

AOS Assignment 4

Linux Kernel Module

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Step 1

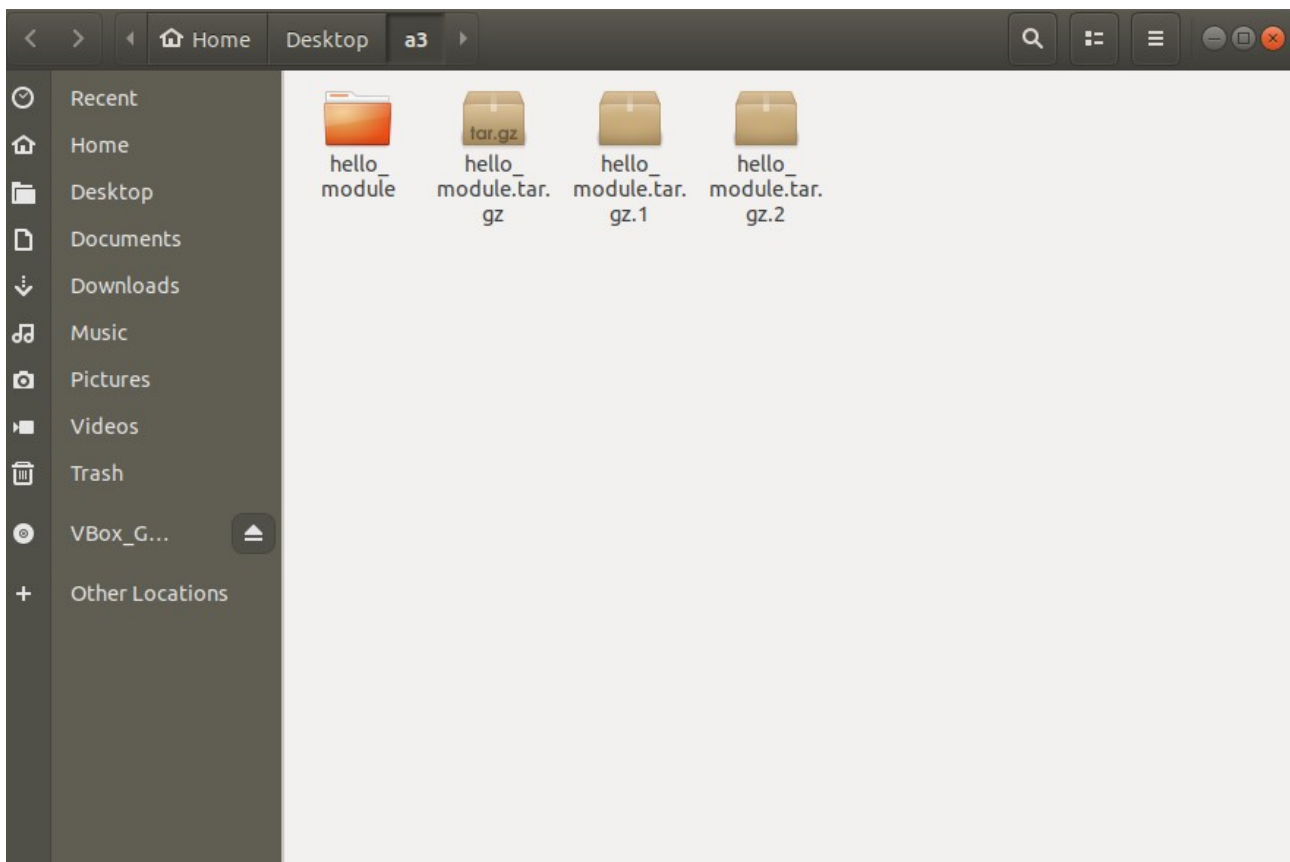
Necessary libraries are installed using the following commands in the terminal.

```
sudo apt update  
sudo apt upgrade  
sudo apt install make binutils gcc
```

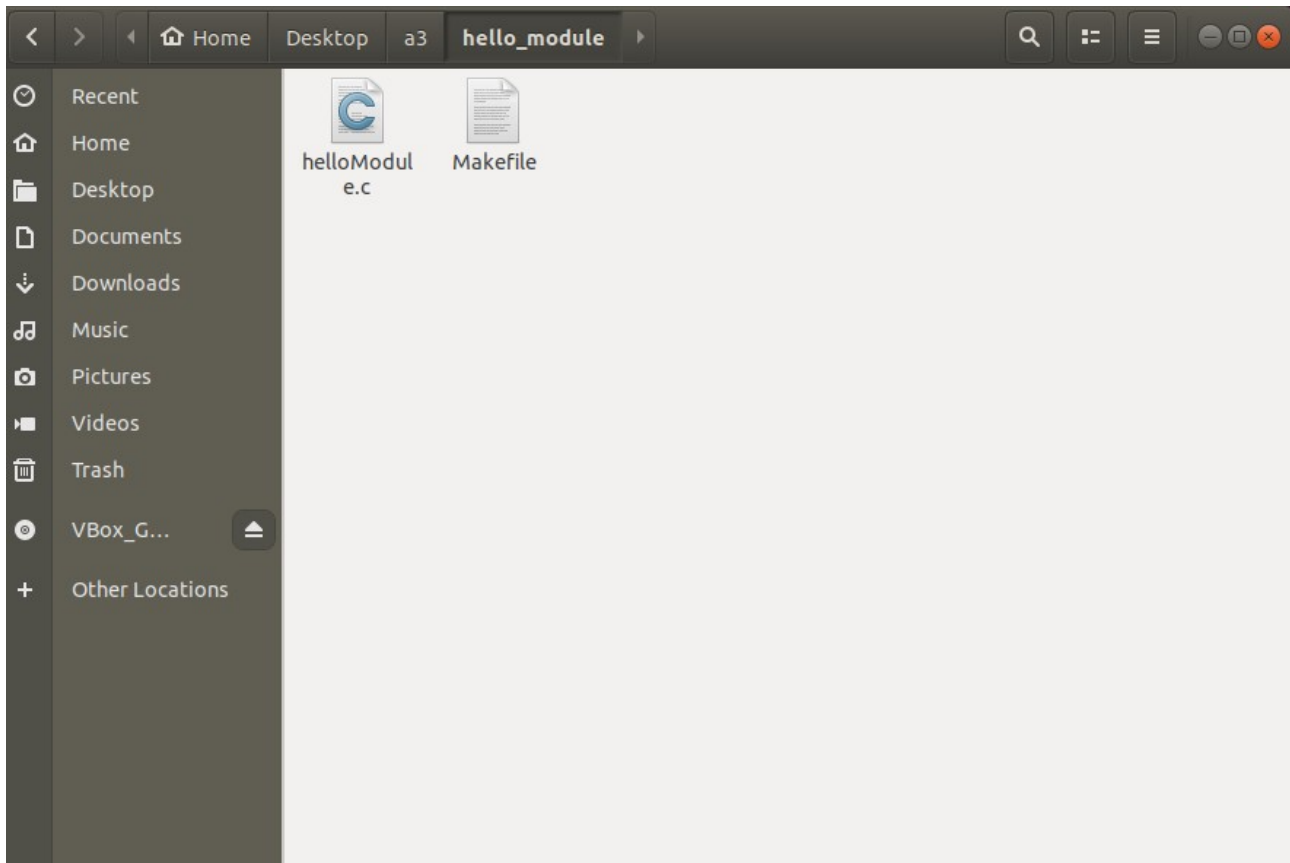
Step 2

A directory named a3 is made. Inside a3 hello_module.tar.gz is downloaded and unzipped

```
mkdir a3  
cd a3  
wget http://faculty.washington.edu/wlloyd/courses/tcss422/assignments/hello_module.tar.gz  
tar xzf hello_module.tar.gz
```
















Navigate into hello_module



Step 3

helloModule.c code is changed as shown below, by adding the function count_running_processes()

```
Open ▾  helloModule.c  
~/Desktop/a3/hello_module Save              
  
#include<linux/module.h>  
  
// The following includes are not initially required, but have been included for Assignment #3 - Sp 2020  
#include<linux/sched/signal.h>  
#include<linux/pid_namespace.h>  
#include<linux/cdev.h>  
#include<linux/proc_fs.h>  
#include<linux/slab.h>  
  
int count_running_processes(void){  
    int count = 0;  
    struct task_struct *child;  
    for_each_process(child) count++;  
    return count;  
}  
  
int proc_init (void) {  
    printk(KERN_INFO "helloModule: kernel module initialized\n");  
    printk(KERN_INFO "No of running processes = %d\n", count_running_processes());  
    return 0;  
}  
  
void proc_cleanup(void) {  
    printk(KERN_INFO "helloModule: performing cleanup of module\n");  
}  
  
MODULE_LICENSE("GPL");  
module_init(proc_init);  
module_exit(proc_cleanup);
```

C ▾ Tab Width: 8 ▾ Ln 18, Col 39 ▾ INS

Step 4

Module is compiled using the make command. Makefile is shown below.



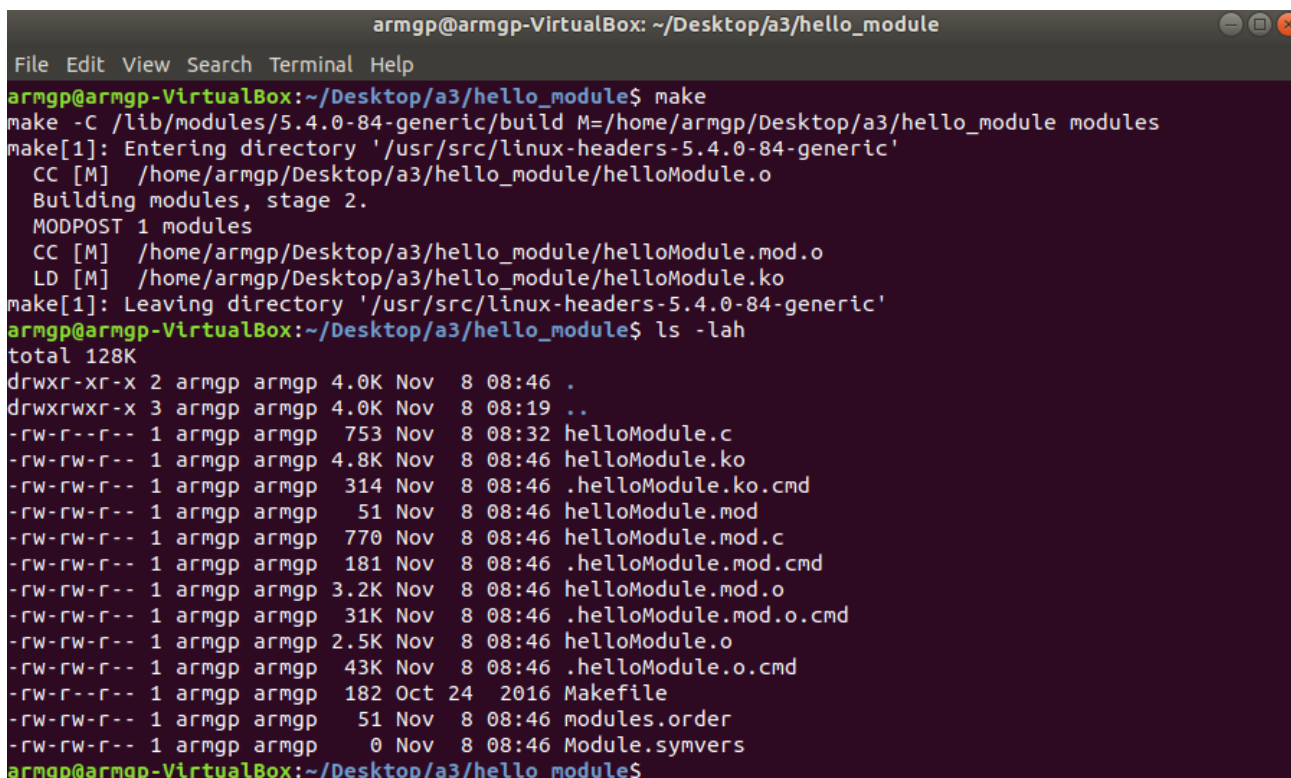
```
Open [icon] Makefile ~/.Desktop/a3/hello_module Save [icon] [icon] [icon]
CONFIG_MODULE_SIG=n

obj-m += helloModule.o

all:
    make -C /lib/modules/$(shell uname -r)/build M=$(PWD) modules

clean:
    make -C /lib/modules/$(shell uname -r)/build M=$(PWD) clean
```

Makefile Tab Width: 8 Ln 1, Col 1 INS



```
armgp@armgp-VirtualBox: ~/.Desktop/a3/hello_module
File Edit View Search Terminal Help
armgp@armgp-VirtualBox:~/.Desktop/a3/hello_module$ make
make -C /lib/modules/5.4.0-84-generic/build M=/home/armgp/Desktop/a3/hello_module modules
make[1]: Entering directory '/usr/src/linux-headers-5.4.0-84-generic'
  CC [M] /home/armgp/Desktop/a3/hello_module/helloModule.o
  Building modules, stage 2.
  MODPOST 1 modules
  CC [M] /home/armgp/Desktop/a3/hello_module/helloModule.mod.o
  LD [M] /home/armgp/Desktop/a3/hello_module/helloModule.ko
make[1]: Leaving directory '/usr/src/linux-headers-5.4.0-84-generic'
armgp@armgp-VirtualBox:~/.Desktop/a3/hello_module$ ls -lah
total 128K
drwxr-xr-x 2 armgp armgp 4.0K Nov  8 08:46 .
drwxrwxr-x 3 armgp armgp 4.0K Nov  8 08:19 ..
-rw-r--r-- 1 armgp armgp 753 Nov  8 08:32 helloModule.c
-rw-rw-r-- 1 armgp armgp 4.8K Nov  8 08:46 helloModule.ko
-rw-rw-r-- 1 armgp armgp 314 Nov  8 08:46 .helloModule.ko.cmd
-rw-rw-r-- 1 armgp armgp  51 Nov  8 08:46 helloModule.mod
-rw-rw-r-- 1 armgp armgp 770 Nov  8 08:46 helloModule.mod.c
-rw-rw-r-- 1 armgp armgp 181 Nov  8 08:46 .helloModule.mod.cmd
-rw-rw-r-- 1 armgp armgp 3.2K Nov  8 08:46 helloModule.mod.o
-rw-rw-r-- 1 armgp armgp 31K Nov  8 08:46 .helloModule.mod.o.cmd
-rw-rw-r-- 1 armgp armgp 2.5K Nov  8 08:46 helloModule.o
-rw-rw-r-- 1 armgp armgp 43K Nov  8 08:46 .helloModule.o.cmd
-rw-r--r-- 1 armgp armgp 182 Oct 24 2016 Makefile
-rw-rw-r-- 1 armgp armgp  51 Nov  8 08:46 modules.order
-rw-rw-r-- 1 armgp armgp   0 Nov  8 08:46 Module.symvers
armgp@armgp-VirtualBox:~/.Desktop/a3/hello_module$
```

Step 5

Kernel object file is loaded.

```
armgp@armgp-VirtualBox: ~/Desktop/a3/hello_module
File Edit View Search Terminal Help
armgp@armgp-VirtualBox:~/Desktop/a3/hello_module$ sudo insmod helloModule.ko
armgp@armgp-VirtualBox:~/Desktop/a3/hello_module$ modinfo helloModule.ko
filename:      /home/armgp/Desktop/a3/hello_module/helloModule.ko
license:       GPL
srcversion:    B18E4DECAC590A9CC1C03BC
depends:
retpoline:     Y
name:          helloModule
vermagic:      5.4.0-84-generic SMP mod_unload modversions
armgp@armgp-VirtualBox:~/Desktop/a3/hello_module$
```

Last 10 lines of Kernel logs is checked using the tail command.

```
armgp@armgp-VirtualBox: ~/Desktop/a3/hello_module
File Edit View Search Terminal Help
armgp@armgp-VirtualBox:~/Desktop/a3/hello_module$ tail -n 10 /var/log/kern.log
Nov  8 08:33:09 armgp-VirtualBox kernel: [ 1265.411628] No of running processes = 234
Nov  8 08:36:28 armgp-VirtualBox kernel: [ 1464.610169] helloModule: performing cleanup of module
Nov  8 08:37:58 armgp-VirtualBox kernel: [ 1553.978220] helloModule: kernel module initialized
Nov  8 08:37:58 armgp-VirtualBox kernel: [ 1553.978253] No of running processes = 239
Nov  8 08:38:40 armgp-VirtualBox kernel: [ 1596.506537] helloModule: performing cleanup of module
Nov  8 08:48:08 armgp-VirtualBox kernel: [ 2163.514902] helloModule: kernel module initialized
Nov  8 08:48:08 armgp-VirtualBox kernel: [ 2163.514932] No of running processes = 241
Nov  8 08:48:48 armgp-VirtualBox kernel: [ 2203.455008] helloModule: performing cleanup of module
Nov  8 08:48:52 armgp-VirtualBox kernel: [ 2207.726261] helloModule: kernel module initialized
Nov  8 08:48:52 armgp-VirtualBox kernel: [ 2207.726291] No of running processes = 241
armgp@armgp-VirtualBox:~/Desktop/a3/hello_module$
```

Step 6

Kernel module is unloaded and kernel logs and syslog is checked.

```
armgp@armgp-VirtualBox: ~/Desktop/a3/hello_module
File Edit View Search Terminal Help
armgp@armgp-VirtualBox:~/Desktop/a3/hello_module$ sudo rmmod helloModule
armgp@armgp-VirtualBox:~/Desktop/a3/hello_module$ tail -n 10 /var/log/kern.log
Nov  8 08:36:28 armgp-VirtualBox kernel: [ 1464.610169] helloModule: performing cleanup of module
Nov  8 08:37:58 armgp-VirtualBox kernel: [ 1553.978220] helloModule: kernel module initialized
Nov  8 08:37:58 armgp-VirtualBox kernel: [ 1553.978253] No of running processes = 239
Nov  8 08:38:40 armgp-VirtualBox kernel: [ 1596.506537] helloModule: performing cleanup of module
Nov  8 08:48:08 armgp-VirtualBox kernel: [ 2163.514902] helloModule: kernel module initialized
Nov  8 08:48:08 armgp-VirtualBox kernel: [ 2163.514932] No of running processes = 241
Nov  8 08:48:48 armgp-VirtualBox kernel: [ 2203.455008] helloModule: performing cleanup of module
Nov  8 08:48:52 armgp-VirtualBox kernel: [ 2207.726261] helloModule: kernel module initialized
Nov  8 08:48:52 armgp-VirtualBox kernel: [ 2207.726291] No of running processes = 241
Nov  8 08:50:24 armgp-VirtualBox kernel: [ 2300.123607] helloModule: performing cleanup of module
armgp@armgp-VirtualBox:~/Desktop/a3/hello_module$ tail -n 10 /var/log/syslog
Nov  8 08:48:08 armgp-VirtualBox kernel: [ 2163.514902] helloModule: kernel module initialized
Nov  8 08:48:08 armgp-VirtualBox kernel: [ 2163.514932] No of running processes = 241
Nov  8 08:48:09 armgp-VirtualBox org.gnome.Shell.desktop[1515]: Fontconfig warning: Directory/file mtime in the future. New fonts may not be detected.
Nov  8 08:48:40 armgp-VirtualBox org.gnome.Shell.desktop[1515]: Fontconfig warning: Directory/file mtime in the future. New fonts may not be detected.
Nov  8 08:48:48 armgp-VirtualBox kernel: [ 2203.455008] helloModule: performing cleanup of module
Nov  8 08:48:52 armgp-VirtualBox kernel: [ 2207.726261] helloModule: kernel module initialized
Nov  8 08:48:52 armgp-VirtualBox kernel: [ 2207.726291] No of running processes = 241
Nov  8 08:49:11 armgp-VirtualBox org.gnome.Shell.desktop[1515]: Fontconfig warning: Directory/file mtime in the future. New fonts may not be detected.
Nov  8 08:50:13 armgp-VirtualBox org.gnome.Shell.desktop[1515]: message repeated 2 times: [ Fontconfig warning: Directory/file mtime in the future. New fonts may not be detected.]
Nov  8 08:50:24 armgp-VirtualBox kernel: [ 2300.123607] helloModule: performing cleanup of module
armgp@armgp-VirtualBox:~/Desktop/a3/hello_module$
```