



Fayoum unveracity

Operating System report

how to add your system call the Linux OS kernel.

Name Here

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Description of my system

CPU cores, RAM capacity

Device	Summary
Memory	4 GB
Processors	2
Hard Disk (SCSI)	20 GB
CD/DVD (SATA)	Using file C:\Users\Semo\Do...
Network Adapter	NAT
USB Controller	Present
Sound Card	Auto detect
Printer	Present
Display	Auto detect

Memory

Specify the amount of memory allocated to this virtual machine. The memory size must be a multiple of 4 MB.

Memory for this virtual machine: 4096 MB

128 GB -
64 GB -
32 GB -
16 GB -
8 GB -
4 GB -
2 GB -
1 GB -
512 MB -
256 MB -
128 MB -
64 MB -
32 MB -
16 MB -
8 MB -
4 MB -

Maximum recommended memory
(Memory swapping may occur beyond this size.)
13.4 GB

Recommended memory
4 GB

Guest OS recommended minimum
2 GB

Kernel version

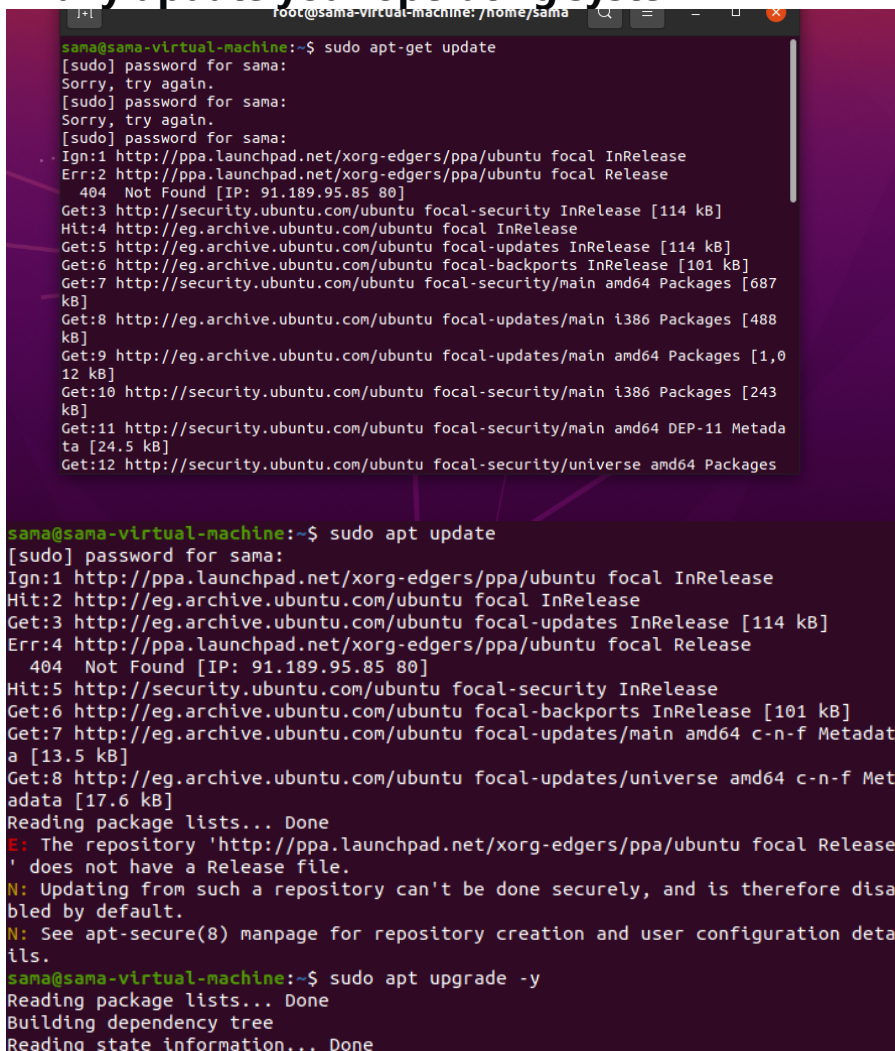
5.8.0-55-generic

```
sama@sama-virtual-machine:~$ uname -r
5.8.0-55-generic
sama@sama-virtual-machine:~$ cd ~
sama@sama-virtual-machine:~$ nano report.c
sama@sama-virtual-machine:~$
```

Steps of how adding the system call & Screenshots.

1 - Preparation

1.1 - Fully update your operating system



```
sama@sama-virtual-machine:~$ sudo apt-get update
[sudo] password for sama:
Sorry, try again.
[sudo] password for sama:
Sorry, try again.
[sudo] password for sama:
Ign:1 http://ppa.launchpad.net/xorg-edgers/ppa/ubuntu focal InRelease
Err:2 http://ppa.launchpad.net/xorg-edgers/ppa/ubuntu focal Release
  404 Not Found [IP: 91.189.95.85 80]
Get:3 http://security.ubuntu.com/ubuntu focal-security InRelease [114 kB]
Hit:4 http://eg.archive.ubuntu.com/ubuntu focal InRelease
Get:5 http://eg.archive.ubuntu.com/ubuntu focal-updates InRelease [114 kB]
Get:6 http://eg.archive.ubuntu.com/ubuntu focal-backports InRelease [101 kB]
Get:7 http://security.ubuntu.com/ubuntu focal-security/main amd64 Packages [687 kB]
Get:8 http://eg.archive.ubuntu.com/ubuntu focal-updates/main i386 Packages [488 kB]
Get:9 http://eg.archive.ubuntu.com/ubuntu focal-updates/main amd64 Packages [1,012 kB]
Get:10 http://security.ubuntu.com/ubuntu focal-security/main i386 Packages [243 kB]
Get:11 http://security.ubuntu.com/ubuntu focal-security/main amd64 DEP-11 Metadata [24.5 kB]
Get:12 http://security.ubuntu.com/ubuntu focal-security/universe amd64 Packages

sama@sama-virtual-machine:~$ sudo apt update
[sudo] password for sama:
Ign:1 http://ppa.launchpad.net/xorg-edgers/ppa/ubuntu focal InRelease
Hit:2 http://eg.archive.ubuntu.com/ubuntu focal InRelease
Get:3 http://eg.archive.ubuntu.com/ubuntu focal-updates InRelease [114 kB]
Err:4 http://ppa.launchpad.net/xorg-edgers/ppa/ubuntu focal Release
  404 Not Found [IP: 91.189.95.85 80]
Hit:5 http://security.ubuntu.com/ubuntu focal-security InRelease
Get:6 http://eg.archive.ubuntu.com/ubuntu focal-backports InRelease [101 kB]
Get:7 http://eg.archive.ubuntu.com/ubuntu focal-updates/main amd64 c-n-f Metadata [13.5 kB]
Get:8 http://eg.archive.ubuntu.com/ubuntu focal-updates/universe amd64 c-n-f Metadata [17.6 kB]
Reading package lists... Done
E: The repository 'http://ppa.launchpad.net/xorg-edgers/ppa/ubuntu focal Release' does not have a Release file.
N: Updating from such a repository can't be done securely, and is therefore disabled by default.
N: See apt-secure(8) manpage for repository creation and user configuration details.

sama@sama-virtual-machine:~$ sudo apt upgrade -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
```

1.2 - Download and install the essential packages to compile kernels.

```
root@sama-virtual-machine: /home/sama
sama@sama-virtual-machine:~$ sudo apt-get update
[sudo] password for sama:
Sorry, try again.
[sudo] password for sama:
Sorry, try again.
[sudo] password for sama:
Ign:1 http://ppa.launchpad.net/xorg-edgers/ppa/ubuntu focal InRelease
Err:2 http://ppa.launchpad.net/xorg-edgers/ppa/ubuntu focal Release
404 Not Found [IP: 91.189.95.85 80]
Get:3 http://security.ubuntu.com/ubuntu focal-security InRelease [114 kB]
Hit:4 http://eg.archive.ubuntu.com/ubuntu focal InRelease
Get:5 http://eg.archive.ubuntu.com/ubuntu focal-updates InRelease [114 kB]
Get:6 http://eg.archive.ubuntu.com/ubuntu focal-backports InRelease [101 kB]
Get:7 http://security.ubuntu.com/ubuntu focal-security/main amd64 Packages [687 kB]
Get:8 http://eg.archive.ubuntu.com/ubuntu focal-updates/main i386 Packages [488 kB]
Get:9 http://eg.archive.ubuntu.com/ubuntu focal-updates/main amd64 Packages [1,012 kB]
Get:10 http://security.ubuntu.com/ubuntu focal-security/main i386 Packages [243 kB]
Get:11 http://security.ubuntu.com/ubuntu focal-security/main amd64 DEP-11 Metadata [24.5 kB]
Get:12 http://security.ubuntu.com/ubuntu focal-security/universe amd64 Packages
```

2 - Creation

2.1 - Check the version of your current kernel.

2.2 - Change your working directory to the root directory of the recently unpacked source code.

That is `cd ~/linux-5.8.1/`

2.3 - Create the home directory of your system call. Name is identity

2.4 - Create a C file for your system call.

By nano identity/identity.c & Write the following code in it.

```
done
Removing linux-modules-5.8.0-43-generic (5.8.0-43.49~20.04.1) ...
Processing triggers for libc-bin (2.31-0ubuntu9.2) ...
sama@sama-virtual-machine:~$ sudo apt autoremove -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
sama@sama-virtual-machine:~$ wget -P ~/ https://cdn.kernel.org/pub/linux/kernel/v5.x/linux-5.8.1.tar.xz
--2021-06-03 23:18:51-- https://cdn.kernel.org/pub/linux/kernel/v5.x/linux-5.8.1.tar.xz
Resolving cdn.kernel.org (cdn.kernel.org)... 199.232.81.176, 2a04:4e42:54::432
Connecting to cdn.kernel.org (cdn.kernel.org)|199.232.81.176|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 114458544 (109M) [application/x-xz]
Saving to: '/home/sama/linux-5.8.1.tar.xz'

linux-5.8.1.tar.xz      100%[=====] 109.16M  1.57MB/s   in 67s

2021-06-03 23:19:58 (1.62 MB/s) - '/home/sama/linux-5.8.1.tar.xz' saved [114458544/114458544]

sama@sama-virtual-machine:~$ uname -r
5.8.0-53-generic
sama@sama-virtual-machine:~$ cd ~/linux-5.8.1/
bash: cd: /home/sama/linux-5.8.1/: No such file or directory
sama@sama-virtual-machine:~$ ls
Desktop/  Documents/  Downloads/  linux-5.8.1.tar.xz  Music/  Pictures/  Public/  snap/  Templates/  Videos/
sama@sama-virtual-machine:~$ ls
Desktop  Documents  Downloads  linux-5.8.1.tar.xz  Music  Pictures  Public  snap  Templates  Videos
sama@sama-virtual-machine:~$ cd ~/linux-5.8.1/
sama@sama-virtual-machine:~/linux-5.8.1$ mkdir identity
sama@sama-virtual-machine:~/linux-5.8.1$ nano identity/identity.c
sama@sama-virtual-machine:~/linux-5.8.1$ nano identity/Makefile
```

GNU nano 4.8 identity/identity.c

```
#include <linux/kernel.h>
#include <linux/syscalls.h>

SYSCALL_DEFINE0(identity)
{
    printk("I am sama tarek ahmed ead Al-rashid.\n");
    return 0;
}
```

2.5 – Create a Makefile for your system call name identity Write the following code in it.

GNU nano 4.8 identity/Makefile

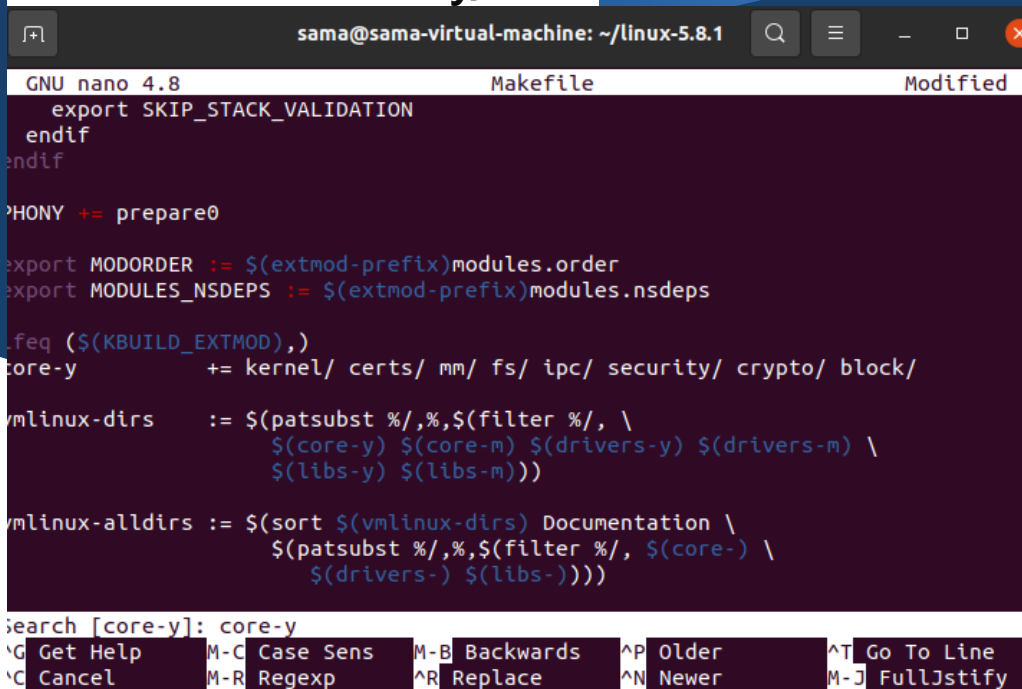
```
obj-y := identity.o
```

Read 1 line

^G Get Help ^O Write Out ^W Where Is ^K Cut Text ^J Justify ^C Cur Pos
 ^X Exit ^R Read File ^\ Replace ^U Paste Text ^T To Spell ^_ Go To Line

2.6 - Add the home directory of your system call to the main Makefile of the kernel

Search for `core-y`. In the second result, you will see a series of directories. Add "identity/" to it



```
GNU nano 4.8 Makefile Modified
export SKIP_STACK_VALIDATION
endif
endif

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-)))
endif

Search [core-y]: core-y
^G Get Help ^M-C Case Sens ^M-B Backwards ^P Older ^T Go To Line
^C Cancel ^M-R Regexp ^R Replace ^N Newer ^M-J Full Justify
```

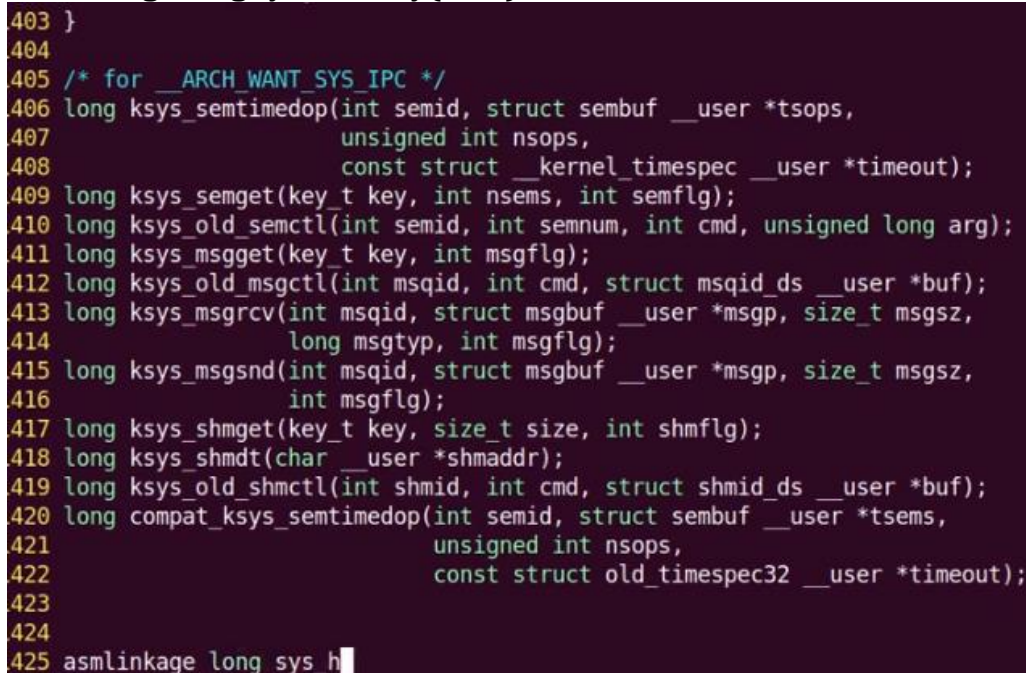
2.7 - Add a corresponding function prototype for your system call to the header file of system calls.

By this command

`nano include/linux/syscalls.h`

following code just above `#endif`

`asmlinkage long sys_identity(void);`

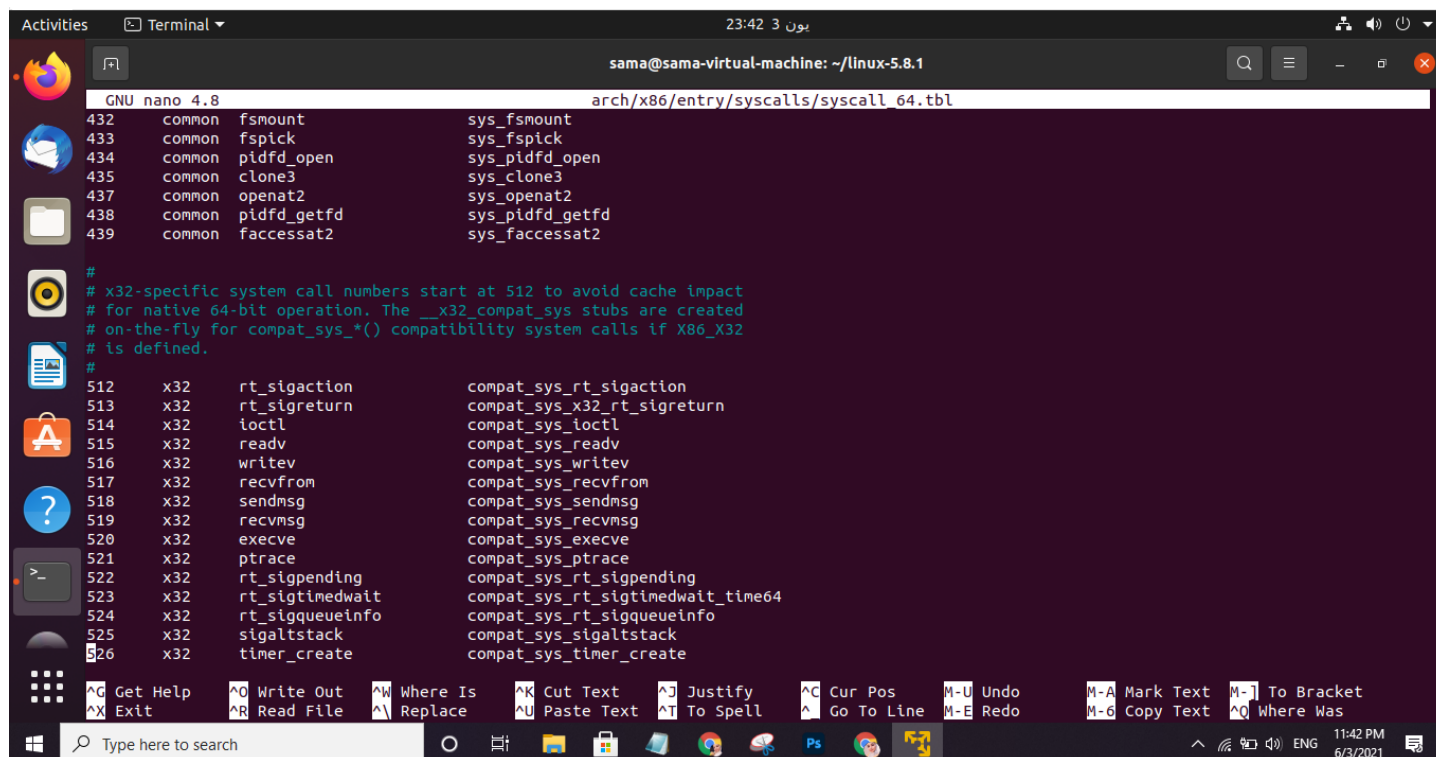


```
403 }
404
405 /* for __ARCH_WANT_SYS_IPC */
406 long ksys_semtimedop(int semid, struct sembuf __user *tsops,
407     unsigned int nsops,
408     const struct __kernel_timespec __user *timeout);
409 long ksys_semget(key_t key, int nsems, int semflg);
410 long ksys_old_semctl(int semid, int semnum, int cmd, unsigned long arg);
411 long ksys_msgget(key_t key, int msgflg);
412 long ksys_old_msgctl(int msqid, int cmd, struct msqid_ds __user *buf);
413 long ksys_msgrcv(int msqid, struct msgbuf __user *msgp, size_t msgsz,
414     long msgtyp, int msgflg);
415 long ksys_msgsnd(int msqid, struct msgbuf __user *msgp, size_t msgsz,
416     int msgflg);
417 long ksys_shmget(key_t key, size_t size, int shmflg);
418 long ksys_shmdt(char __user *shmaddr);
419 long ksys_old_shmctl(int shmid, int cmd, struct shmid_ds __user *buf);
420 long compat_ksys_semtimedop(int semid, struct sembuf __user *tsems,
421     unsigned int nsops,
422     const struct old_timespec32 __user *timeout);
423
424
425 asmlinkage long sys_h
```

2.8 - Add your system call to the kernel's system call table. By this command

```
nano arch/x86/entry/syscalls/syscall_64.tbl
```

```
sama@sama-virtual-machine:~/linux-5.8.1$ nano arch/x86/entry/syscalls/syscall_64.tbl  
sama@sama-virtual-machine:~/linux-5.8.1$
```



```
GNU nano 4.8 arch/x86/entry/syscalls/syscall_64.tbl  
432 common fsmount sys_fsmount  
433 common fspick sys_fspick  
434 common pidfd_open sys_pidfd_open  
435 common clone3 sys_clone3  
437 common openat2 sys_openat2  
438 common pidfd_getfd sys_pidfd_getfd  
439 common faccessat2 sys_faccessat2  
  
#  
# 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 compat_sys_rt_sigaction  
513 x32 rt_sigreturn compat_sys_x32_rt_sigreturn  
514 x32 ioctl compat_sys_ioctl  
515 x32 readv compat_sys_readv  
516 x32 writev compat_sys_writev  
517 x32 recvfrom compat_sys_recvfrom  
518 x32 sendmsg compat_sys_sendmsg  
519 x32 recvmsg compat_sys_recvmsg  
520 x32 execve compat_sys_execve  
521 x32 ptrace compat_sys_ptrace  
522 x32 rt_sigpending compat_sys_rt_sigpending  
523 x32 rt_sigtimedwait compat_sys_rt_sigtimedwait_time64  
524 x32 rt_sigqueueinfo compat_sys_rt_sigqueueinfo  
525 x32 sigaltstack compat_sys_sigaltstack  
526 x32 timer_create compat_sys_timer_create  
  
^G Get Help ^O Write Out ^W Where Is ^K Cut Text ^J Justify ^C Cur Pos ^M-U Undo ^M-A Mark Text ^M-] To Bracket  
^X Exit ^R Read File ^_ Replace ^U Paste Text ^T To Spell ^_ Go To Line ^M-E Redo ^M-C Copy Text ^M-_ Where Was
```

You will find a series of x32 system calls. Scroll to this section
440 common identity sys_identity
above it.


```
sama@sama-virtual-machine: ~/linux-5.8.1
GNU nano 4.8 arch/x86/entry/syscalls/syscall_64.tbl
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
124 common pidfd_send_signal sys_pidfd_send_signal
125 common io_uring_setup sys_io_uring_setup
126 common io_uring_enter sys_io_uring_enter
127 common io_uring_register sys_io_uring_register
128 common open_tree sys_open_tree
129 common move_mount sys_move_mount
130 common fsopen sys_fsopen
131 common fsconfig sys_fsconfig
132 common fsmount sys_fsmount
133 common fspick sys_fspick
134 common pidfd_open sys_pidfd_open
135 common clone3 sys_clone3
137 common openat2 sys_openat2
138 common pidfd_getfd sys_pidfd_getfd
139 common faccessat2 sys_faccessat2
140 common identity sys_identity

# 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 compat_sys_rt_sigaction
513 x32 rt_sigreturn compat_sys_x32_rt_sigreturn
514 x32 ioctl compat_sys_ioctl
```

3 - Installation

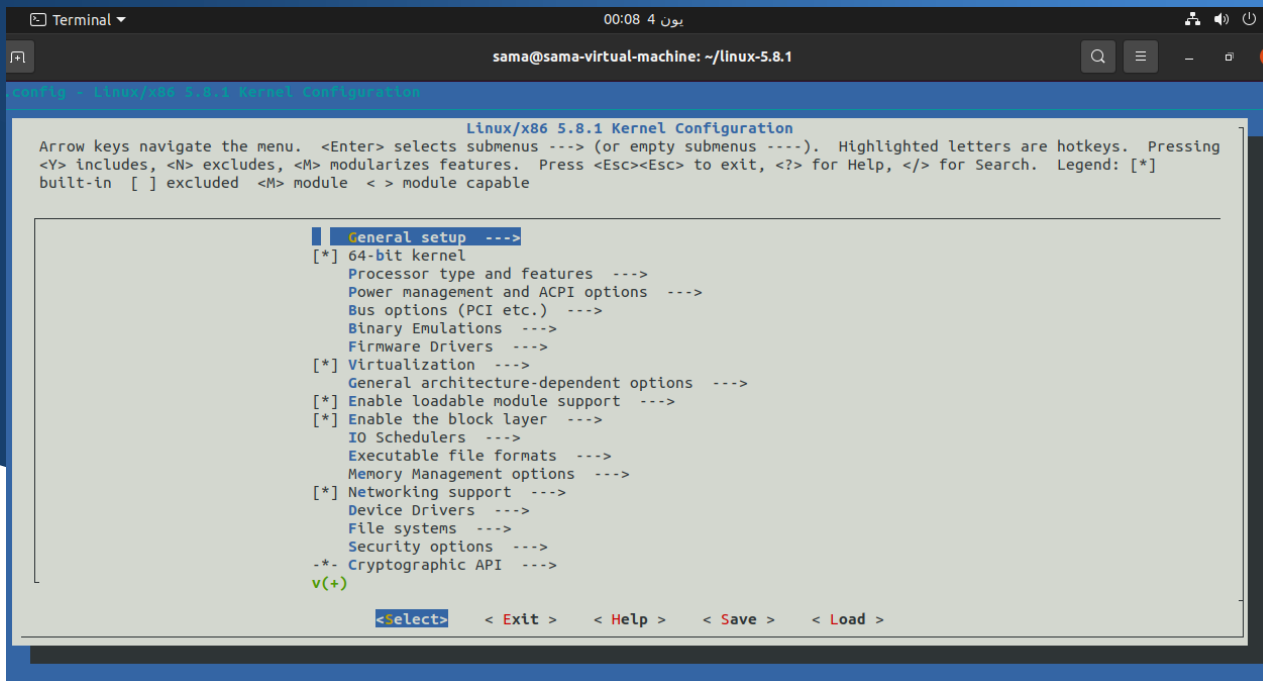
3.1 - Configure the kernel.

configuration window with the following command.

make menuconfig

```
sama@sama-virtual-machine:~/linux-5.8.1$ make menuconfig
HOSTCC scripts/basic/fixdep
UPD scripts/kconfig/mconf.cfg
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/parser.tab.o
HOSTCC scripts/kconfig/preprocess.o
HOSTCC scripts/kconfig/symbol.o
HOSTCC scripts/kconfig/util.o
HOSTLD scripts/kconfig/mconf
scripts/kconfig/mconf Kconfig
#
# using defaults found in /boot/config-5.8.0-53-generic
#
/boot/config-5.8.0-53-generic:8468:warning: symbol value 'm' invalid for ASHMEM
/boot/config-5.8.0-53-generic:9477:warning: symbol value 'm' invalid for ANDROID_BINDER_IPC
/boot/config-5.8.0-53-generic:9478:warning: symbol value 'm' invalid for ANDROID_BINDERFS

*** End of the configuration.
*** Execute 'make' to start the build or try 'make help'.
```

3.2 - Find out how many logical cores you have by nproc

3.2 - Find out how many logical cores you have by make -j12

```
sama@sama-virtual-machine:~/linux-5.8.1$ nproc
2
sama@sama-virtual-machine:~/linux-5.8.1$ make -j12
DESCEND objtool
CALL scripts/atomic/check-atomics.sh
CALL scripts/checksyscalls.sh
CHK include/generated/compile.h
make[1]: *** No rule to make target 'debian/canonical-certs.pem', needed by 'certs/x509_certificate_list'. Stop.
make[1]: *** Waiting for unfinished jobs....
make: *** [Makefile:1756: certs] Error 2
make: *** Waiting for unfinished jobs....
CHK kernel/kheaders_data.tar.xz
```

3.5 - Install the kernel by sudo make install -j12

4 - Result

4.1 - Check the version of your current kernel.

4.2 - Change your working directory to your home directory.

4.3 - Create a C file to generate a report of the success or failure of your system call.

```
sama@sama-virtual-machine:~$ uname -r
5.8.0-55-generic
sama@sama-virtual-machine:~$ cd ~
sama@sama-virtual-machine:~$ nano report.c
sama@sama-virtual-machine:~$
```

Write the following code in it.



```
GNU nano 4.8 report.c Modified
#define __NR_identity 440

long identity_syscall(void)
{
    return syscall(__NR_identity);
}

int main(int argc, char *argv[])
{
    long activity;
    activity = identity_syscall();

    if(activity < 0)
    {
        perror("Sorry, Jasper. Your system call appears to have failed.");
    }
    else
    {
        printf("Congratulations, Jasper! Your system call is functional. Run t>
    }

    return 0;
}
```

^G Get Help ^O Write Out ^W Where Is ^K Cut Text ^J Justify
^X Exit ^R Read File ^\ Replace ^U Paste Text ^T To Spell

4.4 - Compile the C file you just created.

```
gcc -o report report.c
```

4.5 - Run the C file you just compiled. `./report`

```
sama@sama-virtual-machine:~$ ./report  
Congratulations, Jasper! Your system call is functional. Run the command dmesg  
in the terminal and find out!  
sama@sama-virtual-machine:~$
```

References

<https://www.kernel.org/doc/html/latest/process/adding-syscalls.html>

<https://dev.to/jasper/adding-a-system-call-to-the-linux-kernel-5-8-1-in-ubuntu-20-04-lts-2ga8>

<https://medium.com/anubhav-shrimal/adding-a-hello-world-system-call-to-linux-kernel-dad32875872>