

**how to add your system call the Linux OS kernel.**

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**To**

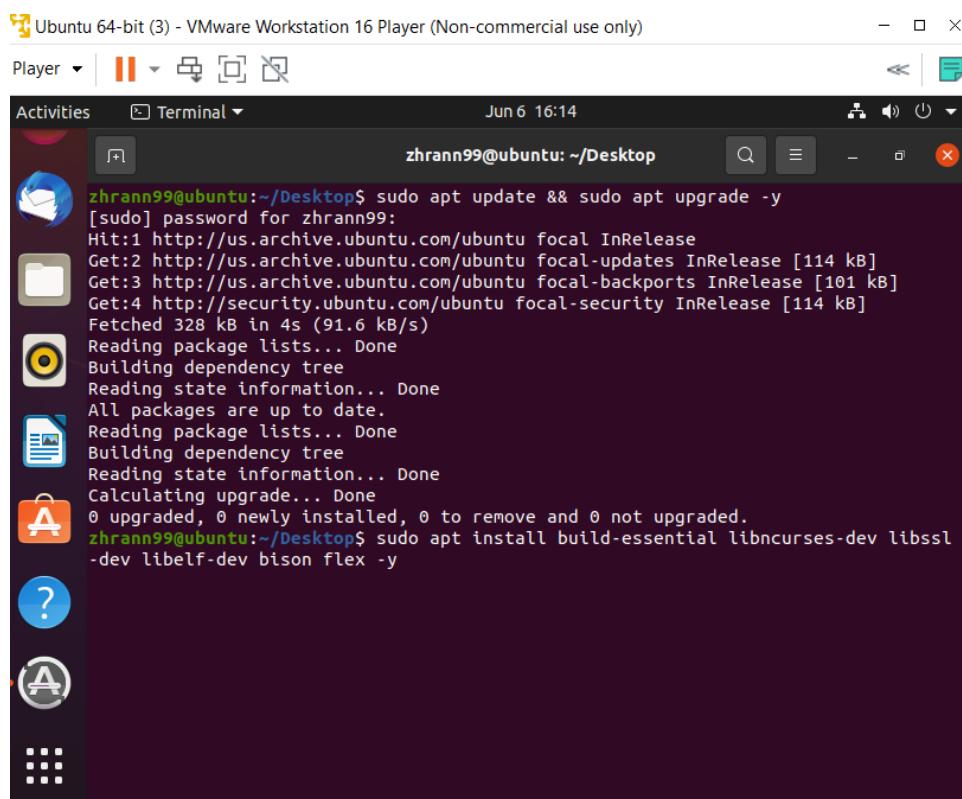
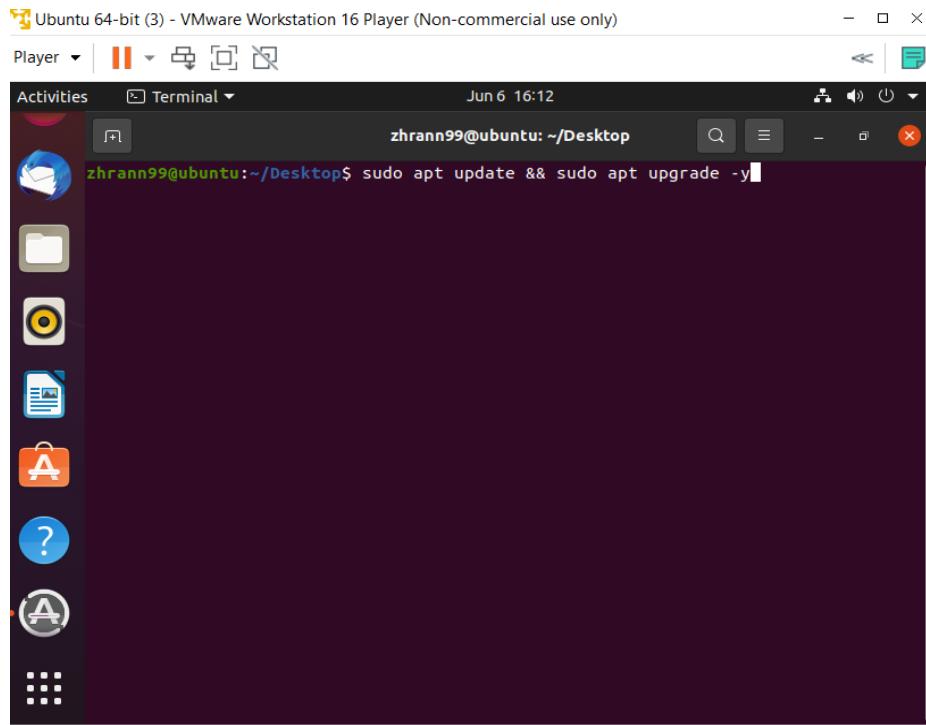
**Dr Samer Shaban AbdelFatah**

**1 - and 2**

*In this section, you will download all necessary tools to add a basic system call to the Linux kernel and run it. This is the only part of the entire process where network connectivity is necessary.*

**1.a** - Fully update your operating system.

**1.b** - Download and install the essential packages to compile kernels.



## 1.c - Download and install the essential packages to compile kernels.

```
Ubuntu 64-bit (3) - VMware Workstation 16 Player (Non-commercial use only)
Player | ||| □ □□ □□□
Activities Terminal ▾ Jun 6 16:14
zhrann99@ubuntu:~/Desktop$ sudo apt update && sudo apt upgrade -y
[sudo] password for zhrann99:
Hit:1 http://us.archive.ubuntu.com/ubuntu focal InRelease
Get:2 http://us.archive.ubuntu.com/ubuntu focal-updates InRelease [114 kB]
Get:3 http://us.archive.ubuntu.com/ubuntu focal-backports InRelease [101 kB]
Get:4 http://security.ubuntu.com/ubuntu focal-security InRelease [114 kB]
Fetched 328 kB in 4s (91.6 kB/s)
Reading package lists... Done
Building dependency tree
Reading state information... Done
All packages are up to date.
Reading package lists... Done
Building dependency tree
Reading state information... Done
Calculating upgrade... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
zhrann99@ubuntu:~/Desktop$ sudo apt install build-essential libncurses-dev libssl-dev libelf-dev bison flex -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
bison is already the newest version (2:3.5.1+dfsg-1).
flex is already the newest version (2.6.4-6.2).
libelf-dev is already the newest version (0.176-1.1build1).
libncurses-dev is already the newest version (6.2-0ubuntu2).
build-essential is already the newest version (12.8ubuntu1.1).
libssl-dev is already the newest version (1.1.1f-1ubuntu2.4).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
zhrann99@ubuntu:~/Desktop$ sudo apt install vim -y
```

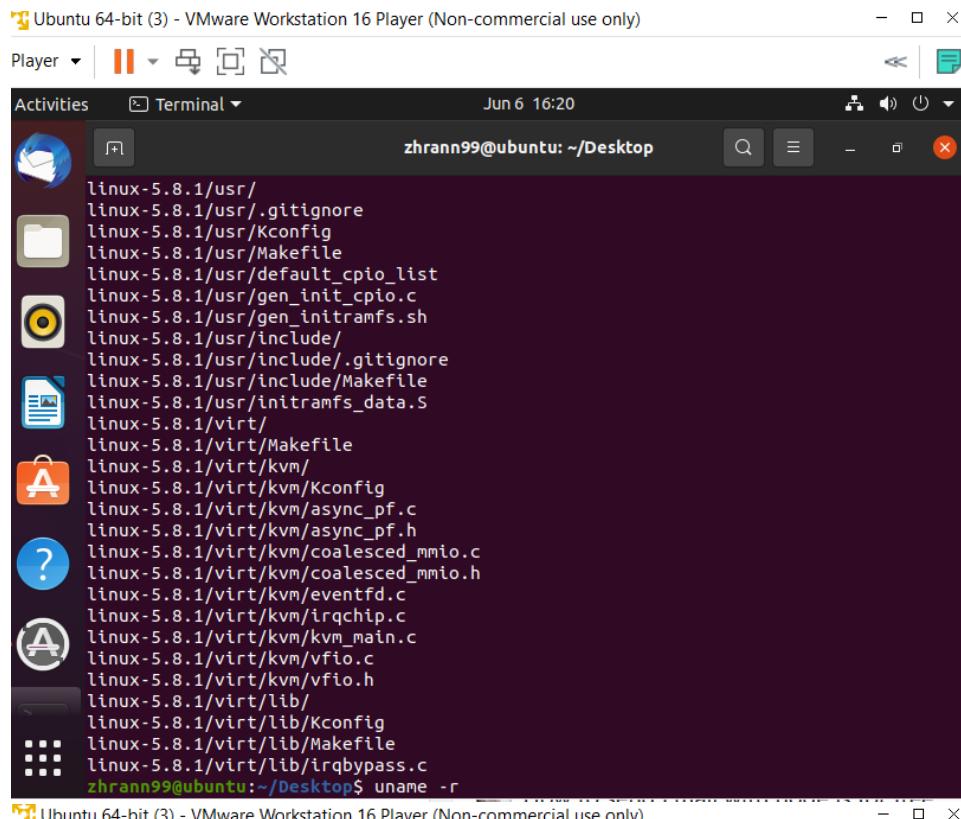
```
Ubuntu 64-bit (3) - VMware Workstation 16 Player (Non-commercial use only)
Player | ||| □ □□ □□□
Activities Terminal ▾ Jun 6 16:15
zhrann99@ubuntu:~/Desktop$ Fetched 328 kB in 4s (91.6 kB/s)
Reading package lists... Done
Building dependency tree
Reading state information... Done
All packages are up to date.
Reading package lists... Done
Building dependency tree
Reading state information... Done
Calculating upgrade... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
zhrann99@ubuntu:~/Desktop$ sudo apt install build-essential libncurses-dev libssl-dev libelf-dev bison flex -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
bison is already the newest version (2:3.5.1+dfsg-1).
flex is already the newest version (2.6.4-6.2).
libelf-dev is already the newest version (0.176-1.1build1).
libncurses-dev is already the newest version (6.2-0ubuntu2).
build-essential is already the newest version (12.8ubuntu1.1).
libssl-dev is already the newest version (1.1.1f-1ubuntu2.4).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
zhrann99@ubuntu:~/Desktop$ sudo apt install vim -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
vim is already the newest version (2:8.1.2269-1ubuntu5).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
zhrann99@ubuntu:~/Desktop$ sudo apt clean && sudo apt autoremove -y
```

## 1.e - Download the source code of the latest stable version and Clean up your installed packages..

```
Ubuntu 64-bit (3) - VMware Workstation 16 Player (Non-commercial use only)
Player ▾ | II ▾ ⌂ ⌃ ⌄ ⌅
Activities Terminal ▾ Jun 6 16:16
zhrann99@ubuntu: ~/Desktop
Reading package lists... Done
Building dependency tree
Reading state information... Done
Calculating upgrade... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
zhrann99@ubuntu:~/Desktop$ sudo apt install build-essential libncurses-dev libssl-dev libelf-dev bison flex -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
bison is already the newest version (2:3.5.1+dfsg-1).
flex is already the newest version (2.6.4-6.2).
libelf-dev is already the newest version (0.176-1.1build1).
libncurses-dev is already the newest version (6.2-0ubuntu2).
build-essential is already the newest version (12.8ubuntu1.1).
libssl-dev is already the newest version (1.1.1f-1ubuntu2.4).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
zhrann99@ubuntu:~/Desktop$ sudo apt install vim -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
V Software Updater is the newest version (2:8.1.2269-1ubuntu5).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
zhrann99@ubuntu:~/Desktop$ sudo apt clean && sudo apt autoremove -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
zhrann99@ubuntu:~/Desktop$
```

```
Ubuntu 64-bit (3) - VMware Workstation 16 Player (Non-commercial use only)
Player ▾ | II ▾ ⌂ ⌃ ⌄ ⌅
Activities Terminal ▾ Jun 6 16:16
zhrann99@ubuntu: ~/Desktop
Building dependency tree
Reading state information... Done
Calculating upgrade... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
zhrann99@ubuntu:~/Desktop$ sudo apt install build-essential libncurses-dev libssl-dev libelf-dev bison flex -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
bison is already the newest version (2:3.5.1+dfsg-1).
flex is already the newest version (2.6.4-6.2).
libelf-dev is already the newest version (0.176-1.1build1).
libncurses-dev is already the newest version (6.2-0ubuntu2).
build-essential is already the newest version (12.8ubuntu1.1).
libssl-dev is already the newest version (1.1.1f-1ubuntu2.4).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
zhrann99@ubuntu:~/Desktop$ sudo apt install vim -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
vim is already the newest version (2:8.1.2269-1ubuntu5).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
zhrann99@ubuntu:~/Desktop$ sudo apt clean && sudo apt autoremove -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
zhrann99@ubuntu:~/Desktop$ wget -P ~/ https://cdn.kernel.org/pub/linux/kernel/v5.x/linux-5.8.1.tar.xz
```

**-part2-** Check the version of your current kernel. And Change your working directory to the root directory of the recently unpacked source code.

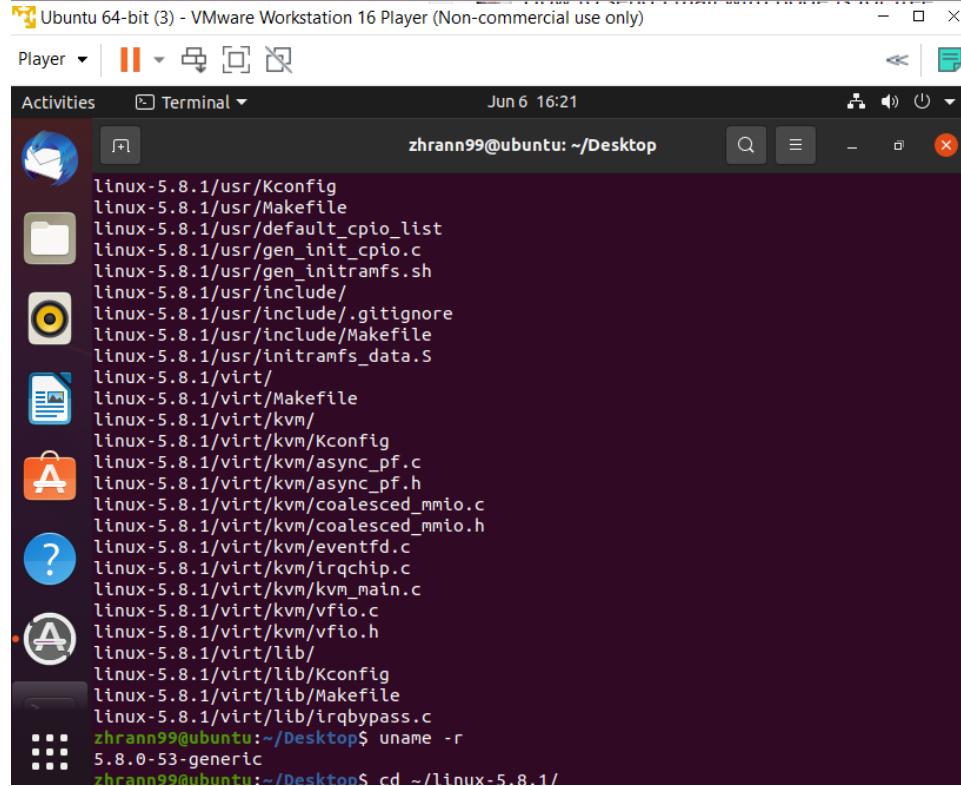


Ubuntu 64-bit (3) - VMware Workstation 16 Player (Non-commercial use only)

Player Activities Terminal Jun 6 16:20

zhrann99@ubuntu: ~/Desktop

```
linux-5.8.1/usr/
linux-5.8.1/usr/.gitignore
linux-5.8.1/usr/Kconfig
linux-5.8.1/usr/Makefile
linux-5.8.1/usr/default_cpio_list
linux-5.8.1/usr/gen_init_cpio.c
linux-5.8.1/usr/gen_initramfs.sh
linux-5.8.1/usr/include/
linux-5.8.1/usr/include/.gitignore
linux-5.8.1/usr/include/Makefile
linux-5.8.1/usr/initramfs_data.S
linux-5.8.1/virt/
linux-5.8.1/virt/Makefile
linux-5.8.1/virt/kvm/
linux-5.8.1/virt/kvm/Kconfig
linux-5.8.1/virt/kvm/async_pf.c
linux-5.8.1/virt/kvm/async_pf.h
linux-5.8.1/virt/kvm/coalesced_mmio.c
linux-5.8.1/virt/kvm/coalesced_mmio.h
linux-5.8.1/virt/kvm/eventfd.c
linux-5.8.1/virt/kvm/irqchip.c
linux-5.8.1/virt/kvm/kvm_main.c
linux-5.8.1/virt/kvm/vfio.c
linux-5.8.1/virt/kvm/vfio.h
linux-5.8.1/virt/lib/
linux-5.8.1/virt/lib/Kconfig
linux-5.8.1/virt/lib/Makefile
linux-5.8.1/virt/lib/irqbypass.c
zhrann99@ubuntu:~/Desktop$ uname -r
```



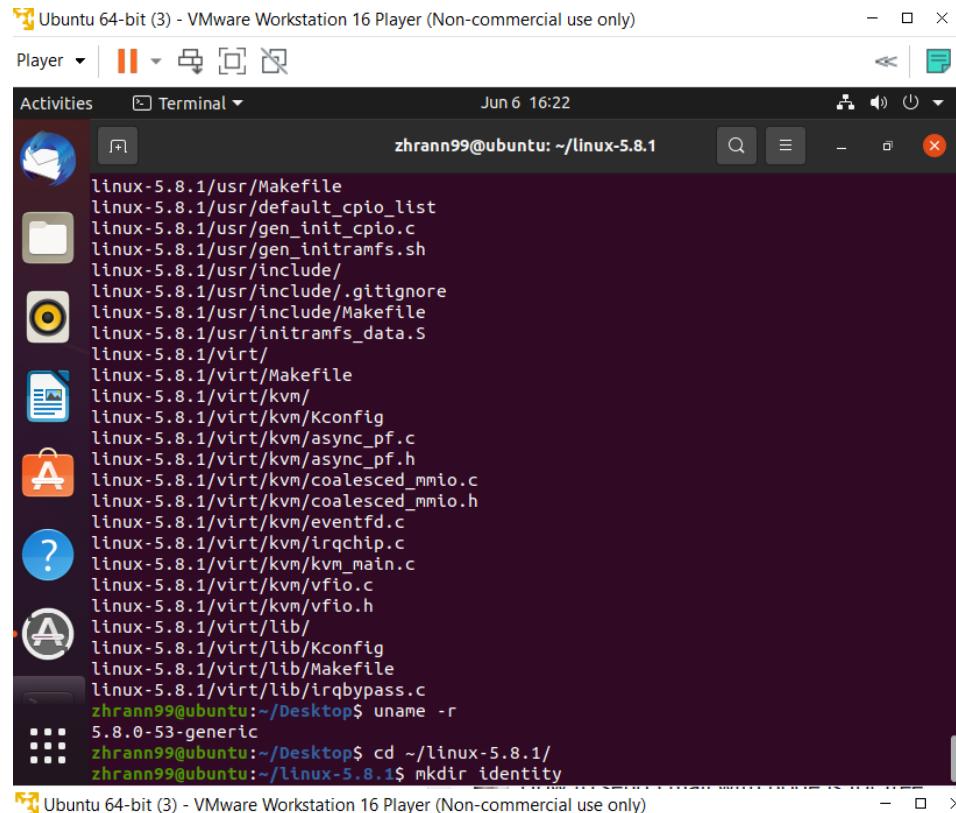
Ubuntu 64-bit (3) - VMware Workstation 16 Player (Non-commercial use only)

Player Activities Terminal Jun 6 16:21

zhrann99@ubuntu: ~/Desktop

```
linux-5.8.1/usr/Kconfig
linux-5.8.1/usr/Makefile
linux-5.8.1/usr/default_cpio_list
linux-5.8.1/usr/gen_init_cpio.c
linux-5.8.1/usr/include/
linux-5.8.1/usr/include/.gitignore
linux-5.8.1/usr/include/Makefile
linux-5.8.1/usr/initramfs_data.S
linux-5.8.1/virt/
linux-5.8.1/virt/Makefile
linux-5.8.1/virt/kvm/
linux-5.8.1/virt/kvm/Kconfig
linux-5.8.1/virt/kvm/async_pf.c
linux-5.8.1/virt/kvm/async_pf.h
linux-5.8.1/virt/kvm/coalesced_mmio.c
linux-5.8.1/virt/kvm/coalesced_mmio.h
linux-5.8.1/virt/kvm/eventfd.c
linux-5.8.1/virt/kvm/irqchip.c
linux-5.8.1/virt/kvm/kvm_main.c
linux-5.8.1/virt/kvm/vfio.c
linux-5.8.1/virt/kvm/vfio.h
linux-5.8.1/virt/lib/
linux-5.8.1/virt/lib/Kconfig
linux-5.8.1/virt/lib/Makefile
linux-5.8.1/virt/lib/irqbypass.c
zhrann99@ubuntu:~/Desktop$ uname -r
5.8.0-53-generic
zhrann99@ubuntu:~/Desktop$ cd ~/linux-5.8.1/
```

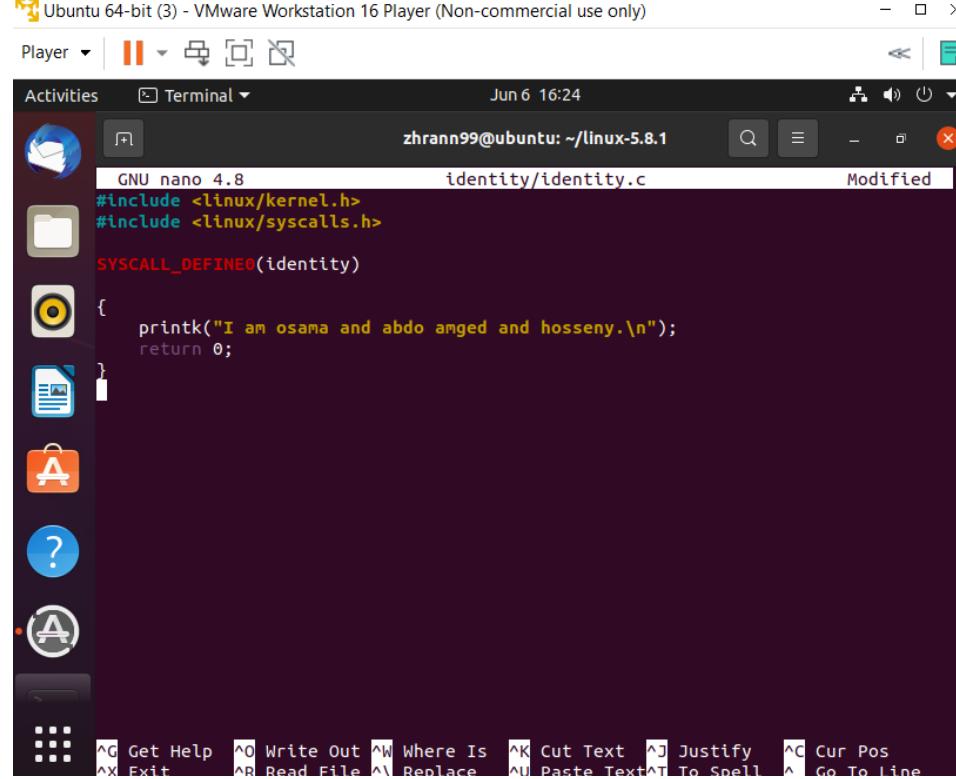
We will Create the home directory of your system call and Create a C file for your system call.



Ubuntu 64-bit (3) - VMware Workstation 16 Player (Non-commercial use only)

Player Activities Terminal Jun 6 16:22 zhrann99@ubuntu: ~/linux-5.8.1

```
linux-5.8.1/usr/Makefile
linux-5.8.1/usr/default_cpio_list
linux-5.8.1/usr/gen_init_cpio.c
linux-5.8.1/usr/gen_initramfs.sh
linux-5.8.1/usr/include/
linux-5.8.1/usr/include/.gitignore
linux-5.8.1/usr/include/Makefile
linux-5.8.1/usr/initramfs_data.S
linux-5.8.1/virt/
linux-5.8.1/virt/Makefile
linux-5.8.1/virt/kvm/
linux-5.8.1/virt/kvm/Kconfig
linux-5.8.1/virt/kvm/async_pf.c
linux-5.8.1/virt/kvm/async_pf.h
linux-5.8.1/virt/kvm/coalesced_mmio.c
linux-5.8.1/virt/kvm/coalesced_mmio.h
linux-5.8.1/virt/kvm/eventfd.c
linux-5.8.1/virt/kvm/irqchip.c
linux-5.8.1/virt/kvm/kvm_main.c
linux-5.8.1/virt/kvm/vfio.c
linux-5.8.1/virt/kvm/vfio.h
linux-5.8.1/virt/lib/
linux-5.8.1/virt/lib/Kconfig
linux-5.8.1/virt/lib/Makefile
linux-5.8.1/virt/lib/irqbypass.c
zhrann99@ubuntu:~/Desktop$ uname -r
5.8.0-53-generic
zhrann99@ubuntu:~/Desktop$ cd ~/linux-5.8.1/
zhrann99@ubuntu:~/linux-5.8.1$ mkdir identity
```



Ubuntu 64-bit (3) - VMware Workstation 16 Player (Non-commercial use only)

Player Activities Terminal Jun 6 16:24 zhrann99@ubuntu: ~/linux-5.8.1

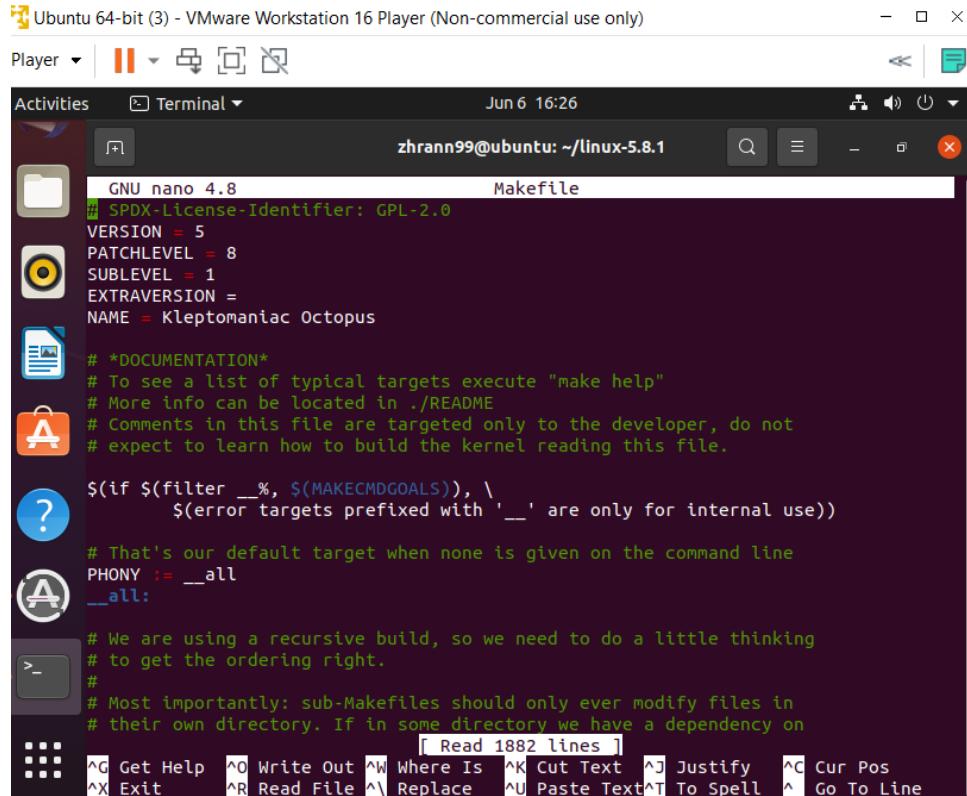
```
GNU nano 4.8           identity/identity.c          Modified
#include <linux/kernel.h>
#include <linux/syscalls.h>

SYSCALL_DEFINENO(identity)

{
    printk("I am osama and abdo amged and hosseny.\n");
    return 0;
}
```

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

We will Create a Makefile for your system call. And Add the home directory of your system call to the main Makefile of the kernel.



The screenshot shows a terminal window titled "Ubuntu 64-bit (3) - VMware Workstation 16 Player (Non-commercial use only)". The window title bar includes icons for minimize, maximize, and close. Below the title bar, there are tabs for "Activities" and "Terminal". The status bar shows the date and time: "Jun 6 16:26". The terminal window itself has a dark background and displays a file named "Makefile". The file content is as follows:

```
GNU nano 4.8           Makefile
# SPDX-License-Identifier: GPL-2.0
VERSION = 5
PATCHLEVEL = 8
SUBLEVEL = 1
EXTRAVERSION =
NAME = Kleptomaniac Octopus

# *DOCUMENTATION*
# To see a list of typical targets execute "make help"
# More info can be located in ./README
# Comments in this file are targeted only to the developer, do not
# expect to learn how to build the kernel reading this file.

$(if $(filter __%, $(MAKECMDGOALS)), \
    $(error targets prefixed with '__' are only for internal use))

# That's our default target when none is given on the command line
PHONY := __all
__all:

# We are using a recursive build, so we need to do a little thinking
# to get the ordering right.
#
# Most importantly: sub-Makefiles should only ever modify files in
# their own directory. If in some directory we have a dependency on
# [ Read 1882 lines ]
^G Get Help ^O Write Out ^W Where Is ^K Cut Text ^J Justify ^C Cur Pos
^X Exit      ^R Read File ^\ Replace   ^U Paste Text ^T To Spell ^_ Go To Line
```

After we will Add a corresponding function prototype for your system call to the header file of system calls.

```
GNU nano 4.8          include/linux/syscalls.h      Modified
#include <linux/personality.h>
#include <trace/syscall.h>

#ifndef CONFIG_ARCH_HAS_SYSCALL_WRAPPER
/*
 * It may be useful for an architecture to override the definitions of the
 * __SYSCALL_DEFINEx() and __SYSCALL_DEFINEx() macros, in particular to use a
 * different calling convention for syscalls. To allow for that, the prototypes
 * for the sys_*() functions below will *not* be included if
 * CONFIG_ARCH_HAS_SYSCALL_WRAPPER is enabled.
 */
#include <asm/syscall_wrapper.h>
asm linkage long sys_identity(void);

#endif /* CONFIG_ARCH_HAS_SYSCALL_WRAPPER */

/*
 * __MAP - apply a macro to syscall arguments
 * __MAP(n, m, t1, a1, t2, a2, ..., tn, an) will expand to
 *   m(t1, a1), m(t2, a2), ..., m(tn, an)
 * The first argument must be equal to the amount of type/name
 * pairs given. Note that this list of pairs (i.e. the arguments
 * of __MAP starting at the third one) is in the same format as
 * for __SYSCALL_DEFINE<n>/COMPAT_SYSCALL_DEFINE<n>
 */

```

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

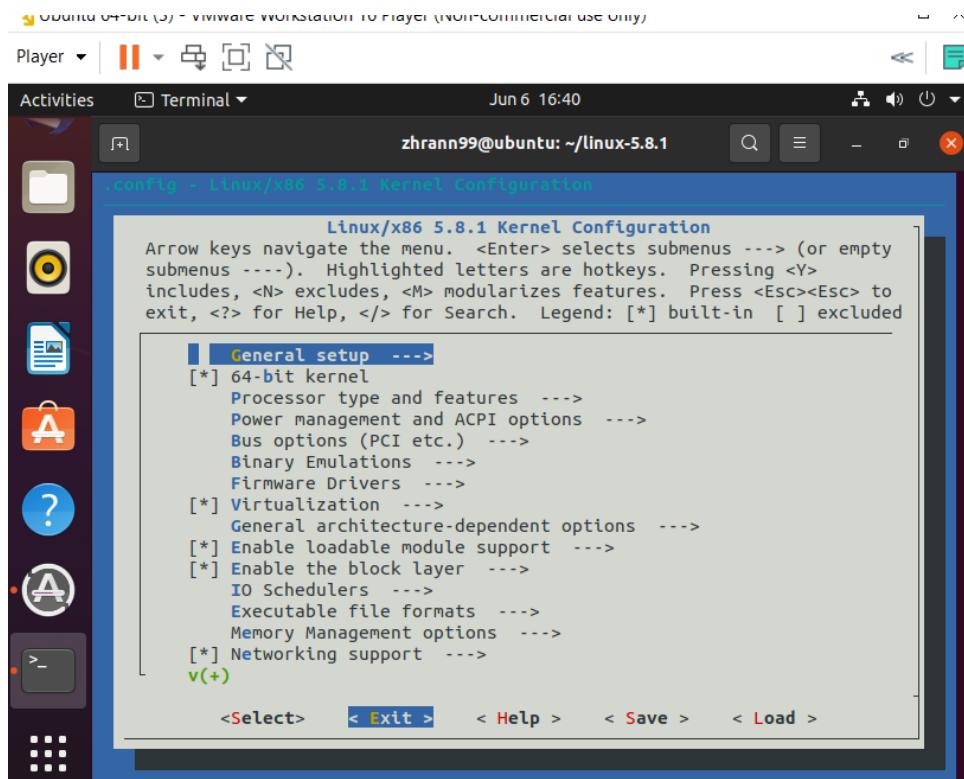
After this Add your system call to the kernel's system call table.

```
GNU nano 4.8      arch/x86/entry/syscalls/syscall_64.tbl      Modified
428  common  open_tree          sys_open_tree
429  common  move_mount        sys_move_mount
430  common  fsopen            sys_fsopen
431  common  fsconfig           sys_fsconfig
432  common  fsmount           sys_fsmount
433  common  fspick             sys_fspick
434  common  pidfd_open        sys_pidfd_open
435  common  clone3             sys_clone3
437  common  openat2            sys_openat2
438  common  pidfd_getfd       sys_pidfd_getfd
439  common  faccessat2        sys_faccessat2
440  common  identity           sys_identity

#
# x32-specific system call numbers start at 512 to avoid cache impact
# For native 64-bit operation. The __x32_compat_sys stubs are created
# on-the-fly for compat_sys_*() compatibility system calls if X86_X32
# is defined.
#
512  x32   rt_sigaction        compat_sys_rt_sigaction
513  x32   rt_sigreturn         compat_sys_x32_rt_sigreturn
514  x32   ioctl                compat_sys_ioctl
515  x32   readyv               compat_sys_readyv
516  x32   writev               compat_sys_writev
517  x32   recvfrom              compat_sys_recvfrom
518  x32   sendmsg              compat_sys_sendmsg

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

## Configure the kernel.



We skip some screenshots ....for some command like

Find out how many logical cores you have

Compile the kernel's source code.

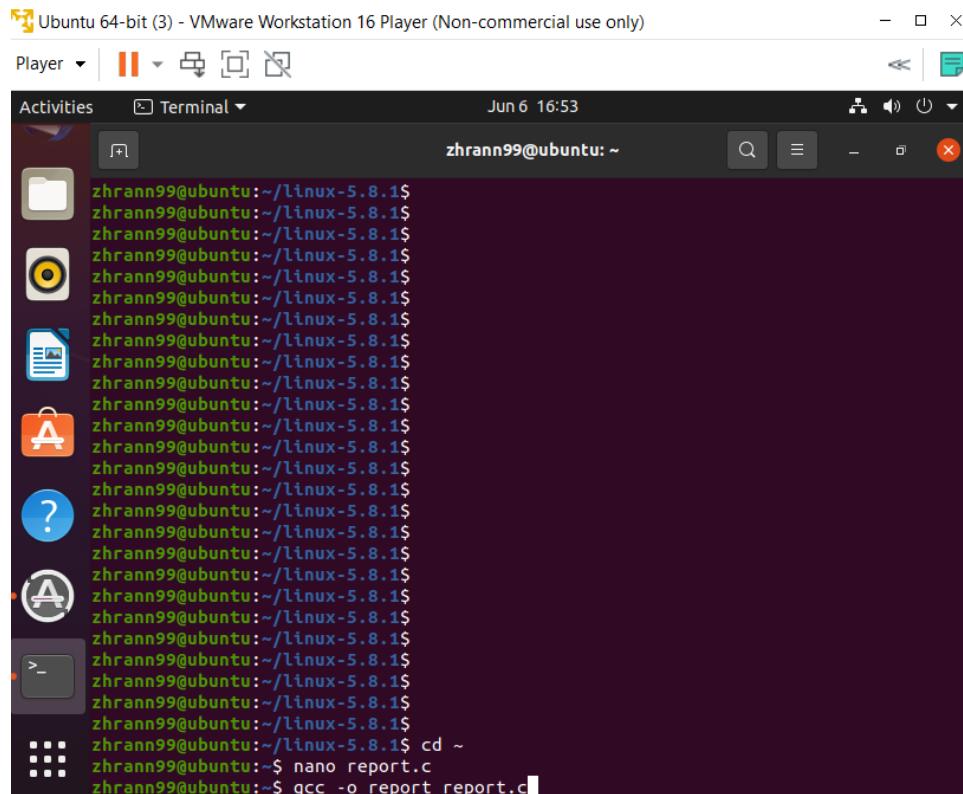
Prepare the Install the kernel.

Install the kernel.

Update the bootloader of the operating system with the new kernel.

Change your working directory to home directory.

After this command we will [Create the C file with the following command](#)



```
Ubuntu 64-bit (3) - VMware Workstation 16 Player (Non-commercial use only)
Player ▾ Jun 6 16:53
Activities Terminal zhrann99@ubuntu: ~
zhrann99@ubuntu:~/linux-5.8.1$ zhrann99@ubuntu:~/nano report.c zhrann99@ubuntu:~$ gcc -o report report.c
```

In final - Run the C file you just compiled.

The screenshot shows a terminal window titled "zhrann99@ubuntu: ~". The terminal is displaying a series of identical command-line entries, each consisting of "zhrann99@ubuntu:~/linux-5.8.1\$". This repetition suggests a loop or a stuck state. The terminal window has a dark background and light-colored text. At the bottom of the terminal, there is a command history and a prompt: "zhrann99@ubuntu:~/linux-5.8.1\$ cd ~", "zhrann99@ubuntu:~\$ nano report.c", "zhrann99@ubuntu:~\$ gcc -o report report.c", and "zhrann99@ubuntu:~\$ ./report".

It shoe to me Congratulations, osama Your system call is functional.but I forget to photo screen

Thanks.