

VE482 Lab Report

Lab 9 - Fall 2020

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Kernel Device

What needs to be returned by read and write file operations for a character device?

- Read: if error, -1; if success the number of bytes read.
- Write: if error, -1; if success, the number of bytes written.

How are exactly those major and minor numbers working? You vaguely remember that you can display them using `ls -l /dev`.

- Major number: a `unsigned int` (0–255) that identifies the driver associated with the device. It is the same when driven by the same driver.
- Minor number: a `unsigned int` that is used by kernel to determine exactly which device is being referred to. It is unique for devices with the same driver. In this example, `dice` is registered with one major number and three minor numbers, each minor number representing one type of dice.

Knowing the major number and minor numbers of a device, how to add a character device to `/dev`?

```
1 # (Create a new device directly)
2 mknod /dev/$device_name c $major_id $minor_id
3
4 # (add a character device to /dev)
5 cdev_add(struct cdev *dev, dev_t num, unsigned int count);
```

Where are the following terms located in linux source code?

- `module_init` `include/linux/module.h`
- `module_exit` `include/linux/module.h`
- `printk` `include/linux/printk.h`
- `container_of` `include/linux/kernel.h`

- dev_t include/linux/types.h
- MAJOR include/linux/kdev_t.h
- MINOR include/linux/kdev_t.h
- MKDEV include/linux/kdev_t.h
- alloc_chrdev_region fs/char_dev.c
- module_param include/linux/moduleparam.h
- cdev_init fs/char_dev.c
- cdev_add fs/char_dev.c
- cdev_del fs/char_dev.c
- THIS_MODULE include/linux/export.h

How to generate random numbers when working inside the Linux kernel? You think that a while back you read something about getting the current time.

```
1 #include <sys/random.h>
2 ssize_t getrandom(void *buf, size_t buflen, unsigned int flags);
```

How to define and specify module options?

By using ioctl function.

```
1 static long my_ioctl (struct file *file, unsigned int cmd, unsigned long
    arg);
```

List options:

modinfo -p XXXXX

Implementation of dice

For source code, see attached files.

modified Makefile:

```
1 obj-m := dicedevice.o
2 dicedevice-objs := dice.o
3
4 all: ko
5
6 ko:
7     make -C /lib/modules/$(shell uname -r)/build M=$(PWD) modules
8
9 clean:
10     make -C /lib/modules/$(shell uname -r)/build M=$(PWD) clean
11
12 transf:
13     scp -rv ./dice william@192.168.1.111:/home/william/code/ve482-19/dice
14
15 load:
```

```

16 insmod ./dicedevice.ko
17 cat /proc/modules | grep "dicedevice"
18 cat /proc/devices | grep "Dice"
19
20 reg240:
21 mknod /dev/dice0 c 240 0
22 mknod /dev/dice1 c 240 1
23 mknod /dev/dice2 c 240 2
24
25 rmdev:
26 rm -f /dev/dice0
27 rm -f /dev/dice1
28 rm -f /dev/dice2
29 rmmmod dicedevice.ko

```

Snapshots:

```

57.937589] Bluetooth: RFCOMM ver 1.11
59.466308] rkill: input handler disabled
154.173247] dicedevice: loading out-of-tree module taints kernel.
154.173293] dicedevice: module verification failed: signature and/or required key missing - tainting kernel
154.174395] Initializing Grandpa's Dice Module...
154.174399] Dice: successfully register the device with major number 240
154.174399] Hi Grandpa!
185.877995] Dice: opening device with minor 0
185.878004] Dice: outputting data
185.878005] Dice: outputting regular dice |
185.878035] Dice: outputting data
185.878035] Dice: outputting regular dice |
185.878037] Dice: printer reaches ending, aborting
190.067490] Dice: opening device with minor 0
190.067499] Dice: outputting data
190.067499] Dice: outputting regular dice |
190.067529] Dice: outputting data
190.067529] Dice: outputting regular dice |
190.067531] Dice: printer reaches ending, aborting
192.706899] Dice: opening device with minor 1
192.706907] Dice: outputting data
192.706907] Dice: outputting backgammon dice |
192.706934] Dice: outputting data
192.706935] Dice: outputting backgammon dice |
192.706936] Dice: printer reaches ending, aborting

```

```

william@ubuntu:~/code/ve482-19/dice$ sudo make load
insmod ./dicedevice.ko
cat /proc/modules | grep "dicedevice"
dicedevice 16384 0 - Live 0xffffffffc05f0000 (OE)
cat /proc/devices | grep "Dice"
240 Dice
william@ubuntu:~/code/ve482-19/dice$ sudo make reg240
mknod /dev/dice0 c 240 0
mknod /dev/dice1 c 240 1
mknod /dev/dice2 c 240 2
william@ubuntu:~/code/ve482-19/dice$ cat /dev/dice0
-----
| o | | o |
|   | |   |
-----
william@ubuntu:~/code/ve482-19/dice$ cat /dev/dice0
-----
| o o | | o o |
| o o | | o o |
| o o | | o o |
-----
william@ubuntu:~/code/ve482-19/dice$ cat /dev/dice1
32 64
william@ubuntu:~/code/ve482-19/dice$ cat /dev/dice2
4 8
william@ubuntu:~/code/ve482-19/dice$ echo 1 > /dev/dice0
bash: /dev/dice0: Permission denied
william@ubuntu:~/code/ve482-19/dice$ sudo echo 1 > /dev/dice0
bash: /dev/dice0: Permission denied
william@ubuntu:~/code/ve482-19/dice$ echo 1
1
william@ubuntu:~/code/ve482-19/dice$ echo 1|sudo tee /dev/dice0
1
william@ubuntu:~/code/ve482-19/dice$ cat /dev/dice0
-----
| o o |
| o   |
| o o |
-----
william@ubuntu:~/code/ve482-19/dice$ echo 7|sudo tee /dev/dice0
7
william@ubuntu:~/code/ve482-19/dice$ cat /dev/dice0
-----
| o o | | o o | | o   | | o o | | o   | | o o |
| o   | | o o | | o   | | o o | | o   | | o o |
| o o | | o o | | o   | | o o | | o o | | o o |
-----
william@ubuntu:~/code/ve482-19/dice$ echo 15 | sudo tee /dev/dice0
15
william@ubuntu:~/code/ve482-19/dice$ cat /dev/dice0
-----
| o | | o o | | o o | | o o | | o   | | o o | | o o | | o o | | o o |
| o | | o o | | o o | | o o | | o o | | o o | | o o | | o o |
| o | | o o | | o o | | o o | | o o | | o o | | o o | | o o |
-----

```

```
[ 271.147378] Dice: outputting regular dice |
[ 271.147400] Dice: outputting data
[ 271.147400] Dice: outputting regular dice |
[ 271.147410] Dice: printer reaches ending, aborting
[ 338.406261] Grandpa, professor Horst told us that do not gamble, probably you should listen to him.
[ 338.406262] Dice: unregistering the device...
[ 338.406263] Hope Mum is not at home. Enjoy the day, goodbye!
william@ubuntu:~$
```

Reference

<https://stackoverflow.com/questions/15832301/understanding-container-of-macro-in-the-linux-kernel>

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<https://github.com/starpos/scull>

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<https://en.wikipedia.org/wiki/Backgammon>

<https://elixir.bootlin.com/linux/latest/source>

<https://www.kernel.org/doc/html/docs/kernel-api/API-sprintf.html>

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