NATIONAL UNIVERSITY OF COMPUTER AND EMERGING SCIENCES
PROGRAM: SOFTWARE ENGINEERING

OPERATING SYSTEMS LAB

ASSIGNMENT-01

SUBMITTED BY:

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A DEPARTMENT OF COMPUTER SCIENCE

So Before Moving to Actual Work of Assignment We will try to remove some dependencies issues. For that first of all I will update my system by using command sudo apt update.

```
amei-302@amei302-HP-EliteBook-840-G3:~$ sudo apt update
[sudo] password for amei-302:
Hit:1 http://pk.archive.ubuntu.com/ubuntu jammy InRelease
Hit:2 http://pk.archive.ubuntu.com/ubuntu jammy-updates In
Hit:3 http://pk.archive.ubuntu.com/ubuntu jammy-backports
Get:4 http://security.ubuntu.com/ubuntu jammy-security InR
Get:5 http://security.ubuntu.com/ubuntu jammy-security/ma
Get:6 http://security.ubuntu.com/ubuntu jammy-security/ma
Get:7 http://security.ubuntu.com/ubuntu jammy-security/ma
Get:8 http://security.ubuntu.com/ubuntu jammy-security/ma
Get:9 http://security.ubuntu.com/ubuntu jammy-security/re
Get:10 http://security.ubuntu.com/ubuntu jammy-security/re
Get:11 http://security.ubuntu.com/ubuntu jammy-security/un
Get:12 http://security.ubuntu.com/ubuntu jammy-security/un
Get:13 http://security.ubuntu.com/ubuntu jammy-security/un
Get:14 http://security.ubuntu.com/ubuntu jammy-security/un
```

Now for downloading and installing some necessary tools that will help in removing dependencies issues like gcc, ncurses, bison, flex, libssl-dev and libelf-dev we will use the following command: sudo apt install build-essential libncurses-dev bison flex libssl-dev libelf-dev

```
amei-302@amei302-HP-EliteBook-840-G3:~$ sudo apt install build-essential libncurses-dev bison flex libssl-dev libelf-dev
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  binutils binutils-common binutils-x86-64-linux-gnu dpkg-dev fakeroot g++
  g++-11 gcc gcc-11 libalgorithm-diff-perl libalgorithm-diff-xs-perl
  libalgorithm-merge-perl libasan6 libbinutils libc-dev-bin libc-devtools
  libc6 libc6-dbg libc6-dev libcc1-0 libcrypt-dev libctf-nobfd0 libctf0
  libdpkg-perl libfakeroot libfile-fcntllock-perl libfl-dev libfl2
  libgcc-11-dev libitm1 liblsan0 libnsl-dev libsigsegv2 libssl3
  libstdc++-11-dev libtirpc-dev libtsan0 libubsan1 linux-libc-dev
  lto-disabled-list m4 make manpages-dev rpcsvc-proto zlib1g-dev
Suggested packages:
  binutils-doc bison-doc debian-keyring flex-doc g++-multilib g++-11-multilib
  gcc-11-doc gcc-multilib autoconf automake libtool gcc-doc gcc-11-multilib
  gcc-11-locales glibc-doc git bzr ncurses-doc libssl-doc libstdc++-11-doc
  m4-doc make-doc
Recommended packages:
```

After installing necessary tools and removing dependencies issues we **Created the Backup Directory using the command**

```
amei-302@amei302-HP-EliteBook-840-G3:~$ mkdir -p ~/backup/
amei-302@amei302-HP-EliteBook-840-G3:~$ ls
backup  Desktop  Documents  Downloads  Music  Pictures  Public  snap  Templates  Videos
```

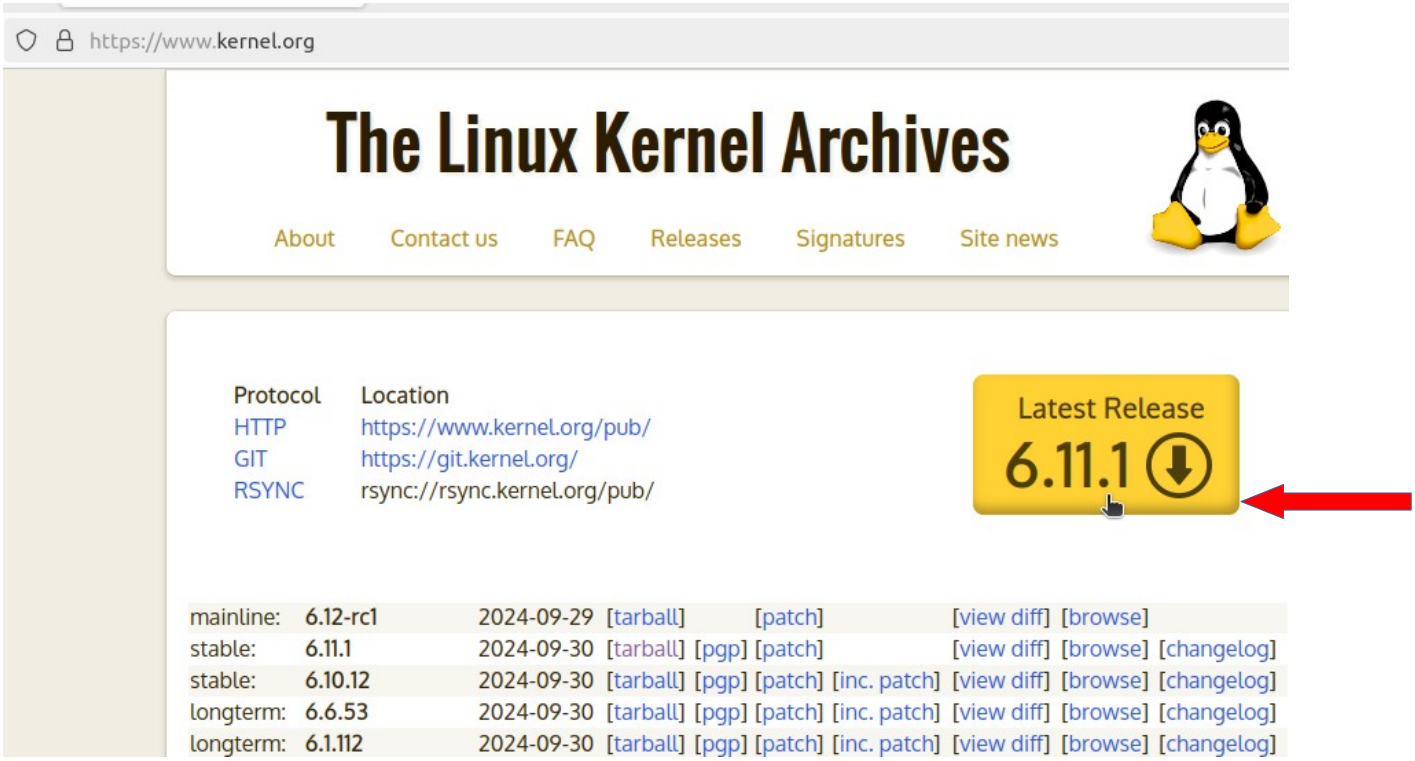
Now Command for backing up the current kernel in backup directory that we have created:

simply copies your current kernel image (the one you're currently running) to the **~/backup/** directory. This provides a backup of the kernel before making any changes, like compiling or upgrading a new kernel.

```
amei-302@amei302-HP-EliteBook-840-G3:~$ sudo cp /boot/vmlinuz-$(uname -r) ~/backup/
amei-302@amei302-HP-EliteBook-840-G3:~$
```

Now your kernel has been backed up in a directory.

Next, download any version of kernel from https://www.kernel.org, I have downloaded the latest version kernel 6.11.1, I have pointed the cursor on the option as shown in image below click on it and the download will start automatically.



Command used to extract the kernal file is tar -xvf linux-6.11.1.tar.xz
(tar -xvf <name of file with .tar extension>)

```
amei-302@amei302-HP-EliteBook-840-G3:~$ ls
backup  Desktop  Documents  Downloads  linux-6.11.1  linux-6.11.1.tar.xz
amei-302@amei302-HP-EliteBook-840-G3:~$ tar -xvf linux-6.11.1
```

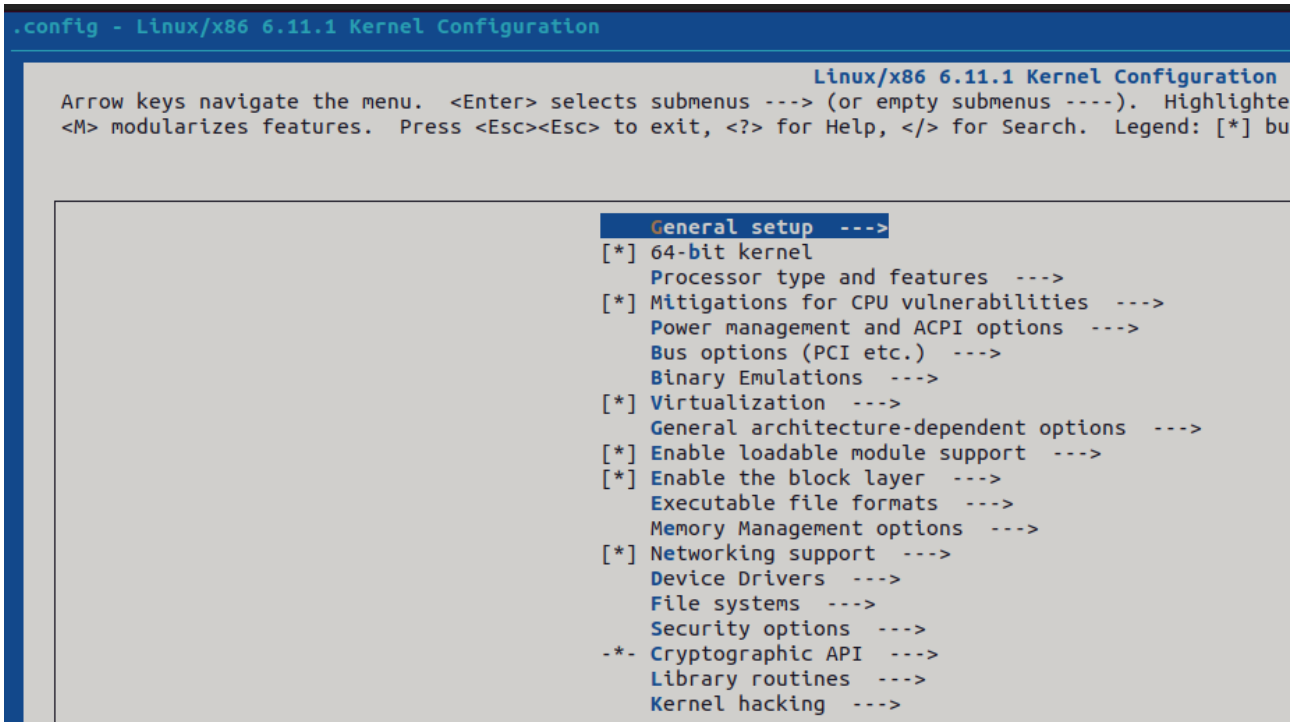
Kernal extraction Process:

```
linux-6.11.1/sound/soc/codecs/rt5677.h
linux-6.11.1/sound/soc/codecs/rt5682-i2c.c
linux-6.11.1/sound/soc/codecs/rt5682-sdw.c
linux-6.11.1/sound/soc/codecs/rt5682.c
linux-6.11.1/sound/soc/codecs/rt5682.h
linux-6.11.1/sound/soc/codecs/rt5682s.c
linux-6.11.1/sound/soc/codecs/rt5682s.h
linux-6.11.1/sound/soc/codecs/rt700-sdw.c
linux-6.11.1/sound/soc/codecs/rt700-sdw.h
linux-6.11.1/sound/soc/codecs/rt700.c
linux-6.11.1/sound/soc/codecs/rt700.h
linux-6.11.1/sound/soc/codecs/rt711-sdca-sdw.c
linux-6.11.1/sound/soc/codecs/rt711-sdca-sdw.h
linux-6.11.1/sound/soc/codecs/rt711-sdca.c
linux-6.11.1/sound/soc/codecs/rt711-sdca.h
linux-6.11.1/sound/soc/codecs/rt711-sdw.c
linux-6.11.1/sound/soc/codecs/rt711-sdw.h
linux-6.11.1/sound/soc/codecs/rt711.c
linux-6.11.1/sound/soc/codecs/rt711.h
```

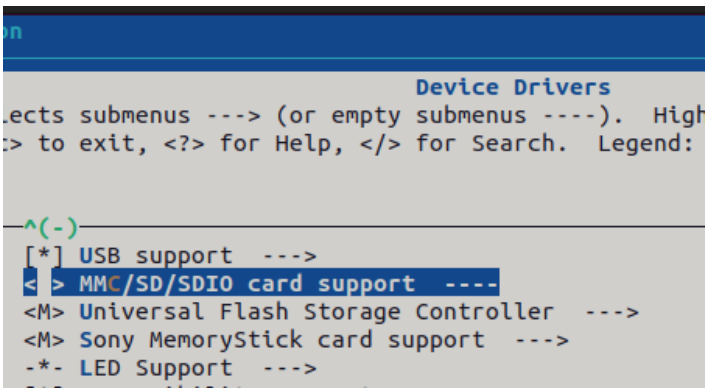
Moving into new kernal directory

```
amei-302@amei302-HP-EliteBook-840-G3:~$ cd linux-6.11.1/
amei-302@amei302-HP-EliteBook-840-G3:~/linux-6.11.1$
```

Now we will configure and customize the kernal:
type the command of ***make menuconfig*** a screen will appear in front of you



I have disabled the MMC/SD/SDIO card support from device drivers which means the memory card/ micro sd card drivers.



Then I disabled the Memory technology devices MTD which is used for embedded systems and flash memory chips from device drivers

```
<*> RapidIO support  --->
    Generic Driver Options  --->
    Bus devices  --->
    Cache Drivers  ----
{*} Connector - unified userspace <-> kernelspace
    Firmware Drivers  --->
<M> GNSS receiver support  --->
< > Memory Technology Device (MTD) support  ----
[ ] Device Tree and Open Firmware support  ----
<M> Parallel port support  --->
-*- Plug and Play support  --->
[*] Block devices  --->
    NVME Support  --->
    Misc devices  --->
```

As My pc does not support touch input so I moved to Device Drivers>Input device support>Touchscreens and disabled Touchscreen drivers.

```
[*]   Keyboards  --->
[*]   Mice  --->
[*]   Joysticks/Gamepads  --->
[*]   Tablets  --->
[ ]   Touchscreens  ----
[*]   Miscellaneous devices  --->
{M}   Synaptics RMI4 bus support
<M>     RMI4 I2C Support
```

Save it with .config name and press <esc><esc> for doing more customization, It will go back.

Now I go in Networking support>Networking options, and disable older and unused network protocols.

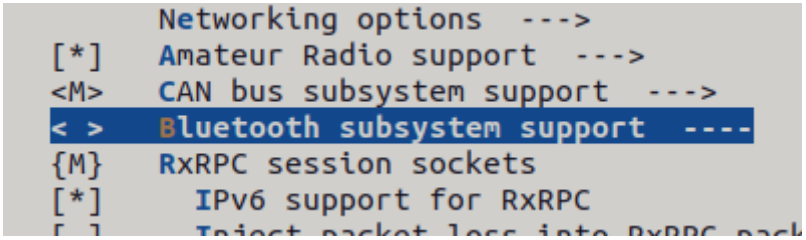
```
    Memory Management options  --->
[*] Networking support  --->
    Device Drivers  --->
    File systems  --->
    Security options  --->
-*- Cryptographic API  --->
    Library routines  --->
    Kernel hacking  --->
```

```
--- Networking support
    Networking options  --->
[*] Amateur Radio support  --->
<M> CAN bus subsystem support
```

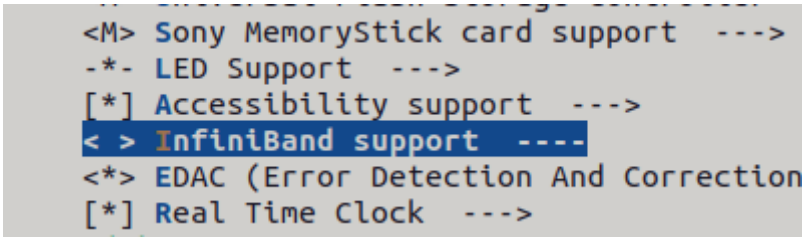
First of all I disabled Appletalk protocol support:

```
[*]   MVRP (Multiple VLAN Registra
<M> ANSI/IEEE 802.2 LLC type 2 Sup
< > Appletalk protocol support
<M> CCITT X.25 Packet Layer
```

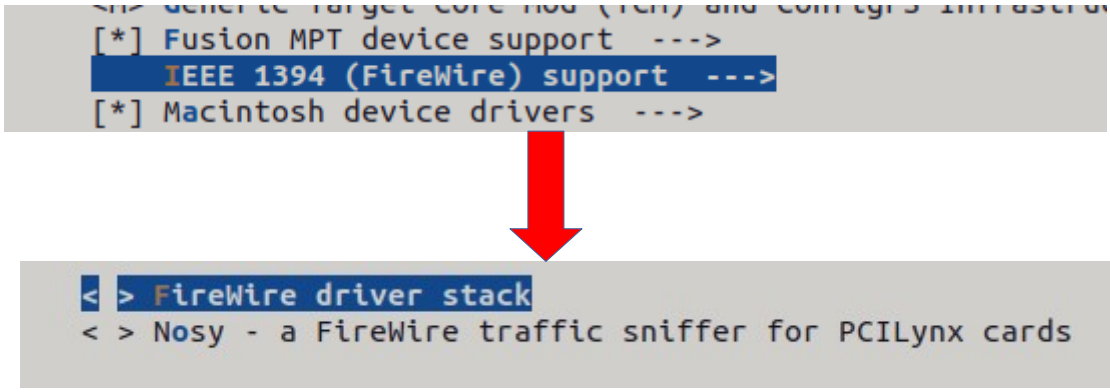
now I press <esc><esc> and come in Networking support option. Here I disabled the bluetooth subsystem support as I do not use bluetooth support in my pc



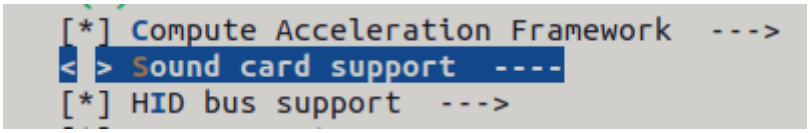
Now I press<esc><esc> and go in device drivers there I disabled the InfiniBand Support which is used for high-performance computing clusters.



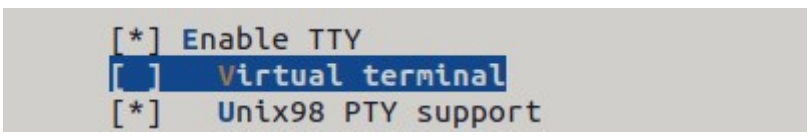
In the Device drivers I moved in IEEE 1394 (FireWire) support and disabled all drivers from there as I do not use any fireWire devices on my system.



Disabling old/unused sound cards drivers, In the Device driver disable sound card support



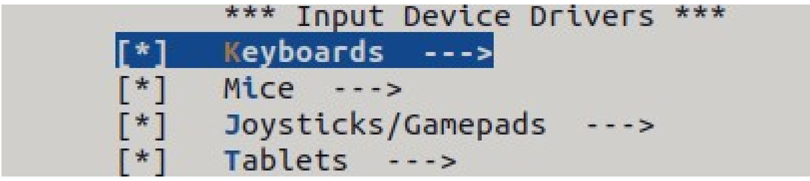
Disabling Virtual Terminal
Device Drivers>Character devices>Virtual Terminal
this is safe to disable if you're using a graphical interface and don't need virtual terminals for troubleshooting)



Drivers to Keep

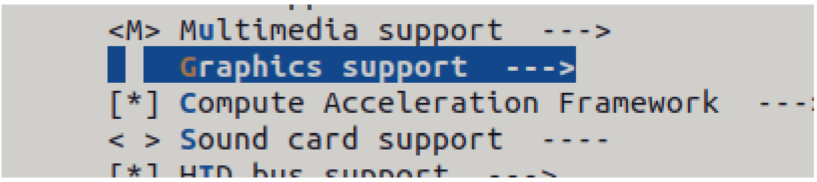
Input Devices (Keyboard/Mouse):

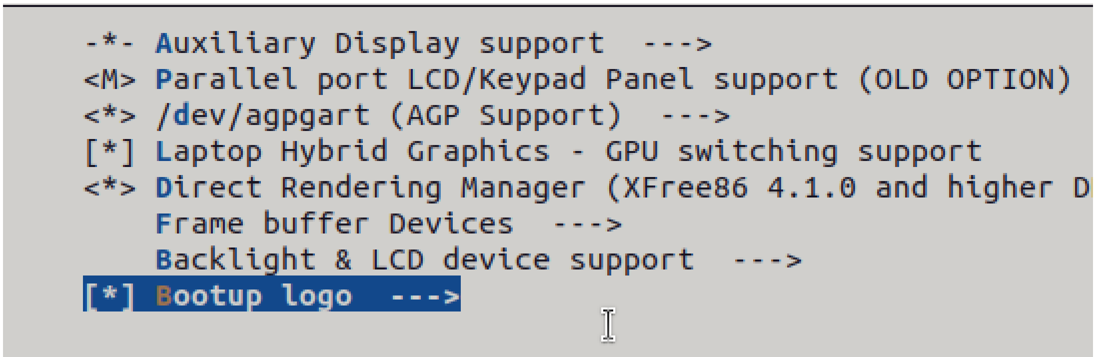
- Enabling drivers for standard input devices like keyboards and mice.
- Location: Device Drivers>Input device support>Keyboards/Mouse.



Graphics Card Drivers:

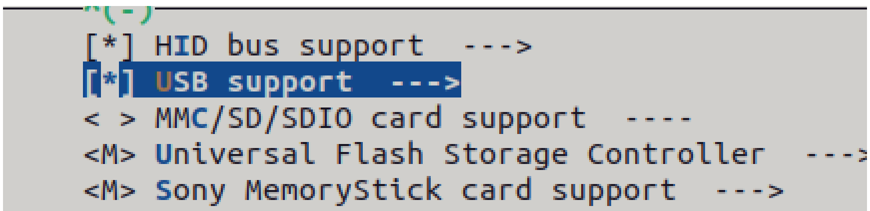
- Enabling and keeping drivers for your GPU
- Location: Device Drivers>Graphics support





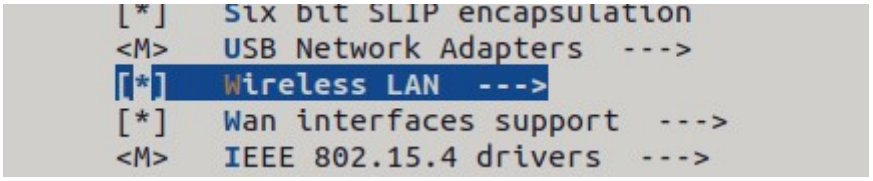
USB Support:

- Keep **USB device support** for peripherals like external drives, keyboards, and mice.
- Location: Device Drivers>USB support



Ethernet/Wi-Fi Drivers:

- Keep drivers for wireless (Wi-Fi) network cards.
- Location: Device Drivers>Network device support>Wireless LAN



File System Drivers:

- Keep drivers for the file systems you use (e.g., **ext4**).
- Location: File systems>

I enabled the Ext4 debugging support for making kernal more efficient.

After this I Select the save command and then Exit, and again I come back on terminal.

Compiling Kernel:

```
amei-302@amei302-HP-EliteBook-840-G3:~/linux-6.11.1$
amei-302@amei302-HP-EliteBook-840-G3:~/linux-6.11.1$ make -j$(nproc)
  SYNC    include/config/auto.conf.cmd
  HOSTCC  scripts/kconfig/conf.o
  HOSTLD  scripts/kconfig/conf
  WRAP    arch/x86/include/generated/uapi/asm/bpf_perf_event.h
  WRAP    arch/x86/include/generated/uapi/asm/errno.h
  WRAP    arch/x86/include/generated/uapi/asm/fcntl.h
  WRAP    arch/x86/include/generated/uapi/asm/ioctl.h
  WRAP    arch/x86/include/generated/uapi/asm/ioctls.h
  WRAP    arch/x86/include/generated/uapi/asm/ipcbuf.h
  WRAP    arch/x86/include/generated/uapi/asm/param.h
  UPD     include/config/kernel.release
  WRAP    arch/x86/include/generated/uapi/asm/poll.h
  WRAP    arch/x86/include/generated/uapi/asm/resource.h
  WRAP    arch/x86/include/generated/uapi/asm/socket.h
  WRAP    arch/x86/include/generated/uapi/asm/sockios.h
```

Instead of manually specifying the number of cores, $(nproc) automatically adjusts to the number of cores on your machine.

While the compilation of kernal I have faced one issue of permission that was occurring due to the file owner name was root so I used sudo chown command and rename the file owner name according to my system name.

```
amei-302@amei302-HP-EliteBook-840-G3:~/linux-6.11.1$ cd ..
amei-302@amei302-HP-EliteBook-840-G3:~$ sudo chown -R amei-302:amei-302 linux-6.11.1
```

Now all file names are according to my system name.

```
amei-302@amei302-HP-EliteBook-840-G3:~/linux-6.11.1$ ls -l security/selinux/av_permissions.h
-rw-r--r-- 1 amei-302 amei-302 105476 18:56 1  اکتوبر security/selinux/av_permissions.h
amei-302@amei302-HP-EliteBook-840-G3:~/linux-6.11.1$
```

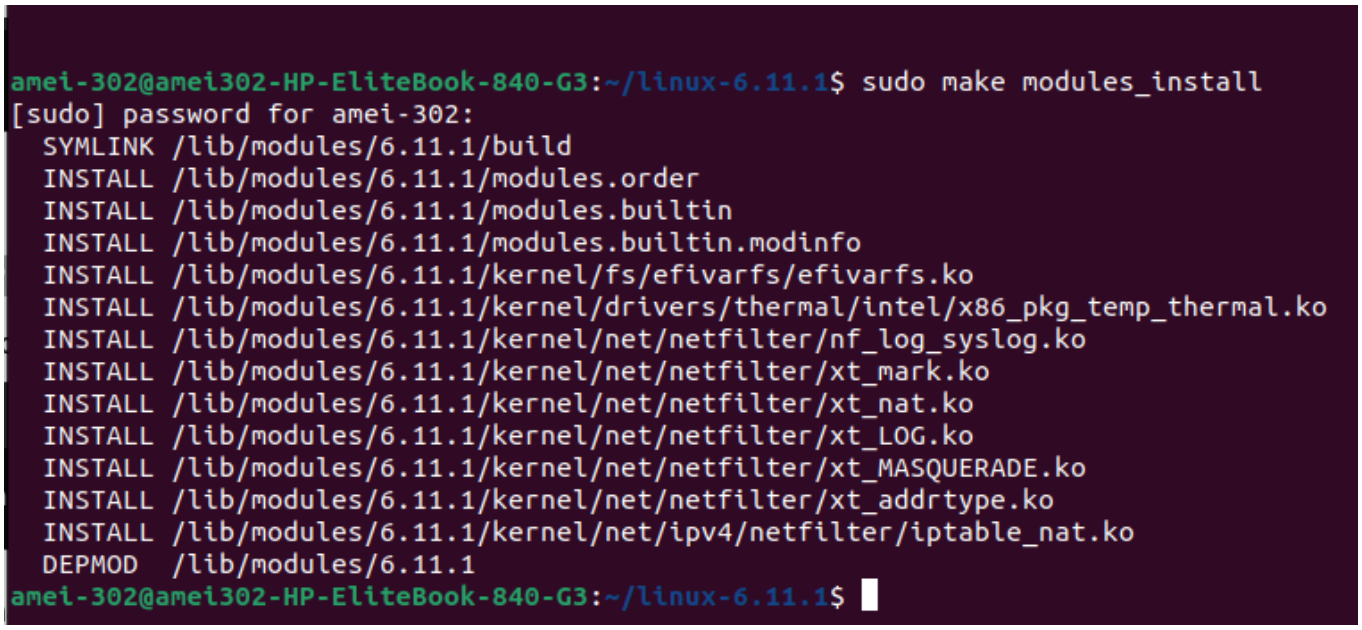
```
amei-302@amei302-HP-EliteBook-840-G3:~$ cd linux-6.11.1/
amei-302@amei302-HP-EliteBook-840-G3:~/linux-6.11.1$ ls -l security/selinux/
total 840
-rw-rw-r-- 1 amei-302 amei-302  31760 19:31 30  ستمبر avc.c
-rw-rw-r-- 1 amei-302 amei-302 100288 18:56 1  اکتوبر avc.o
-rw-r--r-- 1 amei-302 amei-302 105476 18:56 1  اکتوبر av_permissions.h
-rw-rw-r-- 1 amei-302 amei-302   1512 18:57 1  اکتوبر built-in.a
-rw-rw-r-- 1 amei-302 amei-302   8683 18:56 1  اکتوبر flask.h
-rw-rw-r-- 1 amei-302 amei-302 198074 19:31 30  ستمبر hooks.c
-rw-rw-r-- 1 amei-302 amei-302 133864 18:56 1  اکتوبر hooks.o
-rw-rw-r-- 1 amei-302 amei-302   5686 19:31 30  ستمبر ibpkey.c
-rw-rw-r-- 1 amei-302 amei-302   2805 19:31 30  ستمبر ima.c
drwxrwxr-x 2 amei-302 amei-302   4096 19:31 30  ستمبر include
-rw-rw-r-- 1 amei-302 amei-302   3155 19:31 30  ستمبر Kconfig
-rw-rw-r-- 1 amei-302 amei-302   1621 19:31 30  ستمبر Makefile
-rw-rw-r-- 1 amei-302 amei-302      0 18:56 1  اکتوبر modules.order
-rw-rw-r-- 1 amei-302 amei-302   6870 19:31 30  ستمبر netif.c
-rw-rw-r-- 1 amei-302 amei-302   5888 18:56 1  اکتوبر netif.o
-rw-rw-r-- 1 amei-302 amei-302  16387 19:31 30  ستمبر netlabel.c
-rw-rw-r-- 1 amei-302 amei-302   9856 18:57 1  اکتوبر netlabel.o
-rw-rw-r-- 1 amei-302 amei-302   2358 19:31 30  ستمبر netlink.c
-rw-rw-r-- 1 amei-302 amei-302   4024 18:56 1  اکتوبر netlink.o
-rw-rw-r-- 1 amei-302 amei-302   7641 19:31 30  ستمبر netnode.c
-rw-rw-r-- 1 amei-302 amei-302   5872 18:56 1  اکتوبر netnode.o
-rw-rw-r-- 1 amei-302 amei-302   5952 19:31 30  ستمبر netport.c
-rw-rw-r-- 1 amei-302 amei-302   4664 18:56 1  اکتوبر netport.o
-rw-rw-r-- 1 amei-302 amei-302   9040 19:31 30  ستمبر nlmsgtab.c
-rw-rw-r-- 1 amei-302 amei-302   3216 18:56 1  اکتوبر nlmsgtab.o
-rw-rw-r-- 1 amei-302 amei-302  50825 19:31 30  ستمبر selinuxfs.c
-rw-rw-r-- 1 amei-302 amei-302  54864 18:56 1  اکتوبر selinuxfs.o
drwxrwxr-x 2 amei-302 amei-302   4096 18:57 1  اکتوبر ss
-rw-rw-r-- 1 amei-302 amei-302   3354 19:31 30  ستمبر status.c
-rw-rw-r-- 1 amei-302 amei-302   2832 18:56 1  اکتوبر status.o
-rw-rw-r-- 1 amei-302 amei-302  11265 19:31 30  ستمبر xfrm.c
amei-302@amei302-HP-EliteBook-840-G3:~/linux-6.11.1$
```

Again I compiled the kernel using command make -j$(nproc) and it has successfully compiled the kernel according to customization.

Installing the Kernel and Modules

For installing the modules we will use the command sudo make modules_install, This command will install all modules of kernal that were compiled during the kernel build process.

These modules are loadable kernel modules that can be loaded or unloaded dynamically at runtime, this will copy all the compiled modules to the appropriate location on your system lib/modules/kernel-6.11.1.



Next, we will install the newly compiled kernel image and related files: ***sudo make install*** this will copy the newly compiled kernel image to ***/boot*** preparing the system to boot with the newly compiled kernel.

(SEE BELOW FOR ATTACHED SCREENSHOT ON NEXT PAGE)

```
amei-302@amei302-HP-EliteBook-840-G3:~/linux-6.11.1$ sudo make install
  INSTALL /boot
run-parts: executing /etc/kernel/postinst.d/initramfs-tools 6.11.1 /boot/vmlinuz-6.11.1
update-initramfs: Generating /boot/initrd.img-6.11.1
W: Possible missing firmware /lib/firmware/i915/bmg_dmc.bin for built-in driver i915
W: Possible missing firmware /lib/firmware/i915/xe2lpd_dmc.bin for built-in driver i915
W: Possible missing firmware /lib/firmware/rtl_nic/rtl8126a-2.fw for built-in driver r8169
run-parts: executing /etc/kernel/postinst.d/unattended-upgrades 6.11.1 /boot/vmlinuz-6.11.1
run-parts: executing /etc/kernel/postinst.d/update-notifier 6.11.1 /boot/vmlinuz-6.11.1
run-parts: executing /etc/kernel/postinst.d/xx-update-initrd-links 6.11.1 /boot/vmlinuz-6.11.1
I: /boot/initrd.img.old is now a symlink to initrd.img-6.8.0-40-generic
I: /boot/initrd.img is now a symlink to initrd.img-6.11.1
run-parts: executing /etc/kernel/postinst.d/zz-shim 6.11.1 /boot/vmlinuz-6.11.1
run-parts: executing /etc/kernel/postinst.d/zz-update-grub 6.11.1 /boot/vmlinuz-6.11.1
Sourcing file `/etc/default/grub'
Sourcing file `/etc/default/grub.d/init-select.cfg'
Generating grub configuration file ...
Found linux image: /boot/vmlinuz-6.11.1
Found initrd image: /boot/initrd.img-6.11.1
Found linux image: /boot/vmlinuz-6.8.0-40-generic
Found initrd image: /boot/initrd.img-6.8.0-40-generic
Found linux image: /boot/vmlinuz-6.5.0-18-generic
Found initrd image: /boot/initrd.img-6.5.0-18-generic
Memtest86+ needs a 16-bit boot, that is not available on EFI, exiting
Warning: os-prober will be executed to detect other bootable partitions.
Its output will be used to detect bootable binaries on them and create new boot entries.
Found Windows Boot Manager on /dev/sda2@/EFI/Microsoft/Boot/bootmgfw.efi
Found Windows Boot Manager on /dev/sdb1@/efi/Microsoft/Boot/bootmgfw.efi
Adding boot menu entry for UEFI Firmware Settings ...
done
amei-302@amei302-HP-EliteBook-840-G3:~/linux-6.11.1$
```

Updating the Bootloader:

GRUB (Grand Unified Bootloader) is a bootloader used in Linux systems to load the operating system kernel, it allows users to select from multiple operating systems or kernel versions during system startup. GRUB is highly flexible, supporting different file systems and Operating Systems, and provides a user-friendly menu for booting.

```
amei-302@amei302-HP-EliteBook-840-G3:~/linux-6.11.1$ sudo update-grub
Sourcing file `/etc/default/grub'
Sourcing file `/etc/default/grub.d/init-select.cfg'
Generating grub configuration file ...
Found linux image: /boot/vmlinuz-6.11.1
Found initrd image: /boot/initrd.img-6.11.1
Found linux image: /boot/vmlinuz-6.8.0-40-generic
Found initrd image: /boot/initrd.img-6.8.0-40-generic
Found linux image: /boot/vmlinuz-6.5.0-18-generic
Found initrd image: /boot/initrd.img-6.5.0-18-generic
Memtest86+ needs a 16-bit boot, that is not available on EFI, exiting
Warning: os-prober will be executed to detect other bootable partitions
Its output will be used to detect bootable binaries on them and create
Found Windows Boot Manager on /dev/sda2@/EFI/Microsoft/Boot/bootmgfw.ef
Found Windows Boot Manager on /dev/sdb1@/efi/Microsoft/Boot/bootmgfw.ef
Adding boot menu entry for UEFI Firmware Settings ...
done
amei-302@amei302-HP-EliteBook-840-G3:~/linux-6.11.1$
```

My Current Version Of Kernel

```
amei-302@amei302-HP-EliteBook-840-G3:~/linux-6.11.1$ uname -r

6.8.0-40-generic
amei-302@amei302-HP-EliteBook-840-G3:~/linux-6.11.1$
```

Reboot and Select the New Kernel:

```
amei-302@amei302-HP-EliteBook-840-G3:~/linux-6.11.1$ sudo reboot
```

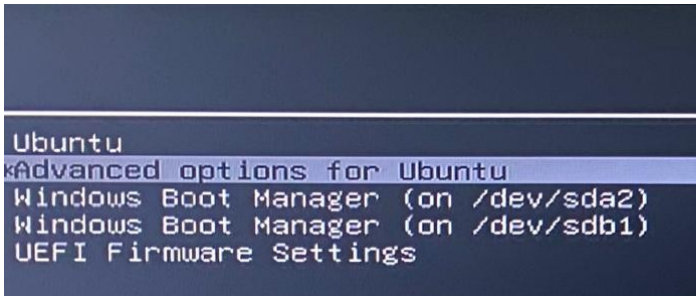
When the system boots up, select your newly installed kernel from the GRUB menu.

While rebooting the GRUB Bootloader interface will appear in front of you;

1. Select Advance Option for UBUNTU

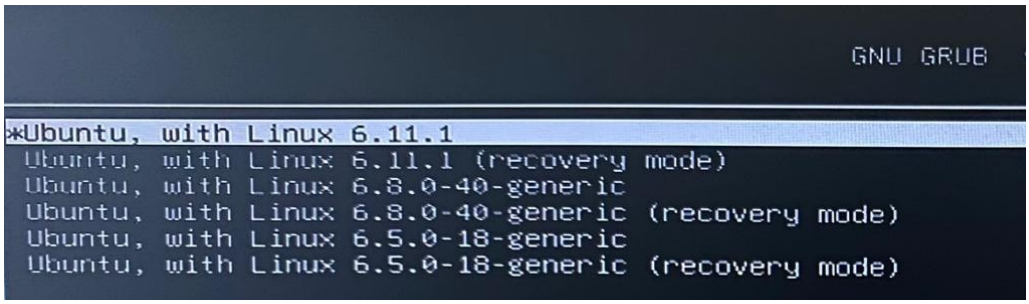
- There List of Kernels will appear, Select the newly compiled kernel by remembering its version like in my case it was linux-6.11.1, So I know which kernel to Select.

I have captured some pictures, They are attached Below:

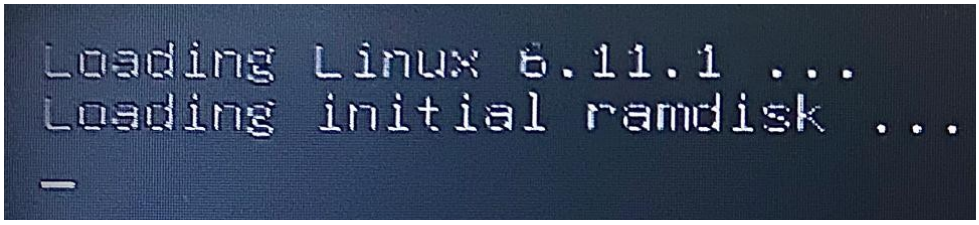


while rebooting when the GRUB Bootloader interface appears select **Advanced options for UBUNTU** and hit enter key.

Now a list of kernels that are compiled at your system will appear here. I selected the Linux 6.11.1 (the latest kernel) as I have downloaded it, made customization in the kernal according to myself and compiled it and press enter key.



After You press Enter Key, it will take a while to process the kernel.



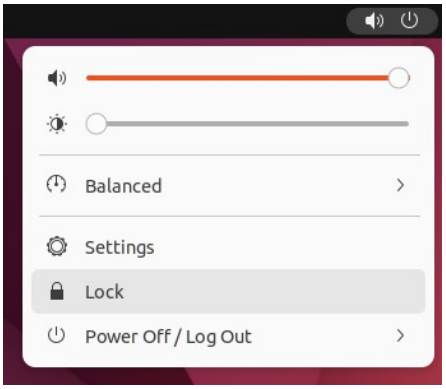
After execution of kernel, The first thing I noticed on my screen is:

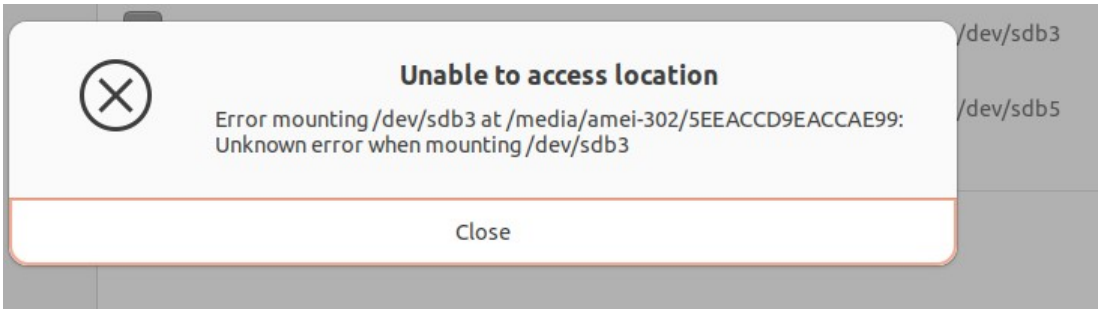
1) the sound option is showing but I cannot hear the voice of any song.

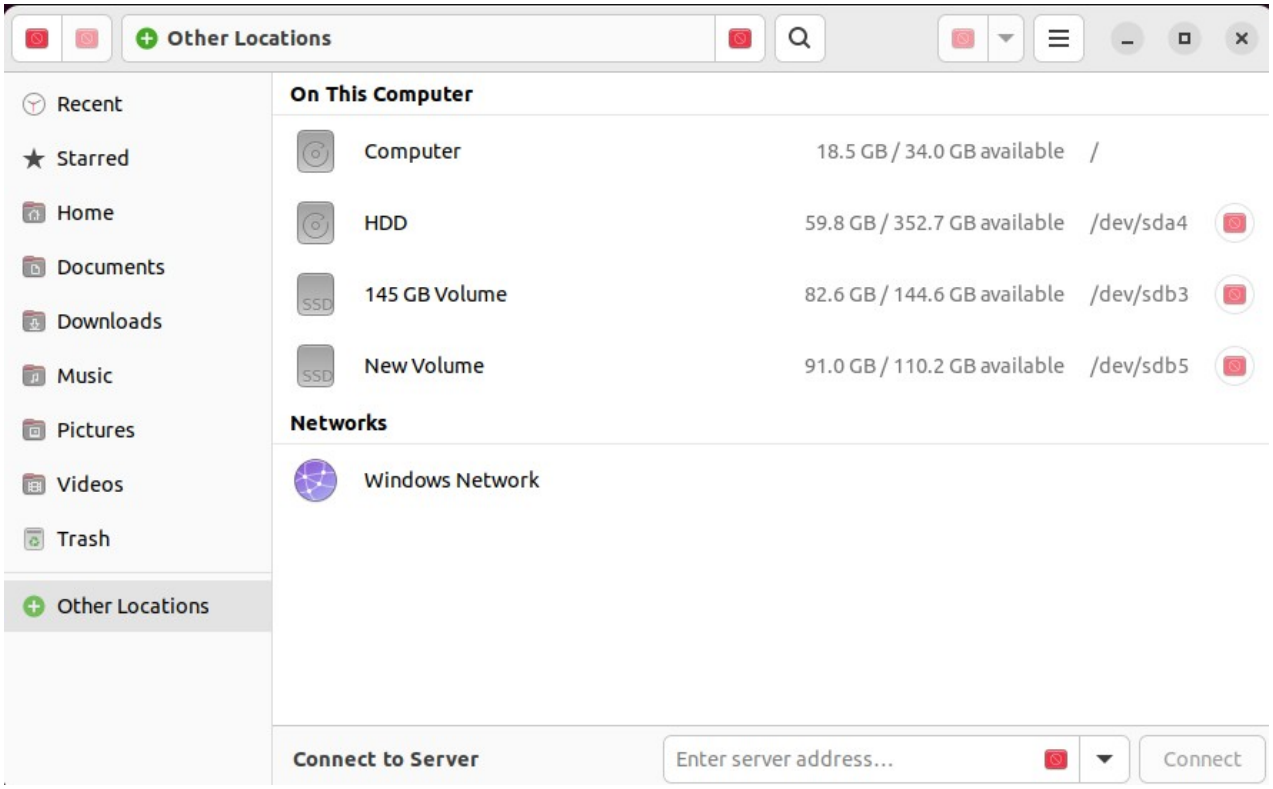
2) No internet

3) unable to access the drives other than Ubuntu

4) symbols of back and forward are changed







New Version Of Kernel: