

# AOS Assignment 4

## Linux Kernel Module

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### Step 1

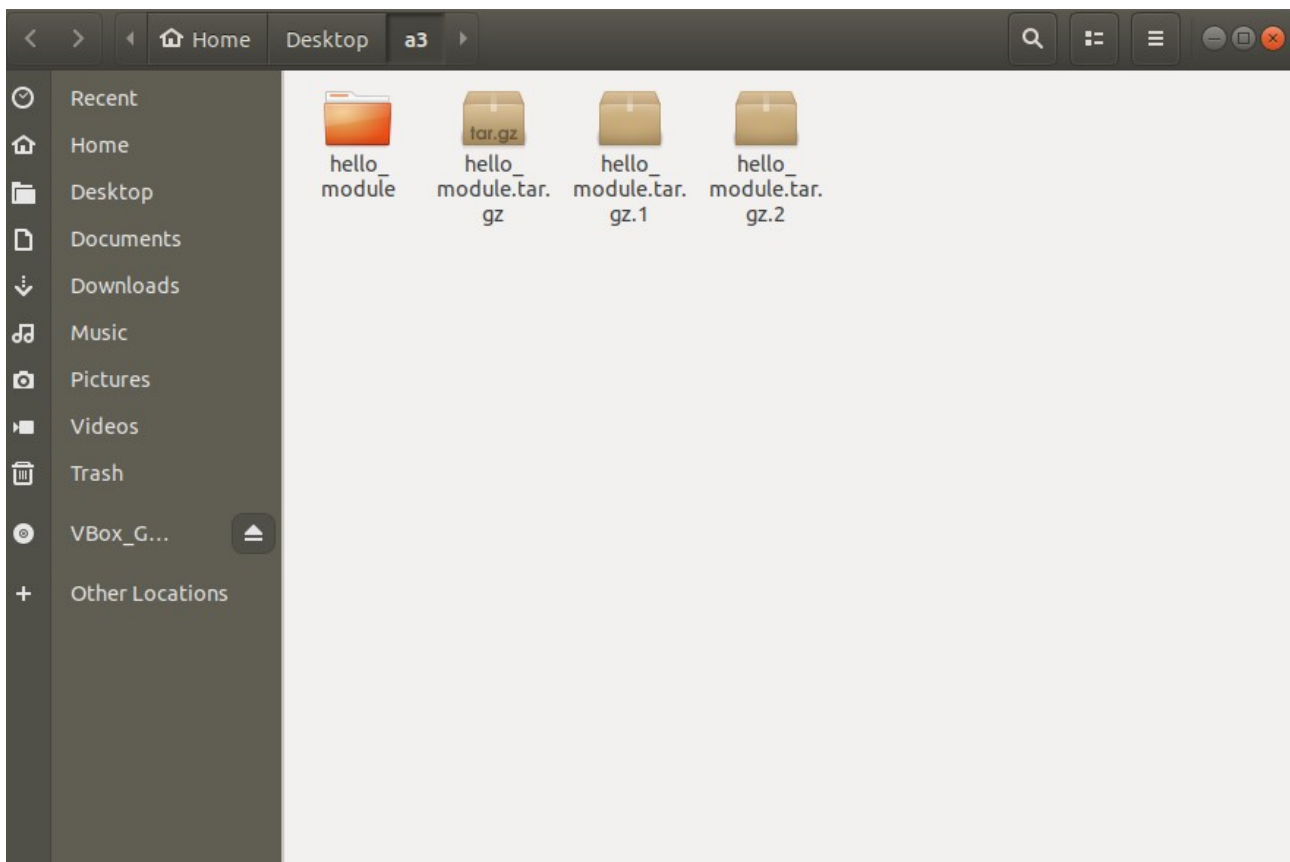
Necessary libraries are installed using the following commands in the terminal.

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

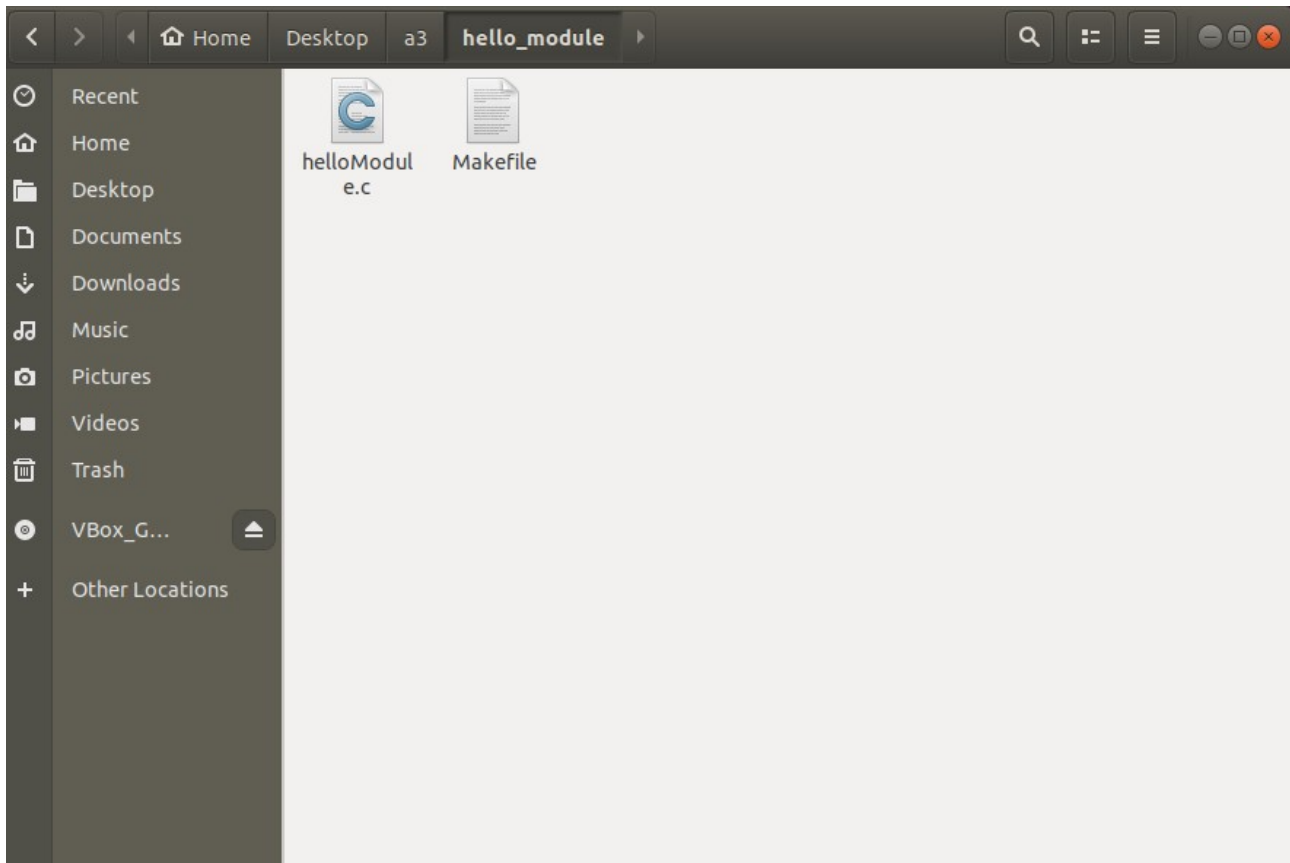
### Step 2

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 | [Icons]

#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>

void count_running_processes(void){
    int count = 0, countRunning = 0, countUninterruptible = 0, countInterruptible = 0;
    struct task_struct *child;
    for_each_process(child) {
        if(child->state == TASK_RUNNING) countRunning++;
        else if(child->state == TASK_UNINTERRUPTIBLE) countUninterruptible++;
        else if(child->state == TASK_INTERRUPTIBLE) countInterruptible++;
        count++;
    }
    printk(KERN_INFO "No of RUNNING processes = %d\n", countRunning);
    printk(KERN_INFO "No of UNINTERRUPTIBLE processes = %d\n", countUninterruptible);
    printk(KERN_INFO "No of INTERRUPTIBLE processes = %d\n", countInterruptible);
    printk(KERN_INFO "Total No of processes = %d\n", count);
}

int proc_init (void) {
    printk(KERN_INFO "helloModule: kernel module initialized\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);
```

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## Step 4

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

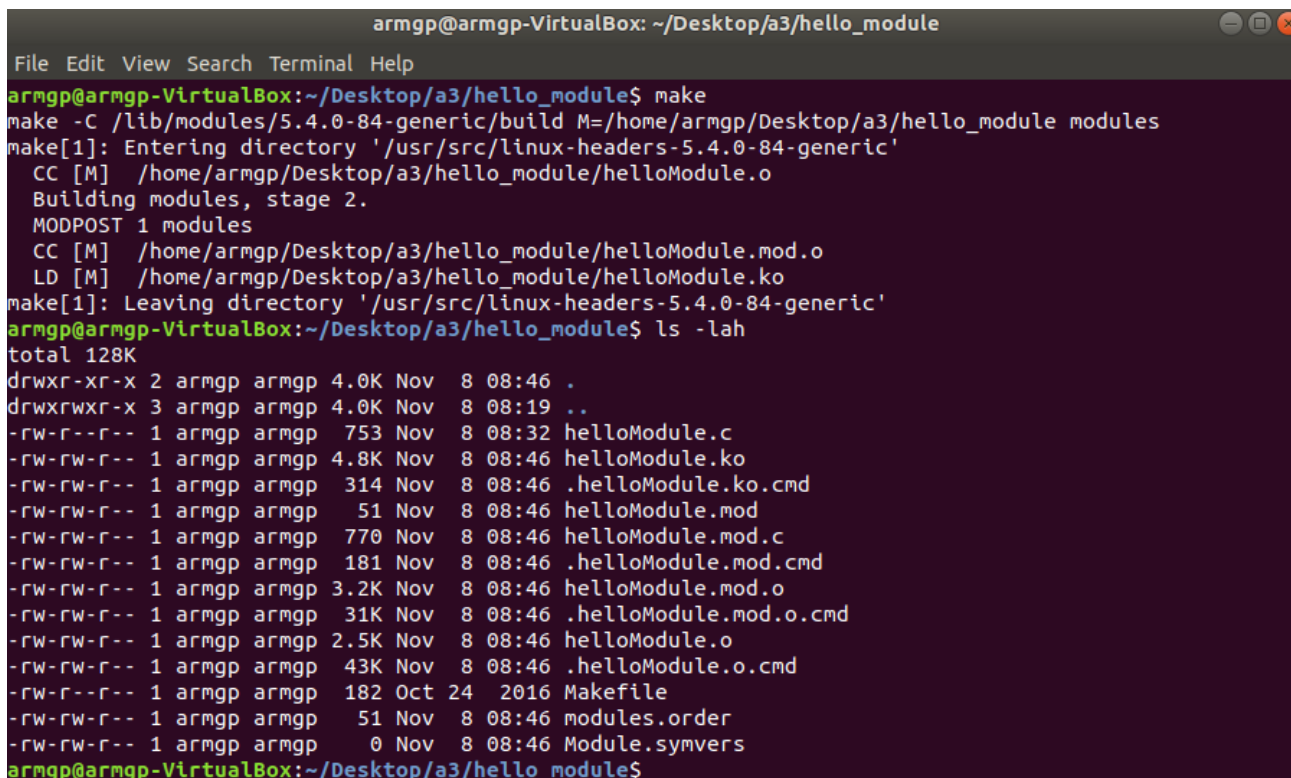


```
CONFIG_MODULE_SIG=n

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
```



```
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:    B18E4DEAC590A9CC1C03BC
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  9 20:29:07 armgp-VirtualBox kernel: [ 1014.951417] No of RUNNING processes = 1
Nov  9 20:29:07 armgp-VirtualBox kernel: [ 1014.951418] No of UNINTERRUPTIBLE processes = 1
Nov  9 20:29:07 armgp-VirtualBox kernel: [ 1014.951419] No of INTERRUPTIBLE processes = 194
Nov  9 20:29:07 armgp-VirtualBox kernel: [ 1014.951419] Total No of processes = 232
Nov  9 20:34:23 armgp-VirtualBox kernel: [ 1331.837113] helloModule: performing cleanup of module
Nov  9 20:40:07 armgp-VirtualBox kernel: [ 1675.275762] helloModule: kernel module initialized
Nov  9 20:40:07 armgp-VirtualBox kernel: [ 1675.275787] No of RUNNING processes = 1
Nov  9 20:40:07 armgp-VirtualBox kernel: [ 1675.275788] No of UNINTERRUPTIBLE processes = 0
Nov  9 20:40:07 armgp-VirtualBox kernel: [ 1675.275788] No of INTERRUPTIBLE processes = 196
Nov  9 20:40:07 armgp-VirtualBox kernel: [ 1675.275788] Total No of processes = 234
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  9 20:29:07 armgp-VirtualBox kernel: [ 1014.951418] No of UNINTERRUPTIBLE processes = 1
Nov  9 20:29:07 armgp-VirtualBox kernel: [ 1014.951419] No of INTERRUPTIBLE processes = 194
Nov  9 20:29:07 armgp-VirtualBox kernel: [ 1014.951419] Total No of processes = 232
Nov  9 20:34:23 armgp-VirtualBox kernel: [ 1331.837113] helloModule: performing cleanup of module
Nov  9 20:40:07 armgp-VirtualBox kernel: [ 1675.275762] helloModule: kernel module initialized
Nov  9 20:40:07 armgp-VirtualBox kernel: [ 1675.275787] No of RUNNING processes = 1
Nov  9 20:40:07 armgp-VirtualBox kernel: [ 1675.275788] No of UNINTERRUPTIBLE processes = 0
Nov  9 20:40:07 armgp-VirtualBox kernel: [ 1675.275788] No of INTERRUPTIBLE processes = 196
Nov  9 20:40:07 armgp-VirtualBox kernel: [ 1675.275788] Total No of processes = 234
Nov  9 20:41:49 armgp-VirtualBox kernel: [ 1777.500709] helloModule: performing cleanup of module
armgp@armgp-VirtualBox:~/Desktop/a3/hello_module$ tail -n 10 /var/log/syslog
Nov  9 20:40:53 armgp-VirtualBox dbus-daemon[10532]: [session uid=1000 pid=10532] Activating service name='org.gnome.Screenshot' requested by ':1.13' (uid=1000 pid=10712 comm="/usr/bin/gnome-shell" label="unconfined")
Nov  9 20:40:53 armgp-VirtualBox dbus-daemon[10532]: [session uid=1000 pid=10532] Successfully activated service 'org.gnome.Screenshot'
Nov  9 20:40:53 armgp-VirtualBox nautilus[11055]: g_queue_foreach: assertion 'queue != NULL' failed
Nov  9 20:40:53 armgp-VirtualBox nautilus[11055]: g_queue_free: assertion 'queue != NULL' failed
Nov  9 20:40:53 armgp-VirtualBox nautilus[11055]: Source ID 53711 was not found when attempting to remove it
Nov  9 20:40:56 armgp-VirtualBox dbus-daemon[500]: [system] Activating via systemd: service name='org.freedesktop.hostname1' unit='dbus-org.freedesktop.hostname1.service' requested by ':1.166' (uid=1000 pid=15698 comm="/usr/bin/gnome-screenshot --application-service" label="unconfined")
Nov  9 20:40:56 armgp-VirtualBox systemd[1]: Starting Hostname Service...
Nov  9 20:40:56 armgp-VirtualBox dbus-daemon[500]: [system] Successfully activated service 'org.freedesktop.hostname1'
Nov  9 20:40:56 armgp-VirtualBox systemd[1]: Started Hostname Service.
Nov  9 20:41:49 armgp-VirtualBox kernel: [ 1777.500709] helloModule: performing cleanup of module
armgp@armgp-VirtualBox:~/Desktop/a3/hello_module$
```