240, "Char Drive", &file_ops);
    return 0;
}

void char_module_exit(void)
{
    printk(KERN_ALERT "Inside the %s function\n", __FUNCTION__);
    unregister_chrdev(240, "Char Drive");
}

module_init(char_module_init);
module_exit(char_module_exit);

yachavenkatarakesh@pop-os:~/char_device-main$ sudo make test
gcc userprog.c -o ./a.out -fPIC -fPIE -pie -Wl,-z,relro -Wl,-z,now
userprog.c: in function 'main':
userprog.c:21:21: warning: implicit declaration of function 'write'; did you mean 'fwrite'? [-Wimplicit-function-declaration]
   21 |     write(fd,buffer,n);
      |     ^~~~~
userprog.c:23:21: warning: implicit declaration of function 'read'; did you mean 'fread'? [-Wimplicit-function-declaration]
   23 |     read(fd,buffer,n);
      |     ^~~~
userprog.c:25:21: warning: implicit declaration of function 'close'; did you mean 'pclose'? [-Wimplicit-function-declaration]
   25 |     close(fd);
      |     ^~~~~~
Enter message : rakesh
The encoded message is "udnhvk"
The decoded message is "rakesh"
yachavenkatarakesh@pop-os:~/char_device-main$

```

#include<unistd.h>

This header file is required for providing read, write permissions to device file. If we don't include this then it cannot recognize 'O\_RDWR'.

```

Oct 27 6:16 PM
yachavenkatarakesh@pop-os: ~/char_device-main
gcc userprog.c 66 ./a.out #Compile and run the user program
Enter message : Ramesh
The encoded message is "Udnhvk"
The decoded message is "Rakesh"
yachavenkatarakesh@pop-os:~/char_device-main$ sudo make test
gcc userprog.c 66 ./a.out #Compile and run the user program
Enter message : Rakesh
The encoded message is "Rakesh"
The decoded message is "Rakesh"
yachavenkatarakesh@pop-os:~/char_device-main$ sudo make test
[sudo] password for yachavenkatarakesh:
gcc userprog.c 66 ./a.out #Compile and run the user program
Enter message : Rakesh
The encoded message is "Udnhvk"
The decoded message is "Rakesh"
yachavenkatarakesh@pop-os:~/char_device-main$ sudo make test
gcc userprog.c 66 ./a.out #Compile and run the user program
Enter message : Ramesh
The encoded message is "Udnhvk"
The decoded message is "Ramesh"
yachavenkatarakesh@pop-os:~/char_device-main$ sudo make test
gcc userprog.c 66 ./a.out #Compile and run the user program
Enter message : hionar
The encoded message is "klrpdn"
The decoded message is "hionar"
yachavenkatarakesh@pop-os:~/char_device-main$ sudo make test
gcc userprog.c 66 ./a.out #Compile and run the user program
Enter message : 44eg
The encoded message is "97hj"
The decoded message is "44eg"
yachavenkatarakesh@pop-os:~/char_device-main$ sudo make test
gcc userprog.c 66 ./a.out #Compile and run the user program
userprog.c: In function 'main':
userprog.c:15:5: warning: implicit declaration of function 'open'; did you mean 'popen'? [-Wimplicit-function-declaration]
   15 |     fd=open("/dev/enc_device",O_RDWR);
       |     ^~~~~
userprog.c:15:28: error: 'O_RDWR' undeclared (first use in this function)
   15 |     fd=open("/dev/enc_device",O_RDWR);
       |                            ^~~~~~
userprog.c:15:28: note: each undeclared identifier is reported only once for each function it appears in
make: *** [Makefile:14: test] Error 1
yachavenkatarakesh@pop-os:~/char_device-main$ cat char_device_encoder.c
#include<linux/init.h>
#include<linux/module.h>
#include<linux/fs.h>
#include<linux/ctype.h>

MODULE_LICENSE("GPL");

```

fd

File descriptor used to open file. It stores negative value when file is inaccessible. This is very useful for debugging purpose or for user to know that there's some error in using device file. So that check is done twice in the program because if either enc\_device or dec\_device is not accessible then there is no point in printing the garbage output. So in that case we simply return the program printing corresponding error message.

buffer

The message which we are inputting is stored into buffer and this take its value from user space to device file and after performing required operation the string's value is taken back to user space from device file.

n

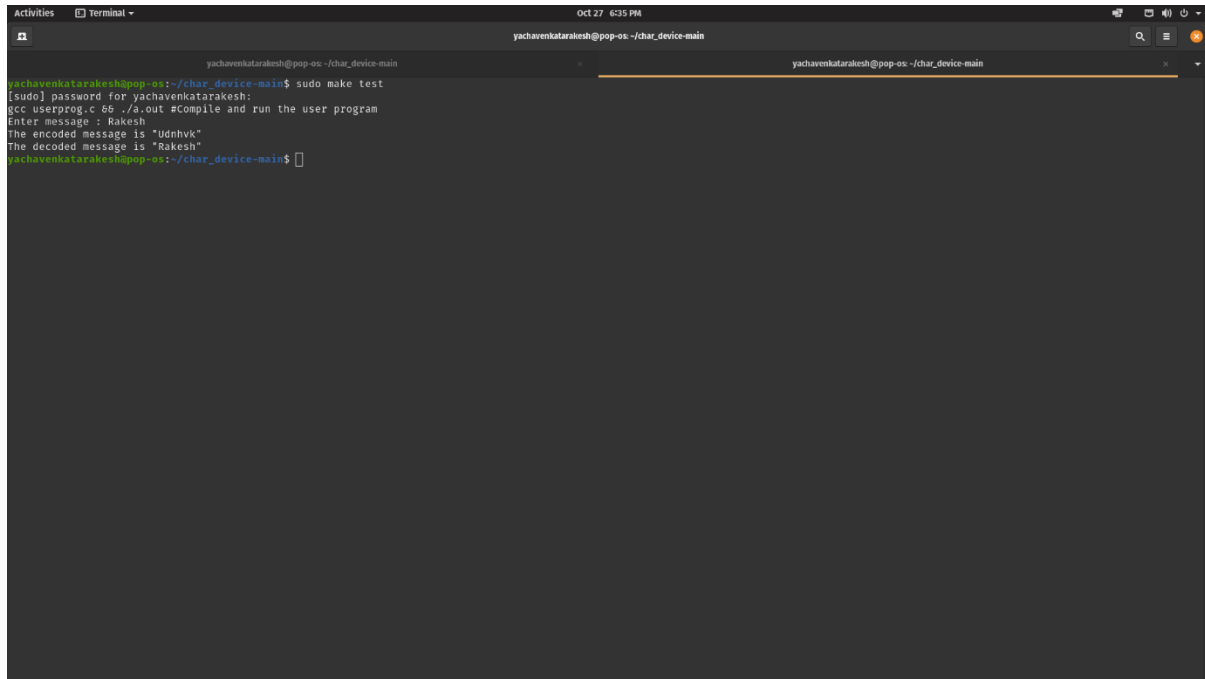
n stores the length of the buffer string we entered. We loop through the string char by char and increase the count and finally store the result in n

write(fd,buffer,n)

This function takes parameters fd(File descriptor), buffer(input string), n(length of the input string). This function call goes to the file\_operations section in device file and there it link this to the actual function(So here there is abstraction of actual device file operations from user). So then finally goes to write\_file function and copy message from user using **copy\_from\_user** command. Then performs respective function(encryption/decryption) and returns back to user program.(**Note:** This **does not** copy the value of buffer resulted in the device file to user program).*"The main functionality of this is to write to device".*

read(fd,buffer,n)

This function takes parameters fd(File descriptor), buffer(input string), n(length of the input string). This function call goes to the file\_operations section in device file and there it link this to the actual function(So here there is abstraction of actual device file operations from user). So then finally goes to read\_file function and copy message from device file to user using **copy\_to\_user** command. *“The main functionality of this function is to read from device to user”.*

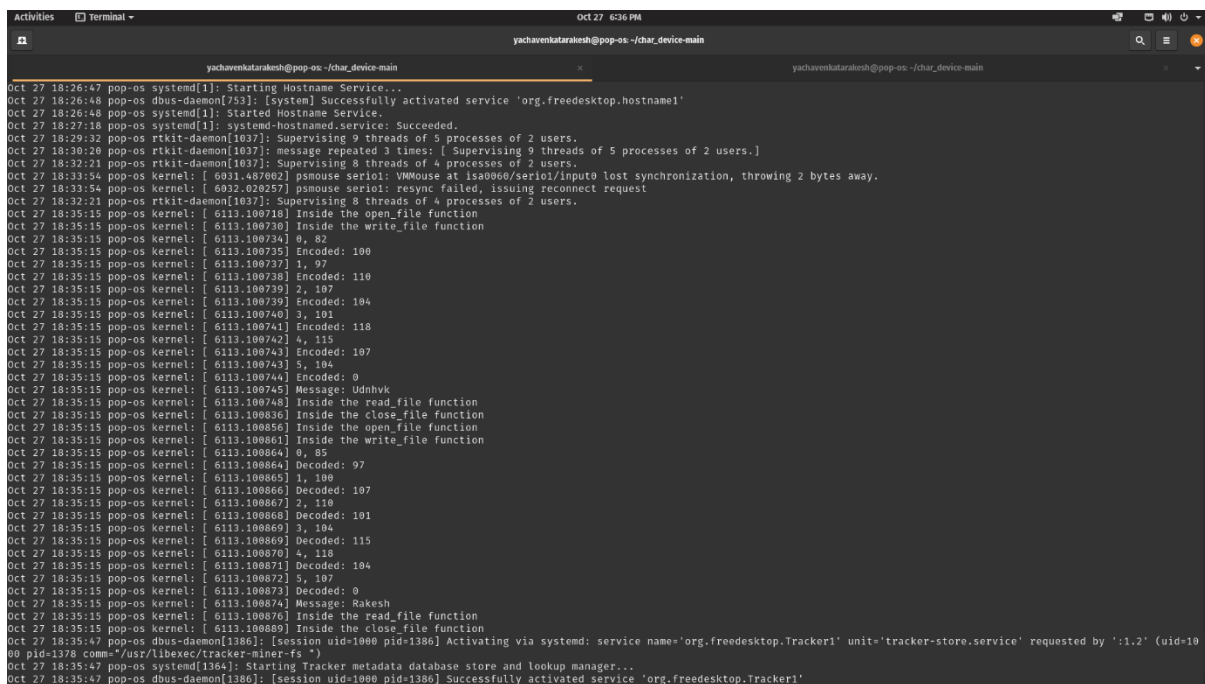


```

yachavenkatarakesh@pop-os: ~/char_device-main
yachavenkatarakesh@pop-os:~/char_device-main$ sudo make test
[sudo] password for yachavenkatarakesh:
gcc userprog.c 55 -o/a.out #Compile and run the user program
Enter message : Rakesh
The encoded message is "Udnhvk"
The decoded message is "Rakesh"
yachavenkatarakesh@pop-os:~/char_device-main$

```

## 1.4 Final Output of the user program



```

Oct 27 18:26:47 pop-os systemd[1]: Starting Hostname Service...
Oct 27 18:26:48 pop-os dbus-daemon[752]: [System] Successfully activated service 'org.freedesktop.hostname'
Oct 27 18:26:48 pop-os systemd[1]: Started Hostname Service.
Oct 27 18:27:18 pop-os systemd[1]: systemd-hostnamed.service: Succeeded.
Oct 27 18:29:32 pop-os rtkit-daemon[1037]: Supervising 9 threads of 5 processes of 2 users.
Oct 27 18:30:28 pop-os rtkit-daemon[1037]: message repeated 3 times: [ Supervising 9 threads of 5 processes of 2 users.]
Oct 27 18:32:21 pop-os rtkit-daemon[1037]: Supervising 8 threads of 4 processes of 2 users.
Oct 27 18:33:54 pop-os kernel: [ 6031.487602] psmouse serial: VMWmouse at isa0060/seriol1/input0 lost synchronization, throwing 2 bytes away.
Oct 27 18:33:54 pop-os kernel: [ 6032.020257] psmouse serial: resync failed, issuing reconnect request
Oct 27 18:32:21 pop-os rtkit-daemon[1037]: Supervising 8 threads of 4 processes of 2 users.
Oct 27 18:35:15 pop-os kernel: [ 6113.100718] Inside the open_file function
Oct 27 18:35:15 pop-os kernel: [ 6113.100720] Inside the write_file function
Oct 27 18:35:15 pop-os kernel: [ 6113.100734] 0, 82
Oct 27 18:35:15 pop-os kernel: [ 6113.100735] Encoded: 100
Oct 27 18:35:15 pop-os kernel: [ 6113.100737] 1, 97
Oct 27 18:35:15 pop-os kernel: [ 6113.100738] Encoded: 110
Oct 27 18:35:15 pop-os kernel: [ 6113.100739] 2, 107
Oct 27 18:35:15 pop-os kernel: [ 6113.100739] Encoded: 104
Oct 27 18:35:15 pop-os kernel: [ 6113.100740] 3, 101
Oct 27 18:35:15 pop-os kernel: [ 6113.100741] Encoded: 118
Oct 27 18:35:15 pop-os kernel: [ 6113.100742] 4, 115
Oct 27 18:35:15 pop-os kernel: [ 6113.100743] Encoded: 107
Oct 27 18:35:15 pop-os kernel: [ 6113.100743] 5, 104
Oct 27 18:35:15 pop-os kernel: [ 6113.100744] Encoded: 0
Oct 27 18:35:15 pop-os kernel: [ 6113.100745] Message: Udnhvk
Oct 27 18:35:15 pop-os kernel: [ 6113.100746] Inside the read_file function
Oct 27 18:35:15 pop-os kernel: [ 6113.100836] Inside the close_file function
Oct 27 18:35:15 pop-os kernel: [ 6113.100856] Inside the open_file function
Oct 27 18:35:15 pop-os kernel: [ 6113.100861] Inside the write_file function
Oct 27 18:35:15 pop-os kernel: [ 6113.100864] 0, 85
Oct 27 18:35:15 pop-os kernel: [ 6113.100864] Decoded: 97
Oct 27 18:35:15 pop-os kernel: [ 6113.100865] 1, 100
Oct 27 18:35:15 pop-os kernel: [ 6113.100866] Decoded: 107
Oct 27 18:35:15 pop-os kernel: [ 6113.100867] 2, 110
Oct 27 18:35:15 pop-os kernel: [ 6113.100868] Decoded: 101
Oct 27 18:35:15 pop-os kernel: [ 6113.100869] 3, 104
Oct 27 18:35:15 pop-os kernel: [ 6113.100869] Decoded: 115
Oct 27 18:35:15 pop-os kernel: [ 6113.100870] 4, 118
Oct 27 18:35:15 pop-os kernel: [ 6113.100871] Decoded: 104
Oct 27 18:35:15 pop-os kernel: [ 6113.100872] 5, 107
Oct 27 18:35:15 pop-os kernel: [ 6113.100873] Decoded: 0
Oct 27 18:35:15 pop-os kernel: [ 6113.100874] Message: Rakesh
Oct 27 18:35:15 pop-os kernel: [ 6113.100876] Inside the read_file function
Oct 27 18:35:15 pop-os kernel: [ 6113.100889] Inside the close_file function
Oct 27 18:35:47 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Activating via systemd: service name='org.freedesktop.Tracker1' unit='tracker-store.service' requested by ':1.2' (uid=1000 pid=1378 comm="/usr/libexec/tracker-miner-fs ")
Oct 27 18:35:47 pop-os systemd[1364]: Starting Tracker metadata database store and lookup manager...
Oct 27 18:35:47 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Successfully activated service 'org.freedesktop.Tracker1'

```

## 1.5 Final Output System log

write function are used twice in the user program once for encryption and then for decryption. So what if they are not properly used.

Case 1 : If 1<sup>st</sup> write function is commented. Then what actually happens is the message inputted by the user is not copied to device file. So the input 'Morning' is not encrypted instead previous value is just printed since we included read function which copies device file string to user program. This can be clearly observed in the syslog in fig 1.6 where we can clearly see if entered to write or not and encrypted or decrypted or not.

```

yachavenkatarakesh@pop-os: ~/char_device-main
yachavenkatarakesh@pop-os: ~/char_device-main$ gcc userprog.c bb./a.out #Compile and run the user program
Enter message : Morning
The encoded message is "Khoor"
The decoded message is "Hello"
yachavenkatarakesh@pop-os: ~/char_device-main$

```

### 1.5 1<sup>st</sup> write function missing

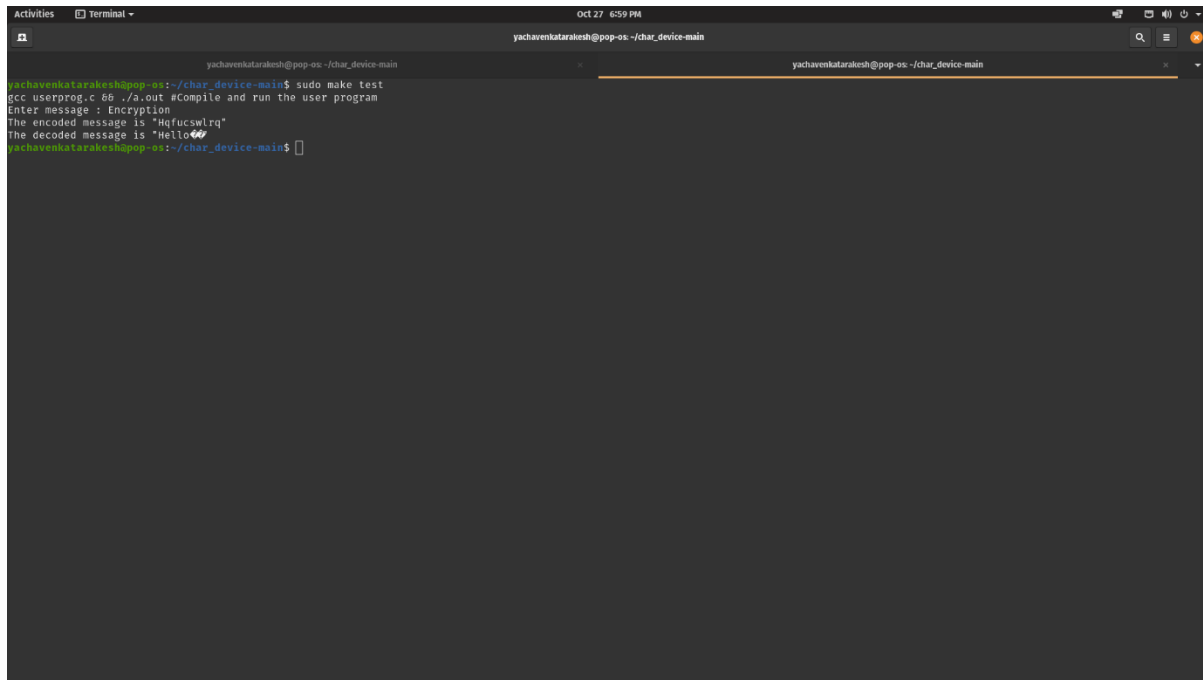
```

Oct 27 18:55:01 pop-os NetworkManager[754]: <info> [1603805101.6204] dhcp4 (ens33): option next_server => '192.168.234.254'
Oct 27 18:55:01 pop-os NetworkManager[754]: <info> [1603805101.6204] dhcp4 (ens33): option requested_broadcast_address => '1'
Oct 27 18:55:01 pop-os NetworkManager[754]: <info> [1603805101.6204] dhcp4 (ens33): option requested_domain_name => '1'
Oct 27 18:55:01 pop-os NetworkManager[754]: <info> [1603805101.6205] dhcp4 (ens33): option requested_domain_name_servers => '1'
Oct 27 18:55:01 pop-os NetworkManager[754]: <info> [1603805101.6205] dhcp4 (ens33): option requested_domain_search => '1'
Oct 27 18:55:01 pop-os NetworkManager[754]: <info> [1603805101.6205] dhcp4 (ens33): option requested_host_name => '1'
Oct 27 18:55:02 pop-os NetworkManager[754]: <info> [1603805101.6206] dhcp4 (ens33): option requested_interface_mtu => '1'
Oct 27 18:55:02 pop-os NetworkManager[754]: <info> [1603805101.6206] dhcp4 (ens33): option requested_ms_classless_static_routes => '1'
Oct 27 18:55:02 pop-os NetworkManager[754]: <info> [1603805101.6206] dhcp4 (ens33): option requested_nis_domain => '1'
Oct 27 18:55:02 pop-os NetworkManager[754]: <info> [1603805101.6206] dhcp4 (ens33): option requested_nis_servers => '1'
Oct 27 18:55:02 pop-os NetworkManager[754]: <info> [1603805101.6207] dhcp4 (ens33): option requested_ntp_servers => '1'
Oct 27 18:55:02 pop-os NetworkManager[754]: <info> [1603805101.6207] dhcp4 (ens33): option requested_rfc3442_classless_static_routes => '1'
Oct 27 18:55:02 pop-os NetworkManager[754]: <info> [1603805101.6207] dhcp4 (ens33): option requested_root_path => '1'
Oct 27 18:55:02 pop-os NetworkManager[754]: <info> [1603805101.6207] dhcp4 (ens33): option requested_routers => '1'
Oct 27 18:55:02 pop-os NetworkManager[754]: <info> [1603805101.6208] dhcp4 (ens33): option requested_static_routes => '1'
Oct 27 18:55:02 pop-os NetworkManager[754]: <info> [1603805101.6208] dhcp4 (ens33): option requested_subnet_mask => '1'
Oct 27 18:55:02 pop-os NetworkManager[754]: <info> [1603805101.6208] dhcp4 (ens33): option requested_time_offset => '1'
Oct 27 18:55:02 pop-os NetworkManager[754]: <info> [1603805101.6208] dhcp4 (ens33): option requested_wpad => '1'
Oct 27 18:55:02 pop-os NetworkManager[754]: <info> [1603805101.6209] dhcp4 (ens33): option routers => '192.168.234.2'
Oct 27 18:55:02 pop-os NetworkManager[754]: <info> [1603805101.6209] dhcp4 (ens33): option subnet_mask => '255.255.255.0'
Oct 27 18:55:02 pop-os NetworkManager[754]: <info> [1603805101.6209] dhcp4 (ens33): state changed extended -> extended
Oct 27 18:55:02 pop-os systemd[1]: Starting Network Manager Script Dispatcher Service...
Oct 27 18:55:02 pop-os dbus-daemon[753]: [system] Successfully activated service 'org.freedesktop.nm_dispatcher'
Oct 27 18:55:02 pop-os systemd[1]: Started Network Manager Script Dispatcher Service.
Oct 27 18:55:12 pop-os systemd[1]: NetworkManager-dispatcher.service: Succeeded.
Oct 27 18:55:48 pop-os tracker-store[5600]: OK
Oct 27 18:55:48 pop-os systemd[1364]: tracker-store.service: Succeeded.
Oct 27 18:55:55 pop-os systemd[1]: fwupd.service: Succeeded.
Oct 27 18:56:02 pop-os kernel: [ 7359.770255] Inside the open_file function
Oct 27 18:56:02 pop-os kernel: [ 7359.770276] Inside the read_file function
Oct 27 18:56:02 pop-os kernel: [ 7359.770290] Inside the close_file function
Oct 27 18:56:02 pop-os kernel: [ 7359.770314] Inside the open_file function
Oct 27 18:56:02 pop-os kernel: [ 7359.770316] Inside the write_file function
Oct 27 18:56:02 pop-os kernel: [ 7359.770318] 0, 75
Oct 27 18:56:02 pop-os kernel: [ 7359.770318] Decoded: 98
Oct 27 18:56:02 pop-os kernel: [ 7359.770319] 1, 194
Oct 27 18:56:02 pop-os kernel: [ 7359.770319] Decoded: 105
Oct 27 18:56:02 pop-os kernel: [ 7359.770319] 2, 111
Oct 27 18:56:02 pop-os kernel: [ 7359.770320] Decoded: 105
Oct 27 18:56:02 pop-os kernel: [ 7359.770320] 3, 111
Oct 27 18:56:02 pop-os kernel: [ 7359.770321] Decoded: 108
Oct 27 18:56:02 pop-os kernel: [ 7359.770321] 4, 114
Oct 27 18:56:02 pop-os kernel: [ 7359.770321] Decoded: 0
Oct 27 18:56:02 pop-os kernel: [ 7359.770322] 5, 0
Oct 27 18:56:02 pop-os kernel: [ 7359.770322] Decoded: 0
Oct 27 18:56:02 pop-os kernel: [ 7359.770322] 6, 0
Oct 27 18:56:02 pop-os kernel: [ 7359.770323] Decoded: 07
Oct 27 18:56:02 pop-os kernel: [ 7359.770323] Message: Hello

```

### 1.6 1<sup>st</sup> write function missing – syslog

Case 2 : If 2<sup>nd</sup> write function is commented. Then what actually happens is the message inputted by the user is not copied to device file. So the input 'Encryption' is encrypted and result is also successfully printed since we included both write and read function. But as write function is missing from device file it does nothing. But as read function is included it takes the message available which is previously decrypted so this takes that value and the value is copied back from device file to user program. This can be clearly observed in the syslog in fig 1.8 where we can clearly see if entered to write or not and encrypted or decrypted or not.

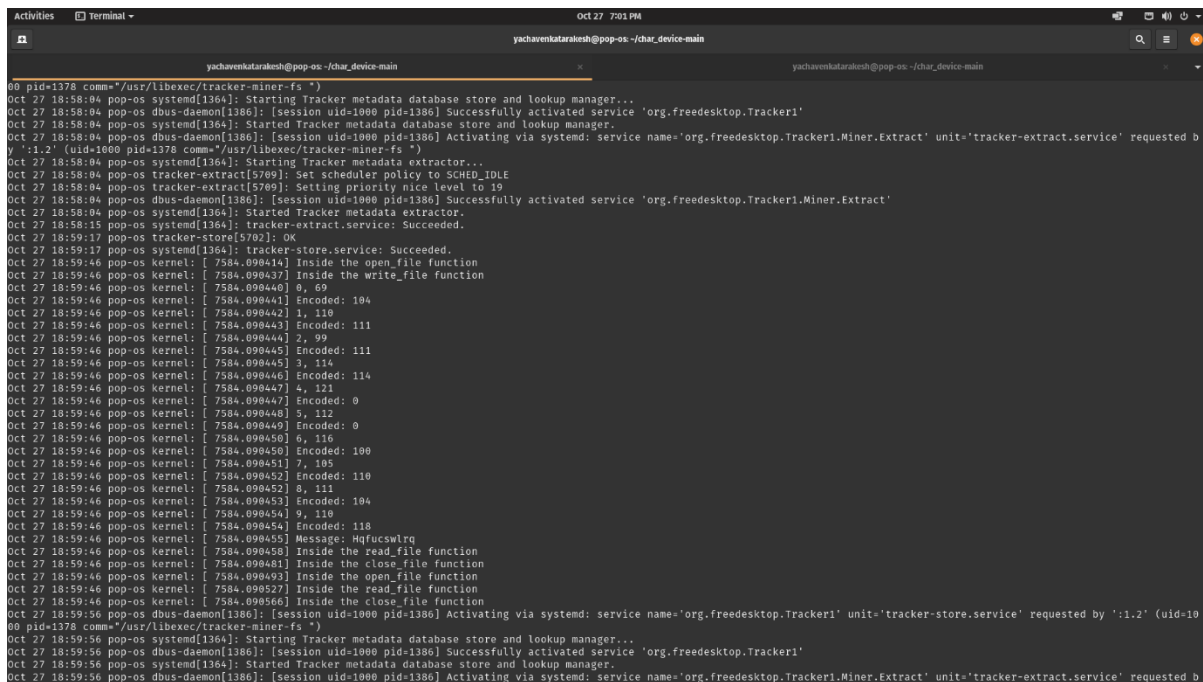


```

yachavenkatarakesh@pop-os: ~/char_device-main
gcc userprog.c -o a.out #Compile and run the user program
Enter message : Encryption
The encoded message is "Hqfucswlrq"
The decoded message is "Hello"
yachavenkatarakesh@pop-os:~/char_device-main$

```

### 1.7 2<sup>nd</sup> write function missing



```

yachavenkatarakesh@pop-os:~/char_device-main
80 pid=1378 comm="/usr/libexec/tracker-miner-fs")
Oct 27 18:58:04 pop-os systemd[1364]: Starting Tracker metadata database store and lookup manager...
Oct 27 18:58:04 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Successfully activated service 'org.freedesktop.Tracker1'
Oct 27 18:58:04 pop-os systemd[1364]: Started Tracker metadata database store and lookup manager.
Oct 27 18:58:04 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Activating via systemd: service name='org.freedesktop.Tracker1.Miner.Extract' unit='tracker-extract.service' requested by ':1.2' (uid=1000 pid=1378 comm="/usr/libexec/tracker-miner-fs")
Oct 27 18:58:04 pop-os systemd[1364]: Starting Tracker metadata extractor...
Oct 27 18:58:04 pop-os tracker-extract[5709]: Set scheduler policy to SCHED_IDLE
Oct 27 18:58:04 pop-os tracker-extract[5709]: Setting priority nice level to 19
Oct 27 18:58:04 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Successfully activated service 'org.freedesktop.Tracker1.Miner.Extract'
Oct 27 18:58:04 pop-os systemd[1364]: Started Tracker metadata extractor.
Oct 27 18:58:15 pop-os systemd[1364]: tracker-extract.service: Succeeded.
Oct 27 18:59:17 pop-os tracker-store[5702]: OK
Oct 27 18:59:17 pop-os systemd[1364]: tracker-store.service: Succeeded.
Oct 27 18:59:46 pop-os kernel: [ 7584.090414] Inside the open_file function
Oct 27 18:59:46 pop-os kernel: [ 7584.090437] Inside the write_file function
Oct 27 18:59:46 pop-os kernel: [ 7584.090440] 0, 60
Oct 27 18:59:46 pop-os kernel: [ 7584.090441] Encoded: 104
Oct 27 18:59:46 pop-os kernel: [ 7584.090442] 1, 110
Oct 27 18:59:46 pop-os kernel: [ 7584.090443] Encoded: 111
Oct 27 18:59:46 pop-os kernel: [ 7584.090444] 2, 99
Oct 27 18:59:46 pop-os kernel: [ 7584.090445] Encoded: 111
Oct 27 18:59:46 pop-os kernel: [ 7584.090445] 3, 114
Oct 27 18:59:46 pop-os kernel: [ 7584.090446] Encoded: 114
Oct 27 18:59:46 pop-os kernel: [ 7584.090447] 4, 121
Oct 27 18:59:46 pop-os kernel: [ 7584.090447] Encoded: 0
Oct 27 18:59:46 pop-os kernel: [ 7584.090448] 5, 112
Oct 27 18:59:46 pop-os kernel: [ 7584.090449] Encoded: 0
Oct 27 18:59:46 pop-os kernel: [ 7584.090450] 6, 116
Oct 27 18:59:46 pop-os kernel: [ 7584.090450] Encoded: 100
Oct 27 18:59:46 pop-os kernel: [ 7584.090451] 7, 105
Oct 27 18:59:46 pop-os kernel: [ 7584.090452] Encoded: 110
Oct 27 18:59:46 pop-os kernel: [ 7584.090452] 8, 111
Oct 27 18:59:46 pop-os kernel: [ 7584.090453] Encoded: 104
Oct 27 18:59:46 pop-os kernel: [ 7584.090454] 9, 110
Oct 27 18:59:46 pop-os kernel: [ 7584.090454] Encoded: 118
Oct 27 18:59:46 pop-os kernel: [ 7584.090455] Message: Hqfucswlrq
Oct 27 18:59:46 pop-os kernel: [ 7584.090458] Inside the read_file function
Oct 27 18:59:46 pop-os kernel: [ 7584.090461] Inside the close_file function
Oct 27 18:59:46 pop-os kernel: [ 7584.090493] Inside the open_file function
Oct 27 18:59:46 pop-os kernel: [ 7584.090527] Inside the read_file function
Oct 27 18:59:46 pop-os kernel: [ 7584.090567] Inside the close_file function
Oct 27 18:59:56 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Activating via systemd: service name='org.freedesktop.Tracker1' unit='tracker-store.service' requested by ':1.2' (uid=1000 pid=1378 comm="/usr/libexec/tracker-miner-fs")
Oct 27 18:59:56 pop-os systemd[1364]: Starting Tracker metadata database store and lookup manager...
Oct 27 18:59:56 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Successfully activated service 'org.freedesktop.Tracker1'
Oct 27 18:59:56 pop-os systemd[1364]: Started Tracker metadata database store and lookup manager.
Oct 27 18:59:56 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Activating via systemd: service name='org.freedesktop.Tracker1.Miner.Extract' unit='tracker-extract.service' requested by ':1.2' (uid=1000 pid=1378 comm="/usr/libexec/tracker-miner-fs")

```

### 1.8 2<sup>nd</sup> write function missing - syslog

Case 3 : If both write functions are commented. Then what actually happens is the message inputted by the user is not copied to device file. So the input 'Rakesh' is not taken to the device file. Since there is no write function there is no encryption or decryption taking place. We have included read function so in first case it checks the encrypted string that is there in previous function call and copies it back to user program and in it's second call it checks the decrypted string that is there in previous function call and copies it back to user program. This can be clearly observed from syscall where we can see what are functions it passed to whether encrypted or not decrypted or not etc.,

```

Activities  Terminal
Oct 27 6:42 PM
yachavenkatarakesh@pop-os: ~/char_device-main
yachavenkatarakesh@pop-os: ~/char_device-main
yachavenkatarakesh@pop-os: ~/char_device-main$ sudo make test
gcc userprog.c 66 ./a.out #Compile and run the user program
Enter message : Rakesh
The encoded message is "Khooq"
The decoded message is "ibill"
yachavenkatarakesh@pop-os: ~/char_device-main$

```

## 1.9 Both write functions missing

```

Activities  Terminal
Oct 27 6:42 PM
yachavenkatarakesh@pop-os: ~/char_device-main
yachavenkatarakesh@pop-os: ~/char_device-main
yachavenkatarakesh@pop-os: ~/char_device-main
Oct 27 18:41:08 pop-os kernel: [ 6465.867932] Decoded: 115
Oct 27 18:41:08 pop-os kernel: [ 6465.867933] 4, 111
Oct 27 18:41:08 pop-os kernel: [ 6465.867934] Decoded: 194
Oct 27 18:41:08 pop-os kernel: [ 6465.867935] Message: Ebill
Oct 27 18:41:08 pop-os kernel: [ 6465.867937] Inside the read_file function
Oct 27 18:41:08 pop-os kernel: [ 6465.867945] Inside the close_file function
Oct 27 18:41:26 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Activating via systemd: service name='org.freedesktop.Tracker1' unit='tracker-store.service' requested by ':1.2' (uid=1000 pid=1378 comm="/usr/libexec/tracker-miner-fs ")
Oct 27 18:41:26 pop-os systemd[1364]: Starting Tracker metadata database store and lookup manager...
Oct 27 18:41:26 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Successfully activated service 'org.freedesktop.Tracker1'
Oct 27 18:41:26 pop-os systemd[1364]: Started Tracker metadata database store and lookup manager.
Oct 27 18:41:26 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Activating via systemd: service name='org.freedesktop.Tracker1.Miner.Extract' unit='tracker-extract.service' requested by ':1.2' (uid=1000 pid=1378 comm="/usr/libexec/tracker-miner-fs ")
Oct 27 18:41:26 pop-os systemd[1364]: Starting Tracker metadata extractor...
Oct 27 18:41:26 pop-os tracker-extract[4872]: Set scheduler policy to SCHED_IDLE
Oct 27 18:41:26 pop-os tracker-extract[4872]: Setting priority nice level to 19
Oct 27 18:41:27 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Successfully activated service 'org.freedesktop.Tracker1.Miner.Extract'
Oct 27 18:41:27 pop-os systemd[1364]: Started Tracker metadata extractor.
Oct 27 18:41:37 pop-os systemd[1364]: tracker-extract.service: Succeeded.
Oct 27 18:41:39 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Activating via systemd: service name='org.freedesktop.Tracker1.Miner.Extract' unit='tracker-extract.service' requested by ':1.2' (uid=1000 pid=1378 comm="/usr/libexec/tracker-miner-fs ")
Oct 27 18:41:39 pop-os systemd[1364]: Starting Tracker metadata extractor...
Oct 27 18:41:39 pop-os tracker-extract[4892]: Set scheduler policy to SCHED_IDLE
Oct 27 18:41:39 pop-os tracker-extract[4892]: Setting priority nice level to 19
Oct 27 18:41:39 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Successfully activated service 'org.freedesktop.Tracker1.Miner.Extract'
Oct 27 18:41:39 pop-os systemd[1364]: Started Tracker metadata extractor.
Oct 27 18:41:50 pop-os systemd[1364]: tracker-extract.service: Succeeded.
Oct 27 18:42:10 pop-os tracker-store[4865]: OK
Oct 27 18:42:10 pop-os systemd[1364]: tracker-store.service: Succeeded.
Oct 27 18:42:36 pop-os kernel: [ 6553.601926] Inside the open_file function
Oct 27 18:42:36 pop-os kernel: [ 6553.601936] Inside the read_file function
Oct 27 18:42:36 pop-os kernel: [ 6553.601995] Inside the close_file function
Oct 27 18:42:36 pop-os kernel: [ 6553.602012] Inside the open_file function
Oct 27 18:42:36 pop-os kernel: [ 6553.602016] Inside the read_file function
Oct 27 18:42:36 pop-os kernel: [ 6553.602016] Inside the close_file function
Oct 27 18:42:52 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Activating via systemd: service name='org.freedesktop.Tracker1' unit='tracker-store.service' requested by ':1.2' (uid=1000 pid=1378 comm="/usr/libexec/tracker-miner-fs ")
Oct 27 18:42:52 pop-os systemd[1364]: Starting Tracker metadata database store and lookup manager...
Oct 27 18:42:52 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Successfully activated service 'org.freedesktop.Tracker1'
Oct 27 18:42:52 pop-os systemd[1364]: Started Tracker metadata database store and lookup manager.
Oct 27 18:42:52 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Activating via systemd: service name='org.freedesktop.Tracker1.Miner.Extract' unit='tracker-extract.service' requested by ':1.2' (uid=1000 pid=1378 comm="/usr/libexec/tracker-miner-fs ")
Oct 27 18:42:52 pop-os systemd[1364]: Starting Tracker metadata extractor...
Oct 27 18:42:52 pop-os tracker-extract[4944]: Set scheduler policy to SCHED_IDLE
Oct 27 18:42:52 pop-os tracker-extract[4944]: Setting priority nice level to 19
Oct 27 18:42:52 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Successfully activated service 'org.freedesktop.Tracker1.Miner.Extract'
Oct 27 18:42:52 pop-os systemd[1364]: Started Tracker metadata extractor.

```

## 2.0 Both write functions missing - syslog

read function are used twice in the user program once calling after encrypting and then calling after decrypting. So what if they are not properly used.?

Case 1 : If 1<sup>st</sup> read function is commented. Then what actually happens is the message inputted by the user is taken to the device driver using write function there it copy the value from user program to device file and encrypt the message and that gets stored there. But as read function is not called the input value is not changed and it gets printed. Now this message is passed into decryption function where it decrypts this and as read function is there this is getting printed. This can be clearly observed in the syslog in fig 2.2 where we can clearly see if entered to write or not and encrypted or decrypted or not. Here we could clearly see how it is encrypting char by char in syslog file

```

yachavenkatarakesh@pop-os:~/char_device-main$ sudo make test
gcc userprog.c 66 -fno-out -o.out #Compile and run the user program
Enter message : Hello
The encoded message is "Hello"
The decoded message is "Ebill"
yachavenkatarakesh@pop-os:~/char_device-main$

```

## 2.1 1<sup>st</sup> read function missing

```

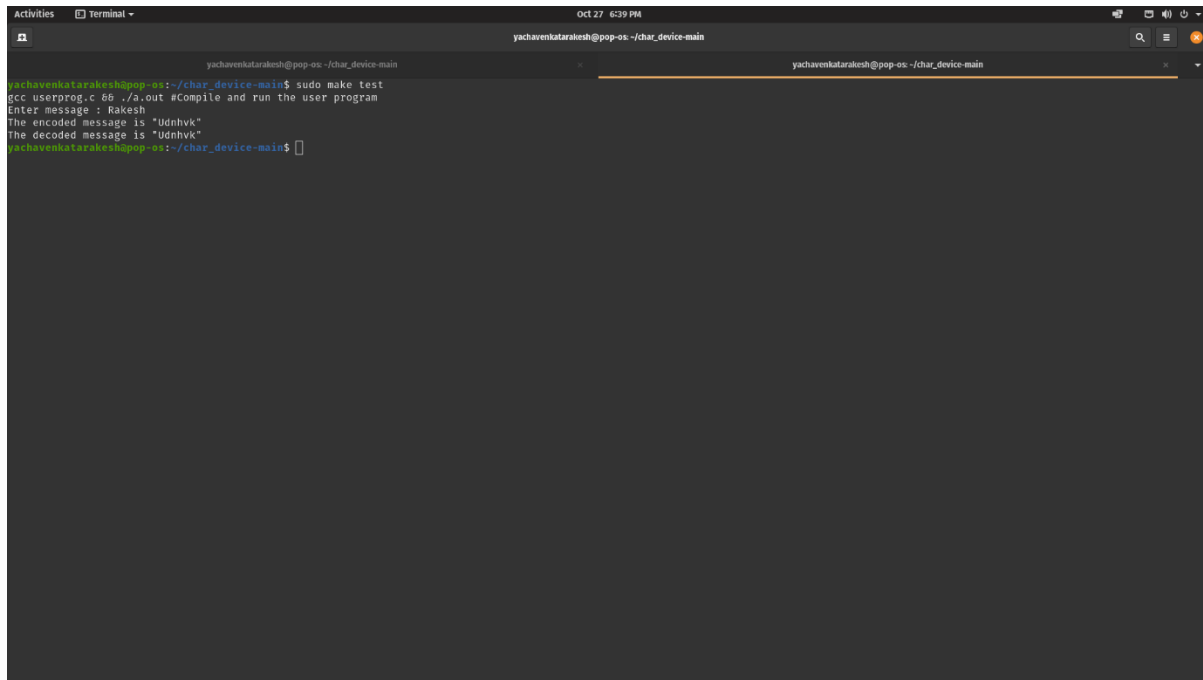
Oct 27 18:40:02 pop-os systemd[1]: Started Network Manager Script Dispatcher Service.
Oct 27 18:40:06 pop-os systemd[1364]: tracker-extract.service: Succeeded.
Oct 27 18:40:12 pop-os systemd[1]: NetworkManager-dispatcher.service: Succeeded.
Oct 27 18:40:26 pop-os tracker-store[4776]: OK
Oct 27 18:40:26 pop-os systemd[1364]: tracker-store.service: Succeeded.
Oct 27 18:41:08 pop-os kernel: [ 6465.867869] Inside the open_file function
Oct 27 18:41:08 pop-os kernel: [ 6465.867879] Inside the write_file function
Oct 27 18:41:08 pop-os kernel: [ 6465.867882] 0, 72
Oct 27 18:41:08 pop-os kernel: [ 6465.867883] Encoded: 100
Oct 27 18:41:08 pop-os kernel: [ 6465.867884] 1, 101
Oct 27 18:41:08 pop-os kernel: [ 6465.867885] Encoded: 110
Oct 27 18:41:08 pop-os kernel: [ 6465.867886] 2, 108
Oct 27 18:41:08 pop-os kernel: [ 6465.867886] Encoded: 194
Oct 27 18:41:08 pop-os kernel: [ 6465.867887] 3, 108
Oct 27 18:41:08 pop-os kernel: [ 6465.867888] Encoded: 118
Oct 27 18:41:08 pop-os kernel: [ 6465.867888] 4, 111
Oct 27 18:41:08 pop-os kernel: [ 6465.867889] Encoded: 107
Oct 27 18:41:08 pop-os kernel: [ 6465.867890] Message: Khoor
Oct 27 18:41:08 pop-os kernel: [ 6465.867909] Inside the close_file function
Oct 27 18:41:08 pop-os kernel: [ 6465.867922] Inside the open_file function
Oct 27 18:41:08 pop-os kernel: [ 6465.867925] Inside the write_file function
Oct 27 18:41:08 pop-os kernel: [ 6465.867927] 0, 72
Oct 27 18:41:08 pop-os kernel: [ 6465.867928] Decoded: 97
Oct 27 18:41:08 pop-os kernel: [ 6465.867929] 1, 101
Oct 27 18:41:08 pop-os kernel: [ 6465.867929] Decoded: 107
Oct 27 18:41:08 pop-os kernel: [ 6465.867930] 2, 108
Oct 27 18:41:08 pop-os kernel: [ 6465.867931] Decoded: 101
Oct 27 18:41:08 pop-os kernel: [ 6465.867932] 3, 108
Oct 27 18:41:08 pop-os kernel: [ 6465.867932] Decoded: 115
Oct 27 18:41:08 pop-os kernel: [ 6465.867933] 4, 111
Oct 27 18:41:08 pop-os kernel: [ 6465.867934] Decoded: 104
Oct 27 18:41:08 pop-os kernel: [ 6465.867935] Message: Ebill
Oct 27 18:41:08 pop-os kernel: [ 6465.867937] Inside the read_file function
Oct 27 18:41:08 pop-os kernel: [ 6465.867945] Inside the close_file function
Oct 27 18:41:26 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Activating via systemd: service name='org.freedesktop.Tracker1' unit='tracker-store.service' requested by ':1.2' (uid=1000 pid=1378 com=~/usr/libexec/tracker-miner-fs *)
Oct 27 18:41:26 pop-os systemd[1364]: Starting Tracker metadata database store and lookup manager...
Oct 27 18:41:26 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Successfully activated service 'org.freedesktop.Tracker1'
Oct 27 18:41:26 pop-os systemd[1364]: Started Tracker metadata database store and lookup manager.
Oct 27 18:41:26 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Activating via systemd: service name='org.freedesktop.Tracker1.Miner.Extract' unit='tracker-extract.service' requested by ':1.2' (uid=1000 pid=1378 com=~/usr/libexec/tracker-miner-fs *)
Oct 27 18:41:26 pop-os systemd[1364]: Starting Tracker metadata extractor...
Oct 27 18:41:26 pop-os tracker-extract[4872]: Set scheduler policy to SCHED_IDLE
Oct 27 18:41:26 pop-os tracker-extract[4872]: Setting priority nice level to 19
Oct 27 18:41:27 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Successfully activated service 'org.freedesktop.Tracker1.Miner.Extract'
Oct 27 18:41:27 pop-os systemd[1364]: Started Tracker metadata extractor.
Oct 27 18:41:37 pop-os systemd[1364]: tracker-extract.service: Succeeded.

```

## 2.2 1<sup>st</sup> read function missing – syslog



Case 2 : If 2<sup>nd</sup> read function is commented. Then what actually happens is the message inputted by the user is taken to the device driver using write function there it copy the value from user program to device file and encrypt the message and that gets stored there. As read function is called that value get copied to buffer in the user program. Now this text is sent for decryption and there it gets decrypted and then the value gets stored there. But as read function is not called the previous encrypted value is not changed and it gets printed. This can be clearly observed in the syslog in fig 2.4 where we can clearly see if entered to write or not and encrypted or decrypted or not. Here we could clearly see how it is encrypting char by char in syslog file

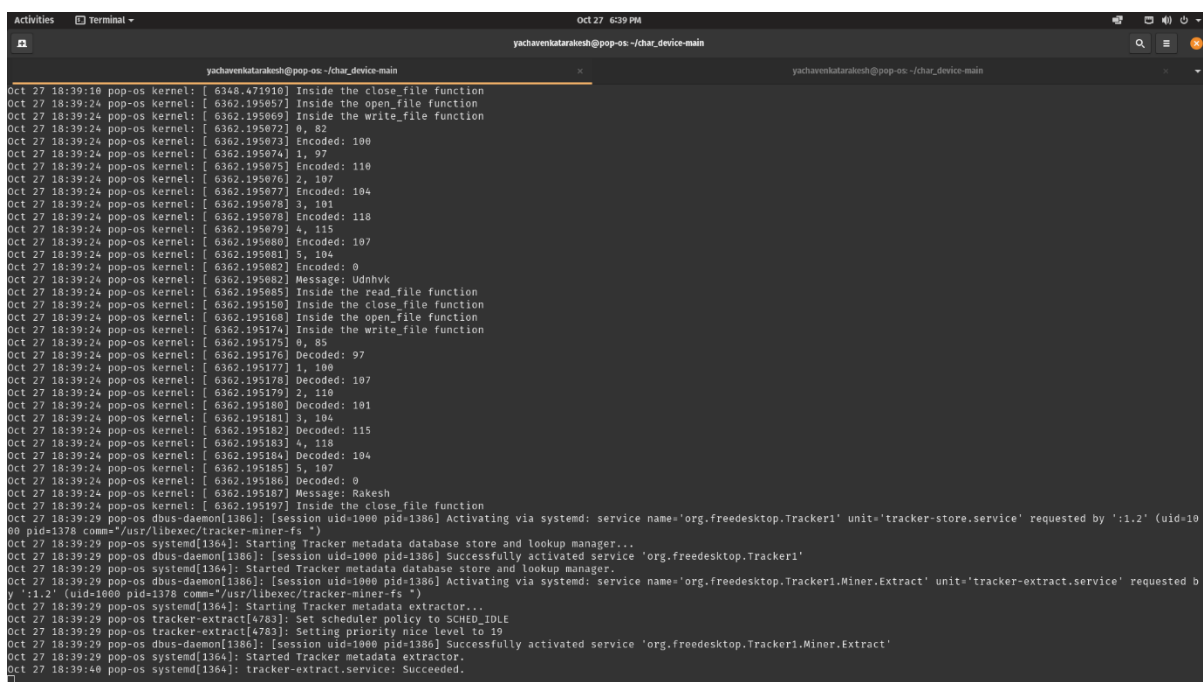


```

yachavenkatarakesh@pop-os: ~/char_device-main
yachavenkatarakesh@pop-os:~/char_device-main$ sudo make test
gcc userprog.c 66 -fa.out #Compile and run the user program
Enter message : Rakesh
The encoded message is "Udnhvk"
The decoded message is "Udnhvk"
yachavenkatarakesh@pop-os:~/char_device-main$

```

### 2.3 2<sup>nd</sup> read file missing



```

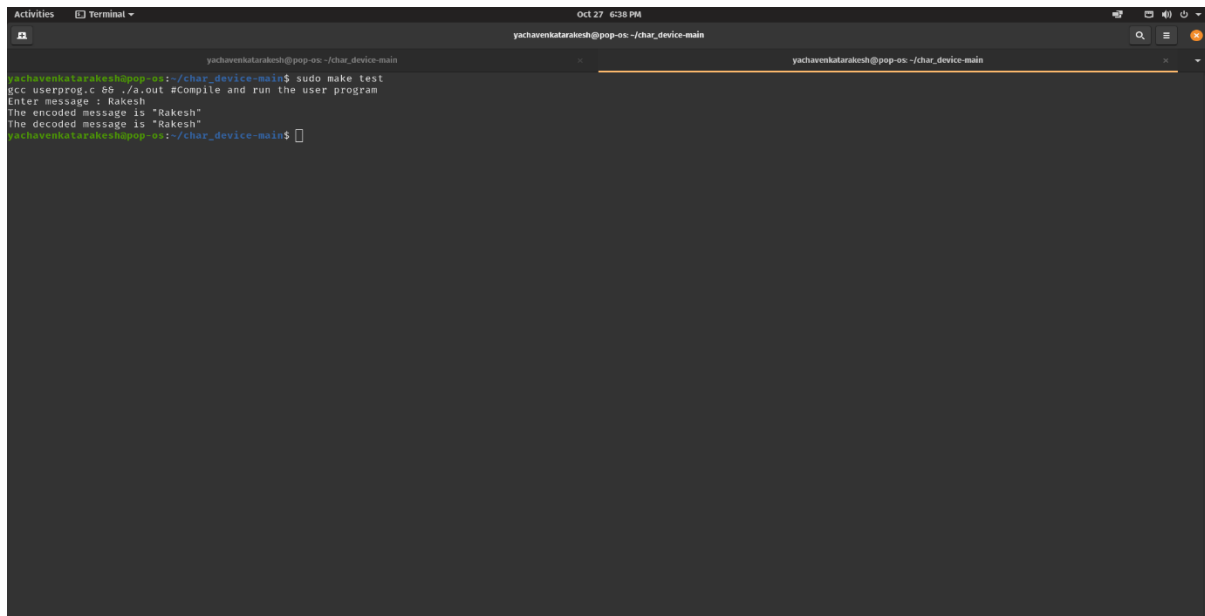
Oct 27 18:39:18 pop-os kernel: [ 6348.471910] Inside the close_file function
Oct 27 18:39:24 pop-os kernel: [ 6362.195057] Inside the open_file function
Oct 27 18:39:24 pop-os kernel: [ 6362.195069] Inside the write_file function
Oct 27 18:39:24 pop-os kernel: [ 6362.195072] 0, 82
Oct 27 18:39:24 pop-os kernel: [ 6362.195073] Encoded: 100
Oct 27 18:39:24 pop-os kernel: [ 6362.195078] 3, 101
Oct 27 18:39:24 pop-os kernel: [ 6362.195074] 1, 97
Oct 27 18:39:24 pop-os kernel: [ 6362.195075] Encoded: 110
Oct 27 18:39:24 pop-os kernel: [ 6362.195076] 2, 107
Oct 27 18:39:24 pop-os kernel: [ 6362.195077] Encoded: 104
Oct 27 18:39:24 pop-os kernel: [ 6362.195078] 3, 101
Oct 27 18:39:24 pop-os kernel: [ 6362.195078] Encoded: 118
Oct 27 18:39:24 pop-os kernel: [ 6362.195079] 4, 115
Oct 27 18:39:24 pop-os kernel: [ 6362.195080] Encoded: 107
Oct 27 18:39:24 pop-os kernel: [ 6362.195081] 5, 104
Oct 27 18:39:24 pop-os kernel: [ 6362.195082] Encoded: 0
Oct 27 18:39:24 pop-os kernel: [ 6362.195082] Message: Udnhvk
Oct 27 18:39:24 pop-os kernel: [ 6362.195085] Inside the read_file function
Oct 27 18:39:24 pop-os kernel: [ 6362.195100] Inside the close_file function
Oct 27 18:39:24 pop-os kernel: [ 6362.195100] Inside the open_file function
Oct 27 18:39:24 pop-os kernel: [ 6362.195174] Inside the write_file function
Oct 27 18:39:24 pop-os kernel: [ 6362.195175] 0, 85
Oct 27 18:39:24 pop-os kernel: [ 6362.195176] Decoded: 97
Oct 27 18:39:24 pop-os kernel: [ 6362.195177] 1, 100
Oct 27 18:39:24 pop-os kernel: [ 6362.195178] Decoded: 107
Oct 27 18:39:24 pop-os kernel: [ 6362.195179] 2, 110
Oct 27 18:39:24 pop-os kernel: [ 6362.195180] Decoded: 101
Oct 27 18:39:24 pop-os kernel: [ 6362.195181] 3, 104
Oct 27 18:39:24 pop-os kernel: [ 6362.195182] Decoded: 115
Oct 27 18:39:24 pop-os kernel: [ 6362.195183] 4, 118
Oct 27 18:39:24 pop-os kernel: [ 6362.195184] Decoded: 104
Oct 27 18:39:24 pop-os kernel: [ 6362.195185] 5, 107
Oct 27 18:39:24 pop-os kernel: [ 6362.195186] Decoded: 0
Oct 27 18:39:24 pop-os kernel: [ 6362.195187] Message: Rakesh
Oct 27 18:39:24 pop-os kernel: [ 6362.195197] Inside the close_file function
Oct 27 18:39:29 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Activating via systemd: service name='org.freedesktop.Tracker1' unit='tracker-store.service' requested by ':1.2' (uid=1000 pid=1378 comm="/usr/libexec/tracker-miner-fs ")
Oct 27 18:39:29 pop-os systemd[1364]: Starting Tracker metadata database store and lookup manager...
Oct 27 18:39:29 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Successfully activated service 'org.freedesktop.Tracker1'
Oct 27 18:39:29 pop-os systemd[1364]: Started Tracker metadata database store and lookup manager.
Oct 27 18:39:29 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Activating via systemd: service name='org.freedesktop.Tracker1.Miner.Extract' unit='tracker-extract.service' requested by ':1.2' (uid=1000 pid=1378 comm="/usr/libexec/tracker-miner-fs ")
Oct 27 18:39:29 pop-os systemd[1364]: Starting Tracker metadata extractor...
Oct 27 18:39:29 pop-os tracker-extract[4783]: Set scheduler policy to SCHED_IDLE
Oct 27 18:39:29 pop-os tracker-extract[4783]: Setting priority nice level to 19
Oct 27 18:39:29 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Successfully activated service 'org.freedesktop.Tracker1.Miner.Extract'
Oct 27 18:39:29 pop-os systemd[1364]: Started Tracker metadata extractor.
Oct 27 18:39:48 pop-os systemd[1364]: tracker-extract.service: Succeeded.

```

### 2.4 2<sup>nd</sup> read file missing – syslog



Case 3 : If both the read files are commented. Then first the input given by user is taken for encryption using write function where it copies the text from user program to device file and then it perform encryption and then the value gets stored. Since there is no read function calling the input string itself get's printed. Now this input string is sent for decryption where it copies the string from user program to device file and then it perform decryption and then the value gets stored. Since there is no read function the value is not copied back to the user program and hence it is just printing input string again. This can be clearly seen from the syslog where it is actually both encrypting and decrypting but there is no change in output just because of read function missing.

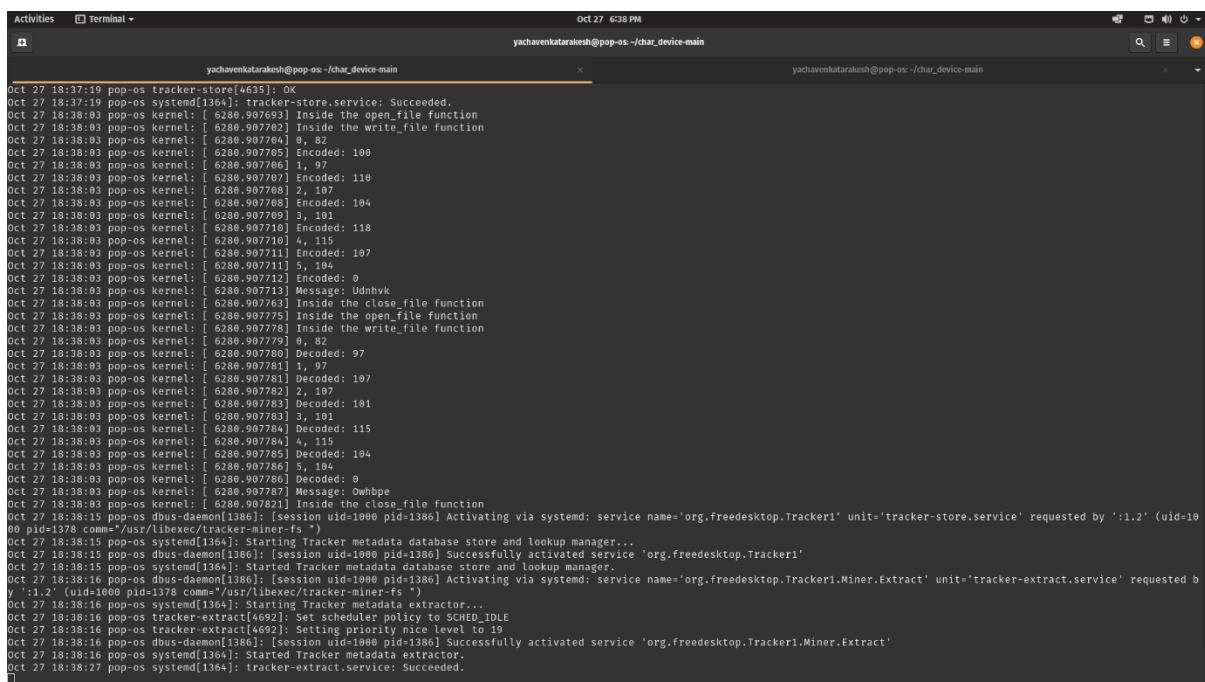


```

yachavenkatarakesh@pop-os: ~/char_device-main
gcc userprog.c 65 -o a.out #Compile and run the user program
Enter message : Rakesh
The encoded message is "Rakesh"
The decoded message is "Rakesh"
yachavenkatarakesh@pop-os: ~/char_device-main$

```

## 2.5 Both read files are missing



```

Oct 27 18:37:19 pop-os tracker-store[4635]: OK
Oct 27 18:37:19 pop-os systemd[1364]: tracker-store.service: Succeeded.
Oct 27 18:38:03 pop-os kernel: [ 6280.907693] Inside the open_file function
Oct 27 18:38:03 pop-os kernel: [ 6280.907702] Inside the write_file function
Oct 27 18:38:03 pop-os kernel: [ 6280.907704] 0, 82
Oct 27 18:38:03 pop-os kernel: [ 6280.907705] Encoded: 100
Oct 27 18:38:03 pop-os kernel: [ 6280.907706] 1, 97
Oct 27 18:38:03 pop-os kernel: [ 6280.907707] Encoded: 110
Oct 27 18:38:03 pop-os kernel: [ 6280.907708] 2, 107
Oct 27 18:38:03 pop-os kernel: [ 6280.907708] Encoded: 104
Oct 27 18:38:03 pop-os kernel: [ 6280.907709] 3, 101
Oct 27 18:38:03 pop-os kernel: [ 6280.907710] Encoded: 118
Oct 27 18:38:03 pop-os kernel: [ 6280.907710] 4, 115
Oct 27 18:38:03 pop-os kernel: [ 6280.907711] Encoded: 107
Oct 27 18:38:03 pop-os kernel: [ 6280.907711] 5, 104
Oct 27 18:38:03 pop-os kernel: [ 6280.907712] Encoded: 0
Oct 27 18:38:03 pop-os kernel: [ 6280.907713] Message: UdhvK
Oct 27 18:38:03 pop-os kernel: [ 6280.907763] Inside the close_file function
Oct 27 18:38:03 pop-os kernel: [ 6280.907775] Inside the open_file function
Oct 27 18:38:03 pop-os kernel: [ 6280.907778] Inside the write_file function
Oct 27 18:38:03 pop-os kernel: [ 6280.907779] 0, 82
Oct 27 18:38:03 pop-os kernel: [ 6280.907780] Decoded: 97
Oct 27 18:38:03 pop-os kernel: [ 6280.907781] 1, 97
Oct 27 18:38:03 pop-os kernel: [ 6280.907781] Decoded: 107
Oct 27 18:38:03 pop-os kernel: [ 6280.907782] 2, 107
Oct 27 18:38:03 pop-os kernel: [ 6280.907783] Decoded: 101
Oct 27 18:38:03 pop-os kernel: [ 6280.907783] 3, 101
Oct 27 18:38:03 pop-os kernel: [ 6280.907784] Decoded: 115
Oct 27 18:38:03 pop-os kernel: [ 6280.907784] 4, 115
Oct 27 18:38:03 pop-os kernel: [ 6280.907785] Decoded: 104
Oct 27 18:38:03 pop-os kernel: [ 6280.907786] 5, 104
Oct 27 18:38:03 pop-os kernel: [ 6280.907786] Decoded: 0
Oct 27 18:38:03 pop-os kernel: [ 6280.907787] Message: Owmbpe
Oct 27 18:38:03 pop-os kernel: [ 6280.907821] Inside the close_file function
Oct 27 18:38:15 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Activating via systemd: service name='org.freedesktop.Tracker1' unit='tracker-store.service' requested by ':1.2' (uid=1000 pid=1378 comm="/usr/libexec/tracker-miner-fs")
Oct 27 18:38:15 pop-os systemd[1364]: Starting Tracker metadata database store and lookup manager...
Oct 27 18:38:15 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Successfully activated service 'org.freedesktop.Tracker1'
Oct 27 18:38:15 pop-os systemd[1364]: Started Tracker metadata database store and lookup manager.
Oct 27 18:38:16 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Activating via systemd: service name='org.freedesktop.Tracker1.Miner.Extract' unit='tracker-extract.service' requested by ':1.2' (uid=1000 pid=1378 comm="/usr/libexec/tracker-miner-fs")
Oct 27 18:38:16 pop-os systemd[1364]: Starting Tracker metadata extractor...
Oct 27 18:38:16 pop-os tracker-extract[4692]: Set scheduler policy to SCHED_IDLE
Oct 27 18:38:16 pop-os tracker-extract[4692]: Setting priority nice level to 19
Oct 27 18:38:16 pop-os dbus-daemon[1386]: [session uid=1000 pid=1386] Successfully activated service 'org.freedesktop.Tracker1.Miner.Extract'
Oct 27 18:38:16 pop-os systemd[1364]: Started Tracker metadata extractor.
Oct 27 18:38:27 pop-os systemd[1364]: tracker-extract.service: Succeeded.

```

## 2.6 Both read function missing - Syslog