Operating Systems

Project #1

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Section	1
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Step 1 :

Include all the needed ***libraries***.

- #include <linux/init.h>
- #include <linux/module.h>
- #include <linux/kernel.h>
- #include <asm/param.h>   // used for getting HZ variable
- #include <linux/jiffies.h>   // used for getting jiffies
- #include <linux/proc_fs.h>
- #include <asm/uaccess.h>

Step 2 :

Create the kernel module using module_init() & module_exit()

- int **proc_init**(void) : This function is called when the module is loaded using
  - sudo insmod module_name.ko
  - Must be passed to the macro module_init()
- void **proc_exit**(void) : This function is called when the module is removed using
  - sudo rmmod module_name.ko
  - Must be passed to the macro module_exit()

Step 3 :

Implement proc_init() function to create /proc file :

- **proc_create**(PROC_NAME, 0666, NULL, &my_proc_ops);
    - Note that PROC_NAME is a predefined macro that contains proc name “jiffies” or “seconds”
    - My_proc_ops : is a defined struct that has one member .proc_read for passing read function

Step 4 :

Implement proc_exit() function to remove /proc file :

- **remove_proc_entry**(PROC_NAME, NULL)

Step 5 :

Implement proc_read() function

- ssize_t **proc_read** (struct file *filee, char __user *usr_buf, size_t count, loff_t *pos);

First we need to make sure that this function *returns 0* after it has collected the data :

```
static int completed = 0;
        if(completed)
{
                completed =0;
                return 0;
}
        completed = 1;
```

After that this step differs when doing different tasks

1. For Task 1 “Display the jiffies value”:
   - rv = sprintf(buffer , "jiffies = %lu \n", jiffies);

   This line is printed when the user calls this command:

   - cat /proc/jiffies where jiffies is the value of PROC_NAME macro.
2. For Task 2 “Display elapsed time”
   - rv = sprintf(buffer ,"elapsed seconds = %lu\n" , res_sec);

   Where *res_sec = (current_sec – init_ sec)/ HZ* ,

   Current_sec is jiffies value in proc_read function

   Init_sec is jiffies value in init_read function

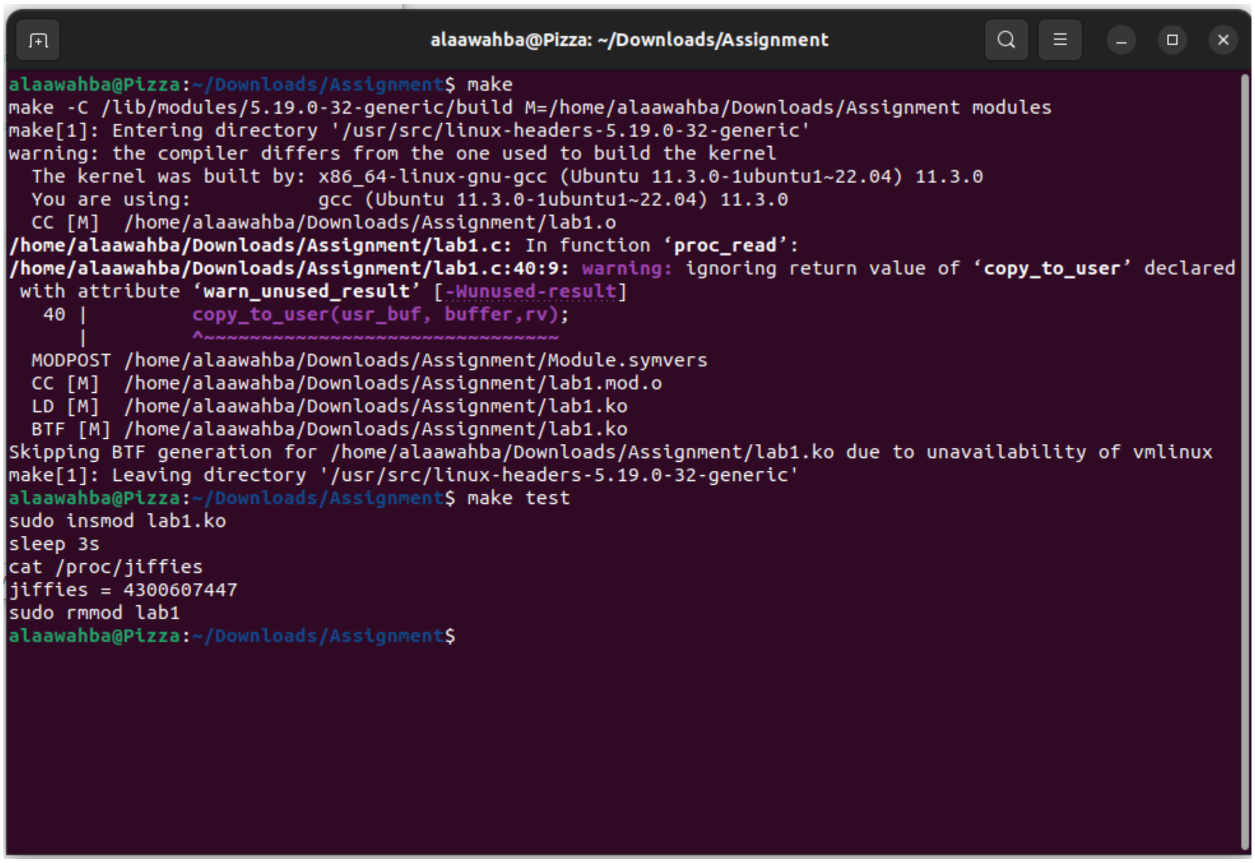
Notes :

- sprintf returns number of printed letters stored in rv and stores the string in buffer variable.
- **copy_to_user**(usr_buf, buffer,rv); we have to copy the buffer value to the usr_buf because it will be called by the user.

For the last step (optional) :

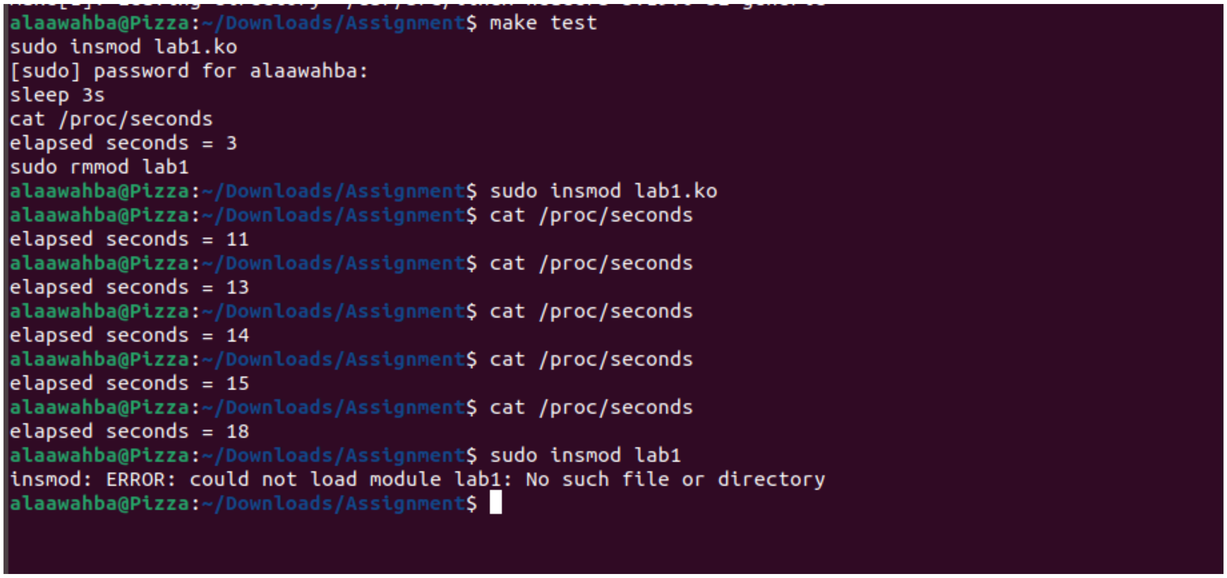
- MODULE_LICENSE("GPL");
- MODULE_AUTHOR("Alaa Wahba");
- MODULE_DESCRIPTION("proc Module");

Task 1 using Makefile :



```
alaawahba@Pizza:~/Downloads/Assignment$ make
make -C /lib/modules/5.19.0-32-generic/build M=/home/alaawahba/Downloads/Assignment modules
make[1]: Entering directory '/usr/src/linux-headers-5.19.0-32-generic'
warning: the compiler differs from the one used to build the kernel
  The kernel was built by: x86_64-linux-gnu-gcc (Ubuntu 11.3.0-1ubuntu1~22.04) 11.3.0
  You are using:           gcc (Ubuntu 11.3.0-1ubuntu1~22.04) 11.3.0
  CC [M]  /home/alaawahba/Downloads/Assignment/lab1.o
/home/alaawahba/Downloads/Assignment/lab1.c: In function ‘proc_read’:
/home/alaawahba/Downloads/Assignment/lab1.c:40:9: warning: ignoring return value of ‘copy_to_user’ declared
 with attribute ‘warn_unused_result’ [-Wunused-result]
   40 |         copy_to_user(usr_buf, buffer,rv);
      |         ^~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  MODPOST /home/alaawahba/Downloads/Assignment/Module.symvers
  CC [M]  /home/alaawahba/Downloads/Assignment/lab1.mod.o
  LD [M]  /home/alaawahba/Downloads/Assignment/lab1.ko
  BTF [M] /home/alaawahba/Downloads/Assignment/lab1.ko
Skipping BTF generation for /home/alaawahba/Downloads/Assignment/lab1.ko due to unavailability of vmlinux
make[1]: Leaving directory '/usr/src/linux-headers-5.19.0-32-generic'
alaawahba@Pizza:~/Downloads/Assignment$ make test
sudo insmod lab1.ko
sleep 3s
cat /proc/jiffies
jiffies = 4300607447
sudo rmmod lab1
alaawahba@Pizza:~/Downloads/Assignment$
```

Task 2 :



```
make[1]: Leaving directory '/usr/src/linux-headers-5.19.0-32-generic'
alaawahba@Pizza:~/Downloads/Assignment$ make test
sudo insmod lab1.ko
[sudo] password for alaawahba:
sleep 3s
cat /proc/seconds
elapsed seconds = 3
sudo rmmod lab1
alaawahba@Pizza:~/Downloads/Assignment$ sudo insmod lab1.ko
alaawahba@Pizza:~/Downloads/Assignment$ cat /proc/seconds
elapsed seconds = 11
alaawahba@Pizza:~/Downloads/Assignment$ cat /proc/seconds
elapsed seconds = 13
alaawahba@Pizza:~/Downloads/Assignment$ cat /proc/seconds
elapsed seconds = 14
alaawahba@Pizza:~/Downloads/Assignment$ cat /proc/seconds
elapsed seconds = 15
alaawahba@Pizza:~/Downloads/Assignment$ cat /proc/seconds
elapsed seconds = 18
alaawahba@Pizza:~/Downloads/Assignment$ sudo insmod lab1
insmod: ERROR: could not load module lab1: No such file or directory
alaawahba@Pizza:~/Downloads/Assignment$
```

Overcoming Challenges :

- Struct ~~file_operations~~ was not working for me, because of the newer and updated ubuntu version that I'm working on so I searched for the alternative and found
    - Struct proc_ops whose members are a little different, eg. .read is equivalent to .proc_read
- Other problem I faced is related to the first one, the .owner member doesn't exit in proc_ops struct so I had to remove that line after dealing with so many errors ☹