

# Assignment #1: Linux Kernel Installation

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## Step 1: System Update and Upgrade

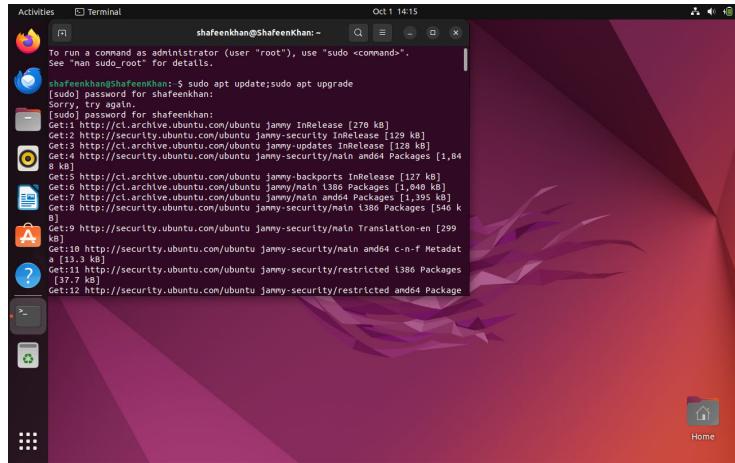


Figure 1: Updating and upgrading the system before kernel compilation.

Before starting the kernel installation process, updating the system using ‘sudo apt update’ and ‘sudo apt upgrade’ to ensure all packages are up to date.

## Step 2: Installing Build Dependencies

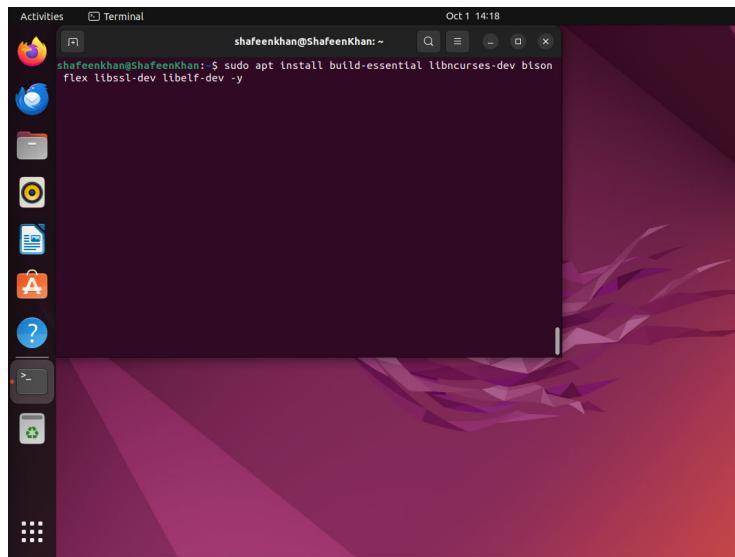


Figure 2: Installing the required build dependencies for kernel compilation.

The user installs essential build tools like ‘build-essential’, ‘libncurses-dev’, ‘bison’, ‘flex’, and others required for compiling the Linux kernel.

## Step 3: Verifying Installed Packages

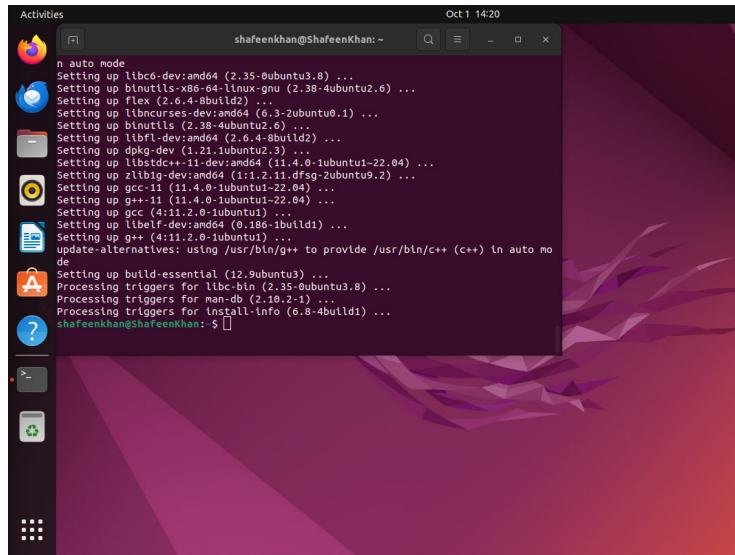


Figure 3: Successful installation of required packages for kernel compilation.

## Step 4: Downloading Kernel from Kernel Archives

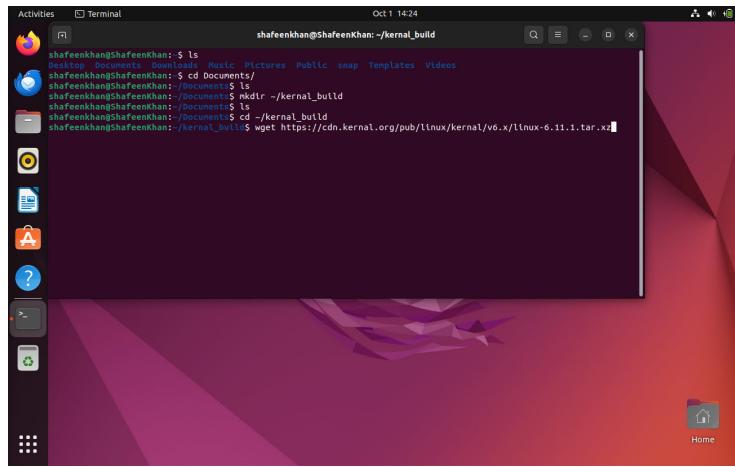


Figure 4: Accessing the Linux Kernel Archives to download the latest stable version.

## Step 5: Extracting the Kernel Source



Figure 5: Downloading the linux kernal

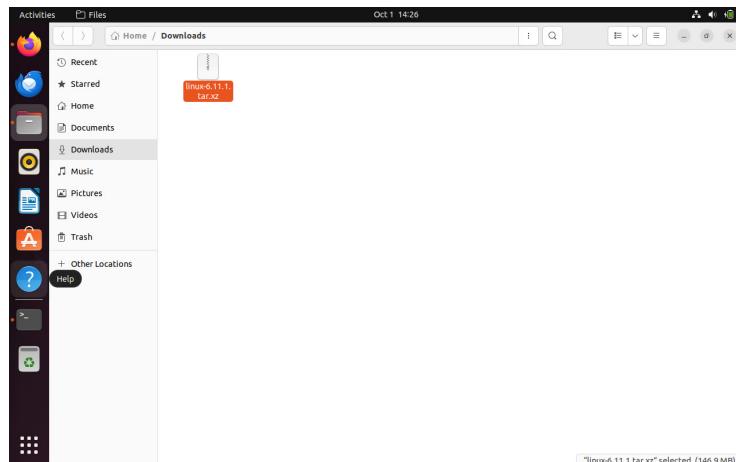


Figure 6: Displaying the downloaded file

**Step 6: Extract the linux source code file**

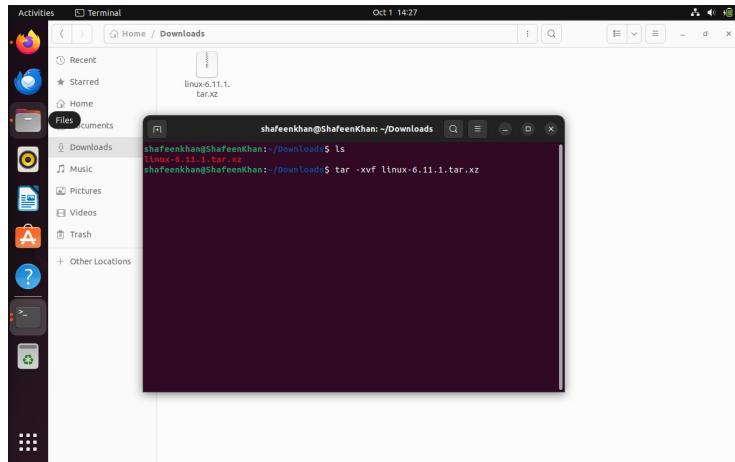


Figure 7: Extracting the kernel source file using the ‘tar’ command.

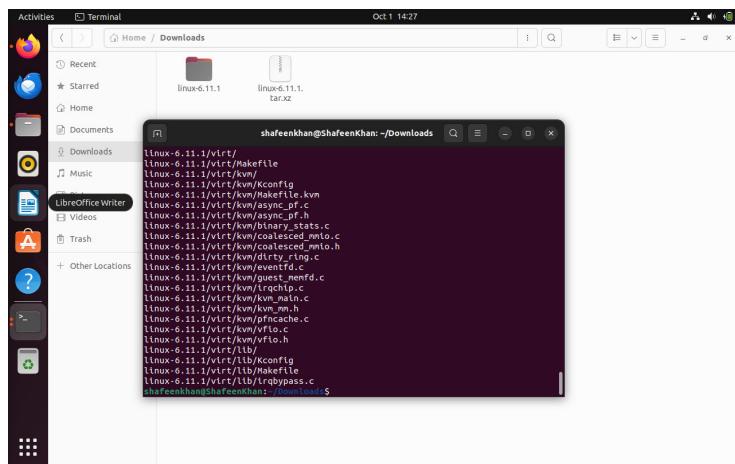


Figure 8: Extraction completed

## Step 7: Kernal Configuration

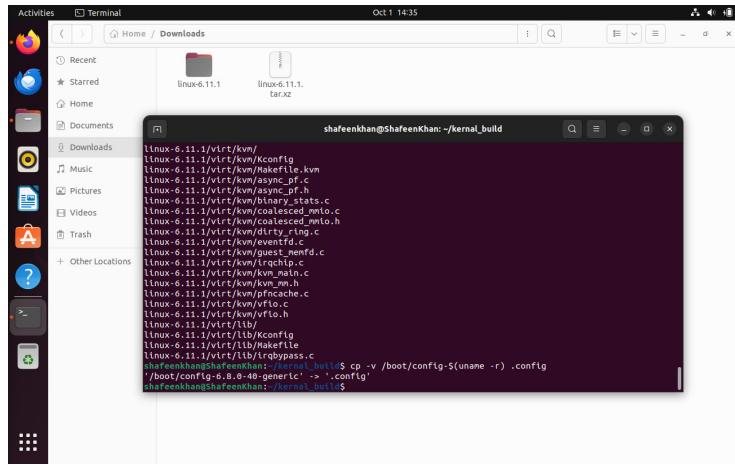


Figure 9: Ensure similar configuration for new kernal

### 0.1 Update Configuration Settings

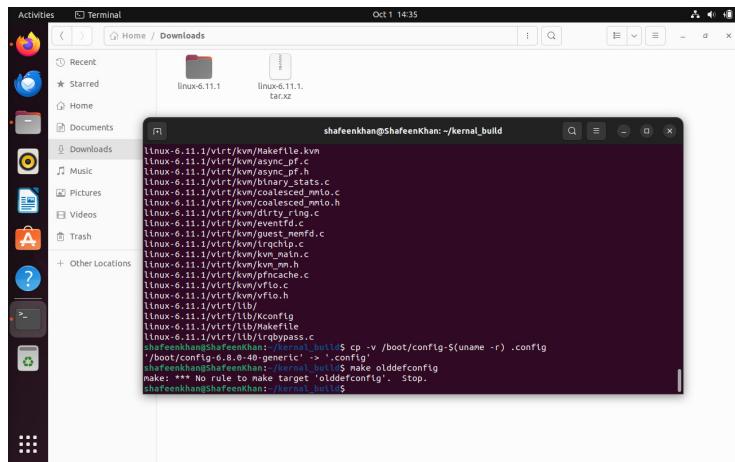


Figure 10: This updates the copied configuration to be compatible with the new kernel version

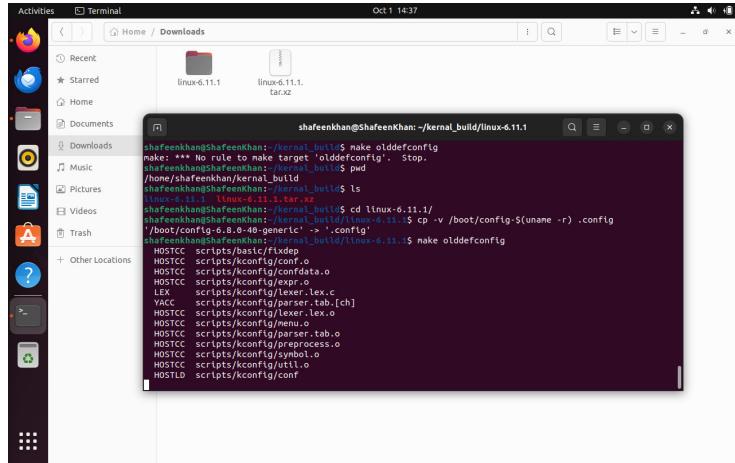


Figure 11: In process

## 0.2 Custom Kernal Configuration

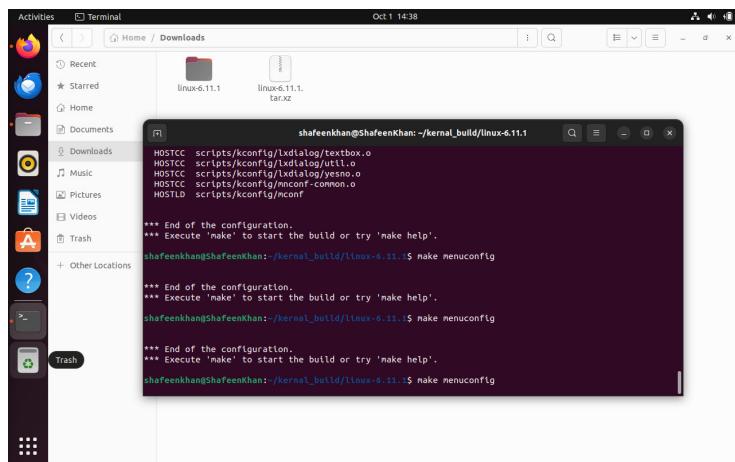


Figure 12: This opens a text-based UI where you can navigate and adjust kernel settings

### 0.3 Bonus Challenge

#### The UI - BASED interface for optional Tweaking

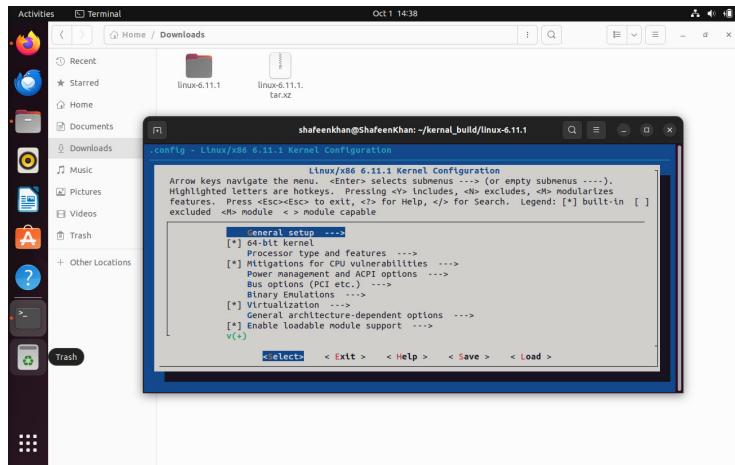


Figure 13: The text-based UI where you can navigate and adjust custom kernel settings for your benefit

## 0.4 Kernel Configuration Setup

### - File System Options

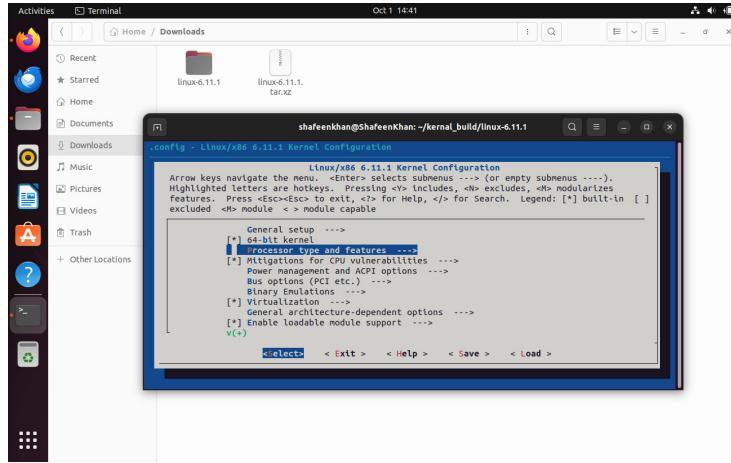


Figure 14: Navigating the kernel configuration menu to modify the file system options. The user is in the kernel configuration interface for Linux version 6.11.1. Various subsystems, including networking support and device drivers, are shown with a focus on selecting file systems for tweaking.

## 0.5 Kernel Configuration Setup

### - General Setup

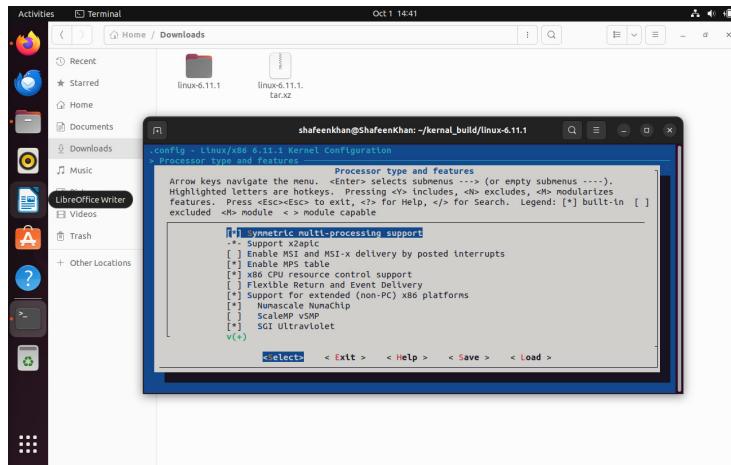


Figure 15: Turning on the Symmetric multi-processing support for faster computations and to increase speed

## 0.6 Kernel Configuration Setup

### - Optimizing for my own Specific Processor

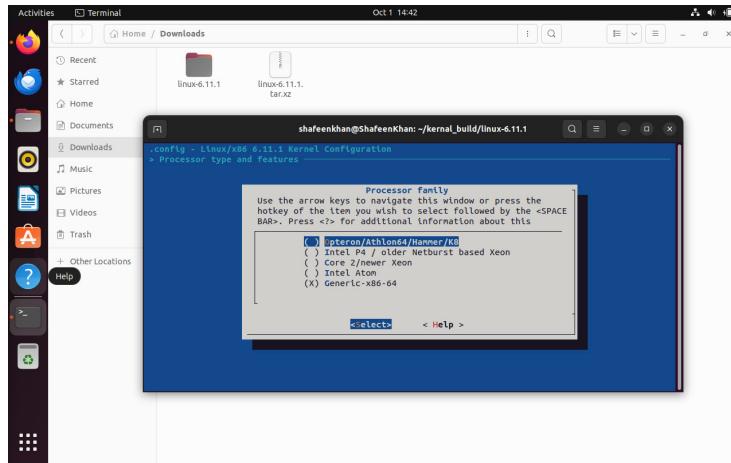


Figure 16: Choosing a specific processor family to optimize it further.

## 0.7 Kernel Configuration Setup

### - Optimizing for my own Specific Processor

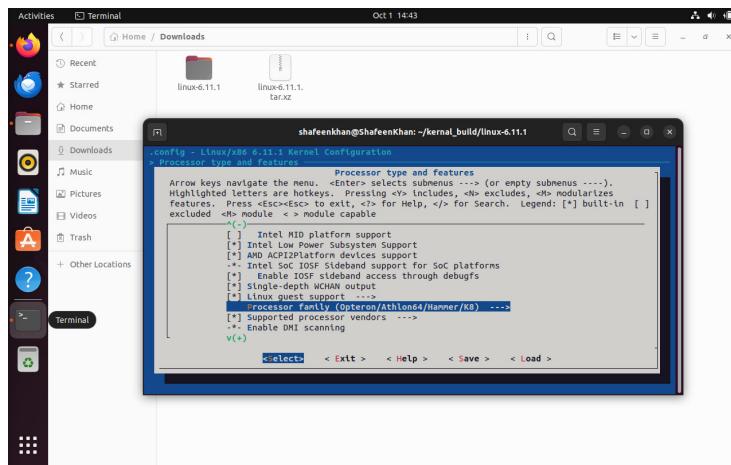


Figure 17: As you can see i chose the Opteron version because i am using an AMD ryzen processor which will give me an edge in processing speed as it is optimized

## 0.8 Kernel Configuration Setup

### - Customize Kernel Local Version

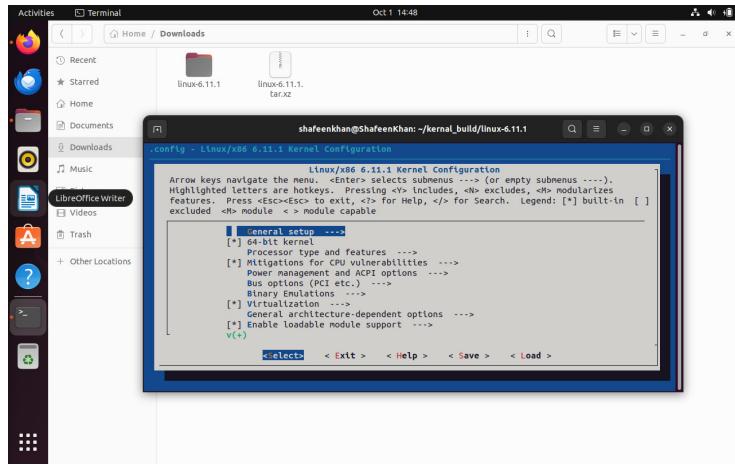


Figure 18: Going into general setup section to change the kernal version to easily identify it

## 0.9 Kernel Configuration Setup

### - Customize Kernel Local Version

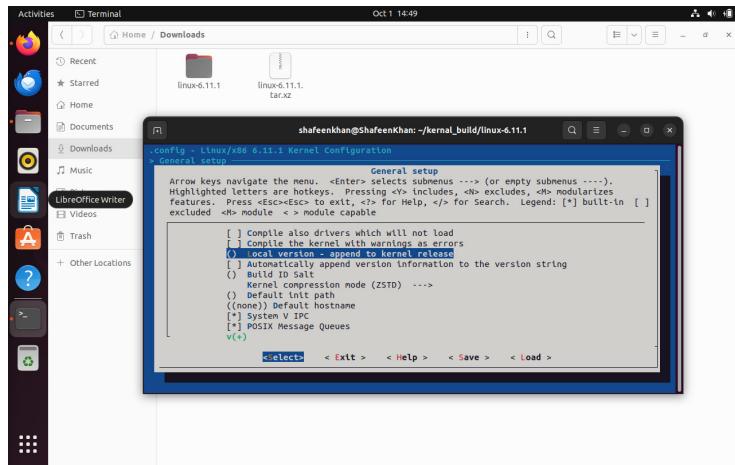


Figure 19: Continued

## 0.10 Kernel Configuration Setup - Customize Kernel Local Version

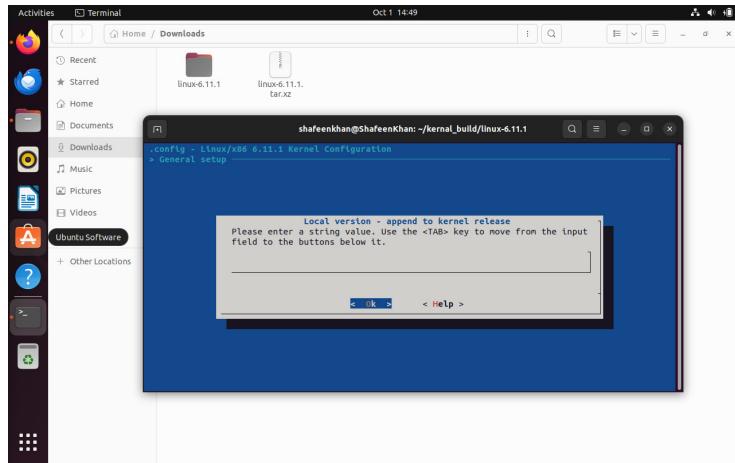


Figure 20: Continued

## 0.11 Kernel Configuration Setup - Customize Kernel Local Version

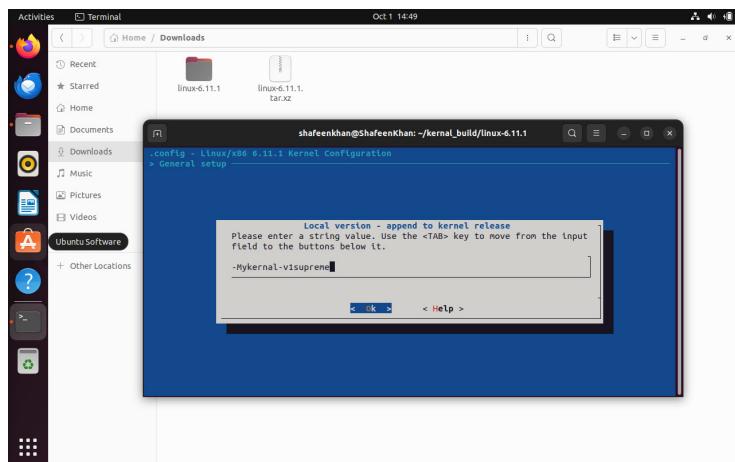


Figure 21: Continued

## 0.12 Kernel Configuration Setup - Customize Kernel Local Version

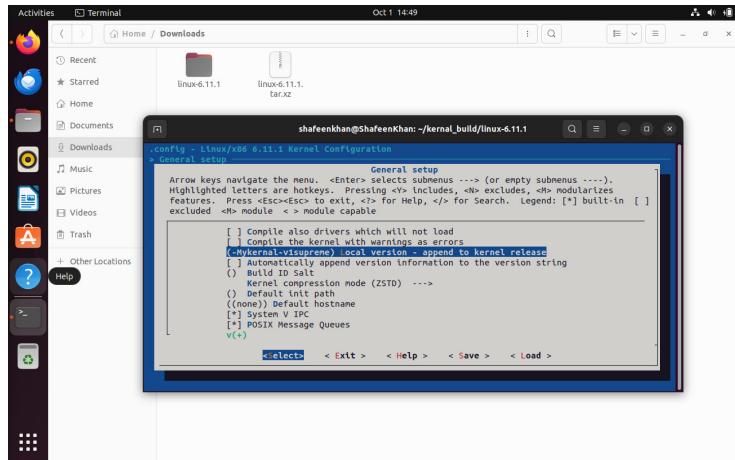


Figure 22: Continued

## 0.13 Kernel Configuration Setup

- Disable Unnecessary Filesystems and Drivers

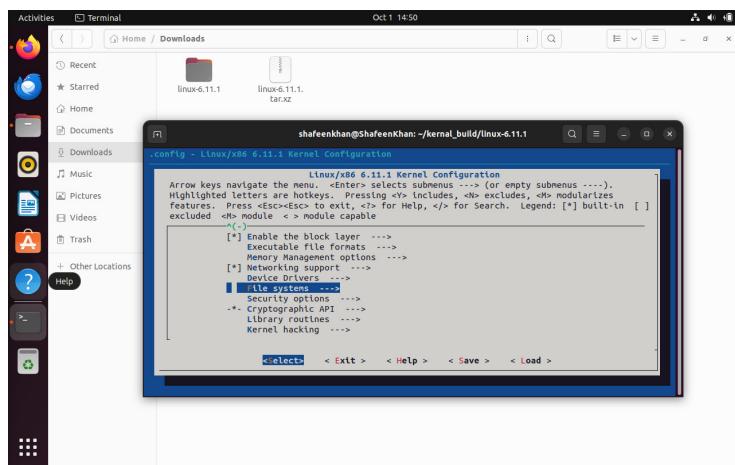


Figure 23: Removing support for filesystems and drivers you don't use can reduce kernel size and potentially speed up boot time

## 0.14 Kernel Configuration Setup

- Disable Unnecessary Filesystems and Drivers

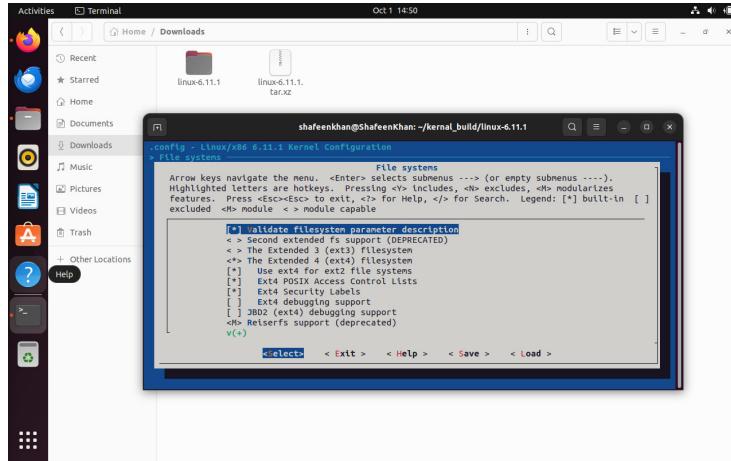


Figure 24: Continued

## 0.15 Kernel Configuration Setup

- Disable Unnecessary Filesystems and Drivers

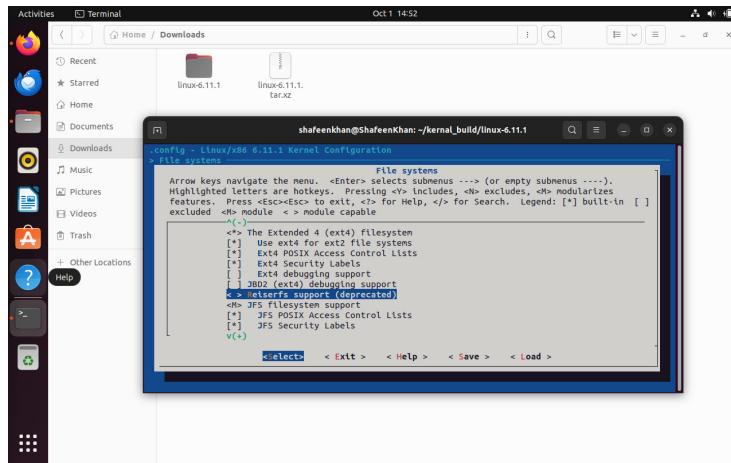


Figure 25: Continued

## 0.16 Kernel Configuration Setup

### - Disable Unnecessary Filesystems and Drivers

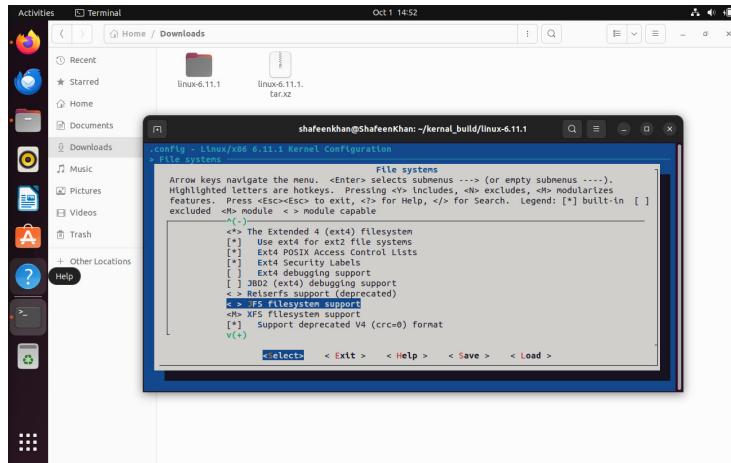


Figure 26: Continued

## 0.17 Kernel Configuration Setup

### - Disable RAID Controllers

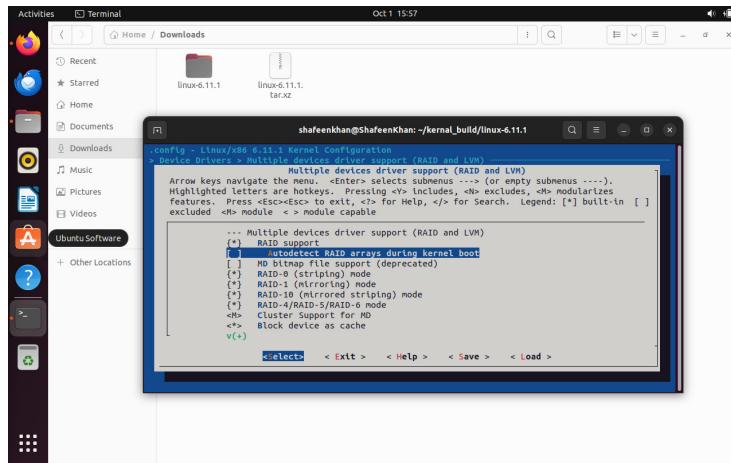


Figure 27: Disabling unused RAID support reduces the kernel size and boot time but also minimizes security risks by removing unnecessary code

## 0.18 Kernel Configuration Setup - Disable Camera

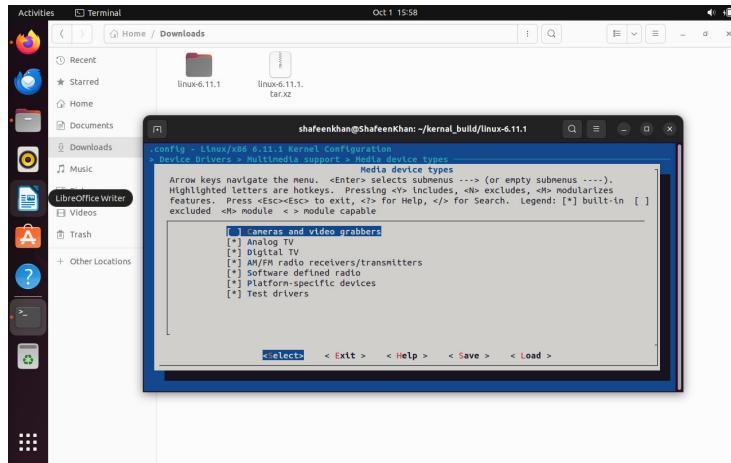


Figure 28: Disabling camera because it is of no use , to save resources / processes and to increase security

## 0.19 Enable Preemptive Kernel for Desktop Responsiveness

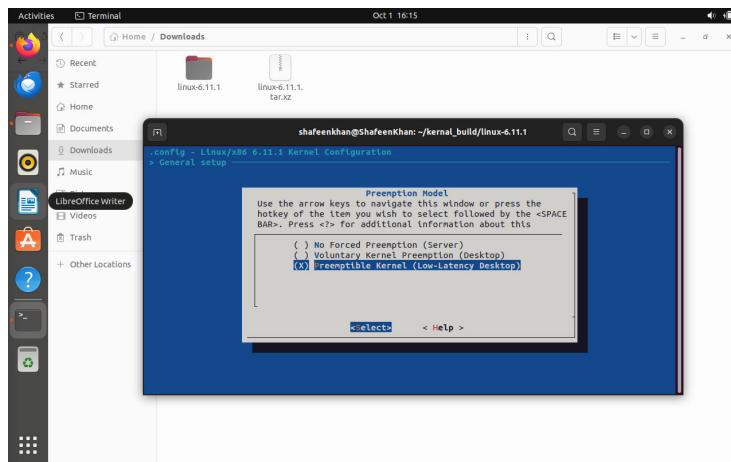


Figure 29: A preemptive kernel allows the system to interrupt tasks more frequently, improving responsiveness in desktop environments.

## 0.20 Enable Preemptive Kernel for Desktop Responsiveness

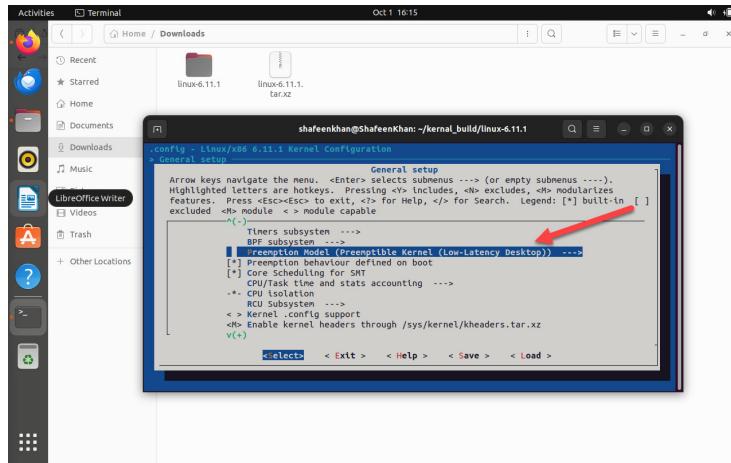


Figure 30: continued

## 0.21 Kernel Configuration Setup - Save Configuration

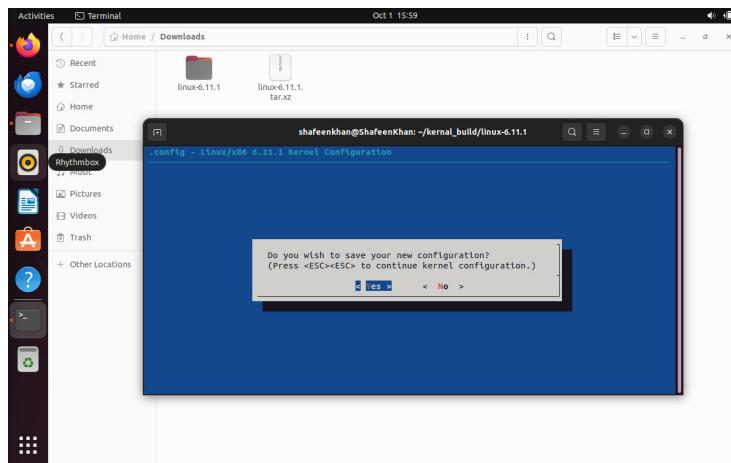


Figure 31

## Step 8: Compiling the Kernel

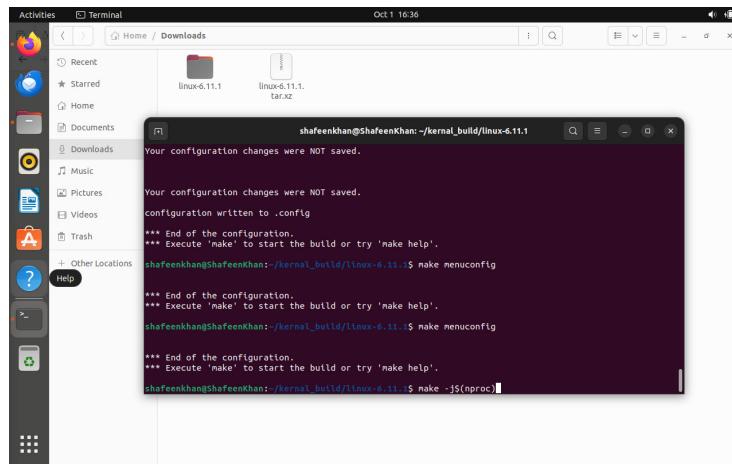


Figure 32: Using make  $-j$(nproc)$  , the command after make is used to utilize all cores for processing resulting in faster compilation

### 0.22 Compiling the Kernel - Continued

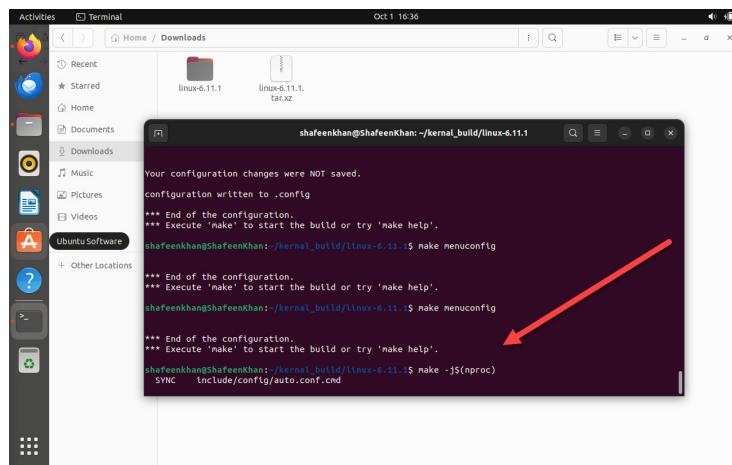
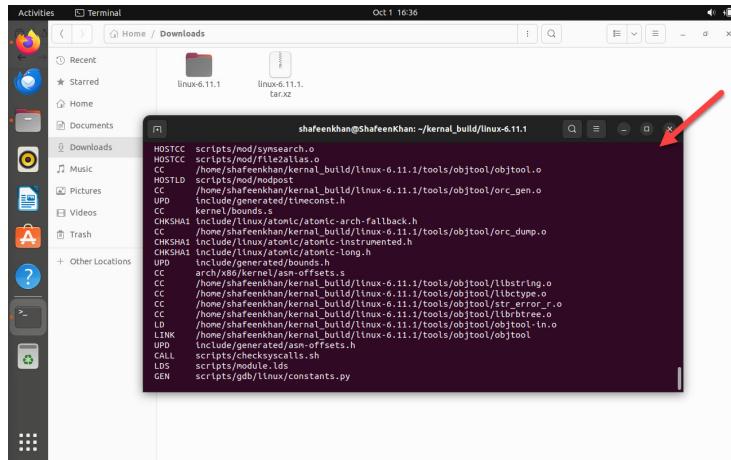


Figure 33

## 0.23 Compiling the Kernel - Continued

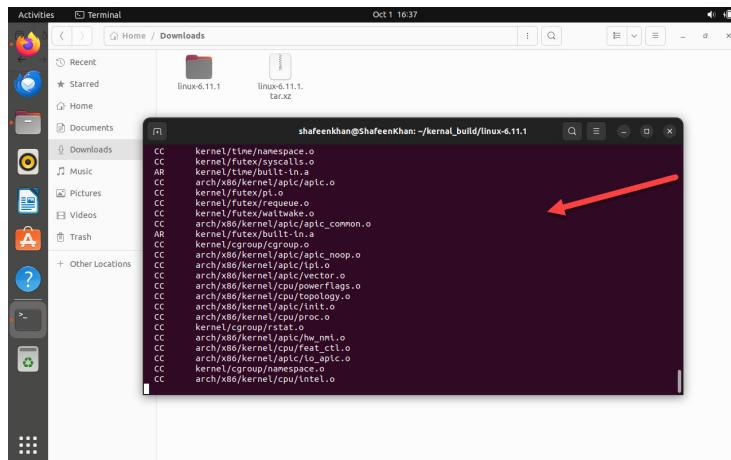


A screenshot of a terminal window titled "Terminal" running on a Linux desktop environment. The window shows the command-line output of a kernel compilation process. A red arrow points to the close button of the terminal window.

```
shafeen Khan@ShafeenKhan: ~/kernel_build/linux-6.11.1
Oct 1 16:36
HOSTCC scripts/mod/syntactic.o
HOSTCC scripts/mod/file2alias.o
CC /home/shafeen Khan/kernel_build/linux-6.11.1/tools/objtool/objtool.o
HOSTLD scripts/mod/modpost
CC /home/shafeen Khan/kernel_build/linux-6.11.1/tools/objtool/orc_gen.o
UPD include/generated/timeconst.h
CC kernel/bounds.s
CC kernel/atomic.h
CHKSHAI include/linux/atomic/atomic-fallback.h
CC /home/shafeen Khan/kernel_build/linux-6.11.1/tools/objtool/orc_dump.o
CHKSHAI include/linux/atomic/atomic-instrumented.h
CHKSHAI include/linux/atomic/atomic-long.h
UPD include/generated/atomic-offsets.s
CC /home/shafeen Khan/kernel_build/linux-6.11.1/tools/objtool/libstring.o
CC /home/shafeen Khan/kernel_build/linux-6.11.1/tools/objtool/libctype.o
CC /home/shafeen Khan/kernel_build/linux-6.11.1/tools/objtool/liballoc.o
CC /home/shafeen Khan/kernel_build/linux-6.11.1/tools/objtool/libtree.o
LD /home/shafeen Khan/kernel_build/linux-6.11.1/tools/objtool/objtool-in.o
LINK /home/shafeen Khan/kernel_build/linux-6.11.1/tools/objtool/objtool
LDFLAGS -fno-strict-aliasing -fno-common -fno-tree-selects.h
CALL scripts/checksyscalls.sh
LDS scripts/module.lds
GEN scripts/gdb/linux/constants.py
```

Figure 34

## 0.24 Compiling the Kernel - Continued



A screenshot of a terminal window titled "Terminal" running on a Linux desktop environment. The window shows the command-line output of a kernel compilation process. A red arrow points to the close button of the terminal window.

```
shafeen Khan@ShafeenKhan: ~/kernel_build/linux-6.11.1
Oct 1 16:37
CC kernel/time/nanoprobe.o
CC kernel/time/syscalls.o
AR kernel/time/built-in.a
CC arch/x86/kernel/cpu/apic.o
CC kernel/time/pit.o
CC kernel/time/queueue.o
CC kernel/time/wallwake.o
CC arch/x86/kernel/time/tsc_common.o
AR kernel/time/built-in.a
CC kernel/group/cgroup.o
CC arch/x86/kernel/apic/atomic_hoop.o
CC arch/x86/kernel/apic/intel.o
CC arch/x86/kernel/apic/vector.o
CC arch/x86/kernel/cpu/powerflags.o
CC arch/x86/kernel/cpu/topology.o
CC arch/x86/kernel/cpu/vtune.o
CC arch/x86/kernel/cpu/proc.o
CC kernel/group/rstat.o
CC arch/x86/kernel/apic/mem.o
CC arch/x86/kernel/fast_ctl.o
CC arch/x86/kernel/apic/io_apic.o
CC kernel/group/namespace.o
CC arch/x86/kernel/cpu/intel.o
```

Figure 35

## 0.25 Compiling the Kernel - Continued

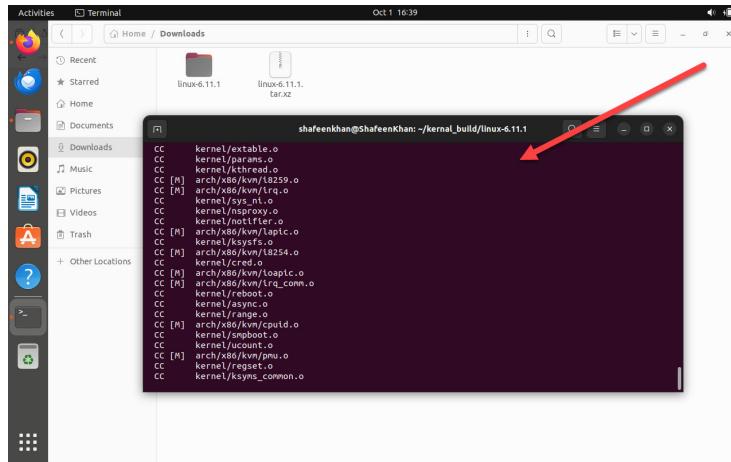


Figure 36

## 0.26 Compiling the Kernel - Continued

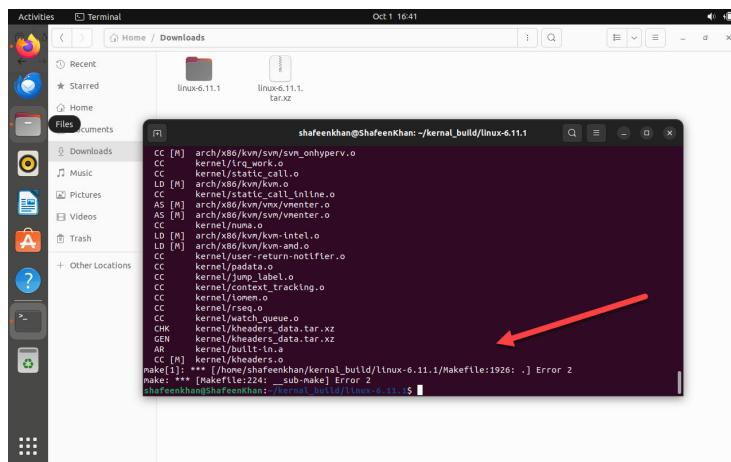


Figure 37: it gives this error to fix this we run to commands

## Step 9: ERROR WHILE - Compiling the Kernel

This error is caused by security reasons from Linux operating system , it gives an error because installing custom linux it checks some predefined keys that

are linked to your current kernel hence the keys do not match which is why it throws an error , we are gonna use some commands to disable the predefined keys and use new signatures and certifications to make the compilation possible. " scripts/config --disable SYSTEM\_TRUSTED\_KEYS: " " scripts/config --disable SYSTEM\_REVOCATION\_KEYS: " These commands disable the kernel's use of trusted and revoked cryptographic keys for module and firmware verification during the build process.

## 0.27 Compiling the Kernel - Continued

```

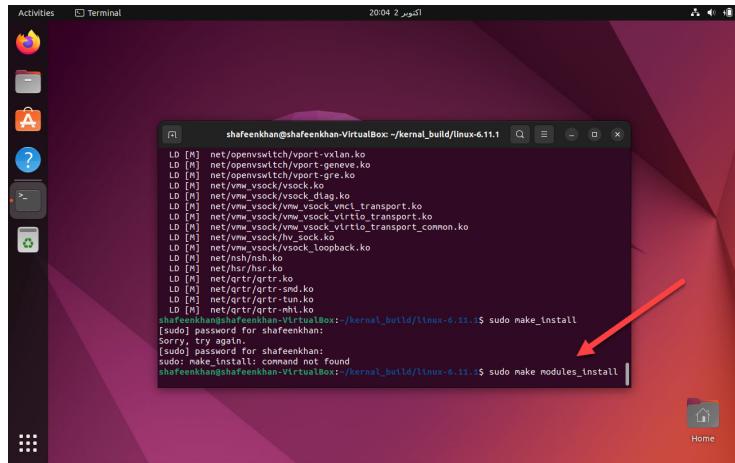
Preparing to unpack .../git_183az_34.1-1ubuntu1.11_amd64.deb ...
Unpacking git (1:2.34.1-1ubuntu1.11) ...
Setting up liberror-perl (0.17029-1) ...
Setting up gtt-man (1:2.34.1-1ubuntu1.11) ...
Setting up libtalloc (2.1.10-1) ...
Processing triggers for man-db (2.10.2-1) ...
shafeenkhango@shafeenhan-VirtualBox:~/kernel_build/linux-6.11$ sudo make
Call       scripts/checksyscalls.sh
DESCEND    libbsbind headers
INSTALL   libbsbind headers
make[3]: *** No rule to make target 'debian/canonical-certs.pem', needed by 'certs/x509_certificate_list'. Stop.
make[2]: *** [scripts/makefile/libbsbind/certs] Error 2
make[1]: *** [scripts/makefile/kernel_build/linux-6.11/Makefile:1926: .] Error 2
make: *** [Makefile:224: _sub-make] Error 2
shafeenkhango@shafeenhan-VirtualBox:~/kernel_build/linux-6.11$ make menuconfig
*** End of the configuration.
*** Execute 'make' to start the build or try 'make help'.
shafeenkhango@shafeenhan-VirtualBox:~/kernel_build/linux-6.11$ sudo make
Call       scripts/checksyscalls.sh
DESCEND    objects
INSTALL   libbsbind headers
HOSTCC   scripts/kconfig/lxdialog/checklist.o
HOSTCC   scripts/kconfig/lxdialog/inputbox.o
HOSTCC   scripts/kconfig/lxdialog/menubox.o
HOSTCC   scripts/kconfig/lxdialog/option.o
HOSTCC   scripts/kconfig/lxdialog/utility.o
HOSTCC   scripts/kconfig/lxdialog/yesno.o
HOSTCC   scripts/kconfig/mmconf-common.o
HOSTLD  scripts/kconfig/nconf

*** End of the configuration.
*** Execute 'make' to start the build or try 'make help'.
shafeenkhango@shafeenhan-VirtualBox:~/kernel_build/linux-6.11$ scripts/config --disable SYSTEM_TRUSTED_KEYS
shafeenkhango@shafeenhan-VirtualBox:~/kernel_build/linux-6.11$ scripts/config --disable SYSTEM_REVOCATION_KEYS
shafeenkhango@shafeenhan-VirtualBox:~/kernel_build/linux-6.11$
```

Figure 38: The above commands fixes the errors

# 1 Step 10: Installing the Kernel Modules

## 1.1 Compiling the Kernel - Continued

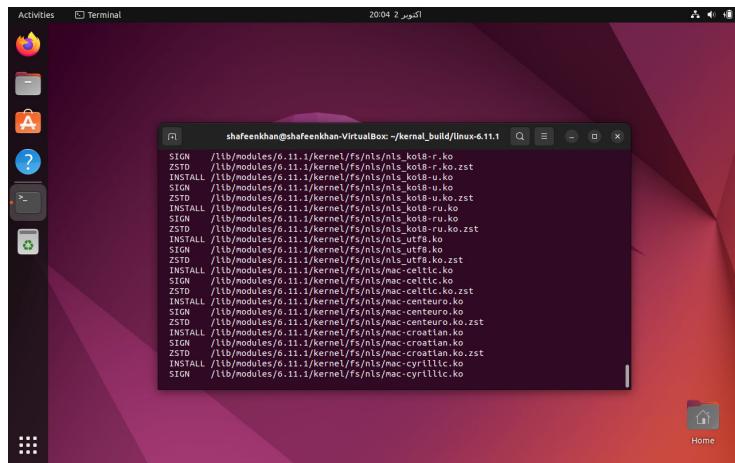


A screenshot of a Linux desktop environment showing a terminal window titled "Terminal". The terminal window contains the following command and its output:

```
shafeenhan@shafeenhan-VirtualBox:~/kernal_build/linux-6.11$ sudo make modules_install
[sudo] password for shafeenhan:
make: *** [modules_install] Error 127
```

A red arrow points to the last line of the terminal output, which is "make: \*\*\* [modules\_install] Error 127".

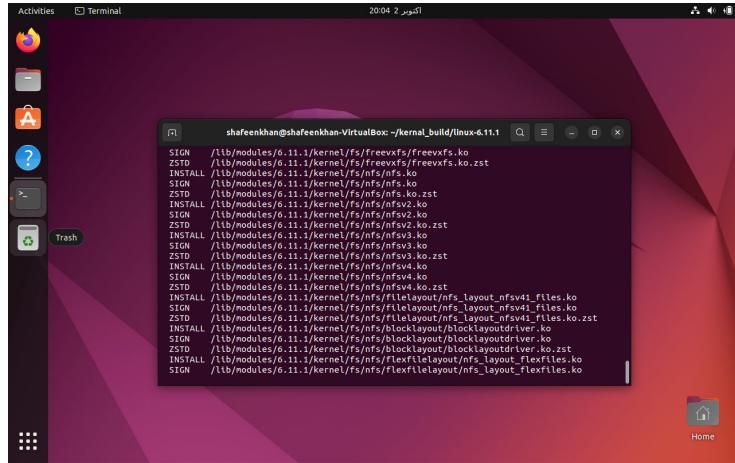
Figure 39: This installs kernel modules to `/lib/modules/kernel-version`.



A screenshot of a Linux desktop environment showing a terminal window titled "Terminal". The terminal window contains the following command and its output:

```
shafeenhan@shafeenhan-VirtualBox:~/kernal_build/linux-6.11$ sudo make modules_install
[...]
SIGN /lib/modules/6.11.1-headers-6.11.1/fs/nls/nls_ko18-r.ko
ZSTD /lib/modules/6.11.1-headers-6.11.1/fs/nls/nls_ko18-r.ko.zst
INSTALL /lib/modules/6.11.1-headers-6.11.1/fs/nls/nls_ko18-u.ko
SIGN /lib/modules/6.11.1-headers-6.11.1/fs/nls/nls_ko18-u.ko
ZSTD /lib/modules/6.11.1-headers-6.11.1/fs/nls/nls_ko18-u.ko.zst
INSTALL /lib/modules/6.11.1-headers-6.11.1/fs/nls/nls_ko18-ru.ko
SIGN /lib/modules/6.11.1-headers-6.11.1/fs/nls/nls_ko18-ru.ko
ZSTD /lib/modules/6.11.1-headers-6.11.1/fs/nls/nls_ko18-ru.ko.zst
INSTALL /lib/modules/6.11.1-headers-6.11.1/fs/nls/nls_utf8.ko
SIGN /lib/modules/6.11.1-headers-6.11.1/fs/nls/nls_utf8.ko
ZSTD /lib/modules/6.11.1-headers-6.11.1/fs/nls/nls_utf8.ko.zst
[...]
```

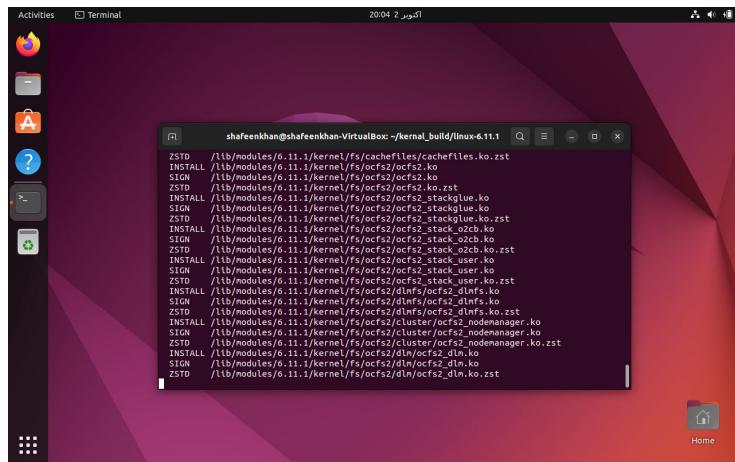
Figure 40



```
shafeenhan@shafeenhan-VirtualBox: ~/kernel_build/linux-6.11.1
```

```
SIGN '/lib/modules/6.11.1/kernel/fs/freexfs/freexvfs.ko
ZSTD '/lib/modules/6.11.1/kernel/fs/freexfs/freexvts.ko.zst
INSTALL '/lib/modules/6.11.1/kernel/fs/nfs/nfs.ko
SIGN '/lib/modules/6.11.1/kernel/fs/nfs/nfs.ko
ZSTD '/lib/modules/6.11.1/kernel/fs/nfs/nfs.ko.zst
INSTALL '/lib/modules/6.11.1/kernel/fs/nfs/nfsv2.ko
SIGN '/lib/modules/6.11.1/kernel/fs/nfs/nfsv2.ko
ZSTD '/lib/modules/6.11.1/kernel/fs/nfs/nfsv2.ko.zst
INSTALL '/lib/modules/6.11.1/kernel/fs/nfs/nfsv3.ko
SIGN '/lib/modules/6.11.1/kernel/fs/nfs/nfsv3.ko
ZSTD '/lib/modules/6.11.1/kernel/fs/nfs/nfsv3.ko.zst
INSTALL '/lib/modules/6.11.1/kernel/fs/nfs/nfsv4.ko
SIGN '/lib/modules/6.11.1/kernel/fs/nfs/nfsv4.ko
ZSTD '/lib/modules/6.11.1/kernel/fs/nfs/nfsv4.ko.zst
INSTALL '/lib/modules/6.11.1/kernel/fs/nfs/fflexfilelayout/nfs_layout_nfsv4i_files.ko
SIGN '/lib/modules/6.11.1/kernel/fs/nfs/fflexfilelayout/nfs_layout_nfsv4i_files.ko
ZSTD '/lib/modules/6.11.1/kernel/fs/nfs/fflexfilelayout/nfs_layout_nfsv4i_files.ko.zst
INSTALL '/lib/modules/6.11.1/kernel/fs/nfs/blocklayout/blocklayoutdriver.ko
SIGN '/lib/modules/6.11.1/kernel/fs/nfs/blocklayout/blocklayoutdriver.ko
ZSTD '/lib/modules/6.11.1/kernel/fs/nfs/blocklayout/blocklayoutdriver.ko.zst
INSTALL '/lib/modules/6.11.1/kernel/fs/nfs/flexfilelayout/nfs_layout_flexfiles.ko
SIGN '/lib/modules/6.11.1/kernel/fs/nfs/flexfilelayout/nfs_layout_flexfiles.ko
ZSTD '/lib/modules/6.11.1/kernel/fs/nfs/flexfilelayout/nfs_layout_flexfiles.ko.zst'
```

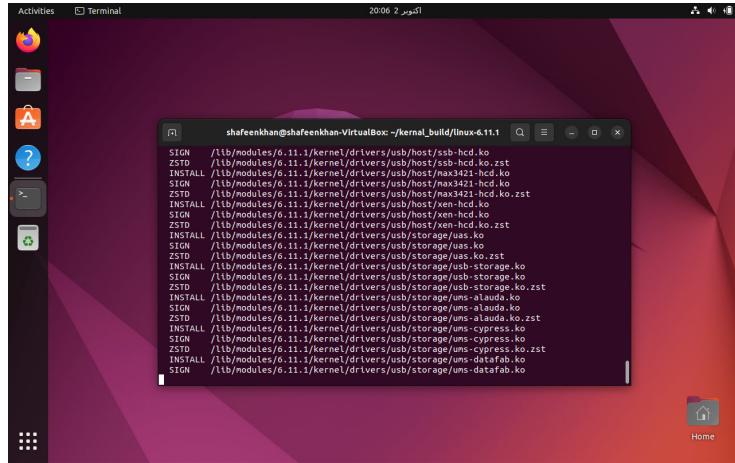
Figure 41



```
shafeenhan@shafeenhan-VirtualBox: ~/kernel_build/linux-6.11.1
```

```
ZSTD '/lib/modules/6.11.1/kernel/fs/cachefiles/cachefiles.ko.zst
INSTALL '/lib/modules/6.11.1/kernel/fs/ocfs2/ocfs2.ko
SIGN '/lib/modules/6.11.1/kernel/fs/ocfs2/ocfs2.ko
ZSTD '/lib/modules/6.11.1/kernel/fs/ocfs2/ocfs2.ko.zst
INSTALL '/lib/modules/6.11.1/kernel/fs/ocfs2/ocfs2_stackglue.ko
SIGN '/lib/modules/6.11.1/kernel/fs/ocfs2/ocfs2_stackglue.ko
ZSTD '/lib/modules/6.11.1/kernel/fs/ocfs2/ocfs2_stackglue.ko.zst
INSTALL '/lib/modules/6.11.1/kernel/fs/ocfs2/ocfs2_stack_oczb.ko
SIGN '/lib/modules/6.11.1/kernel/fs/ocfs2/ocfs2_stack_oczb.ko
ZSTD '/lib/modules/6.11.1/kernel/fs/ocfs2/ocfs2_stack_oczb.ko.zst
INSTALL '/lib/modules/6.11.1/kernel/fs/ocfs2/ocfs2_stack_user.ko
SIGN '/lib/modules/6.11.1/kernel/fs/ocfs2/ocfs2_stack_user.ko
ZSTD '/lib/modules/6.11.1/kernel/fs/ocfs2/ocfs2_stack_user.ko.zst
INSTALL '/lib/modules/6.11.1/kernel/fs/ocfs2/dlmfs/ocfs2_dlmfs.ko
SIGN '/lib/modules/6.11.1/kernel/fs/ocfs2/dlmfs/ocfs2_dlmfs.ko
ZSTD '/lib/modules/6.11.1/kernel/fs/ocfs2/dlmfs/ocfs2_dlmfs.ko.zst
INSTALL '/lib/modules/6.11.1/kernel/fs/ocfs2/cluster/ocfs2_modemanager.ko
SIGN '/lib/modules/6.11.1/kernel/fs/ocfs2/cluster/ocfs2_modemanager.ko
ZSTD '/lib/modules/6.11.1/kernel/fs/ocfs2/cluster/ocfs2_modemanager.ko.zst
INSTALL '/lib/modules/6.11.1/kernel/fs/ocfs2/dlm/ocfs2_dlm.ko
SIGN '/lib/modules/6.11.1/kernel/fs/ocfs2/dlm/ocfs2_dlm.ko
ZSTD '/lib/modules/6.11.1/kernel/fs/ocfs2/dlm/ocfs2_dlm.ko.zst'
```

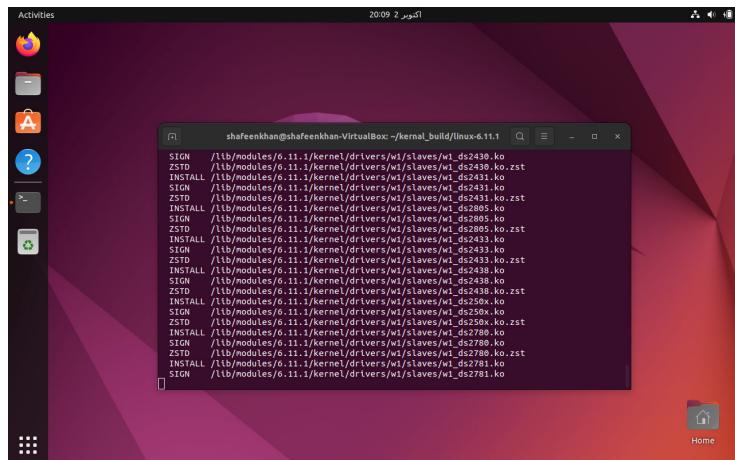
Figure 42



```
shafeenhan@shafeenhan-VirtualBox:~/kernel_build/linux-6.11.1
```

```
SIGN /lib/modules/6.11.1/kernel/drivers/usb/host/s3b-hcd.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/usb/host/s3b-hcd.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/usb/host/nx3421-hcd.ko
SIGN /lib/modules/6.11.1/kernel/drivers/usb/host/nx3421-hcd.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/usb/storage/nx3421-hcd.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/usb/storage/nx3421-hcd.ko
SIGN /lib/modules/6.11.1/kernel/drivers/usb/host/xen-hcd.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/usb/host/xen-hcd.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/usb/storage/usas.ko
SIGN /lib/modules/6.11.1/kernel/drivers/usb/storage/usas.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/usb/storage/usas.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/usb/storage/usb-storage.ko
SIGN /lib/modules/6.11.1/kernel/drivers/usb/storage/usb-storage.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/usb/storage/usb-storage.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-alauda.ko
SIGN /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-alauda.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-alauda.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-cypress.ko
SIGN /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-cypress.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-cypress.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-datafab.ko
SIGN /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-datafab.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-datafab.ko.zst
```

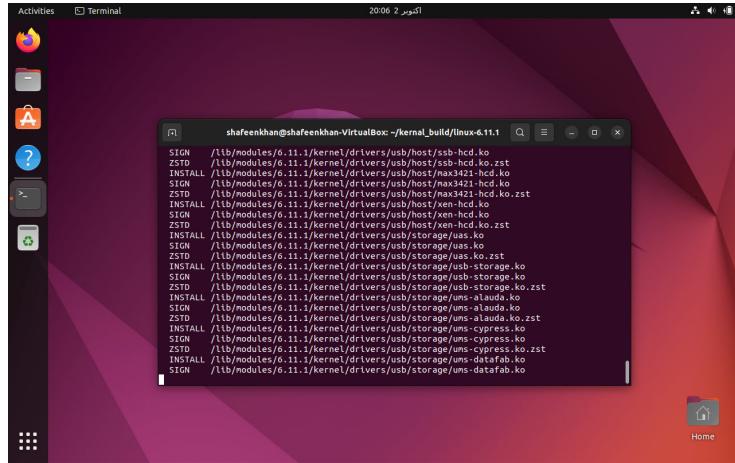
Figure 43



```
shafeenhan@shafeenhan-VirtualBox:~/kernel_build/linux-6.11.1
```

```
SIGN /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2430.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2430.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2431.ko
SIGN /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2431.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2431.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2805.ko
SIGN /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2805.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2805.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2431.ko
SIGN /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2431.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2431.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2438.ko
SIGN /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2438.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2438.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds250x.ko
SIGN /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds250x.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds250x.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2788.ko
SIGN /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2788.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2788.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2781.ko
SIGN /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2781.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/wl/slaves/wl_ds2781.ko.zst
```

Figure 44



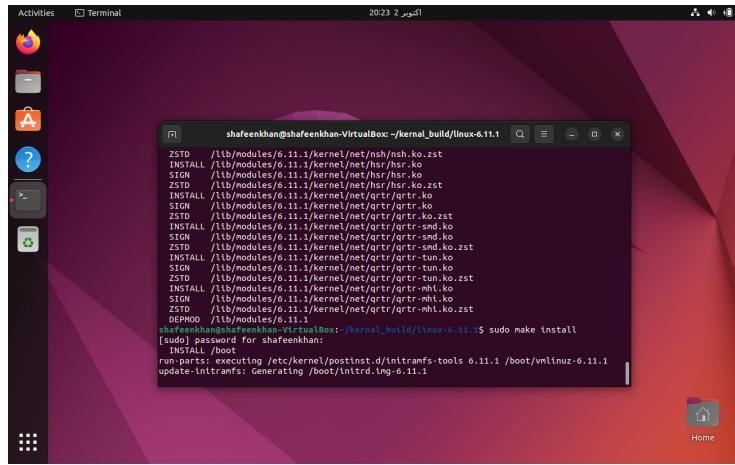
```

shafeenhan@shafeenhan-VirtualBox: ~/kernel_build/linux-6.11.1
SIGN /lib/modules/6.11.1/kernel/drivers/usb/host/sab-hcd.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/usb/host/sab-hcd.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/usb/host/nas321-hcd.ko
SIGN /lib/modules/6.11.1/kernel/drivers/usb/host/nas321-hcd.ko.zst
ZSTD /lib/modules/6.11.1/kernel/drivers/usb/storage/nas321-hcd.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/usb/storage/nas321-hcd.ko.zst
SIGN /lib/modules/6.11.1/kernel/drivers/usb/host/xen-hcd.ko
ZSTD /lib/modules/6.11.1/kernel/drivers/usb/host/xen-hcd.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/usb/storage/usas.ko
SIGN /lib/modules/6.11.1/kernel/drivers/usb/storage/usas.ko.zst
ZSTD /lib/modules/6.11.1/kernel/drivers/usb/storage/usas.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/usb/storage/usb-storage.ko
SIGN /lib/modules/6.11.1/kernel/drivers/usb/storage/usb-storage.ko.zst
ZSTD /lib/modules/6.11.1/kernel/drivers/usb/storage/usb-storage.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-alauda.ko
SIGN /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-alauda.ko.zst
ZSTD /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-alauda.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-cypress.ko
SIGN /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-cypress.ko.zst
ZSTD /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-cypress.ko.zst
INSTALL /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-datafab.ko
SIGN /lib/modules/6.11.1/kernel/drivers/usb/storage/ums-datafab.ko.zst

```

Figure 45: Completed.

## 2 Step 11: Installing the New Kernel



```

shafeenhan@shafeenhan-VirtualBox: ~/kernel_build/linux-6.11.1
ZSTD /lib/modules/6.11.1/kernel/net/sh/nsh.ko.zst
INSTALL /lib/modules/6.11.1/kernel/net/sh/nsh.ko.zst
SIGN /lib/modules/6.11.1/kernel/net/hsr/hsr.ko
ZSTD /lib/modules/6.11.1/kernel/net/hsr/hsr.ko.zst
INSTALL /lib/modules/6.11.1/kernel/net/qtr/qtr.ko
SIGN /lib/modules/6.11.1/kernel/net/qtr/qtr.ko.zst
ZSTD /lib/modules/6.11.1/kernel/net/qtr/qtr.ko.zst
INSTALL /lib/modules/6.11.1/kernel/net/qtr/qtr_snd.ko
SIGN /lib/modules/6.11.1/kernel/net/qtr/qtr_snd.ko.zst
ZSTD /lib/modules/6.11.1/kernel/net/qtr/qtr_snd.ko.zst
INSTALL /lib/modules/6.11.1/kernel/net/qtr/qtr_tun.ko
SIGN /lib/modules/6.11.1/kernel/net/qtr/qtr_tun.ko.zst
ZSTD /lib/modules/6.11.1/kernel/net/qtr/qtr_tun.ko.zst
INSTALL /lib/modules/6.11.1/kernel/net/qtr/qtr_tun.ko.zst
SIGN /lib/modules/6.11.1/kernel/net/qtr/qtr_mhl.ko
ZSTD /lib/modules/6.11.1/kernel/net/qtr/qtr_mhl.ko.zst
DEPROG /lib/modules/6.11.1/kernel/net/qtr/qtr_mhl.ko.zst
shafeenhan@shafeenhan-VirtualBox: ~/kernel_build/linux-6.11.1$ sudo make install
[sudo] password for shafeenhan:
INSTALL /boot/
run-parts: executing /etc/kernel/postinst.d/intramfs-tools 6.11.1 /boot/vmlinuz-6.11.1
update-initramfs: Generating /boot/initrd.img-6.11.1

```

Figure 46: This copies the kernel image (vmlinuz), system map, and config file to /boot

```

shafeenkh@shafeenkh-VirtualBox:~/kernel_build/linux-6.11.1$ ./grub-mkconfig -o /boot/grub/grub.cfg
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-6.8.0-45-generic
I: /boot/initrd.img is now a symlink to /initrd.img-6.11.1
run-parts: executing /etc/kernel/postinst.d/z-z-shim 6.11.1 /boot/vmlinuz-6.11.1
run-parts: executing /etc/kernel/postinst.d/z-z-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 nentest86+ image: /boot/nentest86+.bin
Found nentest86+ image: /boot/nentest86+.bin
Warning: os-prober will not be executed to detect other bootable partitions.
Systems on them will not be added to the GRUB boot configuration.
Check GRUB_DISABLE_OS_PROBER documentation entry.
done
shafeenkh@shafeenkh-VirtualBox:~/kernel_build/linux-6.11.1$
```

Figure 47: Completed.

### 3 Step 12: Updating the Bootloader

```

shafeenkh@shafeenkh-VirtualBox:~/kernel_build/linux-6.11.1$ sudo update-initramfs -c -k 6.11.1
update-initramfs: Generating /boot/initrd.img-6.11.1
shafeenkh@shafeenkh-VirtualBox:~/kernel_build/linux-6.11.1$
```

Figure 48: update-initramfs creates a new initrd image for the new kernel.

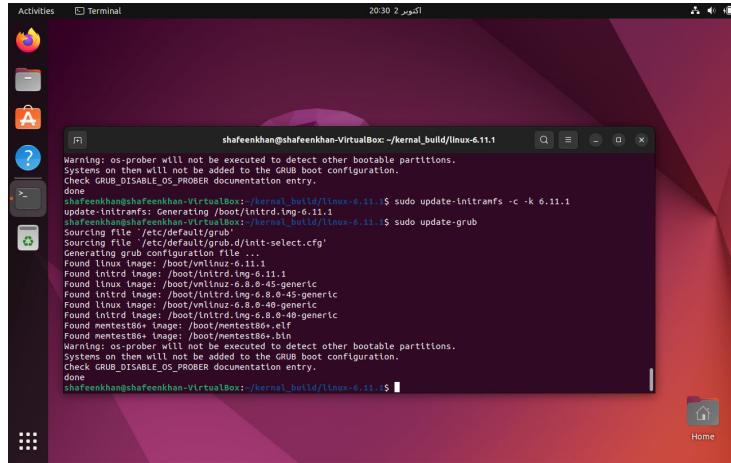


Figure 49: update-grub scans for kernels in /boot and updates the GRUB menu.

#### 4 Step 13 : Step 9: Rebooting and Verify the new kernal

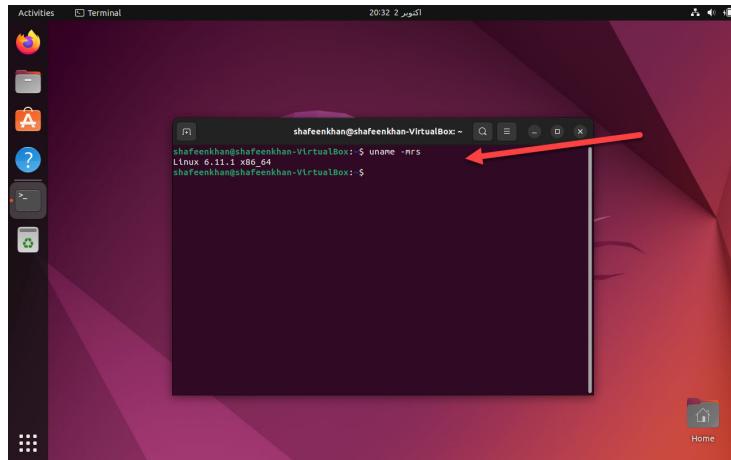


Figure 50: uname -r to display

#### 5 Challanges Faced :

One of the challenges I faced was the \*\*kernel compilation time\*\*. The process of running ‘make’ took significantly longer than expected, especially since I was working in a virtual machine with limited resources. Watching it compile, I had

to be patient, and it made me realize how resource-intensive this task is, even for modern systems.

Another challenge was the **\*\*kernel configuration\*\*** itself. When running ‘make menuconfig’, I was overwhelmed by the sheer number of options available. Deciding what to enable or disable felt like navigating a maze, and I had to be careful not to accidentally disable something critical. This added complexity made the whole process more time-consuming than I initially anticipated.