

OS kernel Assignment 1

K213086 ABDUL-SAMMAD

```
sammad@ubuntu:~$  
To run a command as administrator (user "root"), use "sudo <command>".  
See "man sudo_root" for details.  
  
sammad@ubuntu:~$ uname -r  
4.15.0-112-generic  
sammad@ubuntu:~$ sudo apt-get install gcc  
[sudo] password for sammad:  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
gcc is already the newest version (4:5.3.1-1ubuntu1).  
0 upgraded, 0 newly installed, 0 to remove and 188 not upgraded.  
sammad@ubuntu:~$ sudo apt-get install libncurses5-dev  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
The following additional packages will be installed:  
  libtinfo-dev  
Suggested packages:  
  ncurses-doc  
The following NEW packages will be installed:  
  libncurses5-dev libtinfo-dev  
0 upgraded, 2 newly installed, 0 to remove and 188 not upgraded.  
Need to get 252 kB of archives.  
After this operation, 1,461 kB of additional disk space will be used.  
Do you want to continue? [Y/n] y  
Get:1 http://us.archive.ubuntu.com/ubuntu xenial/main amd64 libtinfo-dev amd64 6.0+20160213-1ubuntu1 ...  
Get:2 http://us.archive.ubuntu.com/ubuntu xenial/main amd64 libncurses5-dev amd64 6.0+20160213-1ubuntu1 ...  
Fetched 252 kB in 10s (24.9 kB/s)  
Selecting previously unselected package libtinfo-dev:amd64.  
(Reading database ... 177262 files and directories currently installed.)  
Preparing to unpack .../libtinfo-dev_6.0+20160213-1ubuntu1_amd64.deb ...  
Unpacking libtinfo-dev:amd64 (6.0+20160213-1ubuntu1) ...  
Selecting previously unselected package libncurses5-dev:amd64.  
Preparing to unpack .../libncurses5-dev_6.0+20160213-1ubuntu1_amd64.deb ...  
Unpacking libncurses5-dev:amd64 (6.0+20160213-1ubuntu1) ...  
Processing triggers for man-db (2.7.5-1) ...  
Setting up libtinfo-dev:amd64 (6.0+20160213-1ubuntu1) ...  
Setting up libncurses5-dev:amd64 (6.0+20160213-1ubuntu1) ...  
sammad@ubuntu:~$ sudo apt-get install bison  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
The following additional packages will be installed:  
  libbison-dev libsigsegv2 m4  
Suggested packages:  
  bison-doc  
The following NEW packages will be installed:  
  bison libbison-dev libsigsegv2 m4
```

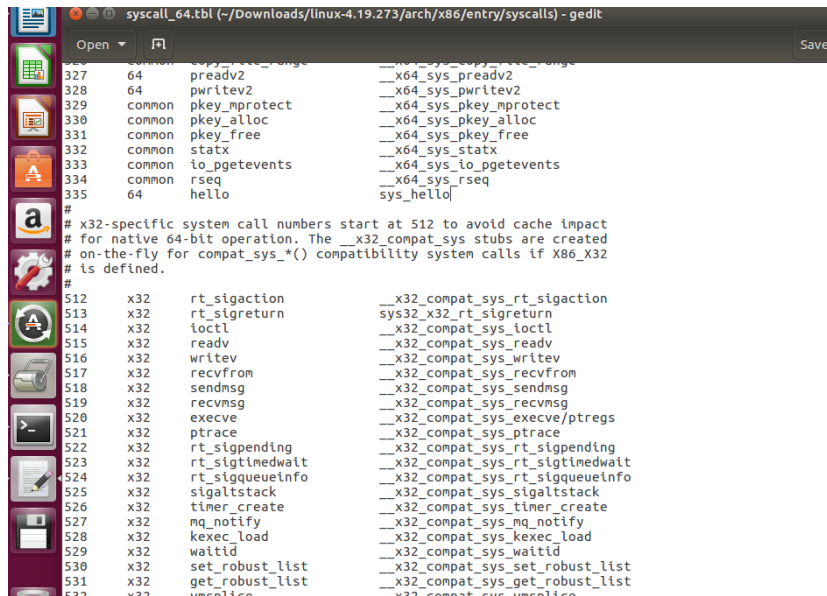
```
update-alternatives: using /usr/bin/bison.yacc to provide /usr/bin/yacc (yacc) in auto mode  
Processing triggers for libc-bin (2.23-0ubuntu1.2) ...  
sammad@ubuntu:~$ sudo apt-get install flex  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
The following additional packages will be installed:  
  libfl-dev  
The following NEW packages will be installed:  
  flex libfl-dev  
0 upgraded, 2 newly installed, 0 to remove and 188 not upgraded.  
Need to get 302 kB of archives.  
After this operation, 897 kB of additional disk space will be used.  
Do you want to continue? [Y/n] y  
Get:1 http://us.archive.ubuntu.com/ubuntu xenial/main amd64 libfl-dev amd64 2.6.0-11 [12.5 kB]  
Get:2 http://us.archive.ubuntu.com/ubuntu xenial/main amd64 flex amd64 2.6.0-11 [290 kB]  
Fetched 302 kB in 10s (29.8 kB/s)  
Selecting previously unselected package libfl-dev:amd64.  
(Reading database ... 177431 files and directories currently installed.)  
Preparing to unpack .../libfl-dev_2.6.0-11_amd64.deb ...  
Unpacking libfl-dev:amd64 (2.6.0-11) ...  
Selecting previously unselected package flex.  
Preparing to unpack .../flex_2.6.0-11_amd64.deb ...  
Unpacking flex (2.6.0-11) ...  
Processing triggers for libc-bin (2.23-0ubuntu1.2) ...  
Processing triggers for install-info (6.1.0.dfsg.1-5) ...  
Processing triggers for doc-base (0.10.7) ...  
Processing 1 added doc-base file...  
Processing triggers for man-db (2.7.5-1) ...  
Setting up libfl-dev:amd64 (2.6.0-11) ...  
Setting up flex (2.6.0-11) ...  
Processing triggers for libc-bin (2.23-0ubuntu1.2) ...  
sammad@ubuntu:~$ sudo apt install make  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
make is already the newest version (4.1-6).  
0 upgraded, 0 newly installed, 0 to remove and 188 not upgraded.  
sammad@ubuntu:~$ sudo apt-get install libssl-dev  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
The following additional packages will be installed:  
  libssl-doc libssl1.0.0 zlib1g-dev  
The following NEW packages will be installed:
```

```
Setting up libssl-doc (1.0.2g-1ubuntu4.20) ...
Processing triggers for libc-bin (2.23-0ubuntu11.2) ...
sammad@ubuntu:~$ sudo apt-get install libelf-dev
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following NEW packages will be installed:
  libelf-dev
0 upgraded, 1 newly installed, 0 to remove and 187 not upgraded.
Need to get 54.5 kB of archives.
After this operation, 359 kB of additional disk space will be used.
Get:1 http://us.archive.ubuntu.com/ubuntu xenial-updates/main amd64 libelf-dev amd64 0.165-3ubuntu1.2 [54.5 kB]
Fetched 54.5 kB in 2s (22.6 kB/s)
Selecting previously unselected package libelf-dev:amd64.
(Reading database ... 179313 files and directories currently installed.)
Preparing to unpack .../libelf-dev_0.165-3ubuntu1.2_amd64.deb ...
Unpacking libelf-dev:amd64 (0.165-3ubuntu1.2) ...
Setting up libelf-dev:amd64 (0.165-3ubuntu1.2) ...
sammad@ubuntu:~$ sudo add-apt-repository "deb http://archive.ubuntu.com/ubuntu $(lsb_release -sc) main universe"
sammad@ubuntu:~$ sudo apt-get update
Get:1 http://security.ubuntu.com/ubuntu xenial-security InRelease [99.8 kB]
Get:2 http://archive.ubuntu.com/ubuntu xenial InRelease [247 kB]
Hit:3 http://us.archive.ubuntu.com/ubuntu xenial InRelease
Get:4 http://us.archive.ubuntu.com/ubuntu xenial-updates InRelease [99.8 kB]
Get:5 http://us.archive.ubuntu.com/ubuntu xenial-backports InRelease [97.4 kB]
Get:6 http://security.ubuntu.com/ubuntu xenial-security/main amd64 DEP-11 Metadata [93.7 kB]
Get:7 http://archive.ubuntu.com/ubuntu xenial/main amd64 Packages [1,201 kB]
Get:8 http://security.ubuntu.com/ubuntu xenial-security/universe amd64 DEP-11 Metadata [130 kB]
Get:9 http://us.archive.ubuntu.com/ubuntu xenial-updates/main amd64 DEP-11 Metadata [327 kB]
Get:10 http://security.ubuntu.com/ubuntu xenial-security/multiverse amd64 DEP-11 Metadata [2,464 B]
Get:11 http://archive.ubuntu.com/ubuntu xenial/main i386 Packages [1,196 kB]
Get:12 http://us.archive.ubuntu.com/ubuntu xenial-updates/universe amd64 DEP-11 Metadata [281 kB]
Get:13 http://archive.ubuntu.com/ubuntu xenial/main Translation-en [568 kB]
Get:14 http://us.archive.ubuntu.com/ubuntu xenial-updates/multiverse amd64 DEP-11 Metadata [5,960 B]
Get:15 http://us.archive.ubuntu.com/ubuntu xenial-backports/main amd64 DEP-11 Metadata [3,328 B]
Get:16 http://us.archive.ubuntu.com/ubuntu xenial-backports/universe amd64 DEP-11 Metadata [6,608 B]
Get:17 http://archive.ubuntu.com/ubuntu xenial/main amd64 DEP-11 Metadata [733 kB]
Get:18 http://archive.ubuntu.com/ubuntu xenial/main DEP-11 64x64 Icons [409 kB]
Get:19 http://archive.ubuntu.com/ubuntu xenial/universe amd64 Packages [7,532 kB]
Get:20 http://archive.ubuntu.com/ubuntu xenial/universe i386 Packages [7,512 kB]
Get:21 http://archive.ubuntu.com/ubuntu xenial/universe Translation-en [4,354 kB]
Get:22 http://archive.ubuntu.com/ubuntu xenial/universe amd64 DEP-11 Metadata [3,410 kB]
Get:23 http://archive.ubuntu.com/ubuntu xenial/universe DEP-11 64x64 Icons [7,448 kB]
Fetched 35.8 MB in 2min 41s (222 kB/s)
Reading package lists... Done
sammad@ubuntu:~$ sudo apt-get upgrade
Reading package lists... Done
Building dependency tree
```

```
sammad@ubuntu:~/Downloads/linux-4.19.273/hello$ gedit hello.c
sammad@ubuntu:~/Downloads/linux-4.19.273/hello$ gedit Makefile

Makefile (~/Downloads/linux-4.19.273/hello) - gedit
Open [v] [F4]
obj-y := hello.o
```

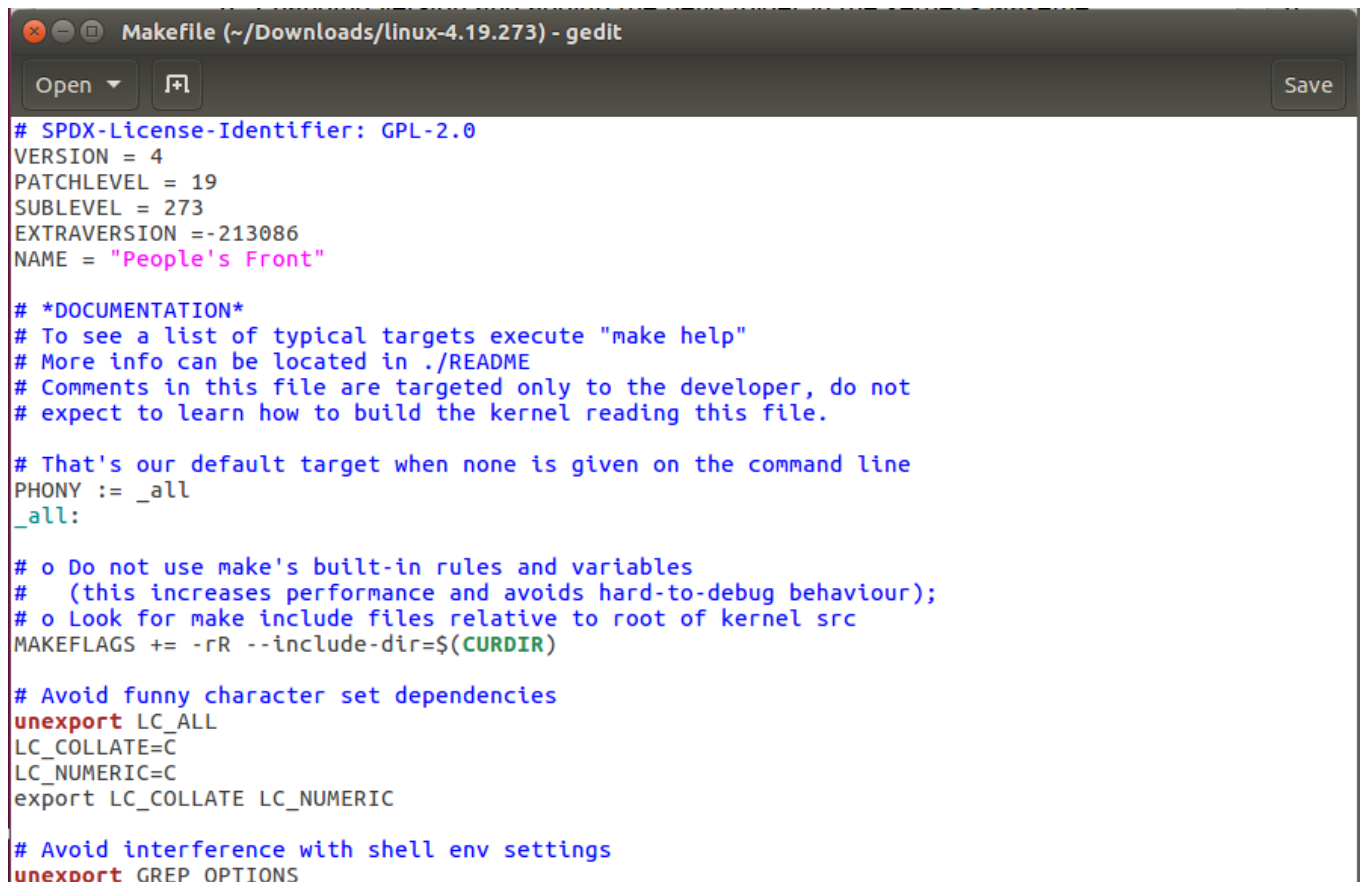
cd arch/x86/entry/syscalls/ gedit syscall_64.tbl



```
327 64 preadv2      __x64_sys_preadv2
328 64 pwritev2     __x64_sys_pwritev2
329 common pkey_mprotect  __x64_sys_pkey_mprotect
330 common pkey_alloc   __x64_sys_pkey_alloc
331 common pkey_free    __x64_sys_pkey_free
332 common statx       __x64_sys_statx
333 common io_pgetevents __x64_sys_io_pgetevents
334 common rseq        __x64_sys_rseq
335 64 hello          sys_hello

#
# x32-specific system call numbers start at 512 to avoid cache impact
# for native 64-bit operation. The __x32_compat_sys stubs are created
# on-the-fly for compat_sys*() compatibility system calls if X86_X32
# is defined.
#
512 x32 rt_sigaction  __x32_compat_sys_rt_sigaction
513 x32 rt_sigreturn  sys32_x32_rt_sigreturn
514 x32 ioctl        __x32_compat_sys_ioctl
515 x32 readv        __x32_compat_sys_readv
516 x32 writev       __x32_compat_sys_writev
517 x32 recvfrom     __x32_compat_sys_recvfrom
518 x32 sendmsg      __x32_compat_sys_sendmsg
519 x32 recvmsg      __x32_compat_sys_recvmsg
520 x32 execve       __x32_compat_sys_execve/ptregs
521 x32 ptrace       __x32_compat_sys_ptrace
522 x32 rt_sigpending __x32_compat_sys_rt_sigpending
523 x32 rt_sigtimedwait __x32_compat_sys_rt_sigtimedwait
524 x32 rt_sigqueueinfo __x32_compat_sys_rt_sigqueueinfo
525 x32 sigaltstack  __x32_compat_sys_sigaltstack
526 x32 timer_create __x32_compat_sys_timer_create
527 x32 mq_notify    __x32_compat_sys_mq_notify
528 x32 kexec_load   __x32_compat_sys_kexec_load
529 x32 waitid       __x32_compat_sys_waitid
530 x32 set_robust_list __x32_compat_sys_set_robust_list
531 x32 get_robust_list __x32_compat_sys_get_robust_list
532 x32 uenumid      __x32_compat_sys_uenumid
```

Writing roll number on Makefile



```
Makefile (~/.Downloads/linux-4.19.273) - gedit

# SPDX-License-Identifier: GPL-2.0
VERSION = 4
PATCHLEVEL = 19
SUBLEVEL = 273
EXTRAVERSION = -213086
NAME = "People's Front"

# *DOCUMENTATION*
# To see a list of typical targets execute "make help"
# More info can be located in ./README
# Comments in this file are targeted only to the developer, do not
# expect to learn how to build the kernel reading this file.

# That's our default target when none is given on the command line
PHONY := _all
_all:

# o Do not use make's built-in rules and variables
# (this increases performance and avoids hard-to-debug behaviour);
# o Look for make include files relative to root of kernel src
MAKEFLAGS += -rR --include-dir=$(CURDIR)

# Avoid funny character set dependencies
unexport LC_ALL
LC_COLLATE=C
LC_NUMERIC=C
export LC_COLLATE LC_NUMERIC

# Avoid interference with shell env settings
unexport GREP_OPTIONS
```

```
Makefile (~/.Downloads/linux-4.19.273) - gedit
Open [icon] Save

else
    SKIP_STACK_VALIDATION := 1
    export SKIP_STACK_VALIDATION
endif
endif

PHONY += prepare0

ifeq ($(KBUILD_EXTMOD),)
core-y += kernel/ certs/ mm/ fs/ ipc/ security/ crypto/ block/ hello/

vmlinux-dirs := $(patsubst %/,%,$(filter %/, $(init-y) $(init-m) \
    $(core-y) $(core-m) $(drivers-y) $(drivers-m) \
    $(net-y) $(net-m) $(libs-y) $(libs-m) $(virt-y)))

vmlinux-alldirs := $(sort $(vmlinux-dirs) $(patsubst %/,%,$(filter %/, \
    $(init-) $(core-) $(drivers-) $(net-) $(libs-) $(virt-))))

init-y := $(patsubst %/, %/built-in.a, $(init-y))
core-y := $(patsubst %/, %/built-in.a, $(core-y))
drivers-y := $(patsubst %/, %/built-in.a, $(drivers-y))
net-y := $(patsubst %/, %/built-in.a, $(net-y))
libs-y1 := $(patsubst %/, %/lib.a, $(libs-y))
libs-y2 := $(patsubst %/, %/built-in.a, $(filter-out %.a, $(libs-y)))
virt-y := $(patsubst %/, %/built-in.a, $(virt-y))

# Externally visible symbols (used by link-vmlinux.sh)
export KBUILD_VMLINUX_INIT := $(head-y) $(init-y)
export KBUILD_VMLINUX_MAIN := $(core-y) $(libs-y2) $(drivers-y) $(net-y) $(virt-y)
export KBUILD_VMLINUX_LIBS := $(libs-y1)
export KBUILD_LDS := arch/$(SRCARCH)/kernel/vmlinux.lds
export LDFLAGS_vmlinux
```

Command: sudo make modules install install

```
sammad@ubuntu: ~/.Downloads/linux-4.19.273

sammad@ubuntu:~/Downloads/linux-4.19.273/arch/x86/entry/syscalls$ gedit arch/x86/entry/syscall_64.tbl
sammad@ubuntu:~/Downloads/linux-4.19.273/arch/x86/entry/syscalls$ cd ..
sammad@ubuntu:~/Downloads/linux-4.19.273/arch/x86/entry$ cd ..
sammad@ubuntu:~/Downloads/linux-4.19.273/arch/x86$ cd ..
sammad@ubuntu:~/Downloads/linux-4.19.273/arch$ cd ..
sammad@ubuntu:~/Downloads/linux-4.19.273$ gedit arch/x86/entry/syscalls/syscall_64.tbl
sammad@ubuntu:~/Downloads/linux-4.19.273$ gedit arch/x86/entry/syscalls/syscall_64.tbl
sammad@ubuntu:~/Downloads/linux-4.19.273$ gedit include/linux/syscalls.h
sammad@ubuntu:~/Downloads/linux-4.19.273$ gedit include/linux/syscalls.h
sammad@ubuntu:~/Downloads/linux-4.19.273$ gedit Makefile
sammad@ubuntu:~/Downloads/linux-4.19.273$ gedit Makefile
sammad@ubuntu:~/Downloads/linux-4.19.273$ ls /boot | grep config
config-4.15.0-112-generic
sammad@ubuntu:~/Downloads/linux-4.19.273$ pwd
/home/sammad/Downloads/linux-4.19.273
sammad@ubuntu:~/Downloads/linux-4.19.273$ cp /boot/config-4.15.0-112-generic/home/sammad/Downloads/linux-4.19.273
cp: missing destination file operand after '/boot/config-4.15.0-112-generic/home/sammad/Downloads/linux-4.19.273'
Try 'cp --help' for more information.
sammad@ubuntu:~/Downloads/linux-4.19.273$ cp /boot/config-4.15.0-112-generic /home/sammad/Downloads/linux-4.19.273
sammad@ubuntu:~/Downloads/linux-4.19.273$
```

```

root@ubuntu:/home/sammad/Downloads/linux-4.19.273# make -j2
DESCEND objtool
CALL scripts/checksyscalls.sh
CHK include/generated/compile.h
SKIPPED include/generated/compile.h
CC drivers/powercap/powercap_sys.o
CC [M] drivers/powercap/intel_rapl.o
AR drivers/powercap/built-in.a
AR drivers/pps/clients/built-in.a
CC [M] drivers/pps/clients/pps_ldisc.o
CC [M] drivers/pps/clients/pps_parport.o
CC [M] drivers/net/ethernet/mellanox/mlx5/core/en_rep.o
CC [M] drivers/pps/clients/pps-gpio.o
AR drivers/pps/generators/built-in.a
CC drivers/pps/pps.o
CC drivers/pps/kapi.o
CC drivers/pps/sysfs.o
AR drivers/pps/built-in.a
CC drivers/ptp/ptp_clock.o

```

Checking Kernel Version with Roll number and System Call

```

sammad@ubuntu :~$ uname -r
4.19.273 - 213086

```

```

Userspace.c (~/) - gedit
Open
#include <stdio.h>
#include <linux/kernel.h>
#include <sys/syscall.h>
#include <unistd.h>

int main()
{
    long int num= syscall(548);
    printf("System call sys_hello returned %ld\n", num);
    return 0;
}

```

Command: dmesg

```

t: Supported (#1)
[ 277.726310] ISO 9660 Extensions: Microsoft Joliet Level 3
[ 278.318455] ISO 9660 Extensions: RRIP_1991A
[ 942.020650] Hello World

```