

Before we create the kernel module, we have to create the specific **Makefile**, which will look like this:

```
< > Makefile x hello.c x
1  obj-m = hello.o
2
3  KVERSION = $(shell uname -r)
4
5  all:
6      make -C /lib/modules/$(KVERSION)/build M=$(PWD) modules
7
8  clean:
9      make -C /lib/modules/$(KVERSION)/build M=$(PWD) clean
10
```

After we have this finished, we have to test the **methods** “all” and “clean” to see if they work:

```
drondur@ROG:~/Desktop/IEP/lab8/exemplu$ make clean
make -C /lib/modules/5.4.0-54-generic/build M=/home/drondur/Desktop/IEP/lab8/exemplu clean
make[1]: Entering directory '/usr/src/linux-headers-5.4.0-54-generic'
make[1]: Leaving directory '/usr/src/linux-headers-5.4.0-54-generic'
```

```
drondur@ROG:~/Desktop/IEP/lab8/exemplu$ make all
make -C /lib/modules/5.4.0-54-generic/build M=/home/drondur/Desktop/IEP/lab8/exemplu modules
make[1]: Entering directory '/usr/src/linux-headers-5.4.0-54-generic'
CC [M] /home/drondur/Desktop/IEP/lab8/exemplu/hello.o
Building modules, stage 2.
MODPOST 1 modules
WARNING: modpost: missing MODULE_LICENSE() in /home/drondur/Desktop/IEP/lab8/exemplu/hello.o
see include/linux/module.h for more information
CC [M] /home/drondur/Desktop/IEP/lab8/exemplu/hello.mod.o
LD [M] /home/drondur/Desktop/IEP/lab8/exemplu/hello.ko
make[1]: Leaving directory '/usr/src/linux-headers-5.4.0-54-generic'
```

After we have the Makefile working, we have to create our kernel module, which should look like(hello.c/cpp file):

```
< > Makefile x hello.c x
1  #include <linux/module.h>
2  #include <linux/kernel.h>
3  #include <linux/init.h>
4
5
6  static int __init hello_start(void)
7  {
8      printk(KERN_INFO "hello, world! \n");
9      return 0;
10 }
11
12 static void __exit hello_end(void)
13 {
14     printk(KERN_INFO "goodbye world \n");
15 }
16
17 module_init(hello_start);
18 module_exit(hello_end);
```

After we execute “make” command in terminal we get the ‘.ko’ file are searching fore:

```
make[1]: Leaving directory '/usr/src/linux-headers-5.4.0-34-g
drondur@ROG:~/Desktop/IEP/lab8/exemplu$ ls -la
total 112
drwxrwxr-x 2 drondur drondur 4096 nov 21 17:42 .
drwxrwxr-x 3 drondur drondur 4096 nov 20 18:30 ..
-rw-rw-r-- 1 drondur drondur 297 nov 21 17:38 hello.c
-rw-rw-r-- 1 drondur drondur 3960 nov 21 17:38 hello.ko
-rw-rw-r-- 1 drondur drondur 298 nov 21 17:38 .hello.ko.cmd
```

To see all existent kernel modules we have this command “**lsmod**”. After executing this command you should see something like:

```
parport          53248  3 parport_pc,lp,ppdev
ip_tables        32768  0
x_tables         40960  1 ip_tables
autofs4          45056  2
usbhid           57344  0
hid_generic      16384  0
crc32_pclmul     16384  0
nvme             49152  2
intel_lpss_pci   20480  0
i2c_i801         32768  0
r8169            90112  0
intel_lpss       16384  1 intel_lpss_pci
nvme_core        102400  4 nvme
idma64           20480  0
realtek          24576  1
virt_dma         20480  1 idma64
i2c_hid          28672  0
i2c_nvidia_gpu   16384  0
hid              131072  4 i2c_hid,usbhid,hid_multitouch,hid_generic
pinctrl_cannonlake 36864  0
wmi              32768  3 asus_wmi,wmi_bmf,mxm_wmi
video            49152  2 asus_wmi,i915
pinctrl_intel    28672  1 pinctrl_cannonlake
```

If we search for our module, we can see that it does not exist yet (**lsmod | grep hello**):

```
1 pinctrl_cannonlake
exemplu$ lsmod | grep hello
exemplu$ S
```

To insert our module we need to execute “**sudo insmod ./hello.ko**”. If we execute the grep again we will find our module there:

```
drondur@ROG:~/Desktop/IEP/lab8/exemplu$ sudo insmod ./hello.ko
drondur@ROG:~/Desktop/IEP/lab8/exemplu$ lsmod | grep hello
hello              16384  0
drondur@ROG:~/Desktop/IEP/lab8/exemplu$
```

To check if our module works we can execute this command **“dmesg”**:

```
drondur@ROG:~/Desktop/IEP/lab8/exemplu$ dmesg | grep "world"
[ 2117.576363] hello, world!
[ 3223.019568] goodbye world
[ 3404.315654] hello, world!
```

Also, to remove this module, you must execute the following command: **“sudo rmmod hello”**.