

## Assignment 6 – Coding A device driver

### Description:

This assignment is to write a device driver that has the capability to encrypt and decrypt a string passed into it. It reads and writes based in Linux file concepts. It also includes to write a sample application to test the driver.

### Approach / What I Did:

1. After analyzing Professor Bierman's code for the Null Driver, I understood and added the code to initialize the driver for my driver.
2. First step was to write the open function, which allocates the kernel buffer using vmalloc. It allocates a space of 4096 bytes.
3. Then I initialize and allocate a private data structure that stores the key for encryption.
4. Next in the close function, I free up space for the kernelBuffer and private data structure.
5. Then I then checked this page <https://www.unix.com/linux/127883-linux-device-driver-avoid-mem-copy-user-kernel-space.html>, to understand copying at the kernel level.
6. Since I cannot use the c library function, I used copy\_to\_user to implement the myRead and myWrite functions.
7. MyRead copies from the kernelBuffer into the user passed buffer. It also has an offset that keeps track of how much of the kernel has been already read.
8. MyWrite copies from the userBuffer into the kernel buffer. It also has an offset that keeps track of how much of the kernel has been written to.
9. Then for the ioctl function I performed Caesar cipher encryption and decryption based on what command is passed to the function.
10. The cleanup module function was inspired by Professor Bierman.

### Issues and Resolutions:

My first issue was the seg fault. I removed it by closely examining professor Bierman's code and the reading more about device drivers.

My second issue was the cyclicity of the cipher. I had to get the relative position of the alphabet from the first or last one in the series.

My last issue is even though I was able to complete the cipher, it did not work when I was committing, it was working perfectly fine.

**Analysis:** (If required for the assignment)

## Screen shot of compilation:

```
Activities Unknown May 15 21:46
parallels@ubuntu-linux-22-04-desktop: ~/Desktop/TESTIG/csc415-device-driver-dsav99/Module
parallels@ubuntu-linux-22-04-desktop:~/Desktop/TESTIG/csc415-device-driver-dsav99/Module$ make
make -C /lib/modules/uname -r -r/build M=/home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module modules
make[1]: Entering directory '/usr/src/linux-headers-5.15.0-71-generic'
warning: the compiler differs from the one used to build the kernel
The kernel was built by: gcc (Ubuntu 11.3.0-1ubuntu1-22.04.1) 11.3.0
You are using: gcc (Ubuntu 11.3.0-1ubuntu1-22.04) 11.3.0
CC [M] /home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.o
In file included from ./include/linux/kernel.h:19,
                 from ./include/linux/list.h:9,
                 from ./include/linux/module.h:12,
                 from /home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.c:17:
/home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.c: In function 'myRead':
./include/linux/kern_levels.h:125:25: warning: format '%d' expects argument of type 'int', but argument 2 has type 'size_t' (aka 'long unsigned int') [-Wformat=]
 5 | #define KERN_SOH          "\001" /* ASCII Start Of Header */
   |
./include/linux/printk.h:422:25: note: in definition of macro 'prntk_index_wrap'
422 |     _p_func(fmt, ##__VA_ARGS__);
   |     ~~~~~^~~~~
/home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.c:125:5: note: in expansion of macro 'prntk'
125 |     printk(KERN_INFO "We read : %d at offset %lld\n", bytes_to_read, *off);
   |     ~~~~~^~~~~
./include/linux/kern_levels.h:14:25: note: in expansion of macro 'KERN_SOH'
14 | #define KERN_INFO          KERN_SOH "6" /* informational */
   |
/home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.c:125:12: note: in expansion of macro 'KERN_INFO'
125 |     printk(KERN_INFO "We read : %d at offset %lld\n", bytes_to_read, *off);
   |     ~~~~~^~~~~
MODPOST /home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/Module.symvers
CC [M] /home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.mod.o
LD [M] /home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.ko
BTF [M] /home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.ko
Skipping BTF generation for /home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.ko due to unavailability of vmlinux
make[1]: Leaving directory '/usr/src/linux-headers-5.15.0-71-generic'
parallels@ubuntu-linux-22-04-desktop:~/Desktop/TESTIG/csc415-device-driver-dsav99/Module$
```

```
Activities Unknown May 15 21:47
parallels@ubuntu-linux-22-04-desktop: ~/Desktop/TESTIG/csc415-device-driver-dsav99/Test
parallels@ubuntu-linux-22-04-desktop:~/Desktop/TESTIG/csc415-device-driver-dsav99/Test$ make
make -C /lib/modules/uname -r -r/build M=/home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module modules
make[1]: Entering directory '/usr/src/linux-headers-5.15.0-71-generic'
warning: the compiler differs from the one used to build the kernel
The kernel was built by: gcc (Ubuntu 11.3.0-1ubuntu1-22.04.1) 11.3.0
You are using: gcc (Ubuntu 11.3.0-1ubuntu1-22.04) 11.3.0
CC [M] /home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.o
In file included from ./include/linux/kernel.h:19,
                 from ./include/linux/list.h:9,
                 from ./include/linux/module.h:12,
                 from /home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.c:17:
/home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.c: In function 'myRead':
./include/linux/kern_levels.h:125:25: warning: format '%d' expects argument of type 'int', but argument 2 has type 'size_t' (aka 'long unsigned int') [-Wformat=]
 5 | #define KERN_SOH          "\001" /* ASCII Start Of Header */
   |
./include/linux/printk.h:422:25: note: in definition of macro 'prntk_index_wrap'
422 |     _p_func(fmt, ##__VA_ARGS__);
   |     ~~~~~^~~~~
/home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.c:125:5: note: in expansion of macro 'prntk'
125 |     printk(KERN_INFO "We read : %d at offset %lld\n", bytes_to_read, *off);
   |     ~~~~~^~~~~
./include/linux/kern_levels.h:14:25: note: in expansion of macro 'KERN_SOH'
14 | #define KERN_INFO          KERN_SOH "6" /* informational */
   |
/home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.c:125:12: note: in expansion of macro 'KERN_INFO'
125 |     printk(KERN_INFO "We read : %d at offset %lld\n", bytes_to_read, *off);
   |     ~~~~~^~~~~
MODPOST /home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/Module.symvers
CC [M] /home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.mod.o
LD [M] /home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.ko
BTF [M] /home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.ko
Skipping BTF generation for /home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module/MyDriver.ko due to unavailability of vmlinux
make[1]: Leaving directory '/usr/src/linux-headers-5.15.0-71-generic'
parallels@ubuntu-linux-22-04-desktop:~/Desktop/TESTIG/csc415-device-driver-dsav99/Test$ cd ../Test/
parallels@ubuntu-linux-22-04-desktop:~/Desktop/TESTIG/csc415-device-driver-dsav99/Test$ make
make: 'Dhillon_Savjot_HM6_main' is up to date.
parallels@ubuntu-linux-22-04-desktop:~/Desktop/TESTIG/csc415-device-driver-dsav99/Test$ make clean
rm *.o Dhillon_Savjot_HM6_main
parallels@ubuntu-linux-22-04-desktop:~/Desktop/TESTIG/csc415-device-driver-dsav99/Test$ make
make -C /lib/modules/uname -r -r/build M=/home/parallels/Desktop/TESTIG/csc415-device-driver-dsav99/Module modules
make[1]: Entering directory '/usr/src/linux-headers-5.15.0-71-generic'
gcc -o Dhillon_Savjot_HM6_main.o Dhillon_Savjot_HM6_main.c -g -I. -l pthread
parallels@ubuntu-linux-22-04-desktop:~/Desktop/TESTIG/csc415-device-driver-dsav99/Test$
```

## Screen shot(s) of the execution of the program:

Show all necessary screen shots (some assignments require more than one).  
These should be in the Linux Terminal window and not visual studio.



```
parallels@ubuntu-linux-22-04-desktop:~/Desktop/SAVJO/csc415-device-driver-dsav99/Test$ make
make: 'Dhillon_Savjot_HW6_main' is up to date.
parallels@ubuntu-linux-22-04-desktop:~/Desktop/SAVJO/csc415-device-driver-dsav99/Test$ make run
./Dhillon_Savjot_HW6_main
Returned from open file, 3
Device Open Success
Enter a string:
hello
Enter a key:
3
Writing string to buffer
Encrypting test
Encrypted DATA IS
Decrypting test
Decrypted DATA IS ***5***
parallels@ubuntu-linux-22-04-desktop:~/Desktop/SAVJO/csc415-device-driver-dsav99/Test$
```