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yopanelly@yopanelly-HP-ProBook-650-G1:~$ cd Desktop
yopanelly@yopanelly-HP-ProBook-650-G1:~/Desktop$ mkdir ~/kernel_module
yopanelly@yopanelly-HP-ProBook-650-G1:~/Desktop$ cd ~/kernel_module/
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ nano helloworld.c
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ nano Makefile
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ make
Makefile:6: *** missing separator. Stop.
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ sudo make module_install
Makefile:6: *** missing separator. Stop.
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ nano Makefile
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ make
make -C /lib/modules/6.5.0-35-generic/build M=/home/yopanelly/kernel_module modules
make[1]: Entering directory '/usr/src/linux-headers-6.5.0-35-generic'
warning: the compiler differs from the one used to build the kernel
The kernel was built by: x86_64-linux-gnu-gcc-12 (Ubuntu 12.3.0-1ubuntu1~22.04) 12.3.0
You are using:
CC [M] /home/yopanelly/kernel_module/helloworld.o
/bin/sh: 1: gcc-12: not found
make[3]: *** [scripts/Makefile.build:251: /home/yopanelly/kernel_module/helloworld.o] Error 1
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make[2]: *** [/usr/src/linux-headers-6.5.0-35-generic/Makefile:2039: /home/yopanelly/kernel_m
odule] Error 2
make[1]: *** [Makefile:234: __sub-make] Error 2
make[1]: Leaving directory '/usr/src/linux-headers-6.5.0-35-generic'
make: *** [Makefile:6: modules] Error 2
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ sudo apt install gcc-12
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  cpp-12 libasan8 libgcc-12-dev libtsan2
Suggested packages:
  gcc-12-locales cpp-12-doc gcc-12-multilib gcc-12-doc
The following NEW packages will be installed:
  cpp-12 gcc-12 libasan8 libgcc-12-dev libtsan2
0 upgraded, 5 newly installed, 0 to remove and 5 not upgraded.
Need to get 40.1 MB of archives.
After this operation, 138 MB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://cm.archive.ubuntu.com/ubuntu jammy-updates/main amd64 cpp-12 amd64 12.3.0-1ubunt
u1~22.04 [10.8 MB]
Get:2 http://cm.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libasan8 amd64 12.3.0-1ubu
ntu1~22.04 [2,442 kB]
Get:3 http://cm.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libtsan2 amd64 12.3.0-1ubu
ntu1~22.04 [2,477 kB]
Get:4 http://cm.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libgcc-12-dev amd64 12.3.0
-1ubuntu1~22.04 [2,618 kB]
Get:5 http://cm.archive.ubuntu.com/ubuntu jammy-updates/main amd64 gcc-12 amd64 12.3.0-1ubunt
u1~22.04 [21.7 MB]
Fetched 40.1 MB in 47s (851 kB/s)
Selecting previously unselected package cpp-12.
(Reading database ... 217326 files and directories currently installed.)
Preparing to unpack .../cpp-12_12.3.0-1ubuntu1~22.04_amd64.deb ...
Unpacking cpp-12 (12.3.0-1ubuntu1~22.04) ...

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Setting up libasan8:amd64 (12.3.0-1ubuntu1~22.04) ...
Setting up libtsan2:amd64 (12.3.0-1ubuntu1~22.04) ...
Setting up libgcc-12-dev:amd64 (12.3.0-1ubuntu1~22.04) ...
Setting up gcc-12 (12.3.0-1ubuntu1~22.04) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for libc-bin (2.35-0ubuntu3.8) ...
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ gcc --version
gcc (Ubuntu 11.4.0-1ubuntu1~22.04) 11.4.0
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This is free software; see the source for copying conditions.  There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.

yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ sudo update-alternatives --install /usr/bin/gcc gcc /usr/bin/gcc-12 12
update-alternatives: using /usr/bin/gcc-12 to provide /usr/bin/gcc (gcc) in auto mode
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ make
make -C /lib/modules/6.5.0-35-generic/build M=/home/yopanelly/kernel_module modules
make[1]: Entering directory '/usr/src/linux-headers-6.5.0-35-generic'
warning: the compiler differs from the one used to build the kernel
The kernel was built by: x86_64-linux-gnu-gcc-12 (Ubuntu 12.3.0-1ubuntu1~22.04) 12.3.0
You are using: gcc-12 (Ubuntu 12.3.0-1ubuntu1~22.04) 12.3.0
CC [M] /home/yopanelly/kernel_module/helloworld.o
MODPOST /home/yopanelly/kernel_module/Module.symvers
CC [M] /home/yopanelly/kernel_module/helloworld.mod.o
LD [M] /home/yopanelly/kernel_module/helloworld.ko
BTF [M] /home/yopanelly/kernel_module/helloworld.ko
Skipping BTF generation for /home/yopanelly/kernel_module/helloworld.ko due to unavailability of vmlinux
make[1]: Leaving directory '/usr/src/linux-headers-6.5.0-35-generic'
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ sudo make modules_install
make: *** No rule to make target 'modules_install'. Stop.
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ nano Makefile
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ make
make -C /lib/modules/6.5.0-35-generic/build M=/home/yopanelly/kernel_module modules
make[1]: Entering directory '/usr/src/linux-headers-6.5.0-35-generic'
warning: the compiler differs from the one used to build the kernel
The kernel was built by: x86_64-linux-gnu-gcc-12 (Ubuntu 12.3.0-1ubuntu1~22.04) 12.3.0
You are using: gcc-12 (Ubuntu 12.3.0-1ubuntu1~22.04) 12.3.0
make[1]: Leaving directory '/usr/src/linux-headers-6.5.0-35-generic'
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ sudo make modules_install
make -C /lib/modules/6.5.0-35-generic/build M=/home/yopanelly/kernel_module modules_install
make[1]: Entering directory '/usr/src/linux-headers-6.5.0-35-generic'
INSTALL /lib/modules/6.5.0-35-generic/updates/helloworld.ko
SIGN /lib/modules/6.5.0-35-generic/updates/helloworld.ko
DEPMOD /lib/modules/6.5.0-35-generic
Warning: modules_install: missing 'System.map' file. Skipping depmod.
make[1]: Leaving directory '/usr/src/linux-headers-6.5.0-35-generic'
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ sudo insmod helloworld.ko
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ dmesg | tail
dmesg: read kernel buffer failed: Operation not permitted
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ ls /lib/modules/$(uname -r)/extra
ls: cannot access '/lib/modules/6.5.0-35-generic/extra': No such file or directory
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ make clean
make -C /lib/modules/6.5.0-35-generic/build M=/home/yopanelly/kernel_module clean

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ls: cannot access '/lib/modules/6.5.0-35-generic/extra': No such file or directory
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ make clean
make -C /lib/modules/6.5.0-35-generic/build M=/home/yopanelly/kernel_module clean
make[1]: Entering directory '/usr/src/linux-headers-6.5.0-35-generic'
CLEAN /home/yopanelly/kernel_module/Module.symvers
make[1]: Leaving directory '/usr/src/linux-headers-6.5.0-35-generic'
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ make
make -C /lib/modules/6.5.0-35-generic/build M=/home/yopanelly/kernel_module modules
make[1]: Entering directory '/usr/src/linux-headers-6.5.0-35-generic'
warning: the compiler differs from the one used to build the kernel
The kernel was built by: x86_64-linux-gnu-gcc-12 (Ubuntu 12.3.0-1ubuntu1~22.04) 12.3.0
You are using: gcc-12 (Ubuntu 12.3.0-1ubuntu1~22.04) 12.3.0
CC [M] /home/yopanelly/kernel_module/helloworld.o
MODPOST /home/yopanelly/kernel_module/Module.symvers
CC [M] /home/yopanelly/kernel_module/helloworld.mod.o
LD [M] /home/yopanelly/kernel_module/helloworld.ko
BTF [M] /home/yopanelly/kernel_module/helloworld.ko
Skipping BTF generation for /home/yopanelly/kernel_module/helloworld.ko due to unavailability
of vmlinux
make[1]: Leaving directory '/usr/src/linux-headers-6.5.0-35-generic'
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ nano Makefile
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ make
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make[1]: Entering directory '/usr/src/linux-headers-6.5.0-35-generic'
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You are using: gcc-12 (Ubuntu 12.3.0-1ubuntu1~22.04) 12.3.0
make[1]: Leaving directory '/usr/src/linux-headers-6.5.0-35-generic'
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ sudo make modules_install
make -C /lib/modules/6.5.0-35-generic/build M=/home/yopanelly/kernel_module modules_install
make[1]: Entering directory '/usr/src/linux-headers-6.5.0-35-generic'
INSTALL /lib/modules/6.5.0-35-generic/updates/helloworld.ko
SIGN /lib/modules/6.5.0-35-generic/updates/helloworld.ko
DEPMOD /lib/modules/6.5.0-35-generic
Warning: modules_install: missing 'System.map' file. Skipping depmod.
make[1]: Leaving directory '/usr/src/linux-headers-6.5.0-35-generic'
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ ls /lib/modules/$(uname -r)/kernel/dri
vers
accel          cpufreq      hid           mailbox      nvdim        rapidio      thermal
accessibility cpuidle      hsi           mcb          nvme         regulator    thunderbolt
acpi           crypto       hv            md            nvme         reset        tty
android       cxl          hwmon        media         parport      rpmsg        ufs
ata           dax          hwtracing    memory        pci           rtc          uio
atm           dca          i2c          memstick      pcmcia        scsi         usb
auxdisplay    dma          i3c          message       peci          siox         vdp
base          edac         tto          mfd           perf          slimbus      vfio
bcma          extcon       infiniband   misc          phy           soc          vhost
block         firewire     input        mmc           pinctrl       soundwire    video
bluetooth     firmware     iommu        most          platform      spi          virt
bus           fpga         ipack        mtd           power         spmi         virtio
char          gss          irqchip      mux           powercap      ssb          wi
clk           gpio         isdn         net           pps           staging       watchdog
comedi        gpu          leds         nfc           ptp           target        xen
counter       greybus      macintosh    ntb           pwm           tee

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auxdisplay    dma      i3c      message    peci      siox      vdpb
base          edac      iio      mfd        perf      slimbus   vfio
bcma          extcon   infiniband  misc      phy       soc       vhost
block         firewall input    mmc        pinctrl   soundwire video
bluetooth     firmware iommu     most      platform  spi       virt
bus           fpga     ipack     mtd        power     spmi      virtio
char          gnss     irqchip   mux        powercap  ssb       wi
clk           gpio     isdn      net        pps       staging   watchdog
comedi        gpu      leds      nfc        ptp       target    xen
counter       greybus  macintosh ntb        pwm       tee

yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ sudo modprobe helloworld
modprobe: FATAL: Module helloworld not found in directory /lib/modules/6.5.0-35-generic
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ find /lib/modules/$(uname -r) -name "helloworld.ko"
/lib/modules/6.5.0-35-generic/updates/helloworld.ko
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ sudo depmod
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ sudo modprobe helloworld
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ lsmod | grep helloworld
helloworld      12288  0
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ sudo dmesg | tail
[49895.803181] audit: type=1400 audit(1718065129.114:118): apparmor="DENIED" operation="open"
  class="file" profile="ubuntu_pro_esm_cache//apt_methods_gpgv" name="/var/lib/dpkg/arch" pid=
57256 comm="dpkg" requested_mask="r" denied_mask="r" fsuid=105 ouid=0
[49895.808466] audit: type=1400 audit(1718065129.122:119): apparmor="DENIED" operation="open"
  class="file" profile="ubuntu_pro_esm_cache//apt_methods_gpgv" name="/var/lib/dpkg/arch" pid=
57258 comm="dpkg" requested_mask="r" denied_mask="r" fsuid=105 ouid=0
[49895.814012] audit: type=1400 audit(1718065129.126:120): apparmor="DENIED" operation="open"
  class="file" profile="ubuntu_pro_esm_cache//apt_methods_gpgv" name="/var/lib/dpkg/arch" pid=
57260 comm="dpkg" requested_mask="r" denied_mask="r" fsuid=105 ouid=0
[49895.819056] audit: type=1400 audit(1718065129.130:121): apparmor="DENIED" operation="open"
  class="file" profile="ubuntu_pro_esm_cache//apt_methods_gpgv" name="/var/lib/dpkg/arch" pid=
57262 comm="dpkg" requested_mask="r" denied_mask="r" fsuid=105 ouid=0
[49895.825363] audit: type=1400 audit(1718065129.138:122): apparmor="DENIED" operation="open"
  class="file" profile="ubuntu_pro_esm_cache//apt_methods_gpgv" name="/var/lib/dpkg/arch" pid=
57265 comm="dpkg" requested_mask="r" denied_mask="r" fsuid=105 ouid=0
[49896.340674] audit: type=1400 audit(1718065129.654:123): apparmor="DENIED" operation="open"
  class="file" profile="ubuntu_pro_esm_cache//apt_methods_gpgv" name="/var/lib/dpkg/arch" pid=
57287 comm="dpkg" requested_mask="r" denied_mask="r" fsuid=105 ouid=0
[49896.347785] audit: type=1400 audit(1718065129.658:124): apparmor="DENIED" operation="open"
  class="file" profile="ubuntu_pro_esm_cache//apt_methods_gpgv" name="/var/lib/dpkg/arch" pid=
57289 comm="dpkg" requested_mask="r" denied_mask="r" fsuid=105 ouid=0
[50919.767241] helloworld: loading out-of-tree module taints kernel.
[50919.767247] helloworld: module verification failed: signature and/or required key missing
- tainting kernel
[50919.767710] Hello, world!
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ sudo rmmod helloworld
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ dmesg | tail
dmesg: read kernel buffer failed: Operation not permitted
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ make clean
make -C /lib/modules/6.5.0-35-generic/build M=/home/yopanelly/kernel_module clean
make[1]: Entering directory '/usr/src/linux-headers-6.5.0-35-generic'
  CLEAN   /home/yopanelly/kernel_module/Module.symvers
make[1]: Leaving directory '/usr/src/linux-headers-6.5.0-35-generic'
yopanelly@yopanelly-HP-ProBook-650-G1:~/kernel_module$ 

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