Add System Call

Step 1: Initially login to cloud server(digitalocean.com) through ssh command and download Kernel(linux-4.17.6 version) file using command : *wget https://www.kernel.org/pub/linux/kernel/v4.x/linux-4.17.6.tar.xz*
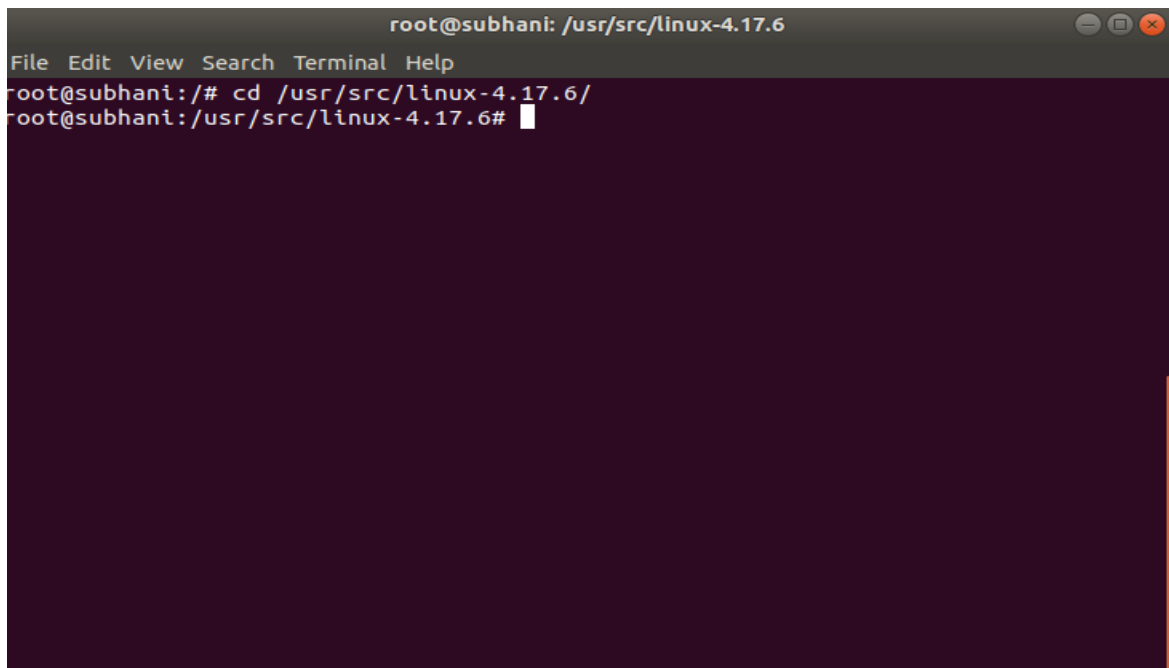
Step 2 : Extract the kernel tar file in */usr/*src/ directory by using command: sudo tar -xvf linux-4.17.6.tar.xz -C */usr/*src/

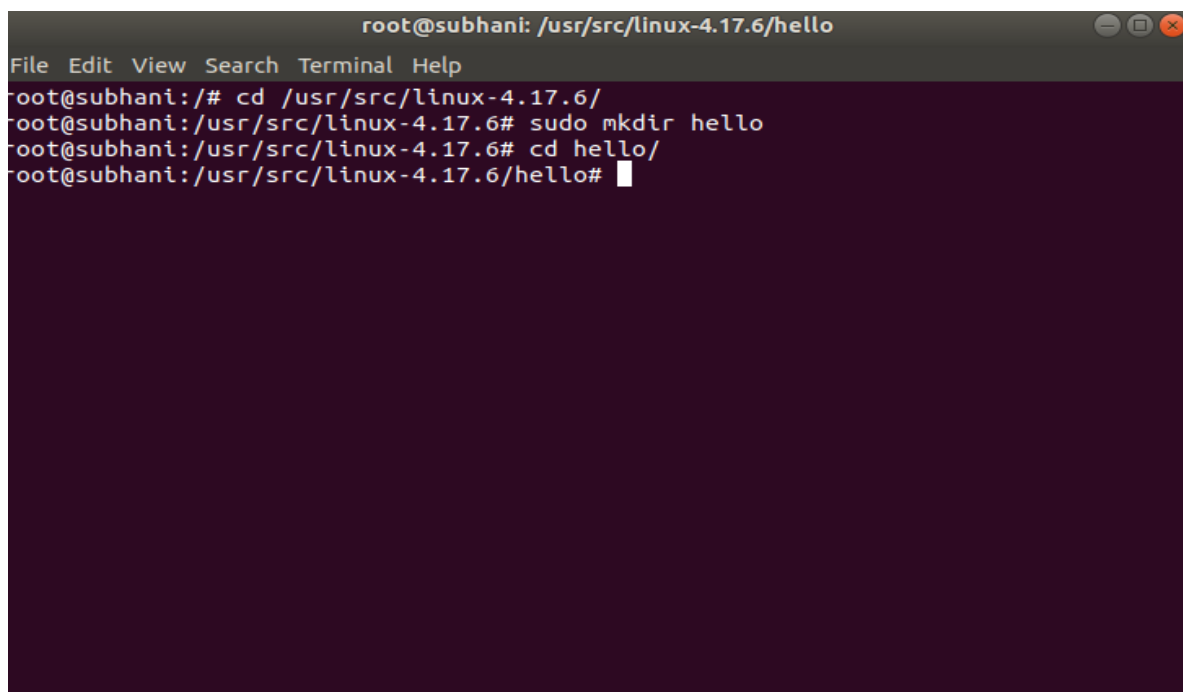**<u>Step 3</u> :** change present working directory to extracted directory by using command: *cd /usr/src/linux-4.17.6/*
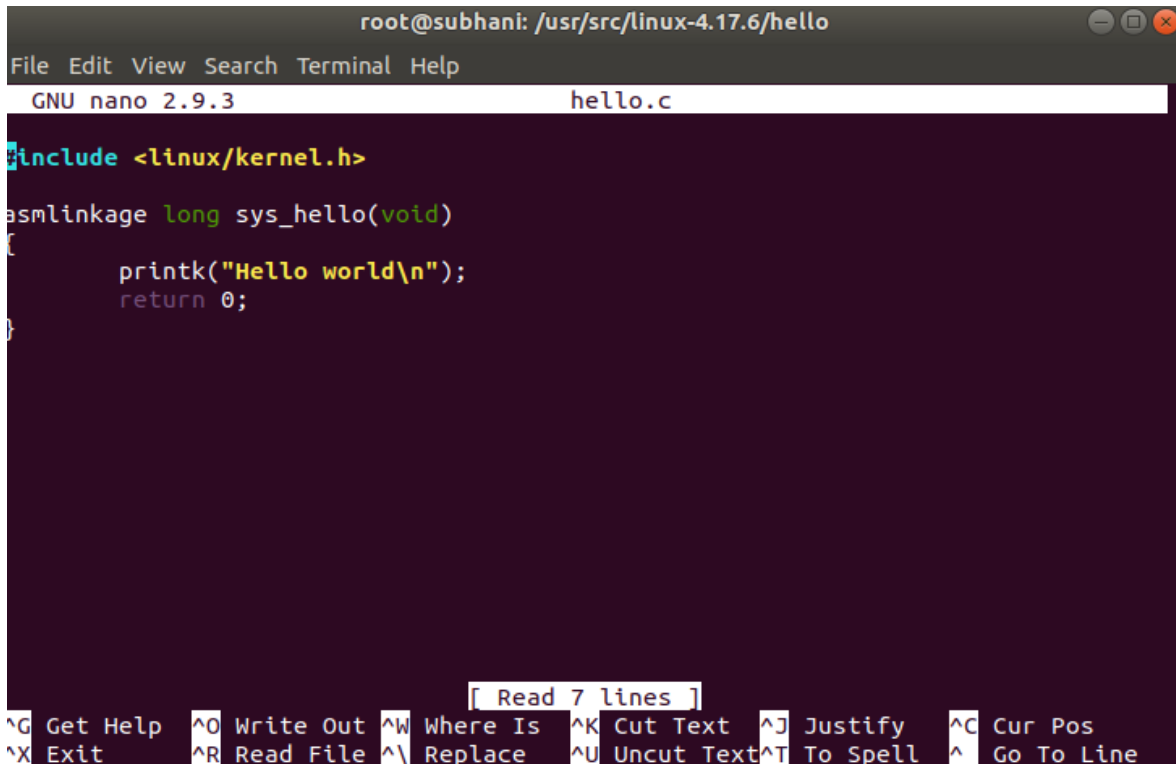
<u>Step 4</u> : Create a folder 'hello' to create a new system call by using command: *sudo mkdir hello* and change directory to that hello folder by command *cd hello/*

Step 5 : Create a new system call sys_hello by using command: *sudo nano sys_hello* and write the system call by using nano editor to print "Hello world" and save it.

Step 6 : Create a makefile in hello folder to invoke sys_hello system call by using nano editor.
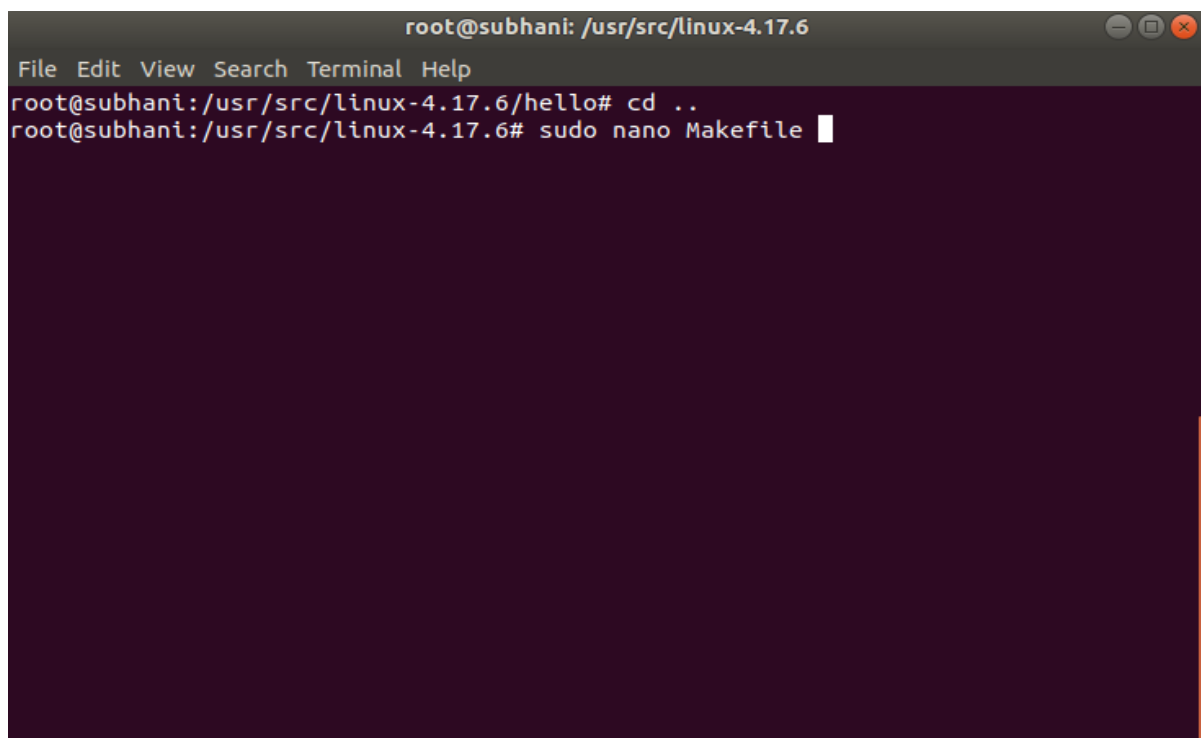
File Edit View Search Terminal Help

```
  GNU nano 2.9.3                         Makefile                        Modified

obj-y := hello.o
```

[New File]

```
^G Get Help    ^O Write Out ^W Where Is   ^K Cut Text   ^J Justify    ^C Cur Pos
^X Exit        ^R Read File ^\ Replace    ^U Uncut Text^T To Spell    ^  Go To Line
```

Step 7 : Now change directory to linux source and change the
code *core-y += kernel/ mm/ fs/ ipc/ security/ crypto/ block/*
to *core-y += kernel/ mm/ fs/ ipc/ security/ crypto/ block/ hello/*
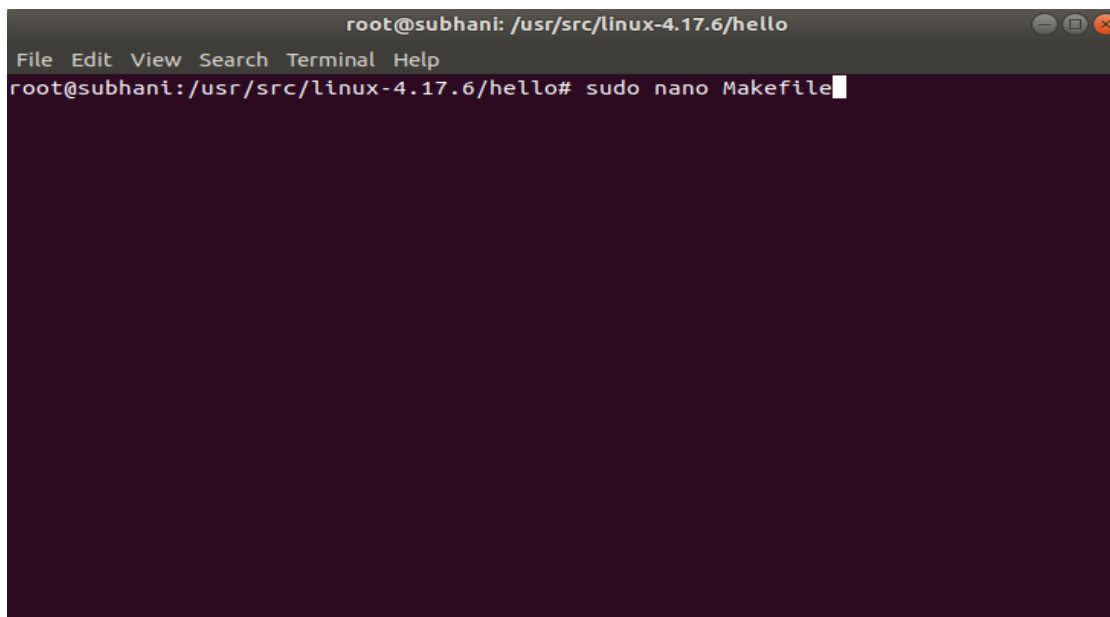
File Edit View Search Terminal Help

```
root@subhani:/usr/src/linux-4.17.6/hello# cd ..
root@subhani:/usr/src/linux-4.17.6# sudo nano Makefile
```

File Edit View Search Terminal Help

```
  GNU nano 2.9.3                          Makefile                          Modified

      $(warning "Cannot use CONFIG_STACK_VALIDATION=y, please install libelf-de$
    endif
    SKIP_STACK_VALIDATION := 1
    export SKIP_STACK_VALIDATION
  endif
endif


ifeq ($(KBUILD_EXTMOD),)
core-y              += kernel/ certs/ mm/ fs/ ipc/ security/ crypto/ block/ hello/

vmlinux-dirs       := $(patsubst %/,%,$(filter %/, $(init-y) $(init-m) \
                      $(core-y) $(core-m) $(drivers-y) $(drivers-m) \
                      $(net-y) $(net-m) $(libs-y) $(libs-m) $(virt-y)))

vmlinux-alldirs := $(sort $(vmlinux-dirs) $(patsubst %/,%,$(filter %/, \
                      $(init-) $(core-) $(drivers-) $(net-) $(libs-) $(virt-))))

init-y             := $(patsubst %/, %/built-in.a, $(init-y))
File Name to Write: Makefile
^G Get Help        M-D DOS Format     M-A Append        M-B Backup File
^C Cancel          M-M Mac Format     M-P Prepend       ^T To Files
```

Step 8 : Now change the directory to *arch/x86/entry/syscalls* to edit *syscall_64.tbl*
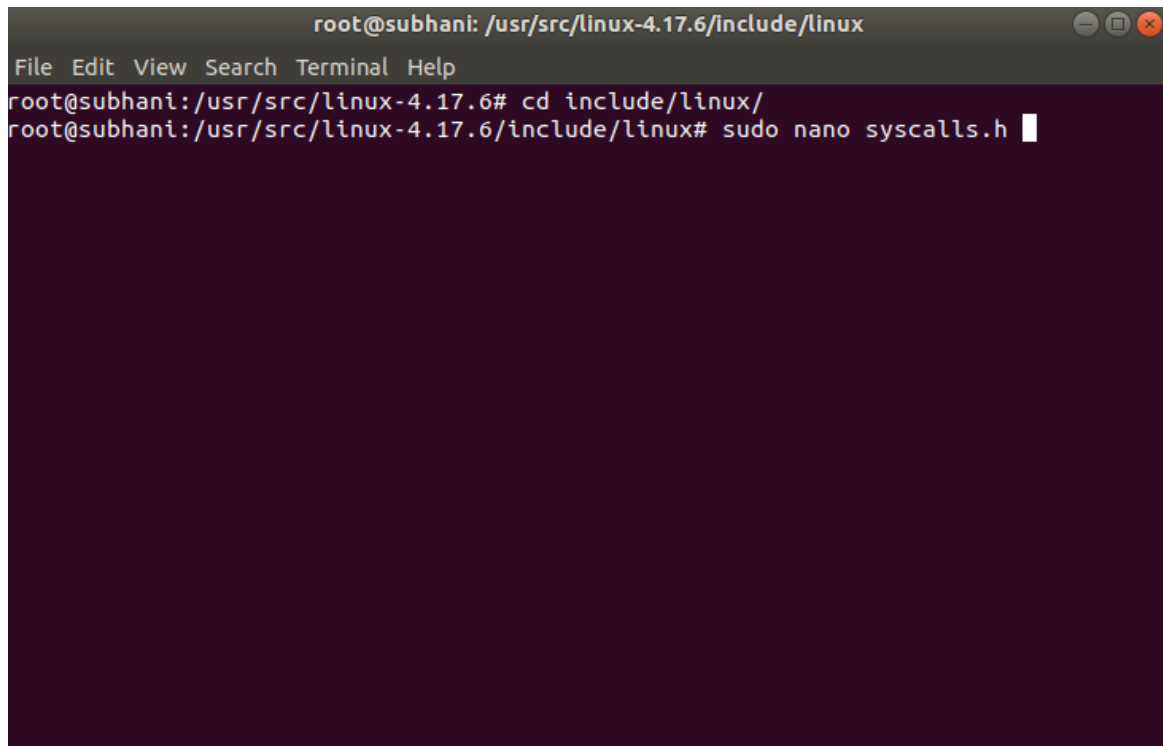
File Edit View Search Terminal Help

```
root@subhani:/usr/src/linux-4.17.6/hello# cd ..
root@subhani:/usr/src/linux-4.17.6# sudo nano Makefile
root@subhani:/usr/src/linux-4.17.6# cd arch/x86/entry/syscalls/
```

add new line –   *333   64   hell0   sys_hello*

Step 9: Now change directory to */include/linux* and edit *syscalls.h*

add our new system call *asmlinkage long sys_hello(void);*

Step 10 : Install gcc, libncurses5-dev, bison, flex, libssl-dev, libelf-dev, make and then update and upgrade the system by using commands.

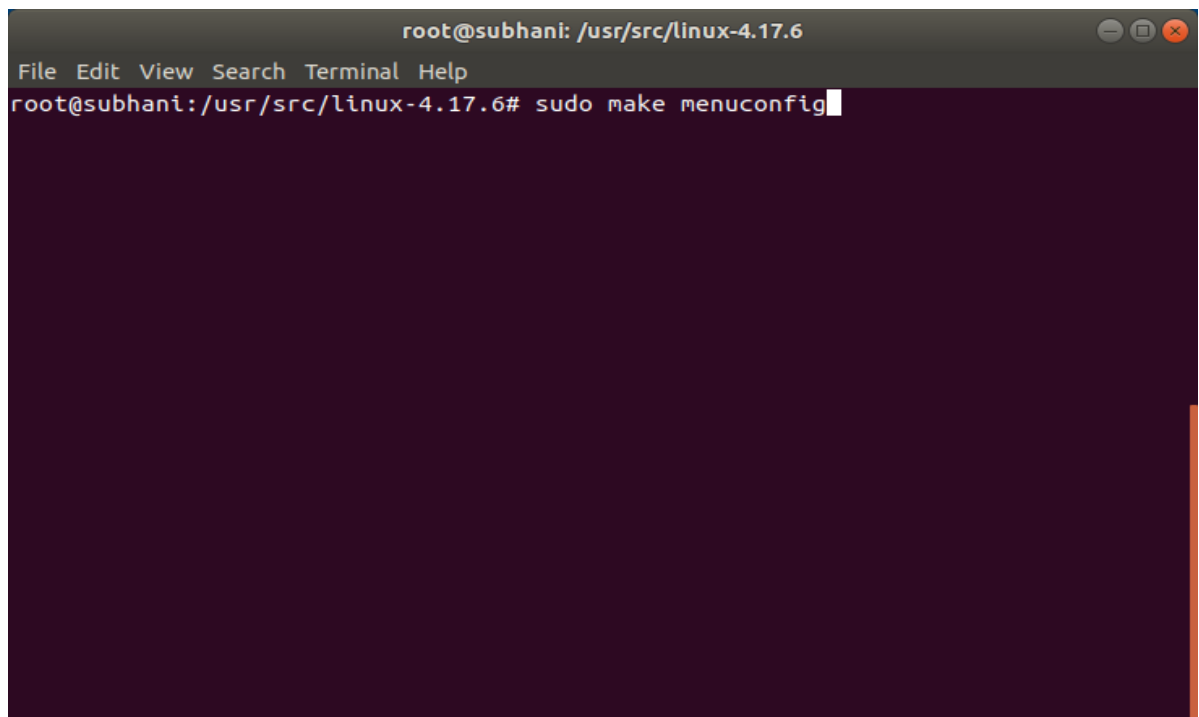   *sudo apt-get install gcc libncurses5-dev bison flex libssl-dev libelf-dev make*

    sudo apt-get update
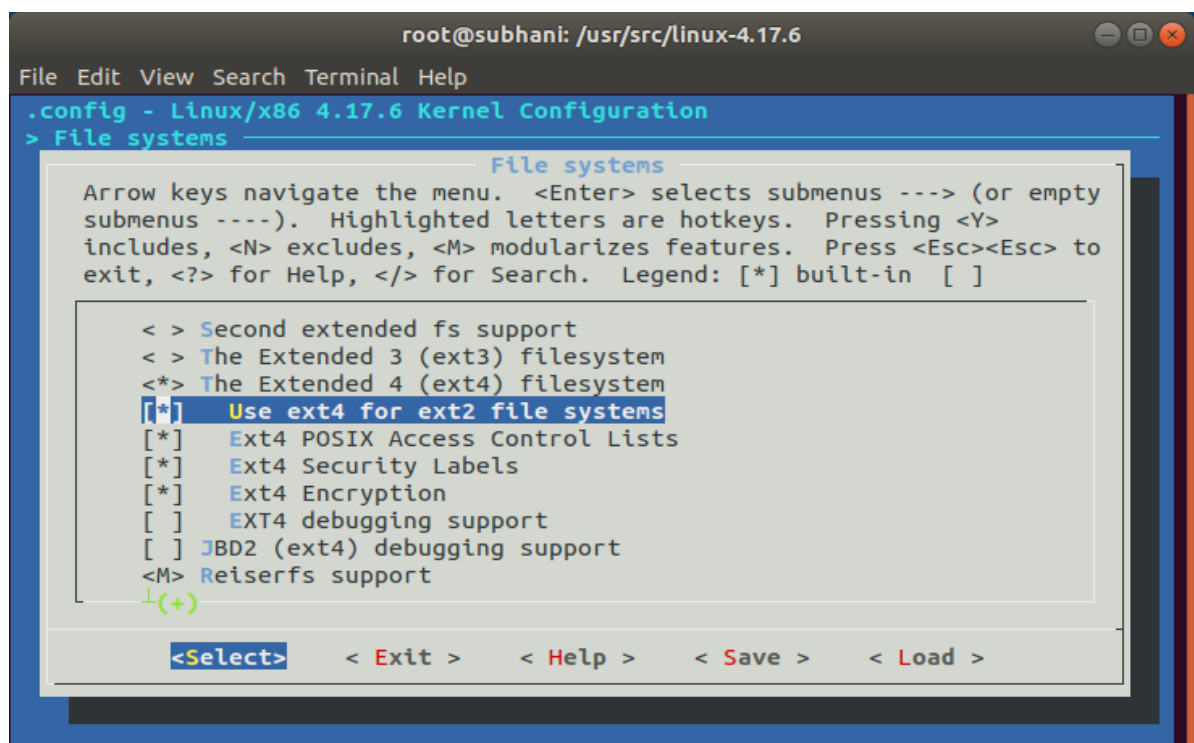   *sudo apt-get upgrade*

```
root@subhani: /usr/src/linux-4.17.6/include/linux

File  Edit  View  Search  Terminal  Help
root@subhani:/usr/src/linux-4.17.6/include/linux# sudo apt-get install gcc
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following package was automatically installed and is no longer required:
  grub-pc-bin
Use 'sudo apt autoremove' to remove it.
The following additional packages will be installed:
  binutils binutils-common binutils-x86-64-linux-gnu cpp cpp-7 gcc-7
  gcc-7-base libasan4 libatomic1 libbinutils libc-dev-bin libc6-dev libcc1-0
  libcilkrts5 libgcc-7-dev libgomp1 libisl19 libitm1 liblsan0 libmpc3 libmpx2
  libquadmath0 libtsan0 libubsan0 linux-libc-dev manpages-dev
Suggested packages:
  binutils-doc cpp-doc gcc-7-locales gcc-multilib make autoconf automake
  libtool flex bison gdb gcc-doc gcc-7-multilib gcc-7-doc libgcc1-dbg
  libgomp1-dbg libitm1-dbg libatomic1-dbg libasan4-dbg liblsan0-dbg
  libtsan0-dbg libubsan0-dbg libcilkrts5-dbg libmpx2-dbg libquadmath0-dbg
  glibc-doc
The following NEW packages will be installed:
  binutils binutils-common binutils-x86-64-linux-gnu cpp cpp-7 gcc gcc-7
  gcc-7-base libasan4 libatomic1 libbinutils libc-dev-bin libc6-dev libcc1-0
  libcilkrts5 libgcc-7-dev libgomp1 libisl19 libitm1 liblsan0 libmpc3 libmpx2
  libquadmath0 libtsan0 libubsan0 linux-libc-dev manpages-dev
0 upgraded, 27 newly installed, 0 to remove and 0 not upgraded.
```

```
root@subhani: /usr/src/linux-4.17.6/include/linux

File  Edit  View  Search  Terminal  Help
root@subhani:/usr/src/linux-4.17.6/include/linux# sudo apt-get install libncurse
s5-dev bison flex bc make libssl-dev libelf-dev
Reading package lists... Done
Building dependency tree
Reading state information... Done
bc is already the newest version (1.07.1-2).
bison is already the newest version (2:3.0.4.dfsg-1build1).
libssl-dev is already the newest version (1.1.0g-2ubuntu4.1).
The following package was automatically installed and is no longer required:
  grub-pc-bin
Use 'sudo apt autoremove' to remove it.
The following additional packages will be installed:
  binutils binutils-common binutils-x86-64-linux-gnu cpp cpp-7 gcc gcc-7
  gcc-7-base libasan4 libatomic1 libbinutils libc-dev-bin libc6-dev libcc1-0
  libcilkrts5 libfl-dev libfl2 libgcc-7-dev libgomp1 libisl19 libitm1 liblsan0
  libmpc3 libmpx2 libquadmath0 libtinfo-dev libtsan0 libubsan0 linux-libc-dev
  manpages-dev zlib1g-dev
Suggested packages:
  binutils-doc cpp-doc gcc-7-locales build-essential flex-doc gcc-multilib
  autoconf automake libtool gdb gcc-doc gcc-7-multilib gcc-7-doc libgcc1-dbg
  libgomp1-dbg libitm1-dbg libatomic1-dbg libasan4-dbg liblsan0-dbg
  libtsan0-dbg libubsan0-dbg libcilkrts5-dbg libmpx2-dbg libquadmath0-dbg
  glibc-doc ncurses-doc make-doc
The following NEW packages will be installed:
```

Step 11 : Make menuconfig

it will prompt a window to select different options. Select filesystem as *ext4* and then exit and save the file.

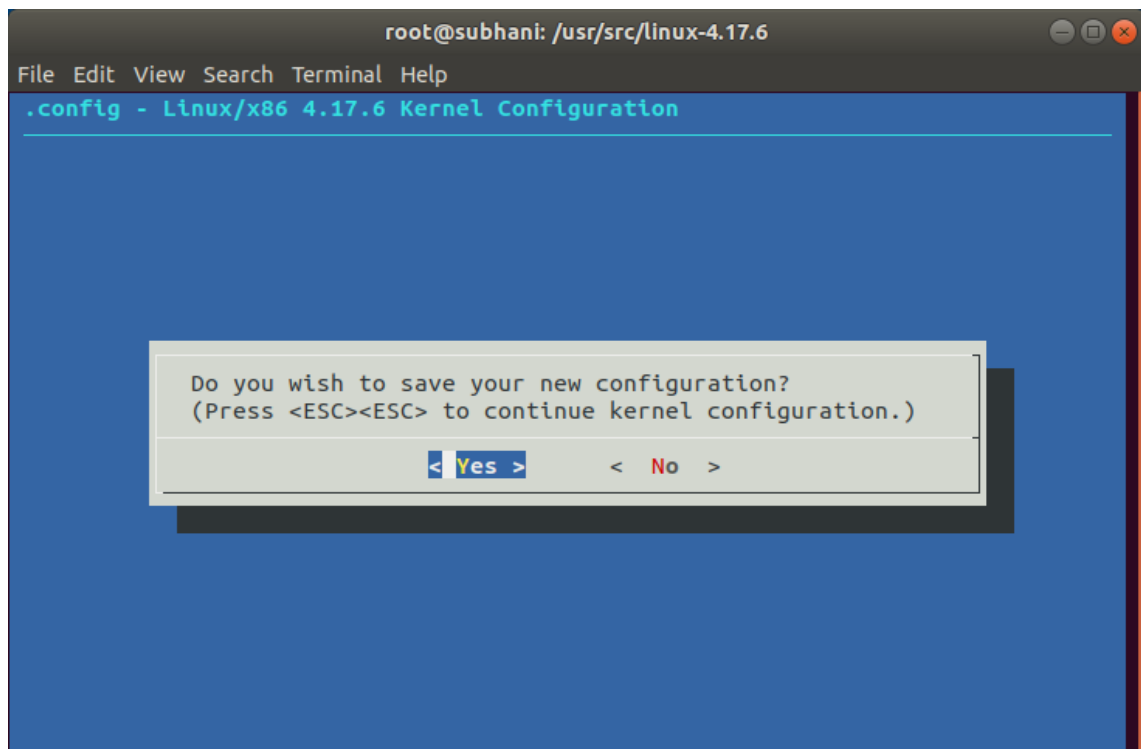**Step 12 :** compile the kernel source code using 6 processes
sudo make -j6 in linux directory.

Step 13 : After make is completed, install the kernel modules by using *sudo make modules_install install*

It will ask for configurations, select according to it
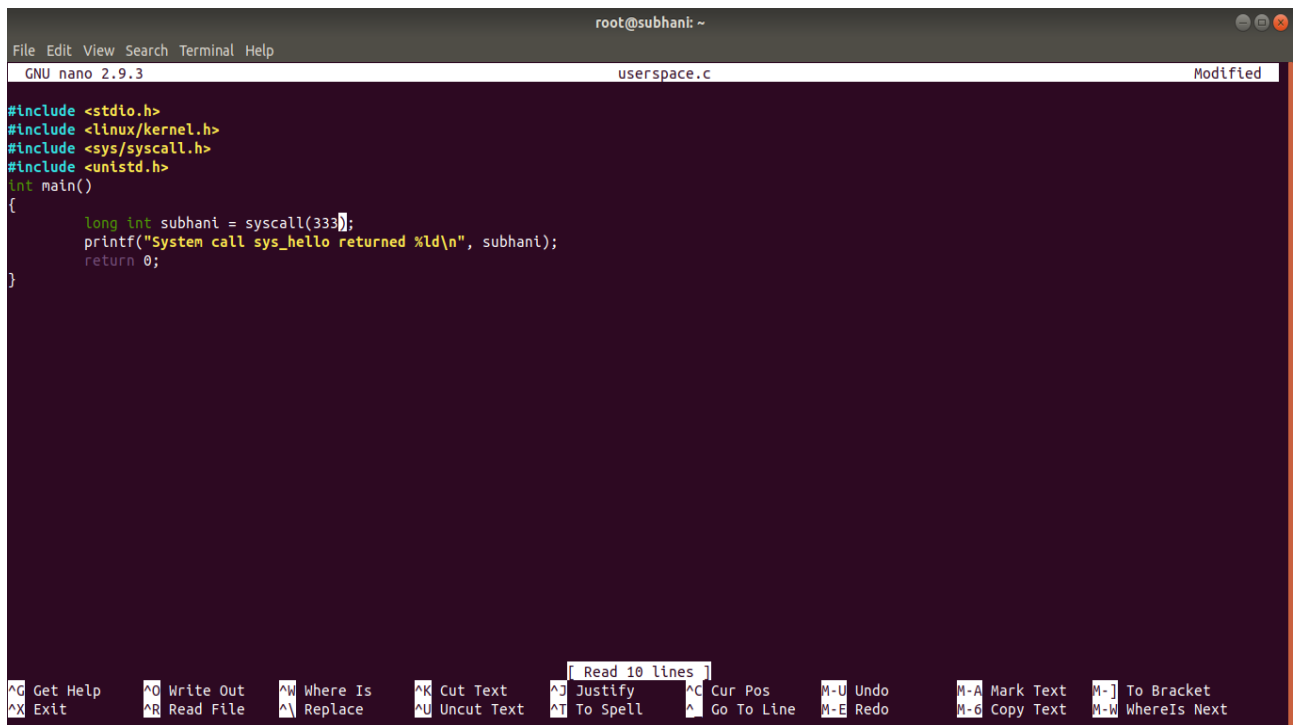
Step 14 : Checking for kernel 4.17.6 module files in boot directory.

Step 15 : Checking installed kernel version by using *uname -a command.*
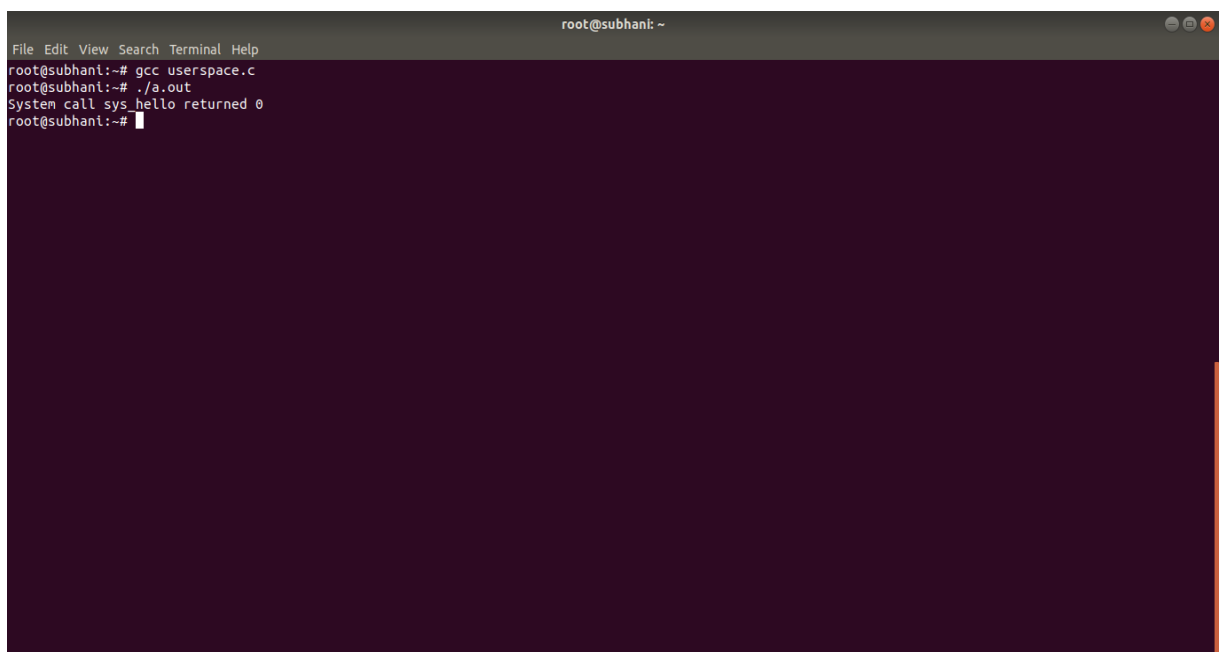
Step 16 : After successful installation of kernel, reboot the system by using command: *shutdown -r now and create a file userspace.c and write the code to invoke our new system_call*


```
#include <stdio.h>
#include <linux/kernel.h>
#include <sys/syscall.h>
#include <unistd.h>
int main()
{
        long int subhani = syscall(333);
        printf("System call sys_hello returned %ld\n", subhani);
        return 0;
}
```

Step 17 : Compile and run the userspace.c program


```
root@subhani:~# gcc userspace.c
root@subhani:~# ./a.out
System call sys_hello returned 0
root@subhani:~#
```

it prints *Hello world and returns 0* in output i.e., our new system call is invoked.

Now by using commande: *dmesg* we can see the kernel log file which prints Hello world.