



PROJECT - NGUYÊN LÝ HỆ ĐIỀU HÀNH

Học kỳ 1 – 2023-2024

Máy ảo sử dụng: Ubuntu VM

Tuyên bố: Project này là do chính tôi, **Ha La Phin** SV (MSSV:**B2110093**), tự thực hiện, không sao chép của bất kỳ ai. Nếu có bất cứ sao chép nào, tôi hoàn toàn chịu trách nhiệm.

PHẦN 1: XÂY DỰNG LINUX KERNEL

Thực hiện ở chế độ người dùng root (root user)

\$su -

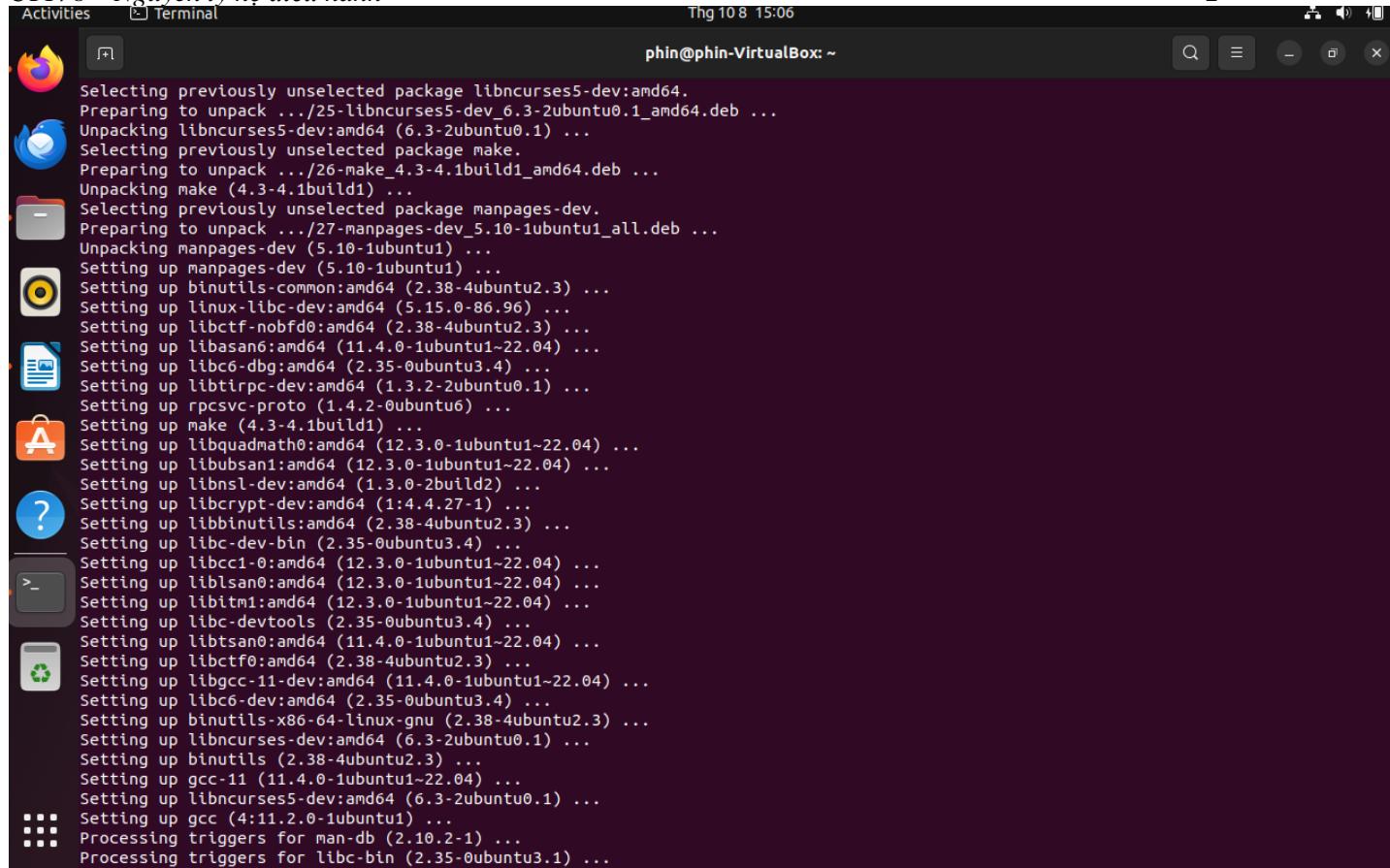
A. CHUẨN BỊ LINUX KERNEL CODE (phản hướng dẫn dưới đây thực hiện trên CentOS. Tuy nhiên, sinh viên cần thực hiện trên Ubuntu)

Thực hiện ở Ubuntu:

\$sudo apt-get install -y gcc libncurses5-dev make wget

```

phin@phin-VirtualBox:~$ sudo apt-get install -y gcc libncurses5-dev make wget
[sudo] password for phin:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
wget is already the newest version (1.21.2-2ubuntu1).
wget set to manually installed.
The following additional packages will be installed:
  binutils binutils-common binutils-x86_64-linux-gnu gcc-11 libasan6
  libbinutils libc-dev-bin libc6 libc6-dbg libc6-dev libcc1-0
  libcrypt-dev libctf-nobfd0 libctf0 libgcc-11-dev libitm1 liblsan0
  libncurses-dev libnsl-dev libquadmath0 libtirpc-dev libtsan0 libubsan1
  linux-libc-dev manpages-dev rpcsvc-proto
Suggested packages:
  binutils-doc gcc-multilib autoconf automake libtool flex bison gcc-doc
  gcc-11-multilib gcc-11-doc gcc-11-locales glibc-doc ncurses-doc make-doc
Recommended packages:
  libnss-nis libnss-nisplus
The following NEW packages will be installed:
  binutils binutils-common binutils-x86_64-linux-gnu gcc gcc-11 libasan6
  libbinutils libc-dev-bin libc-devtools libc6-dev libcc1-0 libcrypt-dev
  libctf-nobfd0 libctf0 libgcc-11-dev libitm1 liblsan0 libncurses-dev
  libncurses5-dev libnsl-dev libquadmath0 libtirpc-dev libtsan0 libubsan1
  linux-libc-dev make manpages-dev rpcsvc-proto
The following packages will be upgraded:
  libc6 libc6-dbg
2 upgraded, 28 newly installed, 0 to remove and 71 not upgraded.
Need to get 39,7 MB/56,8 MB of archives.
After this operation, 134 MB of additional disk space will be used.
Get:1 http://vn.archive.ubuntu.com/ubuntu jammy-updates/main amd64 binutils-common amd64 2.38-4ubuntu2.3 [222 kB]
Get:2 http://vn.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libbinutils amd64 2.38-4ubuntu2.3 [662 kB]
Get:3 http://vn.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libctf-nobfd0 amd64 2.38-4ubuntu2.3 [107 kB]
Get:4 http://vn.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libctf0 amd64 2.38-4ubuntu2.3 [103 kB]
Get:5 http://vn.archive.ubuntu.com/ubuntu jammy-updates/main amd64 binutils-x86_64-linux-gnu amd64 2.38-4ubuntu2.3 [2.327 kB]
Get:6 http://vn.archive.ubuntu.com/ubuntu jammy-updates/main amd64 binutils amd64 2.38-4ubuntu2.3 [3.190 B]
Get:7 http://vn.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libcc1-0 amd64 12.3.0-1ubuntu1~22.04 [48,3 kB]
Get:8 http://vn.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libitm1 amd64 12.3.0-1ubuntu1~22.04 [30,2 kB]
```

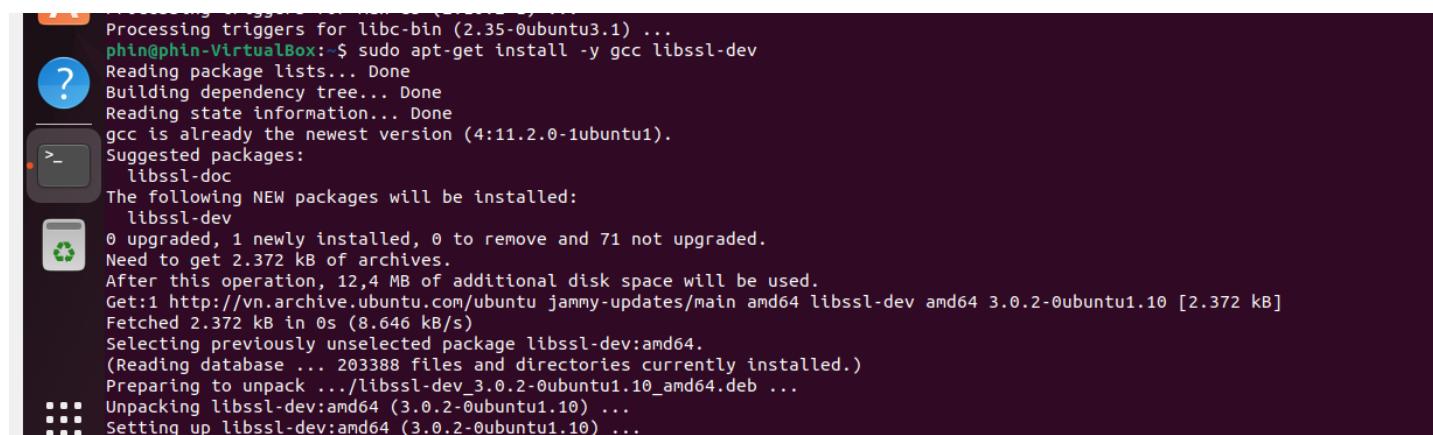


```

Activities Terminal Thg 10 8 15:06
phin@phin-VirtualBox: ~
Selecting previously unselected package libncurses5-dev:amd64.
Preparing to unpack .../25-libncurses5-dev_6.3-2ubuntu0.1_amd64.deb ...
Unpacking libncurses5-dev:amd64 (6.3-2ubuntu0.1) ...
Selecting previously unselected package make.
Preparing to unpack .../26-make_4.3-4.1build1_amd64.deb ...
Unpacking make (4.3-4.1build1) ...
Selecting previously unselected package manpages-dev.
Preparing to unpack .../27-manpages-dev_5.10-1ubuntu1_all.deb ...
Unpacking manpages-dev (5.10-1ubuntu1) ...
Setting up manpages-dev (5.10-1ubuntu1) ...
Setting up binutils-common:amd64 (2.38-4ubuntu2.3) ...
Setting up linux-libc-dev:amd64 (5.15.0-86.96) ...
Setting up libctf-nobfd0:amd64 (2.38-4ubuntu2.3) ...
Setting up libasan6:amd64 (11.4.0-1ubuntu1~22.04) ...
Setting up libc6-dbg:amd64 (2.35-0ubuntu3.4) ...
Setting up libtirpc-dev:amd64 (1.3.2-2ubuntu0.1) ...
Setting up rpcsvc-proto (1.4.2-0ubuntu6) ...
Setting up make (4.3-4.1build1) ...
Setting up libquadmath0:amd64 (12.3.0-1ubuntu1~22.04) ...
Setting up libubsan1:amd64 (12.3.0-1ubuntu1~22.04) ...
Setting up libnsl-dev:amd64 (1.3.0-2build2) ...
Setting up libcrypt-dev:amd64 (1:4.4.27-1) ...
Setting up libbinutils:amd64 (2.38-4ubuntu2.3) ...
Setting up libc-dev-bin (2.35-0ubuntu3.4) ...
Setting up libcc1-0:amd64 (12.3.0-1ubuntu1~22.04) ...
Setting up liblsan0:amd64 (12.3.0-1ubuntu1~22.04) ...
Setting up libitm1:amd64 (12.3.0-1ubuntu1~22.04) ...
Setting up libc-devtools (2.35-0ubuntu3.4) ...
Setting up libtsan0:amd64 (11.4.0-1ubuntu1~22.04) ...
Setting up libctf0:amd64 (2.38-4ubuntu2.3) ...
Setting up libgcc-11-dev:amd64 (11.4.0-1ubuntu1~22.04) ...
Setting up libc6-dev:amd64 (2.35-0ubuntu3.4) ...
Setting up binutils-x86-64-linux-gnu (2.38-4ubuntu2.3) ...
Setting up libncurses-dev:amd64 (6.3-2ubuntu0.1) ...
Setting up binutils (2.38-4ubuntu2.3) ...
Setting up gcc-11 (11.4.0-1ubuntu1~22.04) ...
Setting up libncurses5-dev:amd64 (6.3-2ubuntu0.1) ...
Setting up gcc (4:11.2.0-1ubuntu1) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for libc-bin (2.35-0ubuntu3.1) ...

```

\$sudo apt-get install -y gcc libssl-dev



```

Processing triggers for libc-bin (2.35-0ubuntu3.1) ...
phn@phn-VirtualBox: $ sudo apt-get install -y gcc libssl-dev
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
gcc is already the newest version (4:11.2.0-1ubuntu1).
Suggested packages:
  libssl-doc
The following NEW packages will be installed:
  libssl-dev
0 upgraded, 1 newly installed, 0 to remove and 71 not upgraded.
Need to get 2.372 kB of archives.
After this operation, 12,4 MB of additional disk space will be used.
Get:1 http://vn.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libssl-dev amd64 3.0.2-0ubuntu1.10 [2.372 kB]
Fetched 2.372 kB in 0s (8.646 kB/s)
Selecting previously unselected package libssl-dev:amd64.
(Reading database ... 203388 files and directories currently installed.)
Preparing to unpack .../libssl-dev_3.0.2-0ubuntu1.10_amd64.deb ...
Unpacking libssl-dev:amd64 (3.0.2-0ubuntu1.10) ...
Setting up libssl-dev:amd64 (3.0.2-0ubuntu1.10) ...

```

\$sudo apt-get install bison

```

Setting up libsigsegv2 (2.13-1ubuntu3) ...
phin@phin-VirtualBox:~$ sudo apt-get install bison
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  libsigsegv2 m4
Suggested packages:
  bison-doc m4-doc
The following NEW packages will be installed:
  bison libsigsegv2 m4
0 upgraded, 3 newly installed, 0 to remove and 71 not upgraded.
Need to get 962 kB of archives.
After this operation, 2.924 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://vn.archive.ubuntu.com/ubuntu jammy/main amd64 libsigsegv2 amd64 2.13-1ubuntu3 [14,6 kB]
Get:2 http://vn.archive.ubuntu.com/ubuntu jammy/main amd64 m4 amd64 1.4.18-5ubuntu2 [199 kB]
Get:3 http://vn.archive.ubuntu.com/ubuntu jammy/main amd64 bison amd64 2:3.8.2+dfsg-1build1 [748 kB]
Fetched 962 kB in 0s (5.904 kB/s)
Selecting previously unselected package libsigsegv2:amd64.
(Reading database ... 203536 files and directories currently installed.)
Preparing to unpack .../libsigsegv2_2.13-1ubuntu3_amd64.deb ...
Unpacking libsigsegv2:amd64 (2.13-1ubuntu3) ...
Selecting previously unselected package m4.
Preparing to unpack .../m4_1.4.18-5ubuntu2_amd64.deb ...
Unpacking m4 (1.4.18-5ubuntu2) ...
Selecting previously unselected package bison.
Preparing to unpack .../bison_2%3a3.8.2+dfsg-1build1_amd64.deb ...
Unpacking bison (2:3.8.2+dfsg-1build1) ...
Setting up libsigsegv2:amd64 (2.13-1ubuntu3) ...
Setting up m4 (1.4.18-5ubuntu2) ...
Setting up bison (2:3.8.2+dfsg-1build1) ...
update-alternatives: using /usr/bin/bison.yacc to provide /usr/bin/yacc (yacc) in auto mode
Processing triggers for libc-bin (2.35-0ubuntu3.1) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for install-info (6.8-4build1) ...
phin@phin-VirtualBox:~$
```

\$sudo apt-get install flex

```

phin@phin-VirtualBox:~$ sudo apt-get install flex
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  libfl-dev libfl2
Suggested packages:
  build-essential flex-doc
The following NEW packages will be installed:
  flex libfl-dev libfl2
0 upgraded, 3 newly installed, 0 to remove and 71 not upgraded.
Need to get 324 kB of archives.
After this operation, 1.148 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://vn.archive.ubuntu.com/ubuntu jammy/main amd64 flex amd64 2.6.4-8build2 [307 kB]
Get:2 http://vn.archive.ubuntu.com/ubuntu jammy/main amd64 libfl2 amd64 2.6.4-8build2 [10,7 kB]
Get:3 http://vn.archive.ubuntu.com/ubuntu jammy/main amd64 libfl-dev amd64 2.6.4-8build2 [6.236 B]
Fetched 324 kB in 0s (1.799 kB/s)
Selecting previously unselected package flex.
(Reading database ... 203719 files and directories currently installed.)
Preparing to unpack .../flex_2.6.4-8build2_amd64.deb ...
Unpacking flex (2.6.4-8build2) ...
Selecting previously unselected package libfl2:amd64.
Preparing to unpack .../libfl2_2.6.4-8build2_amd64.deb ...
Unpacking libfl2:amd64 (2.6.4-8build2) ...
Selecting previously unselected package libfl-dev:amd64.
Preparing to unpack .../libfl-dev_2.6.4-8build2_amd64.deb ...
Unpacking libfl-dev:amd64 (2.6.4-8build2) ...
Setting up flex (2.6.4-8build2) ...
Setting up libfl2:amd64 (2.6.4-8build2) ...
Setting up libfl-dev:amd64 (2.6.4-8build2) ...
Processing triggers for libc-bin (2.35-0ubuntu3.1) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for install-info (6.8-4build1) ...
phin@phin-VirtualBox:~$
```

2. Xác định phiên bản hiện tại của kernel:

uname -r

```
root@phin-VirtualBox:~$ sudo su
root@phin-VirtualBox:/home/phin# cd
root@phin-VirtualBox:~# uname -r
6.2.0-34-generic
root@phin-VirtualBox:~#
```

Trả lời: Phiên bản hiện tại của máy là 6.2.0-34-generic

3. Truy cập <http://kernel.org> hoặc <https://cdn.kernel.org/pub/linux/kernel/> và download source code của kernel hiện tại. Kế tiếp, download kernel 6.4.1 và giải nén source code:

wget <http://www.kernel.org/pub/linux/kernel/v6.x/linux-6.4.1.tar.gz>

```
root@phin-VirtualBox:~# wget http://www.kernel.org/pub/linux/kernel/v6.x/linux-6.4.1.tar.xz
--2023-10-08 15:15:14-- http://www.kernel.org/pub/linux/kernel/v6.x/linux-6.4.1.tar.xz
Resolving www.kernel.org (www.kernel.org)... 145.40.73.55, 2604:1380:4e01:4800::1
Connecting to www.kernel.org (www.kernel.org)|145.40.73.55|:80... connected.
HTTP request sent, awaiting response... 301 Moved Permanently
Location: https://www.kernel.org/pub/linux/kernel/v6.x/linux-6.4.1.tar.xz [following]
--2023-10-08 15:15:15-- https://www.kernel.org/pub/linux/kernel/v6.x/linux-6.4.1.tar.xz
Connecting to www.kernel.org (www.kernel.org)|145.40.73.55|:443... connected.
HTTP request sent, awaiting response... 301 Moved Permanently
Location: https://mirrors.edge.kernel.org/pub/linux/kernel/v6.x/linux-6.4.1.tar.xz [following]
--2023-10-08 15:15:15-- https://mirrors.edge.kernel.org/pub/linux/kernel/v6.x/linux-6.4.1.tar.xz
Resolving mirrors.edge.kernel.org (mirrors.edge.kernel.org)... 147.75.48.161, 2604:1380:40f1:3f00::1
Connecting to mirrors.edge.kernel.org (mirrors.edge.kernel.org)|147.75.48.161|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 137809496 (131M) [application/x-xz]
Saving to: 'linux-6.4.1.tar.xz'

linux-6.4.1.tar.xz          100%[=====] 131,42M  1,31MB/s   in 2m 35s
2023-10-08 15:17:51 (871 KB/s) - 'linux-6.4.1.tar.xz' saved [137809496/137809496]

root@phin-VirtualBox:~#
```

tar xf linux-6.4.1.tar.xz

```
[root@phin-VirtualBox ~]# tar xf linux-6.4.1.tar.xz
tar: Error is not recoverable: exiting now
root@phin-VirtualBox:~# tar xf linux-6.4.1.tar.xz
root@phin-VirtualBox:~#
```

(chú ý: thay đổi tên kernel phù hợp)

B. CẤU HÌNH KERNEL MỚI

1. Đảm bảo đường dẫn hiện tại ở ~/linux-6.4.1 và “linux-6.4.1” ở top directory của kernel source.

cd ~/linux-6.4.1

```
Activities Terminal Thg 10 8 15:29
root@phin-VirtualBox:~/linux-6.4.1
```

2. Tạo file cấu hình (config file)

make menuconfig

The screenshot shows a Linux desktop environment with two terminal windows. The top terminal window, titled 'root@phin-VirtualBox: ~/linux-6.4.1', displays the output of the 'make menuconfig' command. The bottom terminal window, also titled 'root@phin-VirtualBox: ~/linux-6.4.1', shows the 'menuconfig' interface for the Linux kernel version 6.4.1. The interface is a text-based menu system with various options for kernel configuration.

```

root@phin-VirtualBox:~# cd ~/linux-6.4.1
root@phin-VirtualBox:~/linux-6.4.1# make menuconfig
HOSTCC scripts/basic/fixdep
HOSTCC scripts/kconfig/mconf.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
HOSTCC scripts/kconfig/confdata.o
HOSTCC scripts/kconfig/expr.o
LEX scripts/kconfig/lexer.lex.c
YACC scripts/kconfig/parser.tab.[ch]
HOSTCC scripts/kconfig/lexer.lex.o
HOSTCC scripts/kconfig/menu.o
HOSTCC scripts/kconfig/parser.tab.o
HOSTCC scripts/kconfig/preprocess.o
HOSTCC scripts/kconfig/symbol.o
HOSTCC scripts/kconfig/util.o
HOSTLD scripts/kconfig/mconf

#
# using defaults found in /boot/config-6.2.0-34-generic
#
.config:10448:warning: symbol value 'm' invalid for ANDROID_BINDER_IPC
.config:10449:warning: symbol value 'm' invalid for ANDROID_BINDERFS

```

.config - Linux/x86 6.4.1 Kernel Configuration

Linux/x86 6.4.1 Kernel Configuration

Arrow keys navigate the menu. <Enter> selects submenus ---> (or empty submenus ----). Highlighted letters are hotkeys. Pressing <> includes, <N> excludes, <M> modularizes features. Press <Esc><Esc> to exit, <?> for Help, </> for Search. Legend: [*] built-in [] excluded <M> module < > module capable

```

[ ] General setup --->
[*] 64-bit kernel
    Processor type and features --->
[*] Mitigations for speculative execution vulnerabilities --->
    Power management and ACPI options --->
    Bus options (PCI etc.) --->
    Binary Emulations --->
[*] Virtualization --->
    General architecture-dependent options --->
[*] Enable loadable module support --->
[*] Enable the block layer --->
    Executable file formats --->
    Memory Management options --->
[*] Networking support --->
    Device Drivers --->
    File systems --->
    Security options --->
    Cryptographic API --->
        Library routines --->
        Kernel hacking --->

```

<Select> < Exit > < Help > < Save > < Load >

Chú ý, không thay đổi thông tin gì cả. Nhấn ESC để save và thoát khỏi menu cấu hình (configuration menu). File cấu hình sẽ được tạo ra.

C. BIÊN DỊCH KERNEL

1. Tại ~/linux-6.4.1, tạo kernel image nén (compressed kernel image)

make -j4

```

Activities Terminal Thg 10 8 15:31
root@phin-VirtualBox: ~/linux-6.4.1

from weak.c:10:
[root/linux-6.4.1/tools/objtool/include/objtool/elf.h:10:10: fatal error: gelf.h: No such file or directory
10 | #include <gelf.h>
      |
      ^~~~~~
MKELF scripts/mod/elfconfig.h
compilation terminated.
make[3]: *** [/root/linux-6.4.1/tools/build/Makefile.build:98: /root/linux-6.4.1/tools/objtool/weak.o] Error 1
make[3]: *** Waiting for unfinished jobs....
HOSTCC scripts/mod/modpost.o
HOSTCC scripts/mod/filealias.o
In file included from /root/linux-6.4.1/tools/objtool/include/objtool/objtool.h:13,
                 from /root/linux-6.4.1/tools/objtool/include/objtool/arch.h:11,
                 from check.c:14:
/root/linux-6.4.1/tools/objtool/include/objtool/elf.h:10:10: fatal error: gelf.h: No such file or directory
10 | #include <gelf.h>
      |
      ^~~~~~
compilation terminated.
make[3]: *** [/root/linux-6.4.1/tools/build/Makefile.build:98: /root/linux-6.4.1/tools/objtool/check.o] Error 1
HOSTCC scripts/mod/sumversion.o
In file included from /root/linux-6.4.1/tools/objtool/include/objtool/objtool.h:13,
                 from /root/linux-6.4.1/tools/objtool/include/objtool/arch.h:11,
                 from /root/linux-6.4.1/tools/objtool/include/objtool/check.h:11,
                 from arch/x86/decode.c:18:
/root/linux-6.4.1/tools/objtool/include/objtool/elf.h:10:10: fatal error: gelf.h: No such file or directory
10 | #include <gelf.h>
      |
      ^~~~~~
compilation terminated.
make[4]: *** [/root/linux-6.4.1/tools/build/Makefile.build:98: /root/linux-6.4.1/tools/objtool/arch/x86/decode.o] Error 1
make[3]: *** [/root/linux-6.4.1/tools/build/Makefile.build:140: arch/x86] Error 2
make[2]: *** [Makefile:66: /root/linux-6.4.1/tools/objtool/objtool-in.o] Error 2
make[1]: *** [Makefile:73: objtool] Error 2
make: *** [Makefile:140: tools/objtool] Error 2
make: *** Waiting for unfinished jobs....
HOSTLD scripts/mod/modpost
CC kernel/bounds.s
CHKSHAI1 include/linux/atomic/atomic-arch-fallback.h
UPD include/generated/timeconst.h
CHKSHAI1 include/linux/atomic/atomic-instrumented.h
CHKSHAI1 include/linux/atomic/atomic-long.h
UPD include/generated/bounds.h

```

Sửa lại lỗi bằng cách gõ câu lệnh sau:

sudo apt-get install libelf1 libelf-dev

```

root@phin-VirtualBox:~/linux-6.4.1# sudo apt-get install libelf1 libelf-dev
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
libelf1 is already the newest version (0.186-1build1).
libelf1 set to manually installed.
The following NEW packages will be installed:
  libelf-dev zlib1g-dev
0 upgraded, 2 newly installed, 0 to remove and 71 not upgraded.
Need to get 228 kB of archives.
After this operation, 979 kB of additional disk space will be used.
Get:1 http://vn.archive.ubuntu.com/ubuntu jammy-updates/main amd64 zlib1g-dev amd64 1:1.2.11.dfsg-2ubuntu9.2 [164 kB]
Get:2 http://vn.archive.ubuntu.com/ubuntu jammy/main amd64 libelf-dev amd64 0.186-1build1 [64,4 kB]
Fetched 228 kB in 0s (596 kB/s)
Selecting previously unselected package zlib1g-dev:amd64.
(Reading database ... 203809 files and directories currently installed.)
Preparing to unpack .../zlib1g-dev_1%3a1.2.11.dfsg-2ubuntu9.2_amd64.deb ...
Unpacking zlib1g-dev:amd64 (1:1.2.11.dfsg-2ubuntu9.2) ...
Selecting previously unselected package libelf-dev:amd64.
Preparing to unpack .../libelf-dev_0.186-1build1_amd64.deb ...
Unpacking libelf-dev:amd64 (0.186-1build1) ...
Setting up zlib1g-dev:amd64 (1:1.2.11.dfsg-2ubuntu9.2) ...
Setting up libelf-dev:amd64 (0.186-1build1) ...
Processing triggers for man-db (2.10.2-1) ...
root@phin-VirtualBox:~/linux-6.4.1#

```

Tiếp tục chạy câu lệnh: #make -j4 phát hiện lỗi

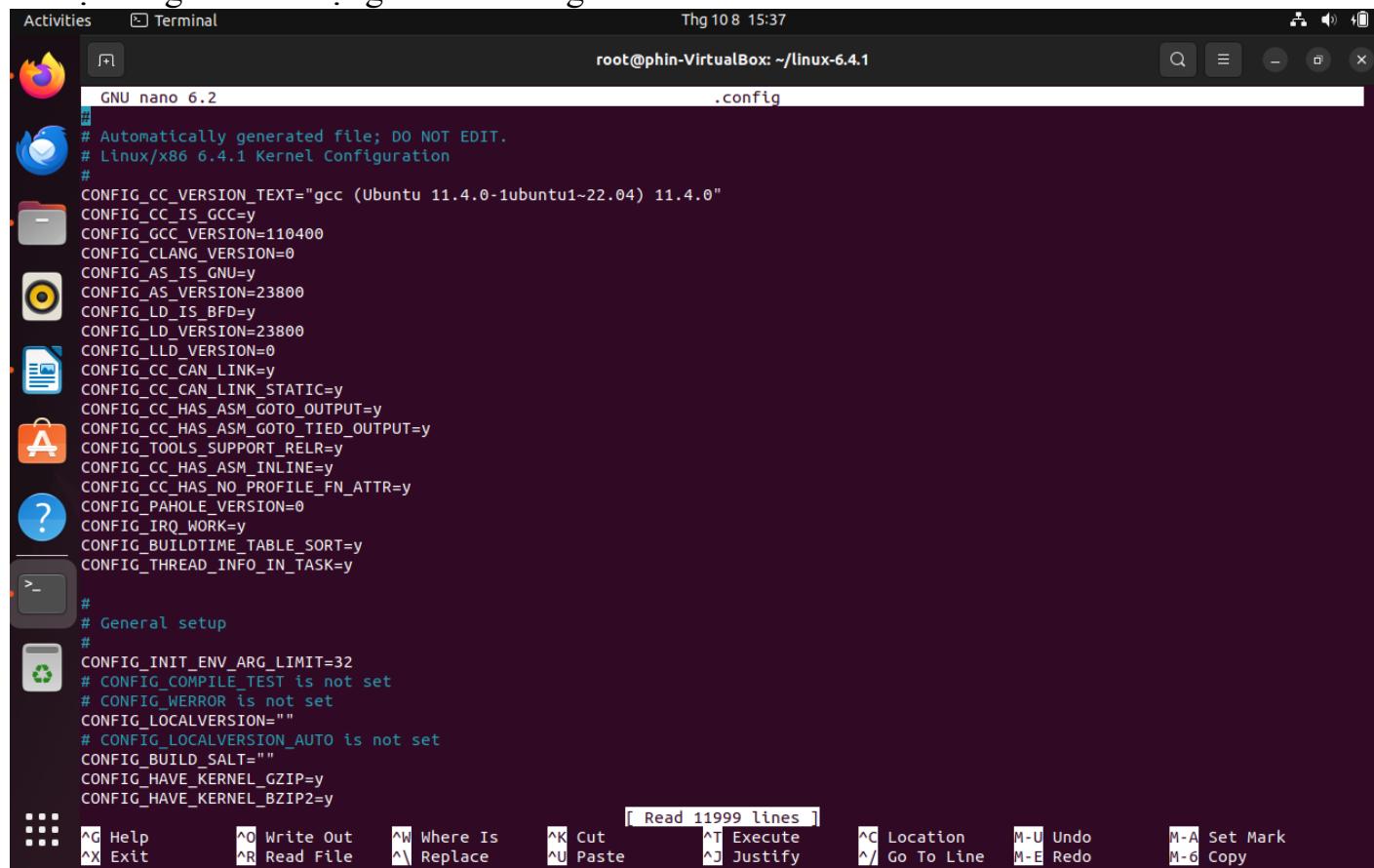


```

LINK /root/linux-6.4.1/tools/objtool/objtool
LDS scripts/module.lds
CC init/main.o
HOSTCC usr/gen_init_cpio
CC arch/x86/coco/tdx/tdx.o
CC kernel/sched/core.o
GEN usr/initramfs_data.cpio
COPY usr/initramfs_inc_data
AS usr/initramfs_data.o
AR usr/built-in.a
make[2]: *** No rule to make target 'debian/canonical-certs.pem', needed by 'certs/x509_certificate_list'. Stop.
make[2]: *** Waiting for unfinished jobs....
CC certs/system_keyring.o
AS arch/x86/coco/tdx/tdcall.o
AR arch/x86/coco/tdx/built-in.a
CC arch/x86/coco/core.o
make[1]: *** [scripts/Makefile.build:494: certs] Error 2
make[1]: *** Waiting for unfinished jobs....
CC kernel/sched/fair.o
AR arch/x86/coco/built-in.a
CC arch/x86/entry/vdso/vma.o
^Z
[1]+ Stopped make -j4
root@phin-VirtualBox:~/linux-6.4.1#

```

Sửa lại bằng cách sử dụng: nano .config



```

Activities Terminal Thg 10 8 15:37
root@phin-VirtualBox: ~/linux-6.4.1
GNU nano 6.2 .config
# Automatically generated file; DO NOT EDIT.
# Linux/x86 6.4.1 Kernel Configuration
#
CONFIG_CC_VERSION_TEXT="gcc (Ubuntu 11.4.0-1ubuntu1~22.04) 11.4.0"
CONFIG_CC_IS_GCC=y
CONFIG_GCC_VERSION=110400
CONFIG_CLANG_VERSION=0
CONFIG_AS_IS_GNU=y
CONFIG_AS_VERSION=23800
CONFIG_LD_IS_BFD=y
CONFIG_LD_VERSION=23800
CONFIG_LLD_VERSION=0
CONFIG_CC_CAN_LINK=y
CONFIG_CC_CAN_LINK_STATIC=y
CONFIG_CC_HAS_ASM_GOTO_OUTPUT=y
CONFIG_CC_HAS_ASM_GOTO_TIED_OUTPUT=y
CONFIG_TOOLS_SUPPORT_RELRL=y
CONFIG_CC_HAS_ASM_INLINE=y
CONFIG_CC_HAS_NO_PROFILE_FN_ATTR=y
CONFIG_PAHOLE_VERSION=0
CONFIG_IRQ_WORK=y
CONFIG_BUILDTIME_TABLE_SORT=y
CONFIG_THREAD_INFO_IN_TASK=y
#
# General setup
#
CONFIG_INIT_ENV_ARG_LIMIT=32
# CONFIG_COMPILE_TEST is not set
# CONFIG_WERROR is not set
CONFIG_LOCALVERSION=""
# CONFIG_LOCALVERSION_AUTO is not set
CONFIG_BUILD_SALT=""
CONFIG_HAVE_KERNEL_GZIP=y
CONFIG_HAVE_KERNEL_BZIP2=y

```

[Read 11999 lines]

Ctrl + W : để tìm thư mục có chứa debian

```

CONFIG_SYSTEM_TRUSTED_KEYS="debian/canonical-certs.pem"
CONFIG_SYSTEM_EXTRA_CERTIFICATE=y
CONFIG_SYSTEM_EXTRA_CERTIFICATE_SIZE=4096
CONFIG_SECONDARY_TRUSTED_KEYRING=y
CONFIG_SYSTEM_BLACKLIST_KEYRING=y
CONFIG_SYSTEM_BLACKLIST_HASH_LIST=""
CONFIG_SYSTEM_REVOCATION_LIST=y
CONFIG_SYSTEM_REVOCATION_KEYS="debian/canonical-revoked-certs.pem"

```

Xóa dòng có chứa debian đi

```
CONFIG_SYSTEM_TRUSTED_KEYRING=y
CONFIG_SYSTEM_TRUSTED_KEYS=""
CONFIG_SYSTEM_EXTRA_CERTIFICATE=y
CONFIG_SYSTEM_EXTRA_CERTIFICATE_SIZE=4096
CONFIG_SECONDARY_TRUSTED_KEYRING=y
CONFIG_SYSTEM_BLACKLIST_KEYRING=y
CONFIG_SYSTEM_BLACKLIST_HASH_LIST=""
CONFIG_SYSTEM_REVOCATION_LIST=y
CONFIG_SYSTEM_REVOCATION_KEYS=""
```

Lưu lại và thoát ra tiếp tục chạy bằng #fg

```
AS [M] arch/x86/kvm/vmx/vmenter.o
AR arch/x86/kernel/built-in.a
AS [M] arch/x86/kvm/svm/vmenter.o
AR arch/x86/built-in.a
CC kernel/jump_label.o
LD [M] arch/x86/kvm/kvm-intel.o
LD [M] arch/x86/kvm/kvm-amd.o
CC kernel/context_tracking.o
CC kernel/iomem.o
CC kernel/rseq.o
CC kernel/watch_queue.o
CHK kernel/kheaders_data.tar.xz
GEN kernel/kheaders_data.tar.xz
AR kernel/built-in.a
CC [M] kernel/kheaders.o
make: *** [Makefile:2026: .] Error 2
```

Tiếp tục gấp lối

Sửa bằng cách dùng lệnh: sudo apt-get upgrade

```
root@phin-VirtualBox:~/linux-6.4.1# sudo apt-get upgrade
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
The following packages have been kept back:
  gjs libgjs0g
The following packages will be upgraded:
  alsu-ucm-conf amd64-microcode apt apt-utils bind9-dnsutils bind9-host bind9-libs cups cups-bsd cups-client cups-common
  cups-core-drivers cups-daemon cups-ppdc cups-server-common file ghostscript ghostscript-x
  gir1.2-javascriptcoregtk-4.0 gir1.2-mutter-10 gir1.2-webkit2-4.0 gnome-remote-desktop initramfs-tools initramfs-tools-bin
  initramfs-tools-core intel-microcode libapt-pkg6.0 libc-bin libcups2 libcupsimage2 libflac8 libfprint-2-2 libfreerdp-client2-2
  libfreerdp-server-2 libfreerdp2-2 libgs9 libgs9-common libjavascriptcoregtk-4.0-18 libjson-c5 libldap-2.5.0 libldap-common
  libmagic-mgc libmagic1 libmutter-10-0 libsmclient libtiff libvpx7 libwbclient0 libwebkit2gtk-4.0-37 libwebp7 libwebpdemux2
  libwebpdmux3 libwinpr2-2 libx11-6 libx11-data libx11-xcb1 libxpm4 linux-firmware mokutil mutter-common openssh-client samba-libs
  thermald ubuntu-advantage-tools vim-common vim-tiny xserver-xorg-video-amdgpu xxd
69 upgraded, 0 newly installed, 0 to remove and 2 not upgraded.
Need to get 0 B/318 MB of archives.
After this operation, 5.865 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
Extracting templates from packages: 100%
Preconfiguring packages ...
(Reading database ... 203854 files and directories currently installed.)
Preparing to unpack .../libc-bin_2.35-0ubuntu3.4_amd64.deb ...
Unpacking libc-bin (2.35-0ubuntu3.4) over (2.35-0ubuntu3.1) ...
Setting up libc-bin (2.35-0ubuntu3.4) ...
(Reading database ... 203854 files and directories currently installed.)
Preparing to unpack .../libapt-pkg6.0_2.4.10_amd64.deb ...
Unpacking libapt-pkg6.0:amd64 (2.4.10) over (2.4.9) ...
Setting up libapt-pkg6.0:amd64 (2.4.10) ...
(Reading database ... 203854 files and directories currently installed.)
Preparing to unpack .../archives/apt_2.4.10_amd64.deb ...
Unpacking apt (2.4.10) over (2.4.9) ...
Setting up apt (2.4.10) ...
(Reading database ... 203854 files and directories currently installed.)
Preparing to unpack .../00-apt-utils_2.4.10_amd64.deb ...
Unpacking apt-utils (2.4.10) over (2.4.9) ...
Preparing to unpack .../01-libcupsimage2_2.4.10p1-1ubuntu4.7_amd64.deb ...
Unpacking libcupsimage2:amd64 (2.4.10p1-1ubuntu4.7) over (2.4.10p1-1ubuntu4.4) ...
Preparing to unpack .../02-cups-ipp-utils_2.4.10p1-1ubuntu4.7_amd64.deb ...
Unpacking cups-ipp-utils (2.4.10p1-1ubuntu4.7) over (2.4.10p1-1ubuntu4.4) ...
```

```

Activities Terminal Thg 10 8 16:00
root@phin-VirtualBox: ~/linux-6.4.1

Setting up libfreerdp-client2-2:amd64 (2.6.1+dfsg1-3ubuntu2.4) ...
Setting up cups-core-drivers (2.4.10p1-1ubuntu4.7) ...
Setting up gir1.2-webkit2-4.0:amd64 (2.40.5-0ubuntu0.22.04.1) ...
Setting up initramfs-tools (0.140ubuntu13.4) ...
update-initramfs: deferring update (trigger activated)
Setting up cups (2.4.10p1-1ubuntu4.7) ...
Updating PPD files for cups ...
Updating PPD files for cups-filters ...
Updating PPD files for foomatic-db-compressed-ppds ...
Updating PPD files for openprinting-ppds ...
Updating PPD files for brlaser ...
Updating PPD files for c2esp ...
Updating PPD files for foo2zjs-common ...
Updating PPD files for hpcups ...
Updating PPD files for m2300w ...
Updating PPD files for postscript-hp ...
Updating PPD files for ptouch ...
Updating PPD files for pxljr ...
Updating PPD files for sag-gdi ...
Updating PPD files for splix ...
Setting up cups-bsd (2.4.10p1-1ubuntu4.7) ...
Setting up ghostscript-x (9.55.0-dfsg1-0ubuntu5.4) ...
Setting up bind9-dnsutils (1:9.18.12-0ubuntu0.22.04.3) ...
Processing triggers for mailcap (3.70+nmu1ubuntu1) ...
Processing triggers for desktop-file-utils (0.26-1ubuntu3) ...
Processing triggers for hicolor-icon-theme (0.17-2) ...
Processing triggers for gnome-menus (3.36.0-1ubuntu3) ...
Processing triggers for libglib2.0-0:amd64 (2.72.4-0ubuntu2.2) ...
Processing triggers for libc-bin (2.35-0ubuntu3.4) ...
Processing triggers for ufw (0.36.1-4ubuntu0.1) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for dbus (1.12.20-2ubuntu4.1) ...
Processing triggers for udev (249.11-0ubuntu3.10) ...
Setting up libmutter-10-0:amd64 (42.9-0ubuntu5) ...
Setting up gir1.2-mutter-10:amd64 (42.9-0ubuntu5) ...
Setting up gnome-remote-desktop (42.9-0ubuntu0.22.04.1) ...
Processing triggers for initramfs-tools (0.140ubuntu13.4) ...
update-initramfs: Generating /boot/initrd.img-6.2.0-34-generic
Processing triggers for libc-bin (2.35-0ubuntu3.4) ...
root@phin-VirtualBox:~/linux-6.4.1#

```

Chạy lại lệnh : #make -j4

```

Activities Terminal Thg 10 8 21:10
root@phin-VirtualBox: ~/linux-6.4.1

LD [M] net/6lowpan/nhc_dest.ko
LD [M] net/6lowpan/nhc_fragment.ko
LD [M] net/6lowpan/nhc_hop.ko
LD [M] net/6lowpan/nhc_ipv6.ko
LD [M] net/6lowpan/nhc_mobility.ko
LD [M] net/6lowpan/nhc_routing.ko
LD [M] net/6lowpan/nhc_udp.ko
LD [M] net/ieee802154/6lowpan/ieee802154_6lowpan.ko
LD [M] net/ieee802154/ieee802154.ko
LD [M] net/ieee802154/ieee802154_socket.ko
LD [M] net/mac802154/mac802154.ko
LD [M] net/ceph/libceph.ko
LD [M] net/batman-adv/batman-adv.ko
LD [M] net/nfc/nfc.ko
LD [M] net/nfc/nci/nci.ko
LD [M] net/nfc/nci/nci_spi.ko
LD [M] net/nfc/nci/nci_uart.ko
LD [M] net/nfc/hci/hci.ko
LD [M] net/nfc/nfc_digital.ko
LD [M] net/psample/psample.ko
LD [M] net/ife/ife.ko
LD [M] net/openvswitch/openvswitch.ko
LD [M] net/openvswitch/vport-vxlan.ko
LD [M] net/openvswitch/vport-geneve.ko
LD [M] net/openvswitch/vport-gre.ko
LD [M] net/vmw_vsock/vsock.ko
LD [M] net/vmw_vsock/vsock_diag.ko
LD [M] net/vmw_vsock/vmw_vsock_vmci_transport.ko
LD [M] net/vmw_vsock/vmw_vsock_virtio_transport.ko
LD [M] net/vmw_vsock/vmw_vsock_virtio_transport_common.ko
LD [M] net/vmw_vsock/hv_sock.ko
LD [M] net/vmw_vsock/vsock_loopback.ko
LD [M] net/nsh/nsh.ko
LD [M] net/hsr/hsr.ko
LD [M] net/qrtr/qrtr.ko
LD [M] net/qrtr/qrtr-smd.ko
LD [M] net/qrtr/qrtr-tun.ko
LD [M] net/qrtr/qrtr-mhi.ko
LD [M] virt/lib/irqbypass.ko
root@phin-VirtualBox:~/linux-6.4.1#

```

2. Biên dịch kernel modules:

make modules

```
LD [M] virt/lib/irqbypass.ko
root@phin-VirtualBox:~/linux-6.4.1# make modules
CALL    scripts/checksyscalls.sh
DESCEND objtool
INSTALL libsubcmd_headers
CHK     kernel/kheaders_data.tar.xz
root@phin-VirtualBox:~/linux-6.4.1#
```

Hoàn thành

D. CÀI ĐẶT KERNEL

1. Cài đặt kernel modules

make modules_install

```
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/adm112.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/adm9240.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/adm9240.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/ads7828.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/ads7828.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/ads7871.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/ads7871.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/adt7x10.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/adt7x10.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/adt7310.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/adt7310.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/adt7410.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/adt7410.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/adt7441.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/adt7441.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/adt7462.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/adt7462.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/adt7470.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/adt7470.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/adt7475.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/adt7475.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/aht10.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/aht10.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/applesmc.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/applesmc.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/aquacomputer_d5next.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/aquacomputer_d5next.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/as370-hwmon.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/as370-hwmon.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/asc7621.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/asc7621.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/atxp1.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/atxp1.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/axi-fan-control.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/axi-fan-control.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/coretemp.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/coretemp.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/corsair-cpro.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/corsair-cpro.ko
INSTALL /lib/modules/6.4.1/kernel/drivers/hwmon/corsair-psu.ko
SIGN /lib/modules/6.4.1/kernel/drivers/hwmon/corsair-psu.ko
```

```

INSTALL /lib/modules/6.4.1/kernel/net/ife/ife.ko
SIGN /lib/modules/6.4.1/kernel/net/ife/ife.ko
INSTALL /lib/modules/6.4.1/kernel/net/openvswitch/openvswitch.ko
SIGN /lib/modules/6.4.1/kernel/net/openvswitch/openvswitch.ko
INSTALL /lib/modules/6.4.1/kernel/net/openvswitch/vport-vxlan.ko
SIGN /lib/modules/6.4.1/kernel/net/openvswitch/vport-vxlan.ko
INSTALL /lib/modules/6.4.1/kernel/net/openvswitch/vport-geneve.ko
SIGN /lib/modules/6.4.1/kernel/net/openvswitch/vport-geneve.ko
INSTALL /lib/modules/6.4.1/kernel/net/openvswitch/vport-gre.ko
SIGN /lib/modules/6.4.1/kernel/net/openvswitch/vport-gre.ko
INSTALL /lib/modules/6.4.1/kernel/net/vmw_vsock/vsock.ko
SIGN /lib/modules/6.4.1/kernel/net/vmw_vsock/vsock.ko
INSTALL /lib/modules/6.4.1/kernel/net/vmw_vsock/vsock_diag.ko
SIGN /lib/modules/6.4.1/kernel/net/vmw_vsock/vsock_diag.ko
INSTALL /lib/modules/6.4.1/kernel/net/vmw_vsock/vmw_vsock_vmc_i_transport.ko
SIGN /lib/modules/6.4.1/kernel/net/vmw_vsock/vmw_vsock_vmc_i_transport.ko
INSTALL /lib/modules/6.4.1/kernel/net/vmw_vsock/vmw_vsock_virtio_transport.ko
SIGN /lib/modules/6.4.1/kernel/net/vmw_vsock/vmw_vsock_virtio_transport.ko
INSTALL /lib/modules/6.4.1/kernel/net/vmw_vsock/vmw_vsock_virtio_transport_common.ko
SIGN /lib/modules/6.4.1/kernel/net/vmw_vsock/vmw_vsock_virtio_transport_common.ko
INSTALL /lib/modules/6.4.1/kernel/net/vmw_vsock/hv_sock.ko
SIGN /lib/modules/6.4.1/kernel/net/vmw_vsock/hv_sock.ko
INSTALL /lib/modules/6.4.1/kernel/net/vmw_vsock/vsock_loopback.ko
SIGN /lib/modules/6.4.1/kernel/net/vmw_vsock/vsock_loopback.ko
INSTALL /lib/modules/6.4.1/kernel/net/nsh/nsh.ko
SIGN /lib/modules/6.4.1/kernel/net/nsh/nsh.ko
INSTALL /lib/modules/6.4.1/kernel/net/hsr/hsr.ko
SIGN /lib/modules/6.4.1/kernel/net/hsr/hsr.ko
INSTALL /lib/modules/6.4.1/kernel/net/qtr/qtr.ko
SIGN /lib/modules/6.4.1/kernel/net/qtr/qtr.ko
INSTALL /lib/modules/6.4.1/kernel/net/qtr/qtr-smd.ko
SIGN /lib/modules/6.4.1/kernel/net/qtr/qtr-smd.ko
INSTALL /lib/modules/6.4.1/kernel/net/qtr/qtr-tun.ko
SIGN /lib/modules/6.4.1/kernel/net/qtr/qtr-tun.ko
INSTALL /lib/modules/6.4.1/kernel/net/qtr/qtr-mhi.ko
SIGN /lib/modules/6.4.1/kernel/net/qtr/qtr-mhi.ko
INSTALL /lib/modules/6.4.1/kernel/virt/lib/irqbypass.ko
SIGN /lib/modules/6.4.1/kernel/virt/lib/irqbypass.ko
DEPMOD /lib/modules/6.4.1

```

Cài Đặt thành công

2. Cài đặt the kernel

make install

```

root@phin-VirtualBox:~/linux-6.4.1# make install
  INSTALL /boot
run-parts: executing /etc/kernel/postinst.d/initramfs-tools 6.4.1 /boot/vmlinuz-6.4.1
update-initramfs: Generating /boot/initrd.img-6.4.1
run-parts: executing /etc/kernel/postinst.d/unattended-upgrades 6.4.1 /boot/vmlinuz-6.4.1
run-parts: executing /etc/kernel/postinst.d/update-notifier 6.4.1 /boot/vmlinuz-6.4.1
run-parts: executing /etc/kernel/postinst.d/xx-update-initrd-links 6.4.1 /boot/vmlinuz-6.4.1
I: /boot/initrd.img.old is now a symlink to initrd.img-6.2.0-34-generic
I: /boot/initrd.img is now a symlink to initrd.img-6.4.1
run-parts: executing /etc/kernel/postinst.d/zz-shim 6.4.1 /boot/vmlinuz-6.4.1
run-parts: executing /etc/kernel/postinst.d/zz-update-grub 6.4.1 /boot/vmlinuz-6.4.1
Sourcing file '/etc/default/grub'
Sourcing file '/etc/default/grub.d/init-select.cfg'
Generating grub configuration file ...
Found linux image: /boot/vmlinuz-6.4.1
Found initrd image: /boot/initrd.img-6.4.1
Found linux image: /boot/vmlinuz-6.2.0-34-generic
Found initrd image: /boot/initrd.img-6.2.0-34-generic
Found linux image: /boot/vmlinuz-6.2.0-26-generic
Found initrd image: /boot/initrd.img-6.2.0-26-generic
Found memtest86+ image: /boot/memtest86+.elf
Found memtest86+ image: /boot/memtest86+.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

```

E. THAY ĐỔI FILE CÁU HÌNH GRUB (GRUB CONFIGURATION FILE)

Thay đổi file cấu hình grub:

Khoa Công nghệ thông tin

GV: Lâm Nhựt Khang

nano /etc/default/grub

```
GNU nano 6.2 /etc/default/grub
# If you change this file, run 'update-grub' afterwards to update
# /boot/grub/grub.cfg.
# For full documentation of the options in this file, see:
#   info -f grub -n 'Simple configuration'

GRUB_DEFAULT=0
GRUB_TIMEOUT_STYLE=hidden
GRUB_TIMEOUT=0
GRUB_DISTRIBUTOR=`lsb_release -i -s 2> /dev/null || echo Debian`
GRUB_CMDLINE_LINUX_DEFAULT="quiet splash"
GRUB_CMDLINE_LINUX=""

# Uncomment to enable BadRAM filtering, modify to suit your needs
# This works with Linux (no patch required) and with any kernel that obtains
# the memory map information from GRUB (GNU Mach, kernel of FreeBSD ...)
#GRUB_BADRAM="0x01234567,0xfefefefe,0x89abcdef,0xefefefef"

# Uncomment to disable graphical terminal (grub-pc only)
#GRUB_TERMINAL=console

# The resolution used on graphical terminal
# note that you can use only modes which your graphic card supports via VBE
# you can see them in real GRUB with the command 'vbeinfo'
#GRUB_GFXMODE=640x480

# Uncomment if you don't want GRUB to pass "root=UUID=xxx" parameter to Linux
#GRUB_DISABLE_LINUX_UUID=true

# Uncomment to disable generation of recovery mode menu entries
#GRUB_DISABLE_RECOVERY="true"

# Uncomment to get a beep at grub start
#GRUB_INIT_TUNE="480 440 1"

[ Read 33 lines ]
```

Thực hiện các thay đổi sau:

GRUB_DEFAULT=0

GRUB_TIMEOUT=25

```
GNU nano 6.2 /etc/de
# If you change this file, run 'update-grub' afterwards to update
# /boot/grub/grub.cfg.
# For full documentation of the options in this file, see:
#   info -f grub -n 'Simple configuration'

GRUB_DEFAULT=0
GRUB_TIMEOUT_STYLE=hidden
GRUB_TIMEOUT=0
GRUB_DISTRIBUTOR=`lsb_release -i -s 2> /dev/null || echo Debian`
GRUB_CMDLINE_LINUX_DEFAULT="quiet splash"
GRUB_CMDLINE_LINUX=""
```

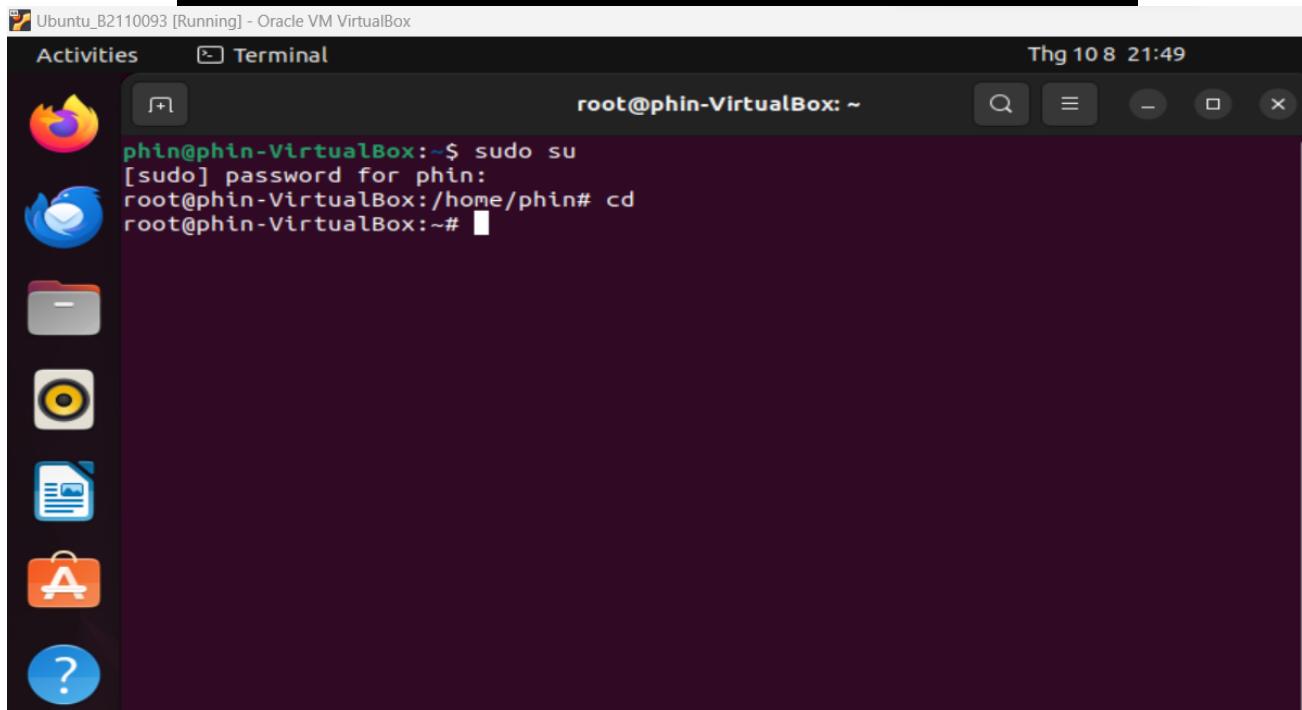
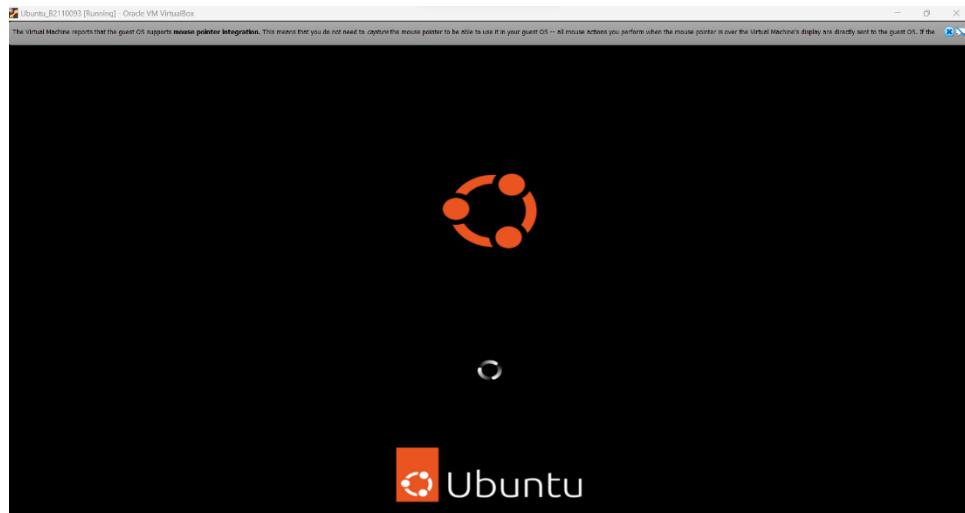
```
GNU nano 6.2
/etc/default/grub
# If you change this file, run 'update-grub' afterwards to update
# /boot/grub/grub.cfg.
# For full documentation of the options in this file, see:
#   info -f grub -n 'Simple configuration'

GRUB_DEFAULT=0
GRUB_TIMEOUT_STYLE=hidden
GRUB_TIMEOUT=25
GRUB_DISTRIBUTOR=`lsb_release -i -s 2> /dev/null || echo Debian`
GRUB_CMDLINE_LINUX_DEFAULT="quiet splash"
GRUB_CMDLINE_LINUX=""
```

F. REBOOT VM

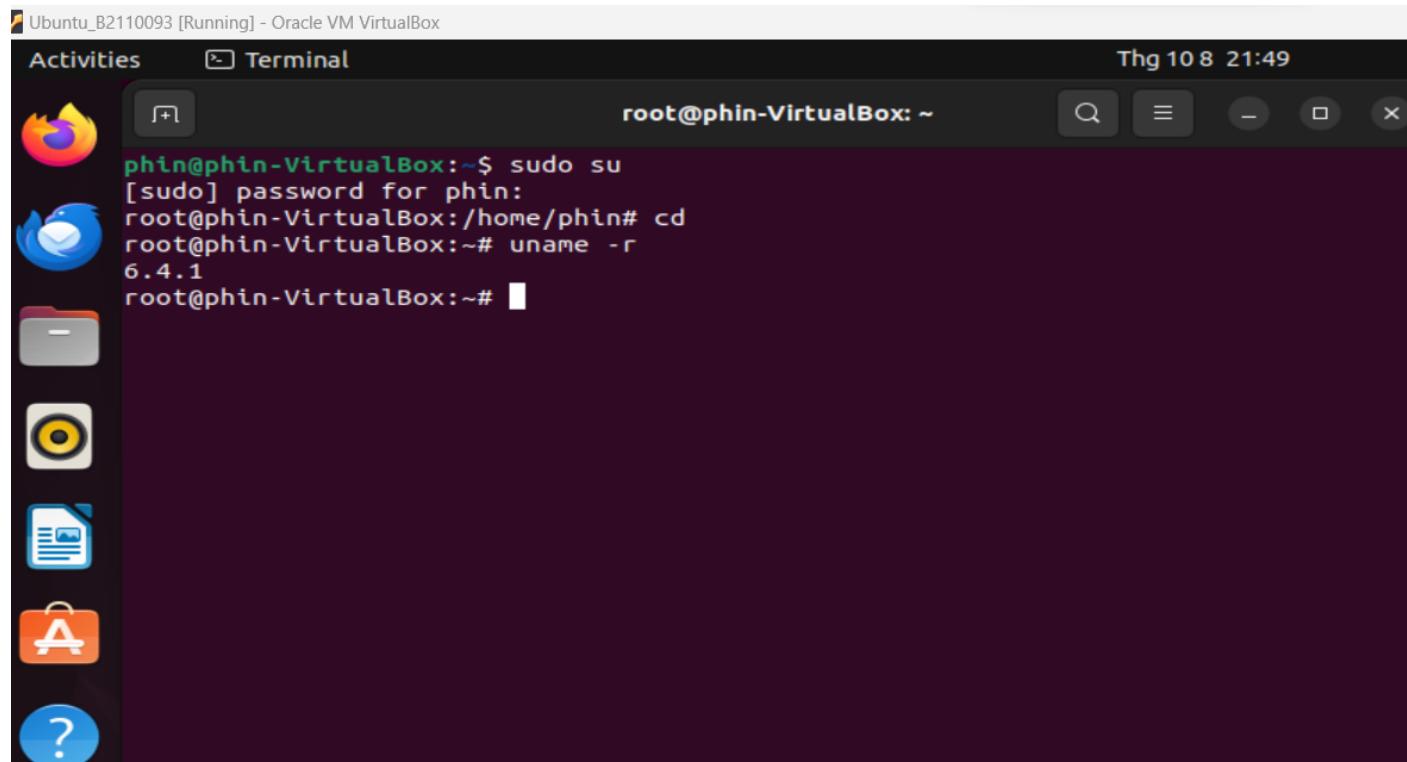
1. Reboot kernel mới:

reboot



2. Sau khi boot, kiểm tra thông tin kernel mới có đúng chưa:

uname -r



```
Ubuntu_B2110093 [Running] - Oracle VM VirtualBox
Activities Terminal root@phin-VirtualBox: ~ Thg 10 8 21:49
root@phin-VirtualBox:~$ sudo su
[sudo] password for phin:
root@phin-VirtualBox:/home/phin# cd
root@phin-VirtualBox:~# uname -r
6.4.1
root@phin-VirtualBox:~#
```

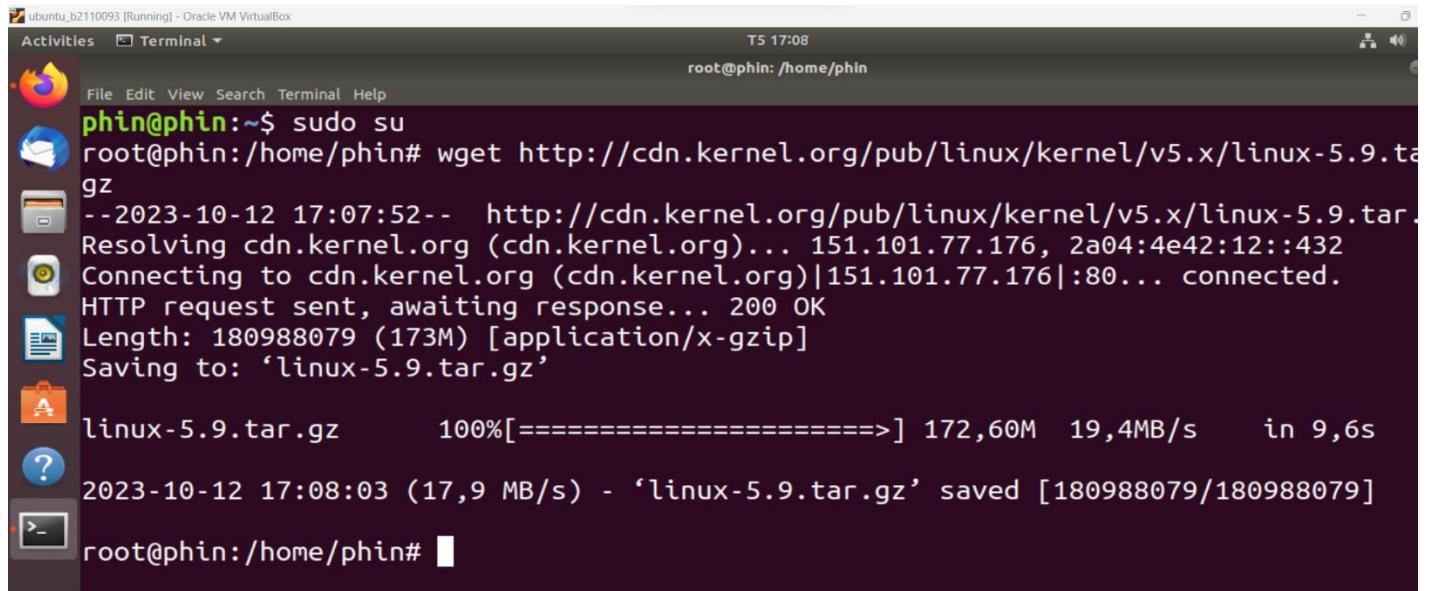
Kết quả sẽ có dạng: 6.4.1

PHẦN 2: THÊM LỜI GỌI HỆ THỐNG VÀO LINUX KERNEL

A. CHUẨN BỊ LINUX KERNEL CODE

1. Download kernel 5.9

```
# wget http://cdn.kernel.org/pub/linux/kernel/v5.x/linux-5.9.tar.gz
```



The screenshot shows a terminal window titled "ubuntu_b2110093 [Running] - Oracle VM VirtualBox". The command "sudo su" is run, followed by "wget http://cdn.kernel.org/pub/linux/kernel/v5.x/linux-5.9.tar.gz". The output shows the progress of the download, including the URL, resolution, connection details, HTTP request sent, response status (200 OK), file length (180988079 bytes or 173M), content type (application/x-gzip), and saving location ('linux-5.9.tar.gz'). The download completes at 17:08:03 with a speed of 17,9 MB/s, saving the file to the current directory.

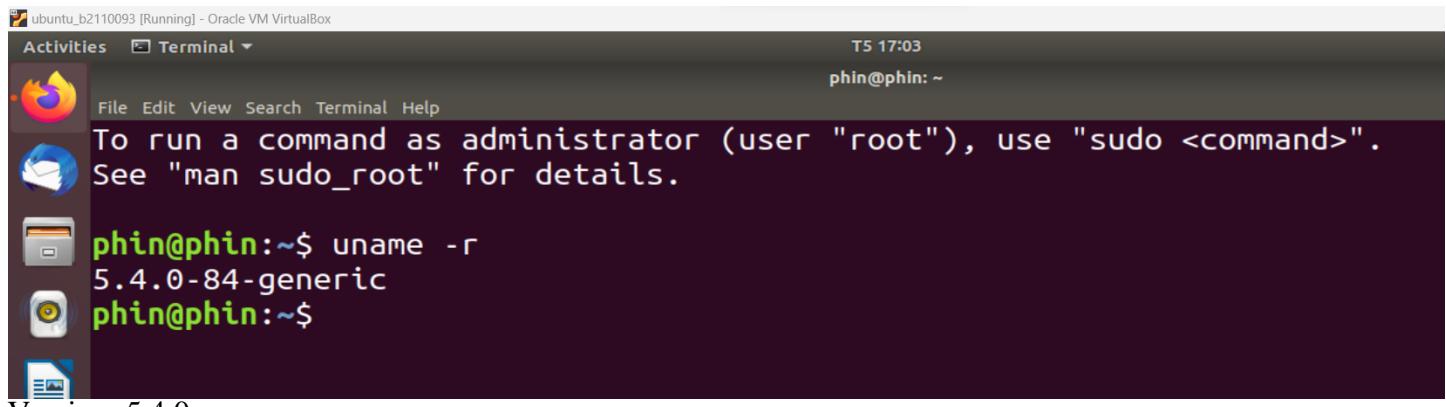
```
phin@phin:~$ sudo su
root@phin:/home/phin# wget http://cdn.kernel.org/pub/linux/kernel/v5.x/linux-5.9.tar.gz
--2023-10-12 17:07:52-- http://cdn.kernel.org/pub/linux/kernel/v5.x/linux-5.9.tar.gz
Resolving cdn.kernel.org (cdn.kernel.org)... 151.101.77.176, 2a04:4e42:12::432
Connecting to cdn.kernel.org (cdn.kernel.org)|151.101.77.176|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 180988079 (173M) [application/x-gzip]
Saving to: 'linux-5.9.tar.gz'

linux-5.9.tar.gz      100%[=====] 172,60M  19,4MB/s    in 9,6s

2023-10-12 17:08:03 (17,9 MB/s) - 'linux-5.9.tar.gz' saved [180988079/180988079]
root@phin:/home/phin#
```

2. Xác định phiên bản hiện tại của kernel:

```
# uname -r
```



The screenshot shows a terminal window titled "ubuntu_b2110093 [Running] - Oracle VM VirtualBox". It displays a warning message from the system about running commands as root. Below this, the command "uname -r" is run, showing the output "5.4.0-84-generic". The terminal prompt "phin@phin:~\$" is visible at the end.

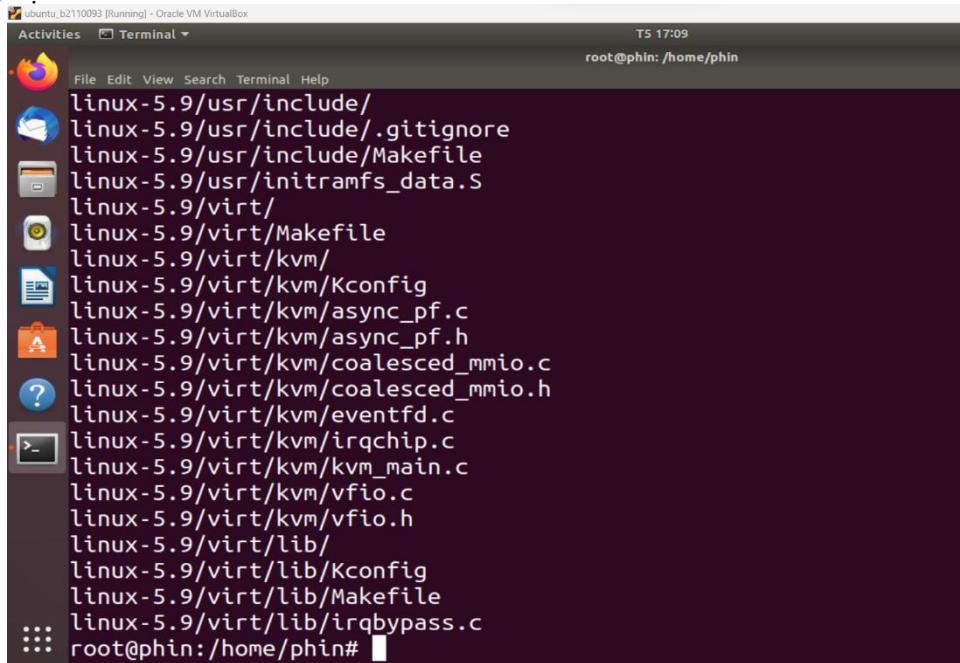
```
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

phin@phin:~$ uname -r
5.4.0-84-generic
phin@phin:~$
```

Version: 5.4.0

3. Giải nén file linux- 5.9

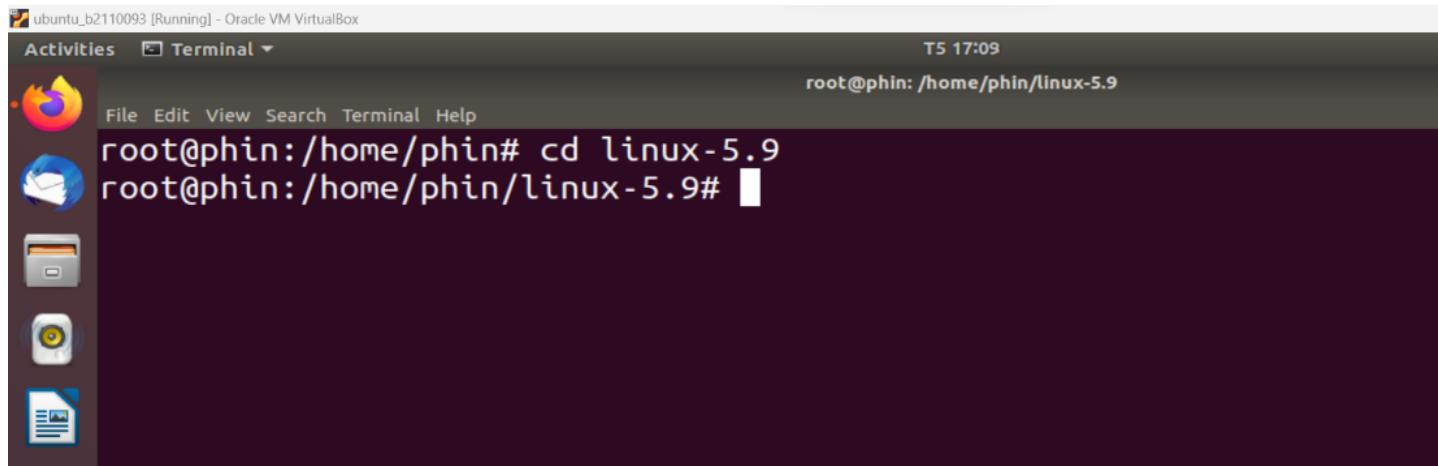
```
# tar xvzf linux-5.9.tar.gz
```



B. Thiết lập lời gọi hệ thống helloworld

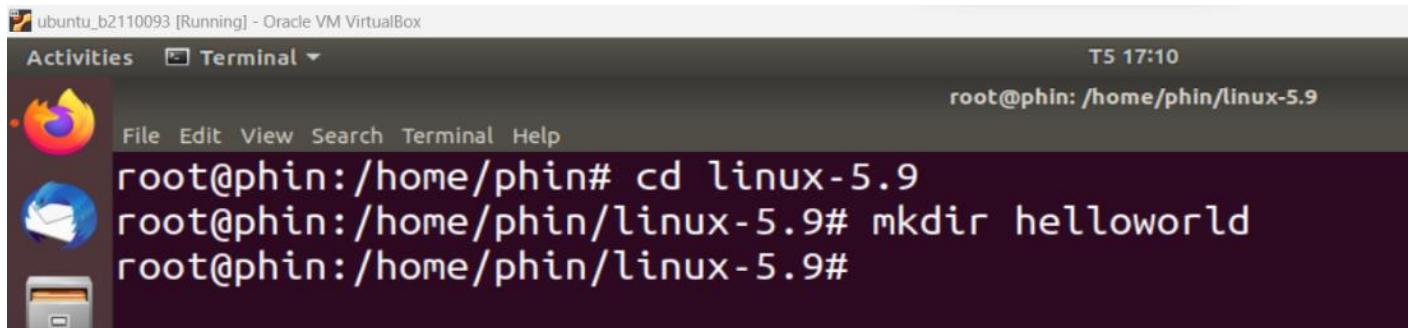
1. Chuyển đến thư mục linux-5.9 bằng lệnh:

```
# cd ~/linux-5.9
```



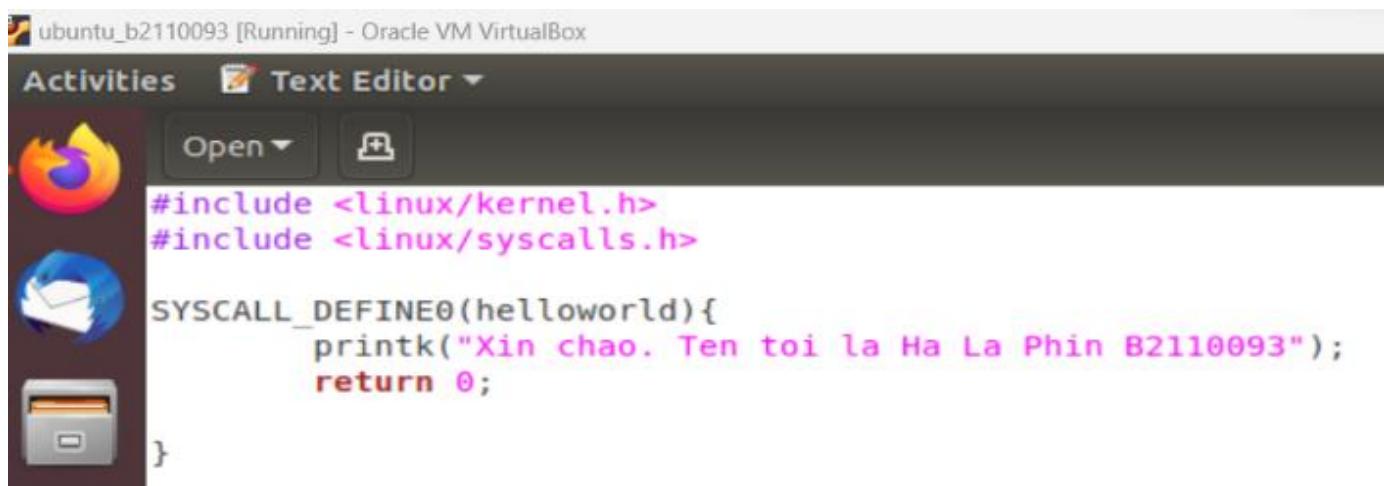
2. Tạo thư mục helloworld, trong thư mục này tạo 2 tệp helloworld.c và Makefile

```
# mkdir helloworld
```



Chèn đoạn code sau vào tệp helloworld.c:

```
#include <linux/kernel.h>
#include <linux/syscalls.h>
SYSCALL_DEFINE0(helloworld){
    printk("Xin chao. Ten toi la Ha La Phin B2110093");
    return 0;
}
```

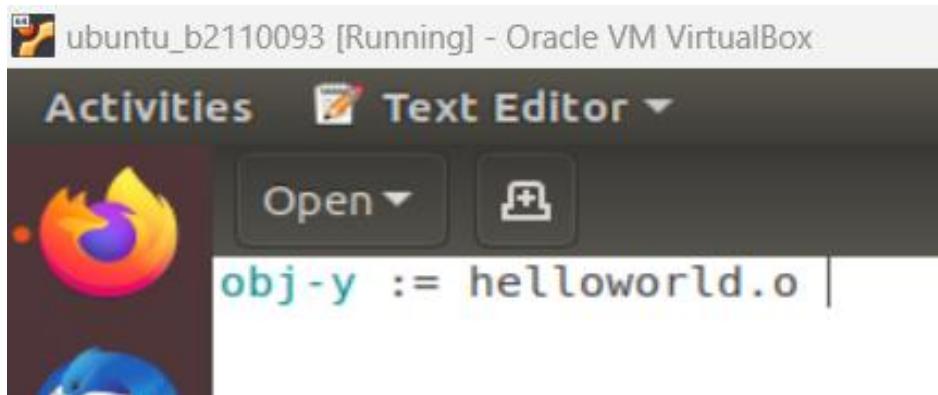


Sau đó lưu lại (Save) và thoát.

gedit helloworld/Makefile

Chèn đoạn code sau vào tệp Makefile:

obj-y := helloworld.o

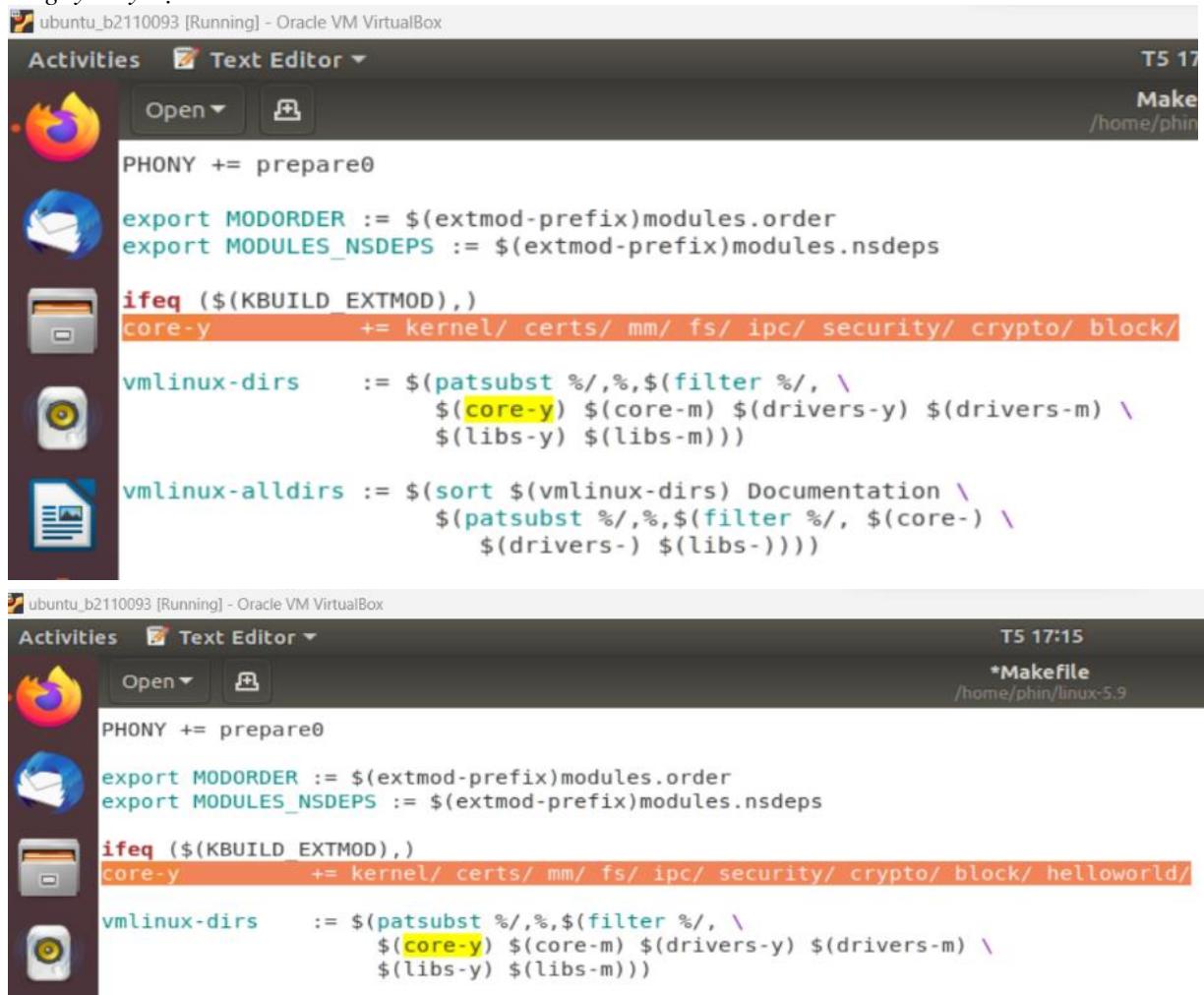


3. Thiết lập lời gọi hệ thống

#gedit Makefile

Tìm dòng : core-y += kernel/ certs/ mm/ fs/ ipc/ security/ crypto/ block

Sửa thành: core-y += kernel/ certs/ mm/ fs/ ipc/ security/ crypto/ block/ helloworld/



```

ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Text Editor T5 17
Makefile /home/phin

PHONY += prepare0

export MODORDER := $(extmod-prefix)modules.order
export MODULES_NSDEPS := $(extmod-prefix)modules.nsdeps

ifeq ($(KBUILD_EXTMOD),)
core-y += kernel/ certs/ mm/ fs/ ipc/ security/ crypto/ block/
vmlinux-dirs := $(patsubst %/,%,$(filter %/, \
$(core-y) $(core-m) $(drivers-y) $(drivers-m) \
$(libs-y) $(libs-m)))
vmlinux-alldirs := $(sort $(vmlinux-dirs) Documentation \
$(patsubst %/,%,$(filter %/, $(core-) \
$(drivers-) $(libs-))))

```



```

ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Text Editor T5 17:15
*Makefile
/home/phin/linux-5.9

PHONY += prepare0

export MODORDER := $(extmod-prefix)modules.order
export MODULES_NSDEPS := $(extmod-prefix)modules.nsdeps

ifeq ($(KBUILD_EXTMOD),)
core-y += kernel/ certs/ mm/ fs/ ipc/ security/ crypto/ block/ helloworld/
vmlinux-dirs := $(patsubst %/,%,$(filter %/, \
$(core-y) $(core-m) $(drivers-y) $(drivers-m) \
$(libs-y) $(libs-m)))

```

Sau đó lưu lại (Save) và thoát.

gedit include/linux/syscalls.h

Sau đó kéo xuống cuối tệp và chèn đoạn code sau vào:
asmlinkage long sys_helloworld(void);

```

    return do_sys_truncate(pathname, length);
}

static inline unsigned int ksys_personality(unsigned int personality)
{
    unsigned int old = current->personality;

    if (personality != 0xffffffff)
        set_personality(personality);

    return old;
}

/* for __ARCH_WANT_SYS_IPC */
long ksys_semtimedop(int semid, struct sembuf __user *tsops,
                     unsigned int nsops,
                     const struct __kernel_timespec __user *timeout);
long ksys_semget(key_t key, int nsems, int semflg);
long ksys_old_semctl(int semid, int semnum, int cmd, unsigned long arg);
long ksys_msgget(key_t key, int msgflg);
long ksys_old_msgrct(int msqid, int cmd, struct msqid_ds __user *buf);
long ksys_msgrcv(int msqid, struct msgbuf __user *msgp, size_t msgsz,
                 long msgtyp, int msgflg);
long ksys_msgsnd(int msqid, struct msgbuf __user *msgp, size_t msgsz,
                 int msgflg);
long ksys_shmget(key_t key, size_t size, int shmflg);
long ksys_shmdt(char __user *shmaddr);
long ksys_old_shmctl(int shmid, int cmd, struct shmid_ds __user *buf);
long compat_ksys_semtimedop(int semid, struct sembuf __user *tsems,
                            unsigned int nsops,
                            const struct old_timespec32 __user *timeout);

int __sys_getsockopt(int fd, int level, int optname, char __user *optval,
                     int __user *optlen);
int __sys_setsockopt(int fd, int level, int optname, char __user *optval,
                     int optlen);
asm linkage long sys_helloworld(void);
#endif

```

Sau đó lưu lại (Save) và thoát.

gedit arch/x86/entry/syscalls/syscall_64.tbl

Kéo xuống số 439 và chèn thêm dòng 440 như sau:

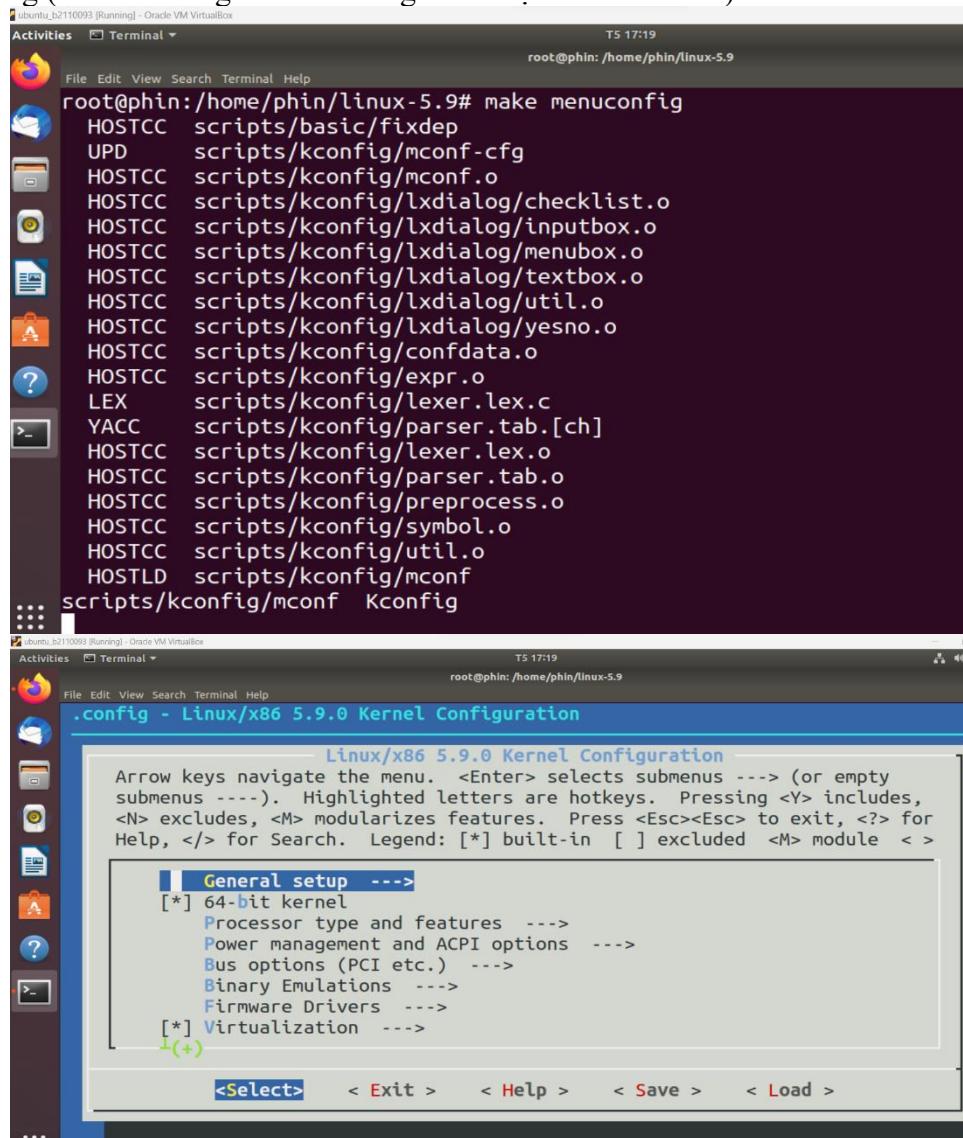
440 common helloworld sys_helloworld

Number	Type	Name	Kernel Function
331	common	pkey_free	sys_pkey_free
332	common	statx	sys_statx
333	common	io_pgetevents	sys_io_pgetevents
334	common	rseq	sys_rseq
# don't use numbers 387 through 423, add new calls after the last			
# 'common' entry			
424	common	pidfd_send_signal	sys_pidfd_send_signal
425	common	io_uring_setup	sys_io_uring_setup
426	common	io_uring_enter	sys_io_uring_enter
427	common	io_uring_register	sys_io_uring_register
428	common	open_tree	sys_open_tree
429	common	move_mount	sys_move_mount
430	common	fsopen	sys_fsopen
431	common	fsconfig	sys_fsconfig
432	common	fsmount	sys_fsmount
433	common	fspick	sys_fspick
434	common	pidfd_open	sys_pidfd_open
435	common	clone3	sys_clone3
436	common	close_range	sys_close_range
437	common	openat2	sys_openat2
438	common	pidfd_getfd	sys_pidfd_getfd
439	common	faccessat2	sys_faccessat2
440	common	helloworld	sys_helloworld

C. CẤU HÌNH KERNEL MỚI

1. Tạo file cấu hình (config file):

```
# make menuconfig (đảm bảo rằng terminal đang ở chế độ toàn màn hình)
```



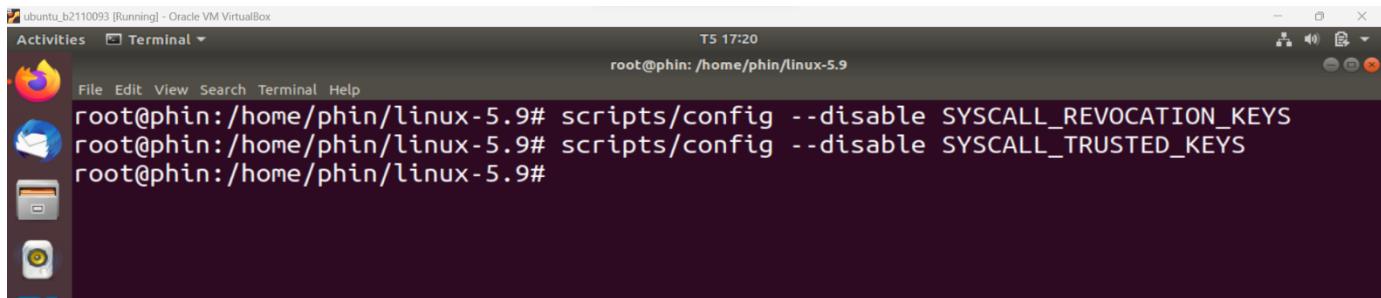
Save lại và thoát ra

Vô hiệu hóa tính năng thu hồi lỗi gọi hệ thống của kernel:

```
# scripts/config --disable SYSCALL_REVOCATION_KEYS
```

Vô hiệu hóa tính năng xác thực và quản lý khóa an toàn trong kernel:

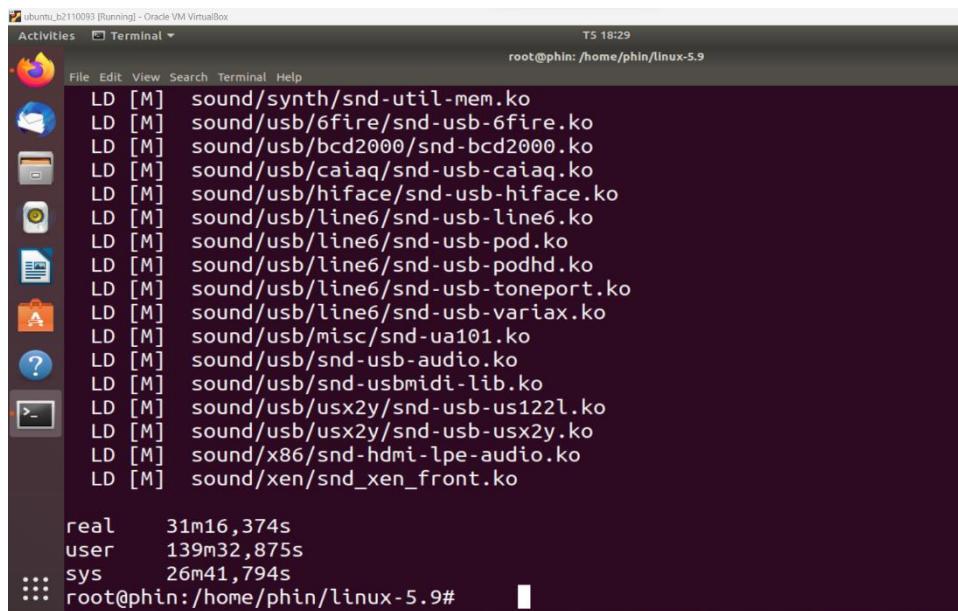
```
# scripts/config --disable SYSCALL_TRUSTED_KEYS
```



D. BIÊN DỊCH KERNEL

1. Tại ~/linux-5.9, tạo kernel image nén (compressed kernel image)

make -j6 (ở đây em dùng # time make -j6 để kiểm tra thời gian chạy của lệnh)

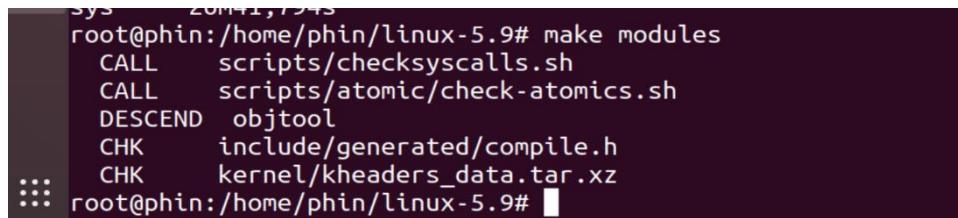


```
ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Terminal T5 18:29
root@phin: /home/phin/linux-5.9#
File Edit View Search Terminal Help
LD [M] sound/synth/snd-util-mem.ko
LD [M] sound/usb/6fire/snd-usb-6fire.ko
LD [M] sound/usb/bcd2000/snd-bcd2000.ko
LD [M] sound/usb/caiaq/snd-usb-caiaq.ko
LD [M] sound/usb/hiface/snd-usb-hiface.ko
LD [M] sound/usb/line6/snd-usb-line6.ko
LD [M] sound/usb/line6/snd-usb-pod.ko
LD [M] sound/usb/line6/snd-usb-podhd.ko
LD [M] sound/usb/line6/snd-usb-toneport.ko
LD [M] sound/usb/line6/snd-usb-variak.ko
LD [M] sound/usb/misc/snd-ua101.ko
LD [M] sound/usb/snd-usb-audio.ko
LD [M] sound/usb/snd-usbmidi-lib.ko
LD [M] sound/usb/usx2y/snd-usb-us122l.ko
LD [M] sound/usb/usx2y/snd-usb-usx2y.ko
LD [M] sound/x86/snd-hdmi-lpe-audio.ko
LD [M] sound/xen/snd_xen_front.ko

real    31m16.374s
user    139m32.875s
sys     26m41.794s
root@phin:/home/phin/linux-5.9#
```

2. Biên dịch kernel modules:

make modules

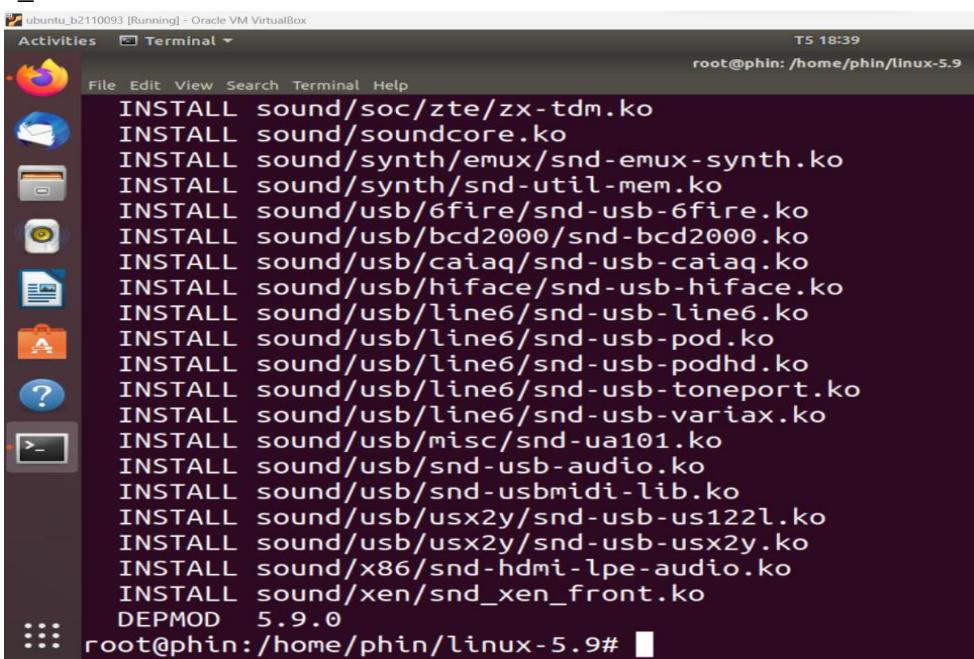


```
ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Terminal T5 18:39
root@phin: /home/phin/linux-5.9#
File Edit View Search Terminal Help
Sys      26m41.794s
root@phin:/home/phin/linux-5.9# make modules
CALL    scripts/checksyscalls.sh
CALL    scripts/atomic/check-atomics.sh
DESCEND objtool
CHK     include/generated/compile.h
CHK     kernel/kheaders_data.tar.xz
root@phin:/home/phin/linux-5.9#
```

E. CÀI ĐẶT KERNEL

1. Cài đặt kernel modules

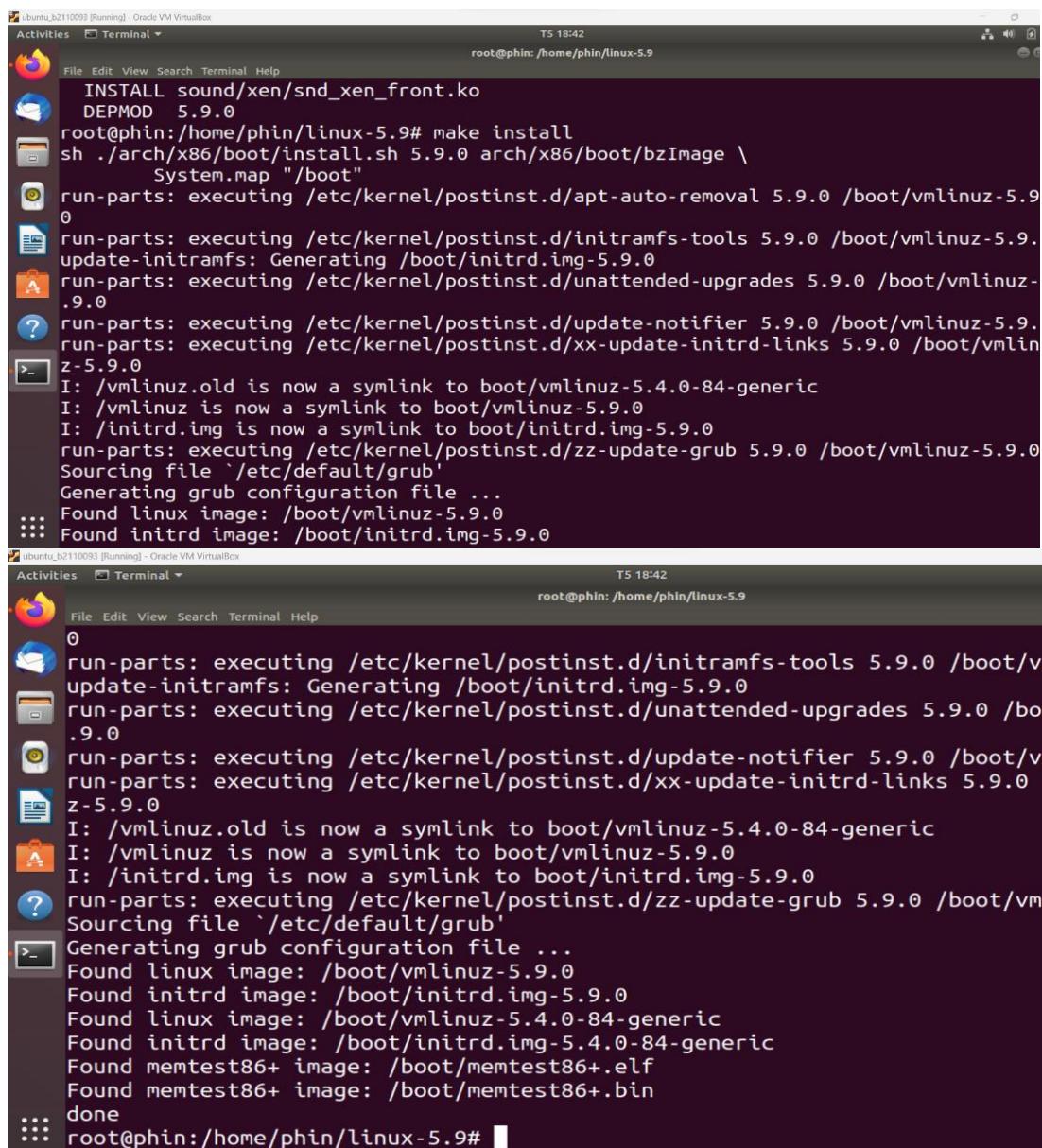
make modules_install



```
ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Terminal T5 18:39
root@phin: /home/phin/linux-5.9#
File Edit View Search Terminal Help
INSTALL sound/soc/zte/zx-tdm.ko
INSTALL sound/soundcore.ko
INSTALL sound/synth/emux/snd-emux-synth.ko
INSTALL sound/synth/snd-util-mem.ko
INSTALL sound/usb/6fire/snd-usb-6fire.ko
INSTALL sound/usb/bcd2000/snd-bcd2000.ko
INSTALL sound/usb/caiaq/snd-usb-caiaq.ko
INSTALL sound/usb/hiface/snd-usb-hiface.ko
INSTALL sound/usb/line6/snd-usb-line6.ko
INSTALL sound/usb/line6/snd-usb-pod.ko
INSTALL sound/usb/line6/snd-usb-podhd.ko
INSTALL sound/usb/line6/snd-usb-toneport.ko
INSTALL sound/usb/line6/snd-usb-variak.ko
INSTALL sound/usb/misc/snd-ua101.ko
INSTALL sound/usb/snd-usb-audio.ko
INSTALL sound/usb/snd-usbmidi-lib.ko
INSTALL sound/usb/usx2y/snd-usb-us122l.ko
INSTALL sound/usb/usx2y/snd-usb-usx2y.ko
INSTALL sound/x86/snd-hdmi-lpe-audio.ko
INSTALL sound/xen/snd_xen_front.ko
DEPMOD 5.9.0
root@phin:/home/phin/linux-5.9#
```

2. Cài đặt kernel

make install



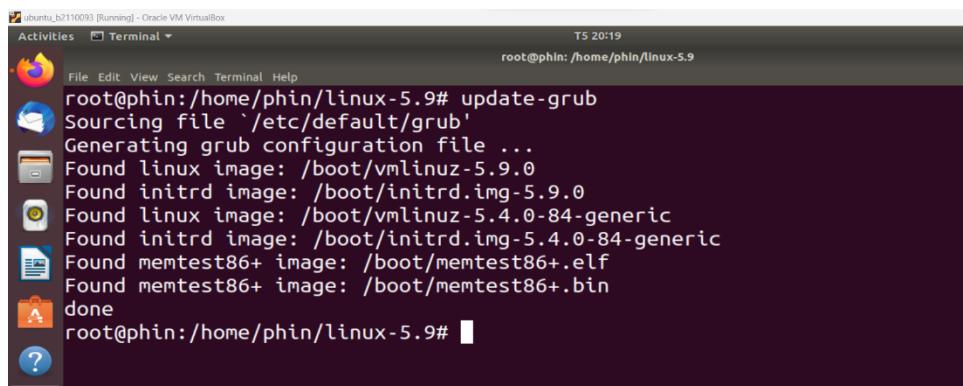
```

ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Terminal T5 18:42
root@phin:/home/phin/linux-5.9#
root@phin:/home/phin/linux-5.9# make install
DEPMOD 5.9.0
root@phin:/home/phin/linux-5.9# sh ./arch/x86/boot/install.sh 5.9.0 arch/x86/boot/bzImage \
System.map "/boot"
run-parts: executing /etc/kernel/postinst.d/apt-auto-removal 5.9.0 /boot/vmlinuz-5.9.0
run-parts: executing /etc/kernel/postinst.d/initramfs-tools 5.9.0 /boot/vmlinuz-5.9.0
update-initramfs: Generating /boot/initrd.img-5.9.0
run-parts: executing /etc/kernel/postinst.d/unattended-upgrades 5.9.0 /boot/vmlinuz-5.9.0
run-parts: executing /etc/kernel/postinst.d/update-notifier 5.9.0 /boot/vmlinuz-5.9.0
run-parts: executing /etc/kernel/postinst.d/xx-update-initrd-links 5.9.0 /boot/vmlinuz-5.9.0
I: /vmlinuz.old is now a symlink to boot/vmlinuz-5.4.0-84-generic
I: /vmlinuz is now a symlink to boot/vmlinuz-5.9.0
I: /initrd.img is now a symlink to boot/initrd.img-5.9.0
run-parts: executing /etc/kernel/postinst.d/zz-update-grub 5.9.0 /boot/vmlinuz-5.9.0
Sourcing file `/etc/default/grub'
Generating grub configuration file ...
Found linux image: /boot/vmlinuz-5.9.0
Found initrd image: /boot/initrd.img-5.9.0
ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Terminal T5 18:42
root@phin:/home/phin/linux-5.9#
root@phin:/home/phin/linux-5.9# 0
run-parts: executing /etc/kernel/postinst.d/initramfs-tools 5.9.0 /boot/vmlinuz-5.9.0
update-initramfs: Generating /boot/initrd.img-5.9.0
run-parts: executing /etc/kernel/postinst.d/unattended-upgrades 5.9.0 /boot/vmlinuz-5.9.0
run-parts: executing /etc/kernel/postinst.d/update-notifier 5.9.0 /boot/vmlinuz-5.9.0
run-parts: executing /etc/kernel/postinst.d/xx-update-initrd-links 5.9.0 /boot/vmlinuz-5.9.0
I: /vmlinuz.old is now a symlink to boot/vmlinuz-5.4.0-84-generic
I: /vmlinuz is now a symlink to boot/vmlinuz-5.9.0
I: /initrd.img is now a symlink to boot/initrd.img-5.9.0
run-parts: executing /etc/kernel/postinst.d/zz-update-grub 5.9.0 /boot/vmlinuz-5.9.0
Sourcing file `/etc/default/grub'
Generating grub configuration file ...
Found linux image: /boot/vmlinuz-5.9.0
Found initrd image: /boot/initrd.img-5.9.0
Found linux image: /boot/vmlinuz-5.4.0-84-generic
Found initrd image: /boot/initrd.img-5.4.0-84-generic
Found memtest86+ image: /boot/memtest86+.elf
Found memtest86+ image: /boot/memtest86+.bin
done
root@phin:/home/phin/linux-5.9# 

```

Cập nhật lại file grub:

update-grub



```

ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Terminal T5 20:19
root@phin:/home/phin/linux-5.9#
root@phin:/home/phin/linux-5.9# update-grub
Sourcing file `/etc/default/grub'
Generating grub configuration file ...
Found linux image: /boot/vmlinuz-5.9.0
Found initrd image: /boot/initrd.img-5.9.0
Found linux image: /boot/vmlinuz-5.4.0-84-generic
Found initrd image: /boot/initrd.img-5.4.0-84-generic
Found memtest86+ image: /boot/memtest86+.elf
Found memtest86+ image: /boot/memtest86+.bin
done
root@phin:/home/phin/linux-5.9# 

```

F. REBOOT VM

1. Reboot kernel mới:

reboot

Kiểm tra phiên bản:

uname -r

```
ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Terminal
File Edit View Search Terminal Help
phin@phin:~$ uname -r
5.9.0
phin@phin:~$
```

G. GỌI LỜI GỌI HỆ THỐNG

Tạo một tệp sử dụng lệnh lời gọi hệ thống.

\$ gedit test.c

```
ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Terminal
File Edit View Search Terminal Help
phin@phin:~$ uname -r
5.9.0
phin@phin:~$ gedit test.c
phin@phin:~$
```

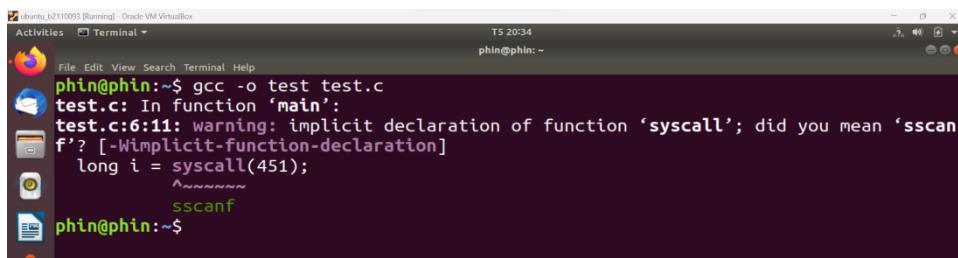
Chèn đoạn code sau vào tệp:

```
#include <linux/kernel.h>
#include <sys/syscall.h>
#include<stdio.h>
int main(){
    long i = syscall(440);
    printf("system call return: %ld\n",i);
    return 0;
}
```

```
Activities Text Editor
Open
#include <linux/kernel.h>
#include <sys/syscall.h>
#include <stdio.h>

int main(){
    long i = syscall(440);
    printf("system call return: %ld\n",i);
    return 0;
}
```

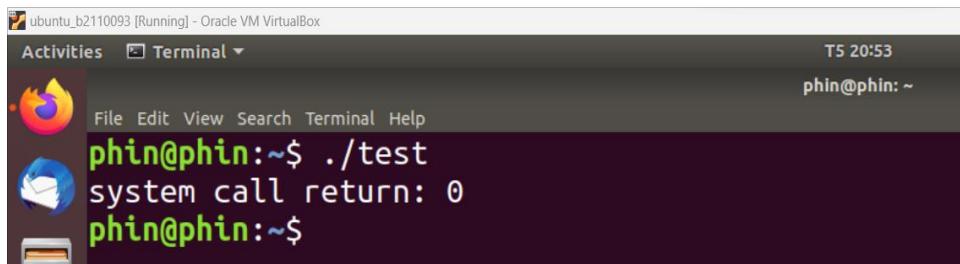
Biên dịch chương trình test.c từ mã nguồn C và tạo tệp thực thi test:
\$ gcc -o test test.c



```
ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Terminal T5 20:34
phin@phin:~$ gcc -o test test.c
test.c: In function 'main':
test.c:6:11: warning: implicit declaration of function 'syscall'; did you mean 'sscanf'
   long i = syscall(451);
           ^
           sscanf
phin@phin:~$
```

Thực thi tệp test:

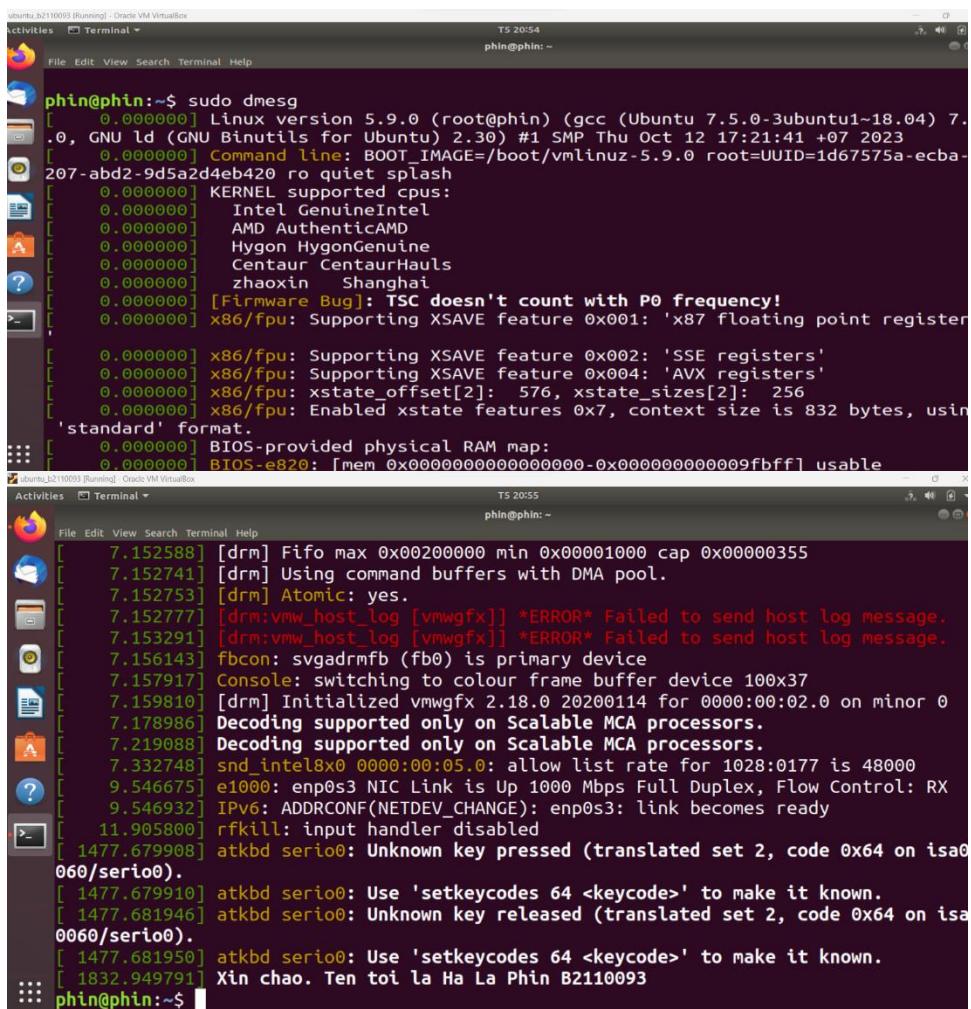
./test



```
ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Terminal T5 20:53
phin@phin:~$ ./test
system call return: 0
phin@phin:~$
```

Giá trị trả về là 0 tức là lời gọi hệ thống đã thực hiện được. Để xem và đọc thông điệp hệ thống (system logs) từ kernel và các modules liên quan ta dùng lệnh sau:

sudo dmesg



```
ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Terminal T5 20:54
phin@phin:~$ sudo dmesg
[    0.000000] Linux version 5.9.0 (root@phin) (gcc (Ubuntu 7.5.0-3ubuntu1~18.04) 7.0.0, GNU ld (GNU Binutils for Ubuntu) 2.30) #1 SMP Thu Oct 12 17:21:41 +07 2023
[    0.000000] Command line: BOOT_IMAGE=/boot/vmlinuz-5.9.0 root=UUID=id67575a-ecba-207-abd2-9d5a2d4eb420 ro quiet splash
[    0.000000] KERNEL supported cpus:
[    0.000000]   Intel GenuineIntel
[    0.000000]   AMD AuthenticAMD
[    0.000000]   Hygon HygonGenuine
[    0.000000]   Centaur CentaurHauls
[    0.000000]   zhaoxin Shanghai
[    0.000000] [Firmware Bug]: TSC doesn't count with P0 frequency!
[    0.000000] x86/fpu: Supporting XSAVE feature 0x001: 'x87 floating point register'
[    0.000000] x86/fpu: Supporting XSAVE feature 0x002: 'SSE registers'
[    0.000000] x86/fpu: Supporting XSAVE feature 0x004: 'AVX registers'
[    0.000000] x86/fpu: xstate_offset[2]: 576, xstate_sizes[2]: 256
[    0.000000] x86/fpu: Enabled xstate features 0x7, context size is 832 bytes, using 'standard' format.
[    0.000000] BIOS-provided physical RAM map:
[    0.000000] BIOS-e820: [mem 0x0000000000000000-0x0000000000009fbff] usable
[    0.000000] BIOS-e820: [mem 0x0000000000000000-0x0000000000009fbff] usable
Activities Terminal T5 20:55
phin@phin:~$ [  1.152588] [drm] Fifo max 0x00200000 min 0x00001000 cap 0x00000355
[  1.152741] [drm] Using command buffers with DMA pool.
[  1.152753] [drm] Atomic: yes.
[  1.152777] [drm:vmw_host_log [vmwgfx]] *ERROR* Failed to send host log message.
[  1.153291] [drm:vmw_host_log [vmwgfx]] *ERROR* Failed to send host log message.
[  1.156143] fbcon: svgadrmfb (fb0) is primary device
[  1.157917] Console: switching to colour frame buffer device 100x37
[  1.159810] [drm] Initialized vmwgfx 2.18.0 20200114 for 0000:00:02.0 on minor 0
[  1.178986] Decoding supported only on Scalable MCA processors.
[  1.219088] Decoding supported only on Scalable MCA processors.
[  1.332748] snd_intel8x0 0000:00:05.0: allow list rate for 1028:0177 is 48000
[  1.546675] e1000: enp0s3 NIC Link is Up 1000 Mbps Full Duplex, Flow Control: RX
[  1.546932] IPv6: ADDRCONF(NETDEV_CHANGE): enp0s3: link becomes ready
[  1.905800] rfkill: input handler disabled
[ 1477.679908] atkbd serio0: Unknown key pressed (translated set 2, code 0x64 on isa0060/serio0).
[ 1477.679910] atkbd serio0: Use 'setkeycodes 64 <keycode>' to make it known.
[ 1477.681946] atkbd serio0: Unknown key released (translated set 2, code 0x64 on isa0060/serio0).
[ 1477.681950] atkbd serio0: Use 'setkeycodes 64 <keycode>' to make it known.
[ 1832.949791] Xin chao. Ten toi la Ha La Phin B2110093
phin@phin:~$
```

PHẦN 3: CẤP PHÁT VÙNG NHỚ

Anh chị hãy cài đặt 3 thuật toán cấp phát vùng nhớ (First-fit, Best-Fit, Worst-Fit) cho tiến trình, đưa ví dụ cụ thể để test kết quả thực hiện.

Tạo tệp baitap.c:

```
# gedit baitap.c
```

Chèn đoạn code

```
#include
```

```
// Hàm sao chép mảng A sang mảng B
```

```
void makeCopyArray(int A[], int B[], int size) {
```

```
    int i;
```

```
    for (i = 0; i < size; i++) {
```

```
        B[i] = A[i];
```

```
    }
```

```
}
```

```
// Thuật toán First Fit
```

```
void firstFit(int partitionInput[], int m, int processInput[], int n) {
```

```
    int i, j;
```

```
    int partition[m], process[n];
```

```
    // Sao chép mảng đầu vào vào mảng tạm thời
```

```
    makeCopyArray(partitionInput, partition, m);
```

```
    makeCopyArray(processInput, process, n);
```

```
    int allocation[n];
```

```
    for (i = 0; i < n; i++) {
```

```
        allocation[i] = -1; }
```

```
    for (i = 0; i < n; i++) {
```

```
        for (j = 0; j < m; j++) {
```

```
            if (partition[j] >= process[i]) {
```

```
                allocation[i] = j; partition[j] -= process[i]; break;
```

```
}
```

```
}
```

```
}
```

```
// In ra kết quả
```

```
printf("\nProcess No.\tProcess Size\t\tPartition no.\n");
```

```
for (int i = 0; i < n; i++) {
```

```
    printf(" %i\t\t", i + 1);
```

```
    printf("%i\t\t\t", process[i]);
```

```
    if (allocation[i] != -1)
```

```
        printf("%i", allocation[i] + 1);
```

```
    else
```

```
        printf("Not Allocated");
```

```
        printf("\n");
```

```
}
```

```
}
```

```
// Thuật toán Best Fit
```

```
void bestFit(int partitionInput[], int m, int processInput[], int n) {
```

```
    int i, j; int partition[m], process[n];
```

```
    // Sao chép mảng đầu vào vào mảng tạm thời
```

```
    makeCopyArray(partitionInput, partition, m);
```

```
    makeCopyArray(processInput, process, n);
```

```
    int allocation[n];
```

```
    for (i = 0; i < n; i++) {
```

```

        allocation[i] = -1; }
    for (i = 0; i < n; i++) {
        int bestIndex = -1;
        for (j = 0; j < m; j++) {
            if (partition[j] >= process[i]) {
                if (bestIndex == -1)
                    bestIndex = j;
                else
                    if (partition[bestIndex] > partition[j])
                        bestIndex = j;
            }
        }
        if (bestIndex != -1) {
            allocation[i] = bestIndex;
            partition[bestIndex] -= process[i];
        }
    }

// In ra kết quả
printf("\nProcess No.\tProcess Size\t\tPartition no.\n");
for (int i = 0; i < n; i++) {
    printf(" %i\t\t", i + 1);
    printf("%i\t\t", process[i]);
    if (allocation[i] != -1)
        printf("%i", allocation[i] + 1);
    else
        printf("Not Allocated");
    printf("\n");
}
}

// Thuật toán Worst Fit
void worstFit(int partitionInput[], int m, int processInput[], int n) {
    int i, j; int partition[m], process[n];
// Sao chép mảng đầu vào vào mảng tạm thời
    makeCopyArray(partitionInput, partition, m);
    makeCopyArray(processInput, process, n);
    int allocation[n];
    for (i = 0; i < n; i++) {
        allocation[i] = -1;
    }
    for (i = 0; i < n; i++) {
        int worstIndex = -1;
        for (j = 0; j < m; j++) {
            if (partition[j] >= process[i]) {
                if (worstIndex == -1) worstIndex = j;
                else
                    if (partition[worstIndex] < partition[j]) worstIndex = j;
            }
        }
        if (worstIndex != -1) {
            allocation[i] = worstIndex;
            partition[worstIndex] -= process[i];
        }
    }
}

```

```

// In ra kết quả
printf("\nProcess No.\tProcess Size\t\tPartition no.\n");
for (int i = 0; i < n; i++) {
    printf(" %i\t\t", i + 1);
    printf("%i\t\t", process[i]);
    if (allocation[i] != -1)
        printf("%i", allocation[i] + 1);
    else
        printf("Not Allocated"); printf("\n");
}
}

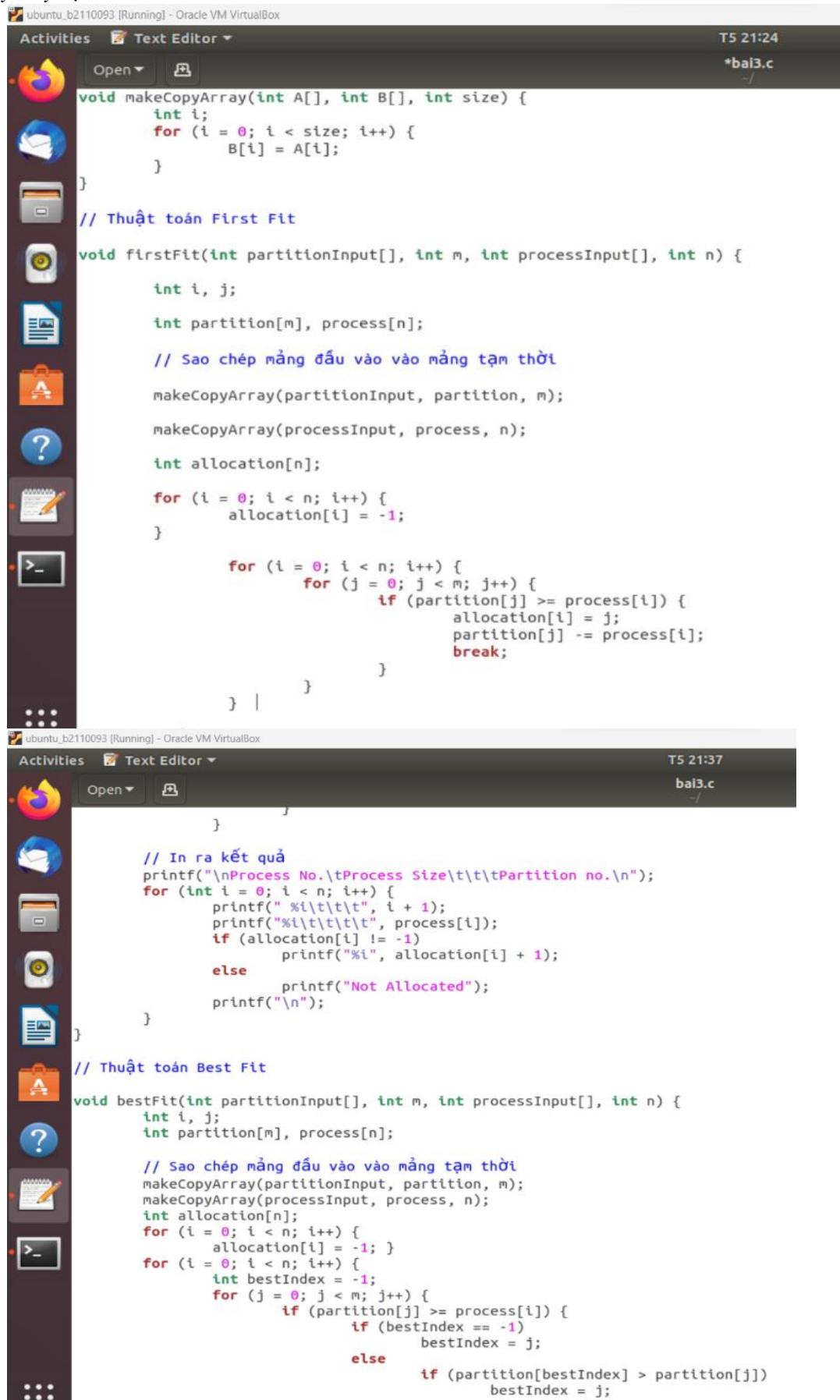
int main() {
    int m, n;
    int i;
    printf("Enter number of partitions: ");
    scanf("%d", &n);
    int partition[n];
    printf("Enter list of partition sizes: ");
    for (i = 0; i < n; i++) {
        scanf("%d", &partition[i]);
    }
    printf("Enter number of processes: ");
    scanf("%d", &m);
    int process[m];
    printf("Enter list of process sizes: ");
    for (i = 0; i < m; i++) {
        scanf("%d", &process[i]);
    }
    printf("\n\n\t---- FIRST FIT ALGORITHM ----\n");
    firstFit(partition, n, process, m);

    printf("\n\n\t---- BEST FIT ALGORITHM ----\n");
    bestFit(partition, n, process, m);

    printf("\n\n\t---- WORST FIT ALGORITHM ----\n");
    worstFit(partition, n, process, m);

    return 0;
}

```



```

ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Text Editor T5 21:24
*bai3.c
void makeCopyArray(int A[], int B[], int size) {
    int i;
    for (i = 0; i < size; i++) {
        B[i] = A[i];
    }
}

// Thuật toán First Fit

void firstFit(int partitionInput[], int m, int processInput[], int n) {
    int i, j;
    int partition[m], process[n];
    // Sao chép mảng đầu vào vào mảng tạm thời
    makeCopyArray(partitionInput, partition, m);
    makeCopyArray(processInput, process, n);
    int allocation[n];
    for (i = 0; i < n; i++) {
        allocation[i] = -1;
    }

    for (i = 0; i < n; i++) {
        for (j = 0; j < m; j++) {
            if (partition[j] >= process[i]) {
                allocation[i] = j;
                partition[j] -= process[i];
                break;
            }
        }
    }
}

```



```

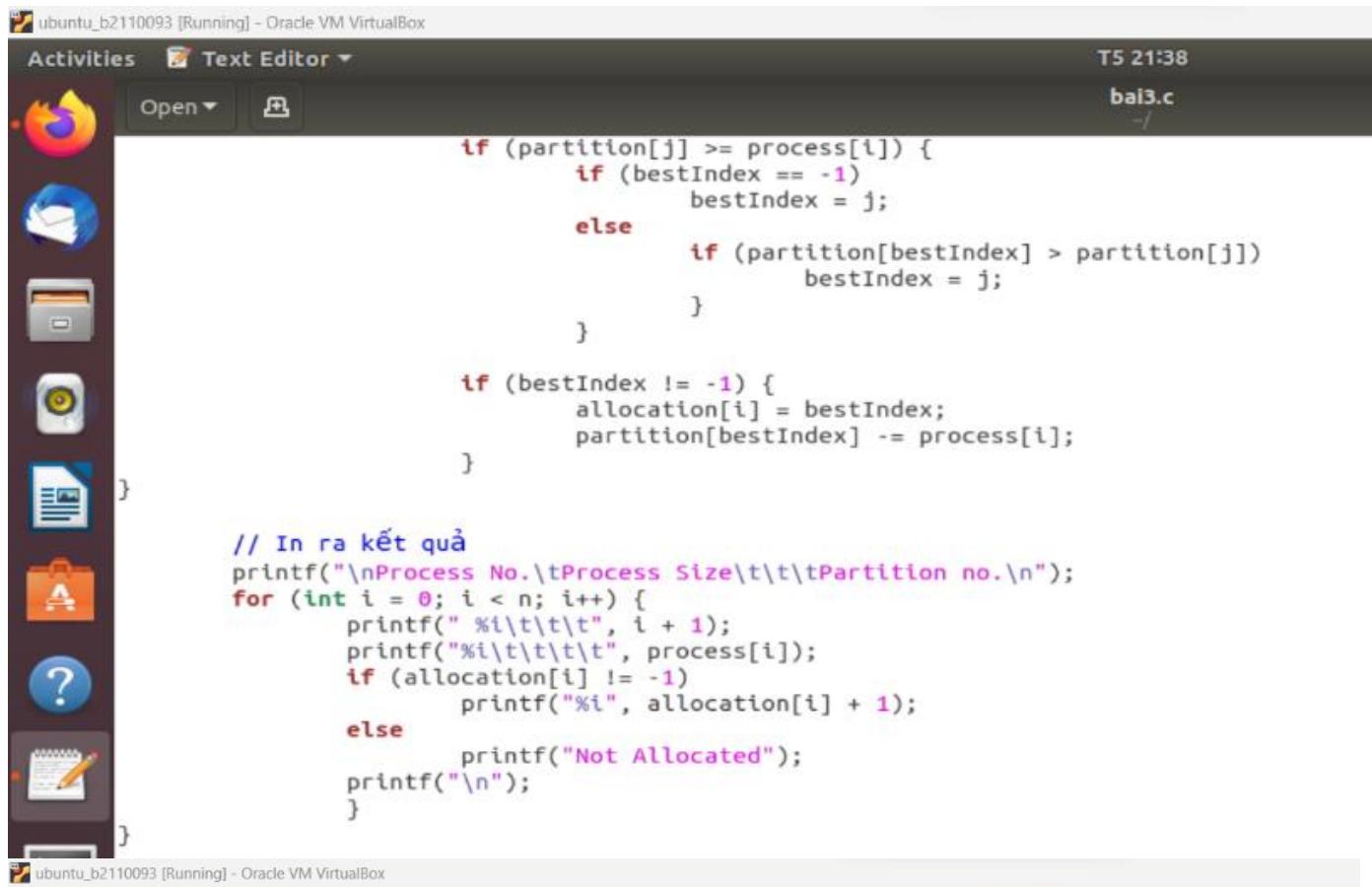
ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Text Editor T5 21:37
bai3.c
}

// In ra kết quả
printf("\nProcess No.\tProcess Size\t\tPartition no.\n");
for (int i = 0; i < n; i++) {
    printf(" %i\t\t", i + 1);
    printf("%i\t\t", process[i]);
    if (allocation[i] != -1)
        printf("%i", allocation[i] + 1);
    else
        printf("Not Allocated");
    printf("\n");
}

// Thuật toán Best Fit

void bestFit(int partitionInput[], int m, int processInput[], int n) {
    int i, j;
    int partition[m], process[n];
    // Sao chép mảng đầu vào vào mảng tạm thời
    makeCopyArray(partitionInput, partition, m);
    makeCopyArray(processInput, process, n);
    int allocation[n];
    for (i = 0; i < n; i++) {
        allocation[i] = -1;
    }
    for (i = 0; i < n; i++) {
        int bestIndex = -1;
        for (j = 0; j < m; j++) {
            if (partition[j] >= process[i]) {
                if (bestIndex == -1)
                    bestIndex = j;
                else
                    if (partition[bestIndex] > partition[j])
                        bestIndex = j;
            }
        }
    }
}

```



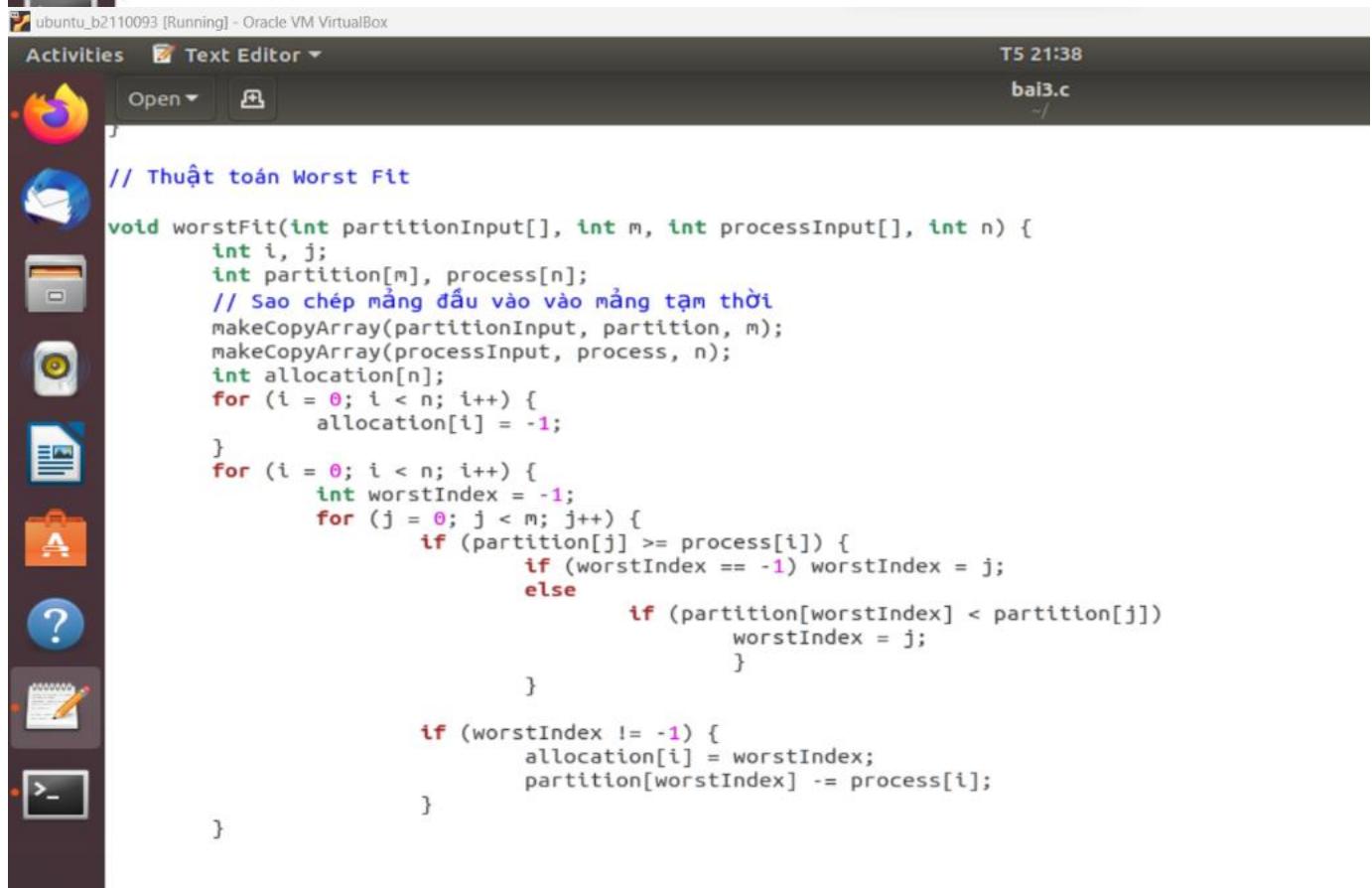
```

Activities Text Editor T5 21:38
Open bai3.c
if (partition[j] >= process[i]) {
    if (bestIndex == -1)
        bestIndex = j;
    else
        if (partition[bestIndex] > partition[j])
            bestIndex = j;
}
}

if (bestIndex != -1) {
    allocation[i] = bestIndex;
    partition[bestIndex] -= process[i];
}

// In ra kết quả
printf("\nProcess No.\tProcess Size\t\tPartition no.\n");
for (int i = 0; i < n; i++) {
    printf("%i\t\t", i + 1);
    printf("%i\t\t", process[i]);
    if (allocation[i] != -1)
        printf("%i", allocation[i] + 1);
    else
        printf("Not Allocated");
    printf("\n");
}
}

```

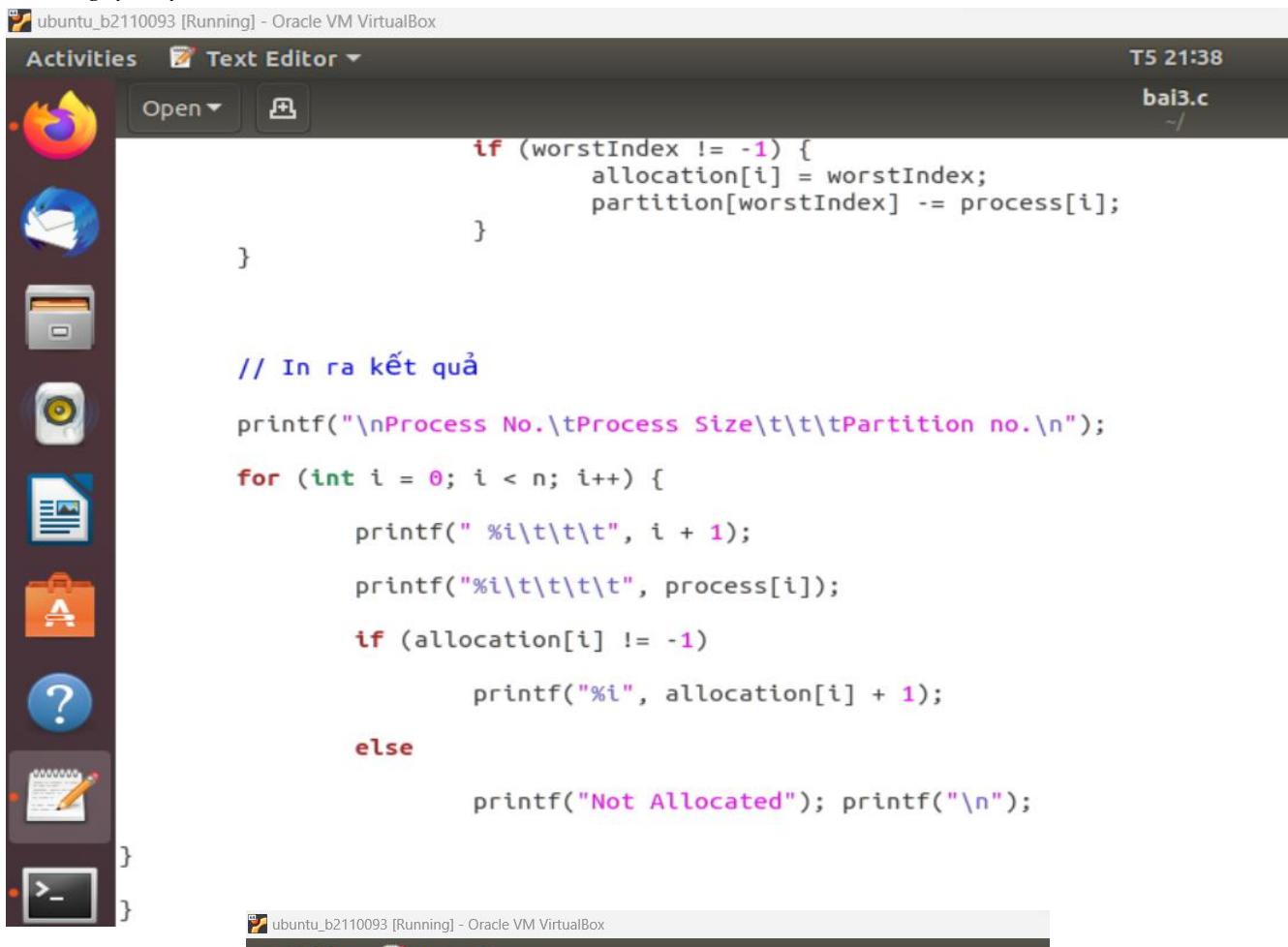


```

Activities Text Editor T5 21:38
Open bai3.c
// Thuật toán Worst Fit

void worstFit(int partitionInput[], int m, int processInput[], int n) {
    int i, j;
    int partition[m], process[n];
    // Sao chép mảng đầu vào vào mảng tạm thời
    makeCopyArray(partitionInput, partition, m);
    makeCopyArray(processInput, process, n);
    int allocation[n];
    for (i = 0; i < n; i++)
        allocation[i] = -1;
    for (i = 0; i < n; i++) {
        int worstIndex = -1;
        for (j = 0; j < m; j++) {
            if (partition[j] >= process[i]) {
                if (worstIndex == -1) worstIndex = j;
                else
                    if (partition[worstIndex] < partition[j])
                        worstIndex = j;
            }
        }
        if (worstIndex != -1) {
            allocation[i] = worstIndex;
            partition[worstIndex] -= process[i];
        }
    }
}

```

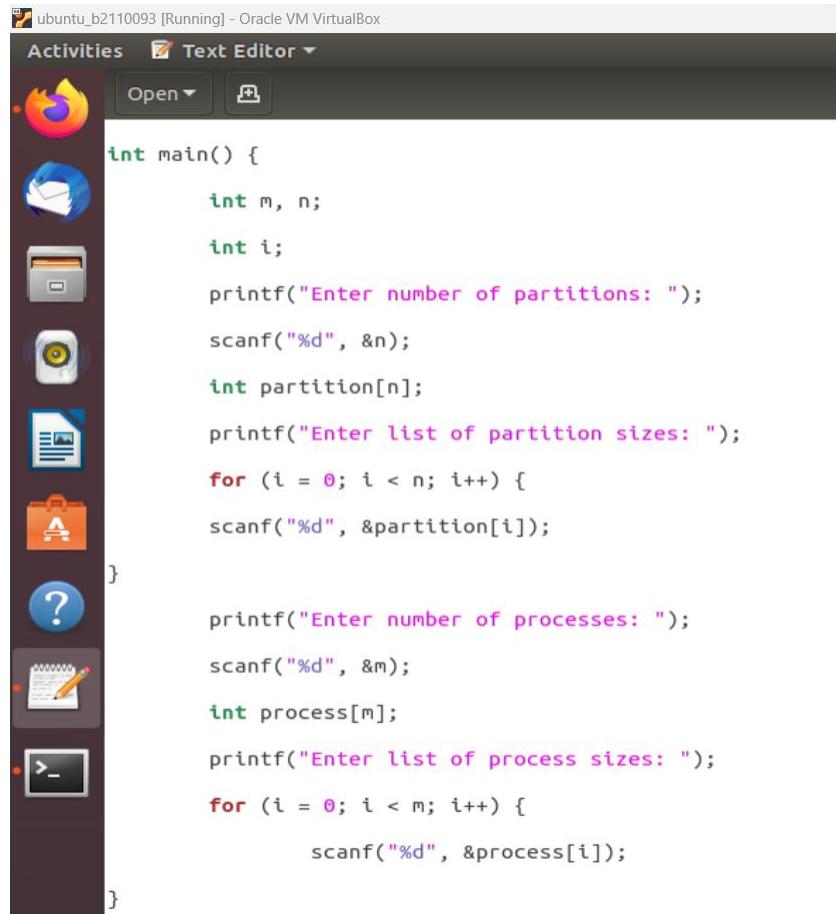


```

if (worstIndex != -1) {
    allocation[i] = worstIndex;
    partition[worstIndex] -= process[i];
}

// In ra kết quả
printf("\nProcess No.\tProcess Size\t\tPartition no.\n");
for (int i = 0; i < n; i++) {
    printf(" %i\t\t", i + 1);
    printf("%i\t\t", process[i]);
    if (allocation[i] != -1)
        printf("%i", allocation[i] + 1);
    else
        printf("Not Allocated"); printf("\n");
}
}
}

```



```

int main() {
    int m, n;

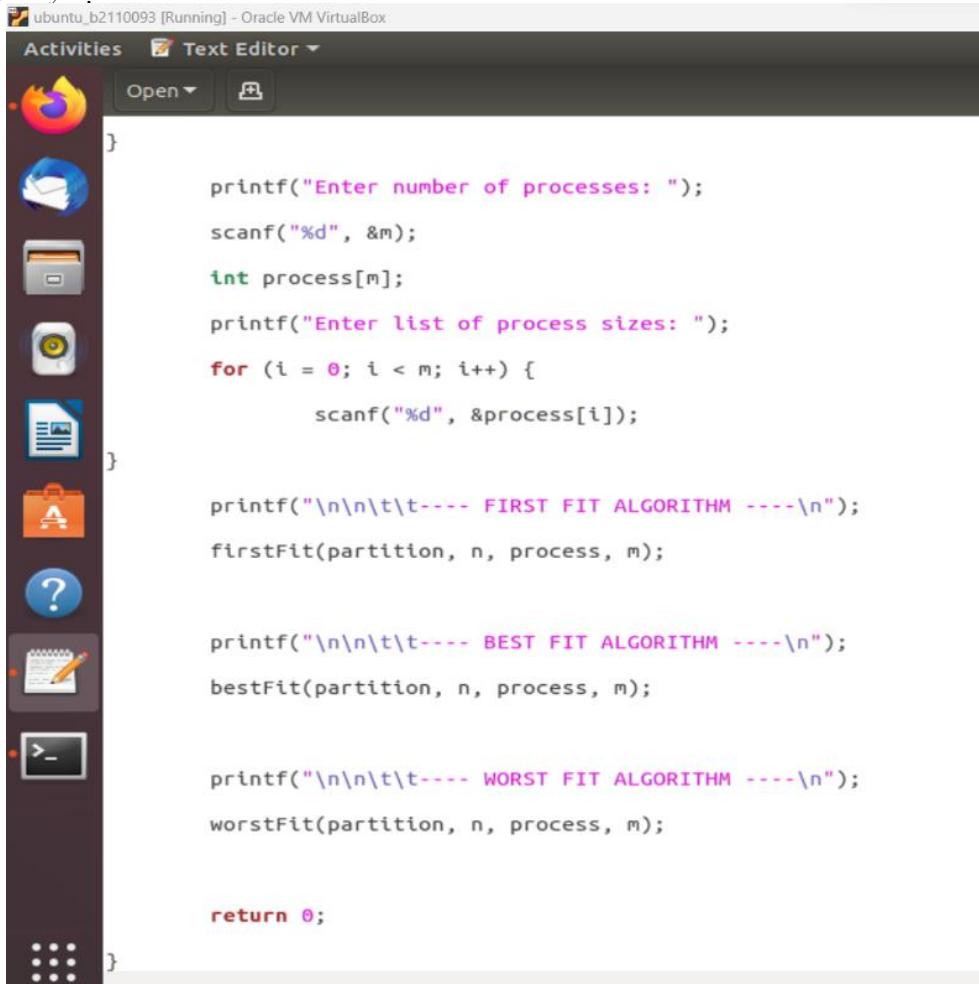
    int i;
    printf("Enter number of partitions: ");
    scanf("%d", &n);

    int partition[n];
    printf("Enter list of partition sizes: ");
    for (i = 0; i < n; i++) {
        scanf("%d", &partition[i]);
    }

    printf("Enter number of processes: ");
    scanf("%d", &m);

    int process[m];
    printf("Enter list of process sizes: ");
    for (i = 0; i < m; i++) {
        scanf("%d", &process[i]);
    }
}

```



```

ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Text Editor

}

        printf("Enter number of processes: ");

        scanf("%d", &m);

        int process[m];

        printf("Enter list of process sizes: ");

        for (i = 0; i < m; i++) {

            scanf("%d", &process[i]);
        }

        printf("\n\n\t---- FIRST FIT ALGORITHM ----\n");
        firstFit(partition, n, process, m);

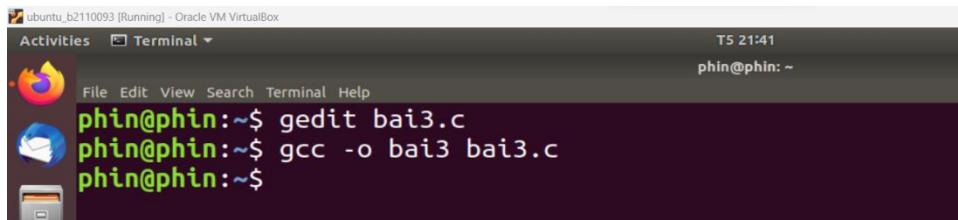
        printf("\n\n\t---- BEST FIT ALGORITHM ----\n");
        bestFit(partition, n, process, m);

        printf("\n\n\t---- WORST FIT ALGORITHM ----\n");
        worstFit(partition, n, process, m);

        return 0;
}

```

Biên dịch chương trình bai3.c từ mã nguồn C và tạo tệp thực thi bai3:
\$ gcc -o bai3 bai3.c

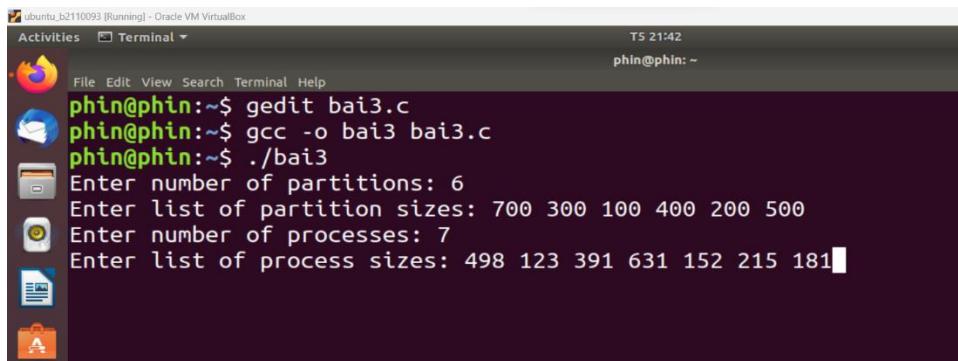


```

ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Terminal T5 21:41
phin@phin:~$ gedit bai3.c
phin@phin:~$ gcc -o bai3 bai3.c
phin@phin:~$

```

Thực thi tệp bai3:
\$./bai3



```

ubuntu_b2110093 [Running] - Oracle VM VirtualBox
Activities Terminal T5 21:42
phin@phin:~$ gedit bai3.c
phin@phin:~$ gcc -o bai3 bai3.c
phin@phin:~$ ./bai3
Enter number of partitions: 6
Enter list of partition sizes: 700 300 100 400 200 500
Enter number of processes: 7
Enter list of process sizes: 498 123 391 631 152 215 181

```

The image consists of three vertically stacked terminal windows from a Linux desktop environment.

Top Window (FIRST FIT ALGORITHM):

```
---- FIRST FIT ALGORITHM ----
Process No.      Process Size      Partition no.
1                498                 1
2                123                 1
3                391                 4
4                631                 Not Allocated
5                152                 2
6                215                 6
7                181                 5
```

Middle Window (BEST FIT ALGORITHM):

```
---- BEST FIT ALGORITHM ----
Process No.      Process Size      Partition no.
1                498                 6
2                123                 5
3                391                 4
4                631                 1
5                152                 2
6                215                 Not Allocated
7                181                 Not Allocated
```

Bottom Window (WORST FIT ALGORITHM):

```
---- WORST FIT ALGORITHM ----
Process No.      Process Size      Partition no.
1                498                 1
2                123                 6
3                391                 4
4                631                 Not Allocated
5                152                 6
6                215                 2
7                181                 6
```

***** HẾT *****