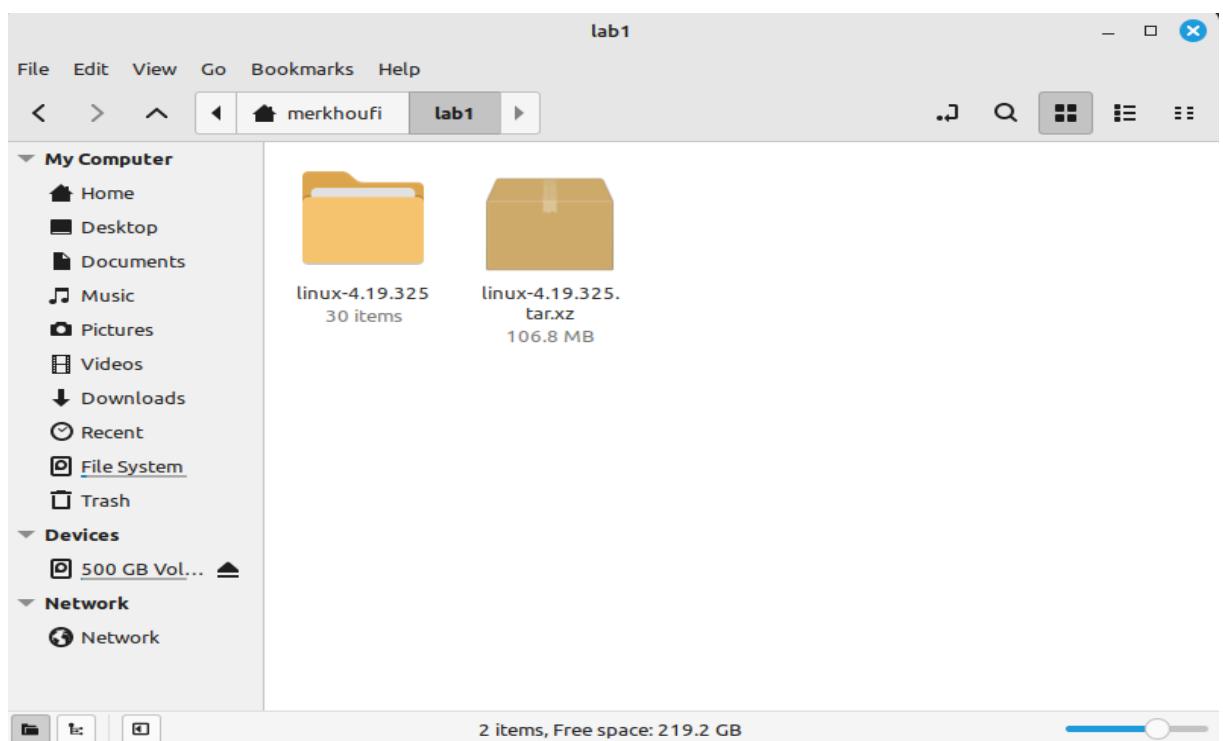
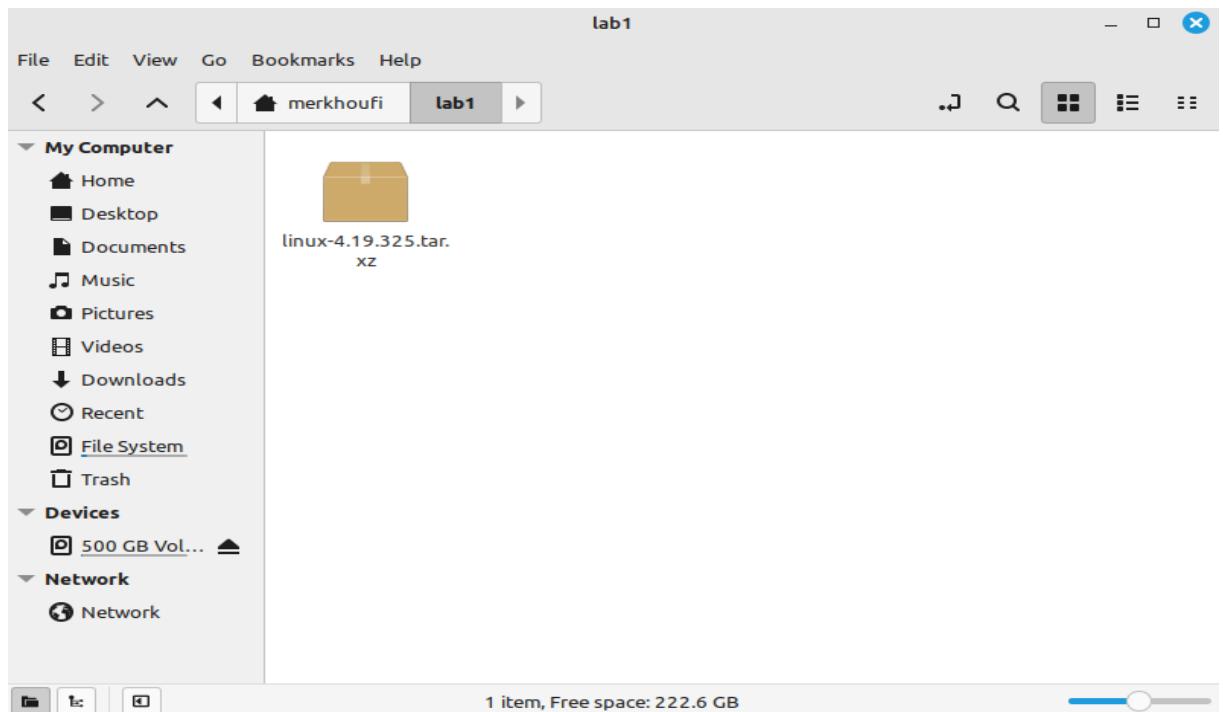


Source Code Download

1. Downloading the Kernel from Kernel.org



Extract the Archive:

Navigate to the Kernel Directory:

```
merkhoufi@merkhoufi: ~/lab1/linux-4.19.325
File Edit View Search Terminal Help
linux-4.19.325/virt/kvm/arm/vgic/trace.h
linux-4.19.325/virt/kvm/arm/vgic/vgic-debug.c
linux-4.19.325/virt/kvm/arm/vgic/vgic-init.c
linux-4.19.325/virt/kvm/arm/vgic/vgic-irqfd.c
linux-4.19.325/virt/kvm/arm/vgic/vgic-its.c
linux-4.19.325/virt/kvm/arm/vgic/vgic-kvm-device.c
linux-4.19.325/virt/kvm/arm/vgic/vgic-mmio-v2.c
linux-4.19.325/virt/kvm/arm/vgic/vgic-mmio-v3.c
linux-4.19.325/virt/kvm/arm/vgic/vgic-mmio.c
linux-4.19.325/virt/kvm/arm/vgic/vgic-mmio.h
linux-4.19.325/virt/kvm/arm/vgic/vgic-v2.c
linux-4.19.325/virt/kvm/arm/vgic/vgic-v3.c
linux-4.19.325/virt/kvm/arm/vgic/vgic-v4.c
linux-4.19.325/virt/kvm/arm/vgic/vgic.c
linux-4.19.325/virt/kvm/arm/vgic/vgic.h
linux-4.19.325/virt/kvm/async_pf.c
linux-4.19.325/virt/kvm/async_pf.h
linux-4.19.325/virt/kvm/coalesced_mmio.c
linux-4.19.325/virt/kvm/coalesced_mmio.h
linux-4.19.325/virt/kvm/eventfd.c
linux-4.19.325/virt/kvm/irqchip.c
linux-4.19.325/virt/kvm/kvm_main.c
linux-4.19.325/virt/kvm/vfio.c
linux-4.19.325/virt/kvm/vfio.h
linux-4.19.325/virt/lib/
linux-4.19.325/virt/lib/Kconfig
linux-4.19.325/virt/lib/Makefile
linux-4.19.325/virt/lib/irqbypass.c
merkhoufi@merkhoufi:~/lab1$ cd linux-4.19.325
merkhoufi@merkhoufi:~/lab1/linux-4.19.325$ sudo apt-get install build-essential libncurses-dev bison flex libssl-dev libelf-dev
[sudo] password for merkhoufi: 
```

```
merkhoufi@merkhoufi: ~/lab1/linux-4.19.325
File Edit View Search Terminal Help
linux-4.19.325/virt/kvm/coalesced_mmio.c
linux-4.19.325/virt/kvm/coalesced_mmio.h
linux-4.19.325/virt/kvm/eventfd.c
linux-4.19.325/virt/kvm/irqchip.c
linux-4.19.325/virt/kvm/kvm_main.c
linux-4.19.325/virt/kvm/vfio.c
linux-4.19.325/virt/kvm/vfio.h
linux-4.19.325/virt/lib/
linux-4.19.325/virt/lib/Kconfig
linux-4.19.325/virt/lib/Makefile
linux-4.19.325/virt/lib/irqbypass.c
merkhoufi@merkhoufi:~/lab1$ cd linux-4.19.325
merkhoufi@merkhoufi:~/lab1/linux-4.19.325$ sudo apt-get install build-essential libncurses-dev bison flex libssl-dev libelf-dev
[sudo] password for merkhoufi:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
bison is already the newest version (2:3.8.2+dfsg-1build1).
flex is already the newest version (2.6.4-8build2).
The following additional packages will be installed:
  g++ g++-11 libc-dev-bin libc-devtools libc6-dev libcrypt-dev libnsl-dev libstdc++-11-dev libtirpc-dev
  rpcsvc-proto zlib1g-dev
Suggested packages:
  g++-multilib g++-11-multilib gcc-11-doc glibc-doc ncurses-doc libssl-doc libstdc++-11-doc
The following NEW packages will be installed:
  build-essential g++ g++-11 libc-dev-bin libc-devtools libc6-dev libcrypt-dev libelf-dev libncurses-dev
  libnsl-dev libssl-dev libstdc++-11-dev libtirpc-dev rpcsvc-proto zlib1g-dev
0 upgraded, 15 newly installed, 0 to remove and 0 not upgraded.
Need to get 19.1 MB of archives.
After this operation, 80.3 MB of additional disk space will be used.
Do you want to continue? [Y/n] 
```

2. Configuring the Kernel

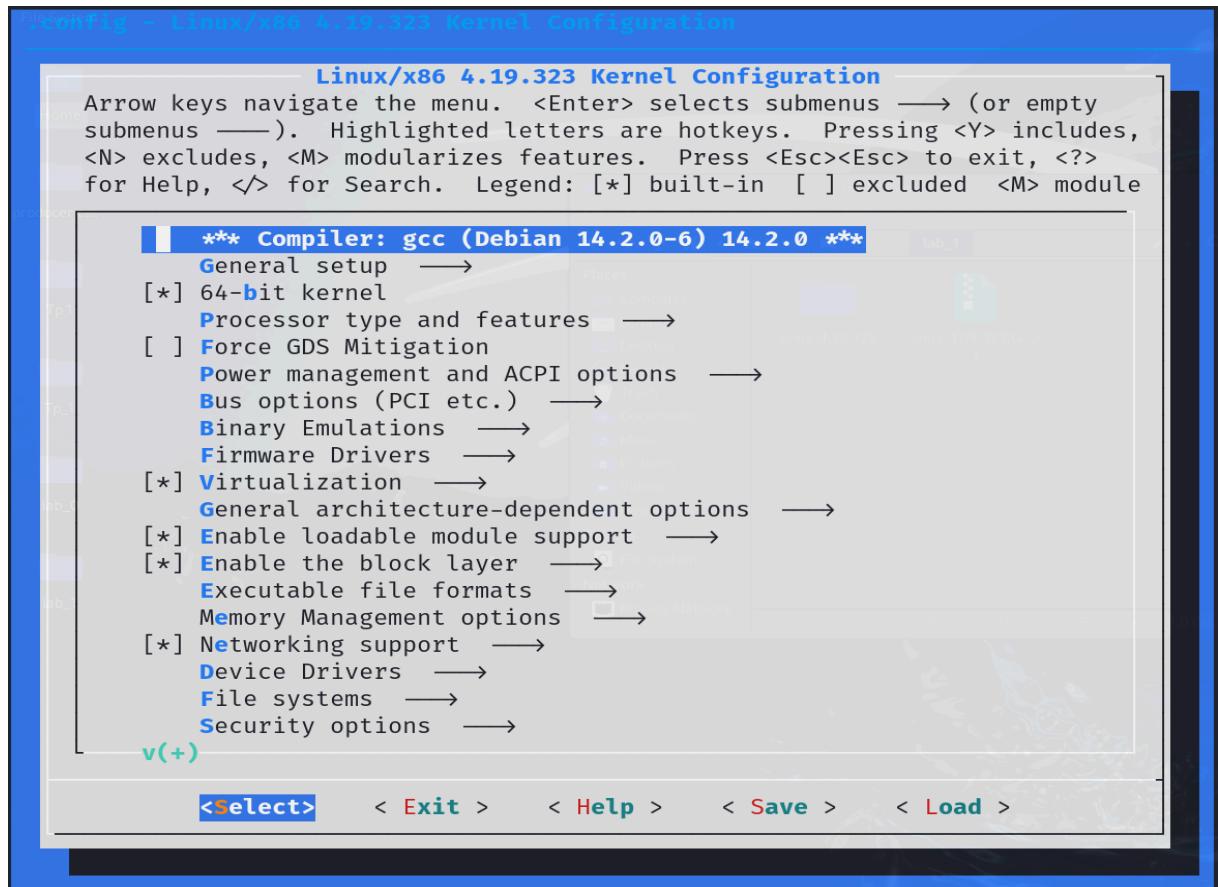
Install Necessary Packages:

```
$ sudo apt-get install build-essential libncurses-dev bison flex libssl-dev libelf-dev  
[sudo] password for baha:  
Reading package lists... Done  
Building dependency tree... Done  
Reading state information... Done  
libncurses-dev is already the newest version (6.5-2).  
libncurses-dev set to manually installed.  
The following additional packages will be installed:  
  cpp cpp-14 cpp-14-x86-64-linux-gnu cpp-x86-64-linux-gnu dpkg dpkg-dev g++  
  g++-14 g++-14-x86-64-linux-gnu g++-x86-64-linux-gnu gcc gcc-14 gcc-14-base  
  gcc-14-x86-64-linux-gnu gcc-x86-64-linux-gnu lib32gcc-s1 lib32stdc++6 libasan8  
  libatomic1 libcc1-0 libdpkg-perl libdw1t64 libelf1t64 libfl-dev libfl2  
  libgcc-14-dev libgcc-s1 libgfortran5 libgomp1 libhwasan0 libitm1 liblsan0  
  libobjc4 libquadmath0 libssl3t64 libstdc++-14-dev libstdc++6 libtsan2 libubsan1  
  libzstd-dev openssl openssl-provider-legacy  
Suggested packages:  
  bison-doc gcc-14-locales cpp-14-doc g++-14-multilib gcc-14-doc gcc-14-multilib  
  libssl-doc libstdc++-14-doc  
The following NEW packages will be installed:  
  bison cpp-14 cpp-14-x86-64-linux-gnu g++-14 g++-14-x86-64-linux-gnu gcc-14  
  gcc-14-x86-64-linux-gnu libelf-dev libgcc-14-dev libssl-dev libstdc++-14-dev  
  libzstd-dev openssl-provider-legacy  
The following packages will be upgraded:  
  build-essential cpp cpp-x86-64-linux-gnu dpkg dpkg-dev flex g++  
  g++-x86-64-linux-gnu gcc gcc-14-base gcc-x86-64-linux-gnu lib32gcc-s1  
  lib32stdc++6 libasan8 libatomic1 libcc1-0 libdpkg-perl libdw1t64 libelf1t64  
  libfl-dev libfl2 libgcc-s1 libgfortran5 libgomp1 libhwasan0 libitm1 liblsan0
```

```
Setting up libasan8:amd64 (14.2.0-6) ...  
Setting up bison (2:3.8.2+dfsg-1+b2) ...  
update-alternatives: using /usr/bin/bison.yacc to provide /usr/bin/yacc (yacc) in auto mode  
Setting up libtsan2:amd64 (14.2.0-6) ...  
Setting up openssl (3.3.2-1) ...  
Setting up libcc1-0:amd64 (14.2.0-6) ...  
Setting up liblsan0:amd64 (14.2.0-6) ...  
Setting up libitm1:amd64 (14.2.0-6) ...  
Setting up cpp-x86-64-linux-gnu (4:14.2.0-1) ...  
Setting up libfl-dev:amd64 (2.6.4-8.2+b3) ...  
Setting up dpkg-dev (1.22.11+kali2) ...  
Setting up cpp (4:14.2.0-1) ...  
Setting up libgcc-14-dev:amd64 (14.2.0-6) ...  
Setting up libstdc++-14-dev:amd64 (14.2.0-6) ...  
Setting up gcc-14-x86-64-linux-gnu (14.2.0-6) ...  
Setting up gcc-x86-64-linux-gnu (4:14.2.0-1) ...  
Setting up gcc-14 (14.2.0-6) ...  
Setting up g++-14-x86-64-linux-gnu (14.2.0-6) ...  
Setting up g++-x86-64-linux-gnu (4:14.2.0-1) ...  
Setting up g++-14 (14.2.0-6) ...  
Setting up gcc (4:14.2.0-1) ...  
Setting up g++ (4:14.2.0-1) ...  
Setting up build-essential (12.12) ...  
Processing triggers for kali-menu (2024.3.1) ...  
Processing triggers for doc-base (0.11.2) ...  
Processing 1 changed doc-base file...  
Processing triggers for libc-bin (2.38-13) ...  
Processing triggers for man-db (2.12.1-2) ...  
Processing triggers for base-files (1:2024.3.0) ...
```

Configure the Kernel:

```
└─$ make menuconfig
HOSTCC scripts/basic/fixdep
UPD scripts/kconfig/.mconf-cfg
HOSTCC scripts/kconfig/mconf.o
YACC scripts/kconfig/zconf.tab.c
LEX scripts/kconfig/zconf.lex.c
HOSTCC scripts/kconfig/zconf.tab.o
HOSTCC scripts/kconfig/lxdialog/checklist.o
HOSTCC scripts/kconfig/lxdialog/inputbox.o
HOSTCC scripts/kconfig/lxdialog/menubox.o
HOSTCC scripts/kconfig/lxdialog/textbox.o
HOSTCC scripts/kconfig/lxdialog/util.o
HOSTCC scripts/kconfig/lxdialog/yesno.o
HOSTLD scripts/kconfig/mconf
scripts/kconfig/mconf Kconfig
#
# using defaults found in /boot/config-6.8.11-amd64
#
/boot/config-6.8.11-amd64:1678:warning: symbol value 'm' invalid for NF_TABLES_BRIDGE
/boot/config-6.8.11-amd64:4130:warning: symbol value 'm' invalid for JOYSTICK_IFORCE_USB
/boot/config-6.8.11-amd64:4131:warning: symbol value 'm' invalid for JOYSTICK_IFORCE_232
/boot/config-6.8.11-amd64:5132:warning: symbol value 'm' invalid for WATCHDOG_CORE
/boot/config-6.8.11-amd64:5744:warning: symbol value 'm' invalid for RADIO_ADAPTERS
/boot/config-6.8.11-amd64:6617:warning: symbol value 'm' invalid for FB_BACKLIGHT
/boot/config-6.8.11-amd64:9661:warning: symbol value 'm' invalid for ANDROID_BINDER_IPC
```



3. Compiling the Kernel

Compile the Kernel:

```
└─$ make -j $(nproc)
HOSTCC scripts/kconfig/conf.o
HOSTLD scripts/kconfig/conf
scripts/kconfig/conf --syncconfig Kconfig
SYSTBL arch/x86/include/generated/asm/syscalls_32.h
SYSHDR arch/x86/include/generated/asm/unistd_32_ia32.h
SYSHDR arch/x86/include/generated/asm/unistd_64_x32.h
SYSTBL arch/x86/include/generated/asm/syscalls_64.h
HYPERCALLS arch/x86/include/generated/asm/xen-hypercalls.h
SYSHDR arch/x86/include/generated/uapi/asm/unistd_32.h
SYSHDR arch/x86/include/generated/uapi/asm/unistd_64.h
SYSHDR arch/x86/include/generated/uapi/asm/unistd_x32.h
UPD include/config/kernel.release
WRAP arch/x86/include/generated/uapi/asm/bpf_perf_event.h
WRAP arch/x86/include/generated/uapi/asm/poll.h
UPD include/generated/uapi/linux/version.h
UPD include/generated/utsrelease.h
DESCEND objtool
HOSTCC /home/baha/Desktop/lab_1/linux-4.19.323/tools/objtool/fixdep.o
HOSTLD /home/baha/Desktop/lab_1/linux-4.19.323/tools/objtool/fixdep-in.o
LINK /home/baha/Desktop/lab_1/linux-4.19.323/tools/objtool/fixdep
CC /home/baha/Desktop/lab_1/linux-4.19.323/tools/objtool/exec-cmd.o
CC /home/baha/Desktop/lab_1/linux-4.19.323/tools/objtool/help.o
CC /home/baha/Desktop/lab_1/linux-4.19.323/tools/objtool/pager.o
CC /home/baha/Desktop/lab_1/linux-4.19.323/tools/objtool/parse-options.o
GEN /home/baha/Desktop/lab_1/linux-4.19.323/tools/objtool/arch/x86/lib/inat-
tables.c
CC /home/baha/Desktop/lab_1/linux-4.19.323/tools/objtool/arch/x86/decode.o
CC /home/baha/Desktop/lab_1/linux-4.19.323/tools/objtool/run-command.o
CC /home/baha/Desktop/lab_1/linux-4.19.323/tools/objtool/builtin-check.o
CC /home/baha/Desktop/lab_1/linux-4.19.323/tools/objtool/sigchain.o
```

Compile Kernel Modules:

ERROR

```
/bin/sh: 1: bc: not found
make[1]: *** [Kbuild:42: include/generated/timeconst.h] Error 127
make[1]: *** Waiting for unfinished jobs....
make: *** [Makefile:1135: prepare0] Error 2
make: *** Waiting for unfinished jobs....
```

Sudo apt update

```
└$ sudo apt update
[sudo] password for baha:
Get:1 http://kali.download/kali kali-rolling InRelease [41.5 kB]
Get:2 http://kali.download/kali kali-rolling/main amd64 Packages [20.2 MB]
Get:3 http://kali.download/kali kali-rolling/main amd64 Contents (deb) [48.3 MB]
77% [3 Contents-amd64 35.0 MB/48.3 MB 72%] 1389 kB/s 10s
```

```
└$ sudo apt update
[sudo] password for baha:
Get:1 http://kali.download/kali kali-rolling InRelease [41.5 kB]
Get:2 http://kali.download/kali kali-rolling/main amd64 Packages [20.2 MB]
Get:3 http://kali.download/kali kali-rolling/main amd64 Contents (deb) [48.3 MB]
Get:4 http://kali.download/kali kali-rolling/contrib amd64 Packages [112 kB]
Get:5 http://kali.download/kali kali-rolling/contrib amd64 Contents (deb) [273 kB]
Get:6 http://kali.download/kali kali-rolling/non-free amd64 Packages [197 kB]
Get:7 http://kali.download/kali kali-rolling/non-free amd64 Contents (deb) [876 kB]
Get:8 http://kali.download/kali kali-rolling/non-free-firmware amd64 Packages [10.8 kB]
Get:9 http://kali.download/kali kali-rolling/non-free-firmware amd64 Contents (deb) [23.1 kB]
Fetched 70.1 MB in 1min 44s (672 kB/s)
1741 packages can be upgraded. Run 'apt list --upgradable' to see them.
```

sudo sudo apt install bc

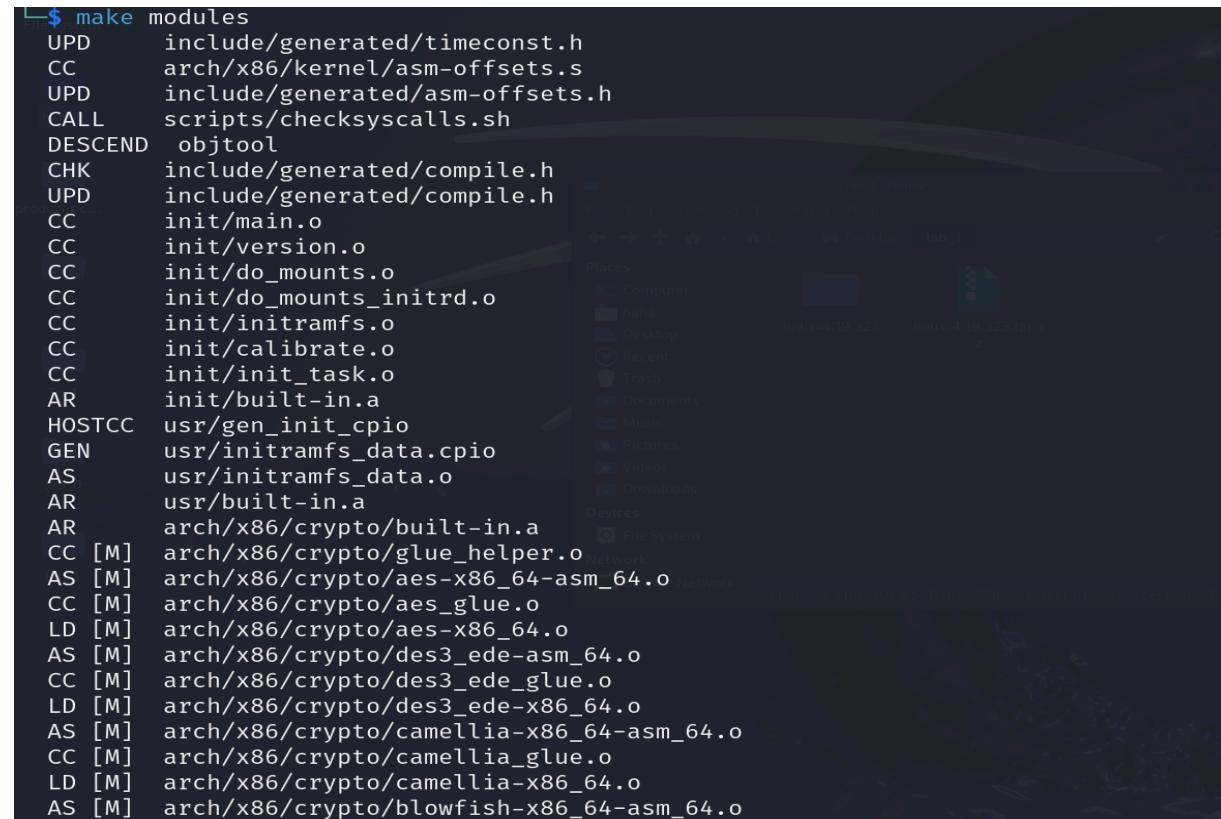
```
└$ sudo apt install bc
Installing:
bc

Summary:
Upgrading: 0, Installing: 1, Removing: 0, Not Upgrading: 1741
Download size: 103 kB
Space needed: 242 kB / 18.0 GB available

Get:1 http://kali.download/kali kali-rolling/main amd64 bc amd64 1.07.1-4 [103 kB]
Fetched 103 kB in 48s (2153 B/s)
Selecting previously unselected package bc.
(Reading database ... 396774 files and directories currently installed.)
Preparing to unpack .../archives/bc_1.07.1-4_amd64.deb ...
Unpacking bc (1.07.1-4) ...
Setting up bc (1.07.1-4) ...
Processing triggers for kali-menu (2024.3.1) ...
Processing triggers for doc-base (0.11.2) ...
Processing 1 added doc-base file...
Processing triggers for man-db (2.12.1-2) ...
```

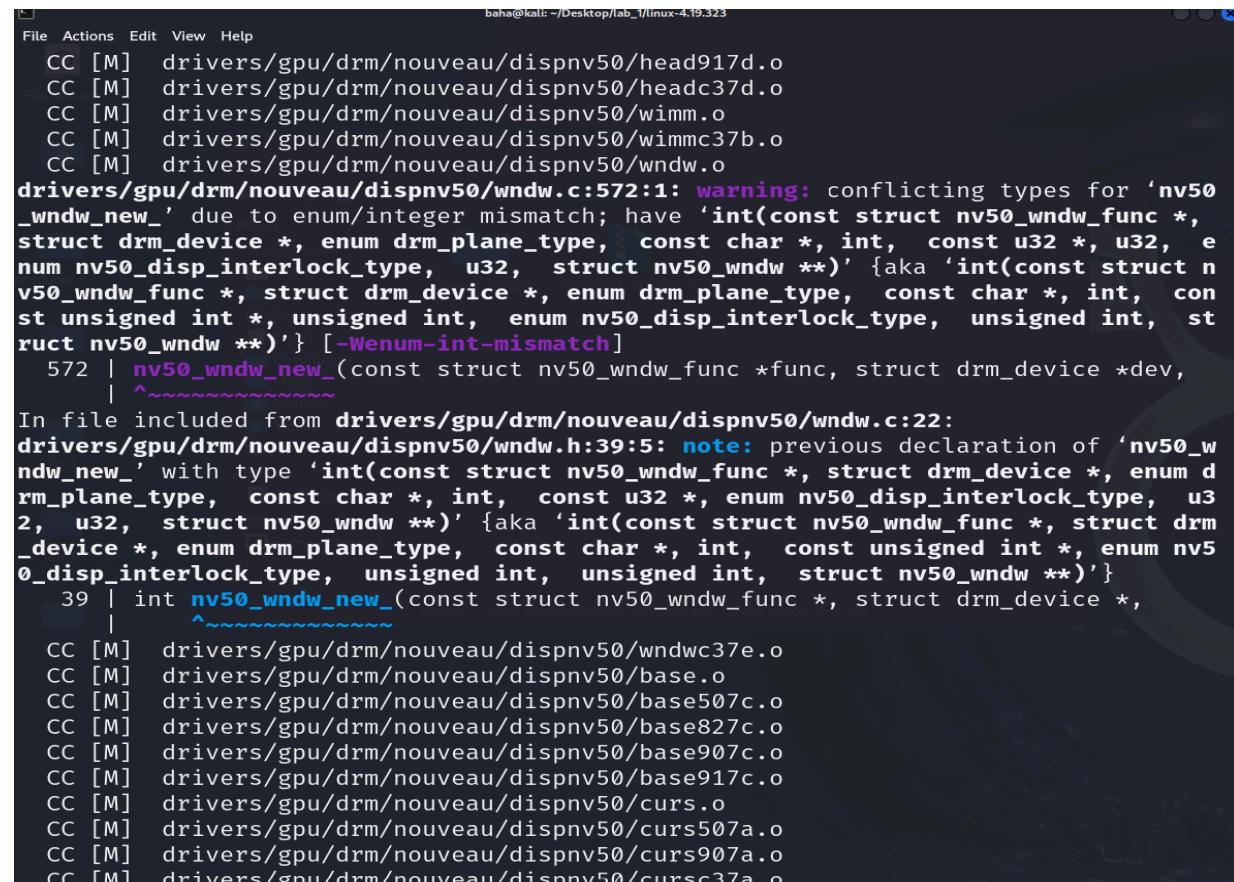
Make modules

```
└$ make modules
```



```
UPD      include/generated/timeconst.h
CC       arch/x86/kernel/asm-offsets.s
UPD      include/generated/asm-offsets.h
CALL    scripts/checksyscalls.sh
DESCEND objtool
CHK     include/generated/compile.h
UPD      include/generated/compile.h
CC       init/main.o
CC       init/version.o
CC       init/do_mounts.o
CC       init/do_mounts_initrd.o
CC       init/initramfs.o
CC       init/calibrate.o
CC       init/init_task.o
AR      init/built-in.a
HOSTCC  usr/gen_init_cpio
GEN     usr/initramfs_data.cpio
AS      usr/initramfs_data.o
AR      usr/built-in.a
AR      arch/x86/crypto/built-in.a
CC [M]  arch/x86/crypto/glue_helper.o
AS [M]  arch/x86/crypto/aes-x86_64-asm_64.o
CC [M]  arch/x86/crypto/aes_glue.o
LD [M]  arch/x86/crypto/aes-x86_64.o
AS [M]  arch/x86/crypto/des3ede-asm_64.o
CC [M]  arch/x86/crypto/des3ede_glue.o
LD [M]  arch/x86/crypto/des3ede-x86_64.o
AS [M]  arch/x86/crypto/camellia-x86_64-asm_64.o
CC [M]  arch/x86/crypto/camellia_glue.o
LD [M]  arch/x86/crypto/camellia-x86_64.o
AS [M]  arch/x86/crypto/blowfish-x86_64-asm_64.o
```

```
baha@kali: ~/Desktop/lab_1/linux-4.19.323
```



```
File Actions Edit View Help
File   CC [M]  drivers/gpu/drm/nouveau/dispnv50/head917d.o
File   CC [M]  drivers/gpu/drm/nouveau/dispnv50/heidc37d.o
File   CC [M]  drivers/gpu/drm/nouveau/dispnv50/wimm.o
File   CC [M]  drivers/gpu/drm/nouveau/dispnv50/wimmc37b.o
File   CC [M]  drivers/gpu/drm/nouveau/dispnv50/wndw.o
drivers/gpu/drm/nouveau/dispnv50/wndw.c:572:1: warning: conflicting types for 'nv50_wndw_new_' due to enum/integer mismatch; have 'int(const struct nv50_wndw_func *, struct drm_device *, enum drm_plane_type, const char *, int, const u32 *, u32, enum nv50_disp_interlock_type, u32, struct nv50_wndw **)' {aka 'int(const struct nv50_wndw_func *, struct drm_device *, enum drm_plane_type, const char *, int, const unsigned int *, unsigned int, enum nv50_disp_interlock_type, unsigned int, struct nv50_wndw **)'}
572 | nv50_wndw_new_(const struct nv50_wndw_func *func, struct drm_device *dev,
| ^~~~~~
In file included from drivers/gpu/drm/nouveau/dispnv50/wndw.c:22:
drivers/gpu/drm/nouveau/dispnv50/wndw.h:39:5: note: previous declaration of 'nv50_wndw_new_' with type 'int(const struct nv50_wndw_func *, struct drm_device *, enum drm_plane_type, const char *, int, const u32 *, enum nv50_disp_interlock_type, u32, u32, struct nv50_wndw **)' {aka 'int(const struct nv50_wndw_func *, struct drm_device *, enum drm_plane_type, const char *, int, const unsigned int *, unsigned int, struct nv50_wndw **)'}
 39 | int nv50_wndw_new_(const struct nv50_wndw_func *, struct drm_device *,
| ^~~~~~
CC [M]  drivers/gpu/drm/nouveau/dispnv50/wndwc37e.o
CC [M]  drivers/gpu/drm/nouveau/dispnv50/base.o
CC [M]  drivers/gpu/drm/nouveau/dispnv50/base507c.o
CC [M]  drivers/gpu/drm/nouveau/dispnv50/base827c.o
CC [M]  drivers/gpu/drm/nouveau/dispnv50/base907c.o
CC [M]  drivers/gpu/drm/nouveau/dispnv50/base917c.o
CC [M]  drivers/gpu/drm/nouveau/dispnv50/curs.o
CC [M]  drivers/gpu/drm/nouveau/dispnv50/curs507a.o
CC [M]  drivers/gpu/drm/nouveau/dispnv50/curs907a.o
CC [M]  drivers/gpu/drm/nouveau/dispnv50/cursc37a.o
```

Period of execution : 3h

4. Installing the Kernel

Install the Kernel Modules:

```
(baha㉿kali)-[~/Desktop/lab_1/linux-4.19.323]
$ sudo make modules_install
[sudo] password for baha:
INSTALL arch/x86/crypto/aegis128-aesni.ko
INSTALL arch/x86/crypto/aes-x86_64.ko
INSTALL arch/x86/crypto/aesni-intel.ko
INSTALL arch/x86/crypto/blowfish-x86_64.ko
INSTALL arch/x86/crypto/camellia-aesni-avx-x86_64.ko
INSTALL arch/x86/crypto/camellia-aesni-avx2.ko
INSTALL arch/x86/crypto/camellia-x86_64.ko
INSTALL arch/x86/crypto/cast5-avx-x86_64.ko
INSTALL arch/x86/crypto/cast6-avx-x86_64.ko
INSTALL arch/x86/crypto/chacha20-x86_64.ko
INSTALL arch/x86/crypto/crc32-pclmul.ko
INSTALL arch/x86/crypto/crc32c-intel.ko
INSTALL arch/x86/crypto/crct10dif-pclmul.ko
INSTALL arch/x86/crypto/des3_edc-x86_64.ko
INSTALL arch/x86/crypto/ghash-clmulni-intel.ko
INSTALL arch/x86/crypto/glue_helper.ko
INSTALL arch/x86/crypto/poly1305-x86_64.ko
INSTALL arch/x86/crypto/serpent-avx-x86_64.ko
INSTALL arch/x86/crypto/serpent-avx2.ko
INSTALL arch/x86/crypto/serpent-sse2-x86_64.ko
INSTALL arch/x86/crypto/sha1-ssse3.ko
INSTALL arch/x86/crypto/sha256-ssse3.ko
INSTALL arch/x86/crypto/sha512-ssse3.ko
INSTALL arch/x86/crypto/twofish-avx-x86_64.ko
INSTALL arch/x86/crypto/twofish-x86_64-3way.ko
INSTALL arch/x86/crypto/twofish-x86_64.ko
INSTALL arch/x86/events/amd/power.ko
INSTALL arch/x86/events/intel/intel-cstate.ko
INSTALL arch/x86/events/intel/intel-rapl-perf.ko
```

Install the Kernel:

- Install the kernel itself:

ERROR

```
$ sudo make install
sh ./arch/x86/boot/install.sh 4.19.323 arch/x86/boot/bzImage \
    System.map "/boot"

*** Missing file: arch/x86/boot/bzImage
*** You need to run "make" before "make install".

make[1]: *** [arch/x86/boot/Makefile:155: install] Error 1
make: *** [arch/x86/Makefile:305: install] Error 2
```

make

```
L$ make
CALL  scripts/checksyscalls.sh
DESCEND objtool
CHK   include/generated/compile.h

LDS   arch/x86/boot/compressed/vmlinux.lds
AS    arch/x86/boot/compressed/head_64.o
VOFFSET arch/x86/boot/compressed/../.voffset.h
CC    arch/x86/boot/compressed/misc.o
CC    arch/x86/boot/compressed/string.o
CC    arch/x86/boot/compressed/cmdline.o
CC    arch/x86/boot/compressed/error.o
OBJCOPY arch/x86/boot/compressed/vmlinux.bin
RELOCS arch/x86/boot/compressed/vmlinux.relocs
XZKERN arch/x86/boot/compressed/vmlinux.bin.xz
HOSTCC arch/x86/boot/compressed/mkpiggy
MKPIGGY arch/x86/boot/compressed/piggy.S
AS    arch/x86/boot/compressed/piggy.o
CC    arch/x86/boot/compressed/cpuflags.o
CC    arch/x86/boot/compressed/early_serial_console.o
CC    arch/x86/boot/compressed/kaslr.o
CC    arch/x86/boot/compressed/kaslr_64.o
AS    arch/x86/boot/compressed/mem_encrypt.o
CC    arch/x86/boot/compressed/pgtable_64.o
CC    arch/x86/boot/compressed/eboot.o
AS    arch/x86/boot/compressed/efi_stub_64.o
AS    arch/x86/boot/compressed/efi_thunk_64.o
LD    arch/x86/boot/compressed/vmlinux
ld: arch/x86/boot/compressed/head_64.o: warning: relocation in read-only section `.
head.text'
ld: warning: creating DT_TEXTREL in a PIE
  CC   arch/x86/boot/a20.o
  AS   arch/x86/boot/bioscall.o
```

sudo make install

```
└$ sudo make install
sh ./arch/x86/boot/install.sh 4.19.323 arch/x86/boot/bzImage \
    System.map "/boot"
run-parts: executing /etc/kernel/postinst.d/initramfs-tools 4.19.323 /boot/vmlinuz-
4.19.323
update-initramfs: Generating /boot/initrd.img-4.19.323
W: zstd compression (CONFIG_RD_ZSTD) not supported by kernel, using gzip
depmod: WARNING: could not open modules.builtin.modinfo at /var/tmp/mkinitramfs_oAz
B1t/lib/modules/4.19.323: No such file or directory
run-parts: executing /etc/kernel/postinst.d/zz-update-grub 4.19.323 /boot/vmlinuz-4
.19.323
Generating grub configuration file ...
Found theme: /boot/grub/themes/kali/theme.txt
Found background image: /usr/share/images/desktop-base/desktop-grub.png
Found linux image: /boot/vmlinuz-6.8.11-amd64
Found initrd image: /boot/initrd.img-6.8.11-amd64
Found linux image: /boot/vmlinuz-4.19.323
Found initrd image: /boot/initrd.img-4.19.323
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.
Adding boot menu entry for UEFI Firmware Settings ...
done
```

Update Boot Loader:

```
└$ sudo update-grub
Generating grub configuration file ...
Found theme: /boot/grub/themes/kali/theme.txt
Found background image: /usr/share/images/desktop-base/desktop-grub.png
Found linux image: /boot/vmlinuz-6.8.11-amd64
Found initrd image: /boot/initrd.img-6.8.11-amd64
Found linux image: /boot/vmlinuz-4.19.323
Found initrd image: /boot/initrd.img-4.19.323
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.
Adding boot menu entry for UEFI Firmware Settings ...
done
```

Reboot:

- Reboot your system to boot into the new kernel:

```
└$ sudo reboot
[sudo] password for baha: [REDACTED]
```

Documentation Points

1. **Chosen Method:** I used the official method of downloading, configuring, compiling, and installing the kernel as outlined above.
2. **Justification:** This method is reliable and provides full control over kernel customization. Using `make menuconfig` allows for a tailored configuration, while the official download ensures the latest stable kernel version with security patches and updates.
3. **Kernel Version:** The version can be checked after reboot with: `uname -r`

```
$ uname -r  
4.19.323
```

display the specific version installed.

Source Code Structure of the Linux Kernel

1. *arch/ (Architecture-Specific Code)*

- **Purpose:** The `arch/` directory contains the architecture-specific code required for building and running the kernel on different hardware platforms (e.g., x86, ARM, PowerPC, etc.).
- **Content:**
 - Each supported architecture has its own subdirectory within `arch/`, such as `arch/x86/` for x86-based systems, `arch/arm/` for ARM-based systems, and so on.
 - The subdirectories include architecture-specific code for CPU initialization, memory management, and low-level system handling.
- **Example:** If you're building the kernel for an ARM system, the code for ARM-specific handling would reside in `arch/arm/`.

2. *drivers* / (Device Drivers)

- **Purpose:** The `drivers/` directory contains code for various hardware device drivers used by the kernel to interact with devices such as storage devices, network interfaces, sound cards, and more.
- **Content:**
 - Subdirectories within `drivers/` are organized by type of device, such as `drivers/net/` for network drivers, `drivers/usb/` for USB device drivers, `drivers/gpu/` for GPU drivers, etc.
 - This directory allows the kernel to interface with hardware in a standardized way, abstracting the low-level details of different devices.
- **Example:** The driver for an Intel Ethernet card would be found under `drivers/net/ethernet/intel/`.

3. *include* / (Header Files)

- **Purpose:** The `include/` directory contains all the kernel's header files that define data structures, constants, and function prototypes used throughout the kernel source code.
- **Content:**
 - This directory is organized into subdirectories based on functionality. For instance, `include/linux/` contains the primary Linux kernel headers that define structures for process management, file systems, memory management, and other core functionalities.
 - `include/asm/` contains architecture-specific headers.
- **Example:** If you're looking for header files defining structures for process management, you would look under `include/linux/sched.h`.

4. *kernel* / (Core Kernel Code)

- **Purpose:** The `kernel/` directory contains the core functionality of the Linux kernel, such as process scheduling, memory management, and other fundamental operations.
- **Content:**
 - Key subdirectories and files in `kernel/` include the process scheduler (`kernel/sched.c`), the kernel's memory management code (`kernel/memory.c`), and system calls.

- This directory defines the core behavior of the Linux operating system, providing essential functionality that the rest of the kernel depends on.
- **Example:** The process scheduler code can be found in `kernel/sched.c`, which is responsible for deciding which process runs on the CPU and when.

5. Documentation / (Kernel Documentation)

- **Purpose:** The `Documentation/` directory contains extensive documentation about the kernel and its features.
- **Content:**
 - This directory includes information about kernel configuration, how to contribute to the kernel, descriptions of kernel subsystems, and how to use kernel features.
 - The documentation is often written in text format (e.g., `.txt` files) or reStructuredText (`.rst` files) and is used by developers to understand how the kernel works.
- **Example:** You can find details on how to configure the kernel in `Documentation/admin-guide/`.

6. Makefile (Build System)

- **Purpose:** The `Makefile` at the root of the kernel source tree controls the kernel build process.
- **Content:**
 - It defines rules and instructions for compiling the kernel and kernel modules.
 - It includes variables for paths, flags, and compiler options, as well as targets for compiling the kernel, building modules, and installing the kernel.
 - The `Makefile` typically invokes other smaller `Makefiles` in subdirectories, organizing the build process for each part of the kernel.
- **Example:** When you run `make` to build the kernel, the top-level `Makefile` is responsible for calling the correct sub-`Makefiles` for different kernel components and for triggering the compilation of the kernel and modules.

Summary of Key Directories

Directory	Purpose
<code>arch/</code>	Contains architecture-specific code for various hardware platforms.
<code>drivers/</code>	Contains device drivers for different hardware components.
<code>include/</code>	Contains header files defining kernel structures, constants, and function prototypes.
<code>kernel/</code>	Contains core kernel functionality such as process scheduling and memory management.
<code>Documentation/</code>	Contains documentation about kernel configuration, subsystems, and usage.
<code>Makefile</code>	Controls the build process for compiling the kernel and its modules.

Each of these directories plays a crucial role in the Linux kernel's structure, allowing for flexibility, portability, and functionality across a wide range of hardware platforms.

Location of Drivers for Your Hardware

To identify the location of drivers for specific hardware on your system:

1. Network Drivers:

Network device drivers are located in `drivers/net/`. For example, drivers for Ethernet devices like Intel cards might be found in `drivers/net/ethernet/intel/`.

2. USB Drivers:

USB drivers can be found in `drivers/usb/`. For instance, drivers for USB storage devices are in `drivers/usb/storage/`.

3. GPU (Graphics Processing Unit) Drivers:

GPU drivers, including those for Intel, NVIDIA, and AMD cards, are located in `drivers/gpu/`.

4. Sound Drivers:

Sound card drivers are in `drivers/sound/`. For ALSA-based sound drivers, this will be the main location.

5. Storage Device Drivers:

Storage device drivers, including those for hard drives and SSDs, are located in `drivers/block/`.

