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OS ASSIGNMENT 2 PDF

Step 1: First, I have downloaded all necessary dependent libraries.

```
sudo apt install –y build-essential flex bison libssl-dev
```

Step 2: update

```
sudo apt-get update && sudo apt-get upgrade
```

Step 3: get the kernel 4.9.210

```
wget https://cdn.kernel.org/pub/linux/kernel/v4.x/linux-4.9.210.tar.xz
```

Step 4: extract the kernel

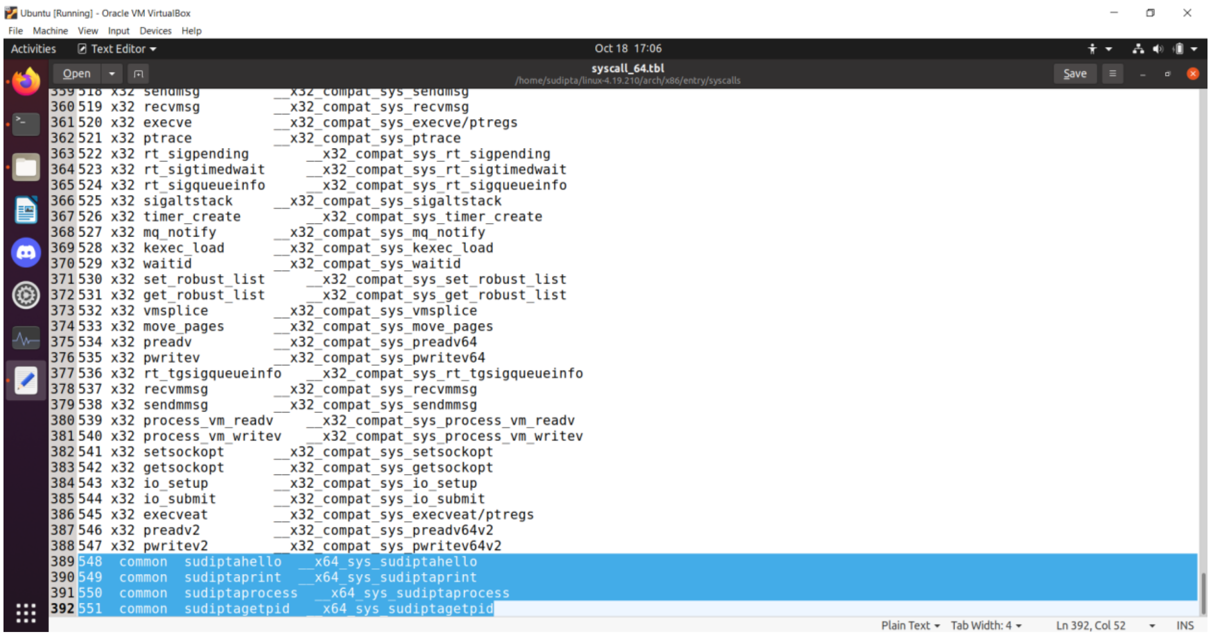
```
xz –v –d linux-4.9.210.tar.xz

tar xvf linux-4.9.210.tar
```

Step 5: Change the directory

```
cd linux-4.9.210
```

Step 6: add new system calls in the syscall_64.tbl

```
sudo gedit arch/x86/entry/syscalls/syacall_64.tbl

548     common      sudiptahello    __x64_sys_sudiptahello

549     common      sudiptaprint    __x64_sys_sudiptaprint

550     common      sudiptaprocess __x64_sys_ sudiptaprocess

551     common      sudiptagetpid __x64_sys_ sudiptagetpid
```


Ubuntu [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities
Text Editor
Oct 18 17:06
Open
syscall_64.tbl
/home/sudipta/linux-4.19.210/arch/x86/entry/syscalls
Save
Plain Text
Tab Width: 4
Ln 392, Col 52
INS

```
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 vmsplice        __x32_compat_sys_vmsplice
533 x32 move_pages      __x32_compat_sys_move_pages
534 x32 preadv          __x32_compat_sys_preadv64
535 x32 pwritev         __x32_compat_sys_pwritev64
536 x32 rt_tgsigqueueinfo   __x32_compat_sys_rt_tgsigqueueinfo
537 x32 recvmmsg        __x32_compat_sys_recvmmsg
538 x32 sendmmsg        __x32_compat_sys_sendmmsg
539 x32 process_vm_readv    __x32_compat_sys_process_vm_readv
540 x32 process_vm_writev   __x32_compat_sys_process_vm_writev
541 x32 setsockopt      __x32_compat_sys_setsockopt
542 x32 getsockopt      __x32_compat_sys_getsockopt
543 x32 io_setup        __x32_compat_sys_io_setup
544 x32 io_submit       __x32_compat_sys_io_submit
545 x32 execveat        __x32_compat_sys_execveat/ptregs
546 x32 preadv2         __x32_compat_sys_preadv64v2
547 x32 pwritev2        __x32_compat_sys_pwritev64v2
548  common  sudiptahello   __x64_sys_sudiptahello
549  common  sudiptaprint   __x64_sys_sudiptaprint
550  common  sudiptaprocess   __x64_sys_sudiptaprocess
551  common  sudiptagetpid    __x64_sys_sudiptagetpid
```

Step 7: add new system calls to the system call header file

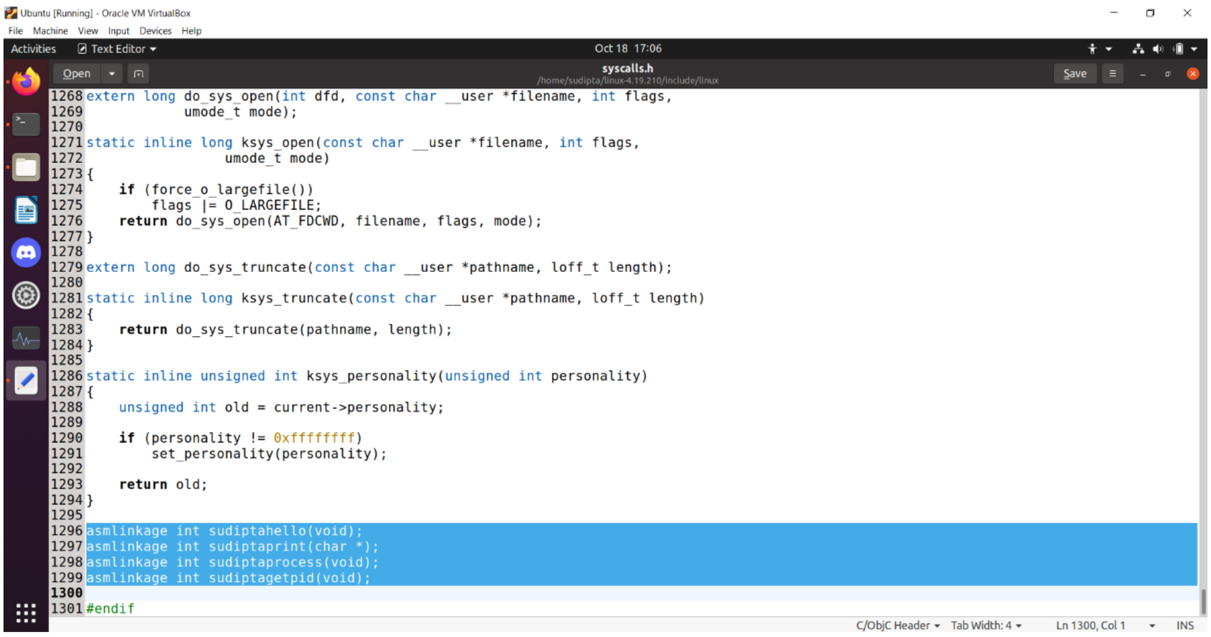
sudo gedit include/linux/syscalls.h

asmlinkage int sudiptahello(void);

asmlinkage int sudiptaprint(char *);

asmlinkage int sudiptaprocess(void);

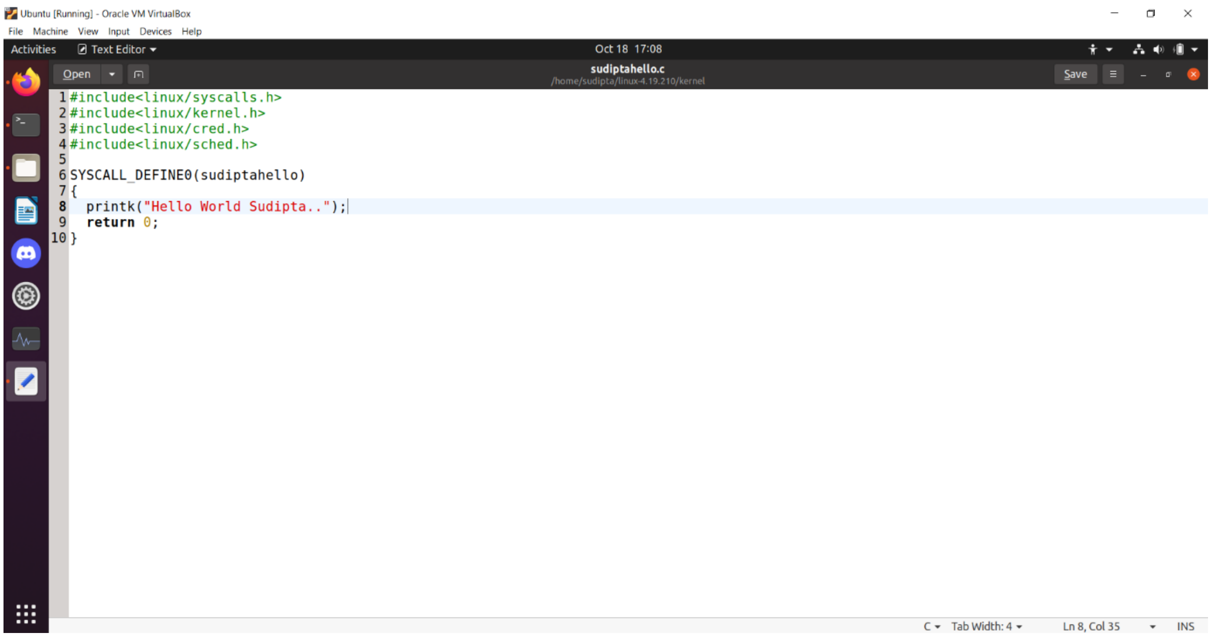
asmlinkage int sudiptagetpid(void);


Ubuntu [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities
Text Editor
Oct 18 17:06
Open
syscalls.h
/home/sudipta/linux-4.19.210/include/linux
Save
C/ObjC Header
Tab Width: 4
Ln 1300, Col 1
INS

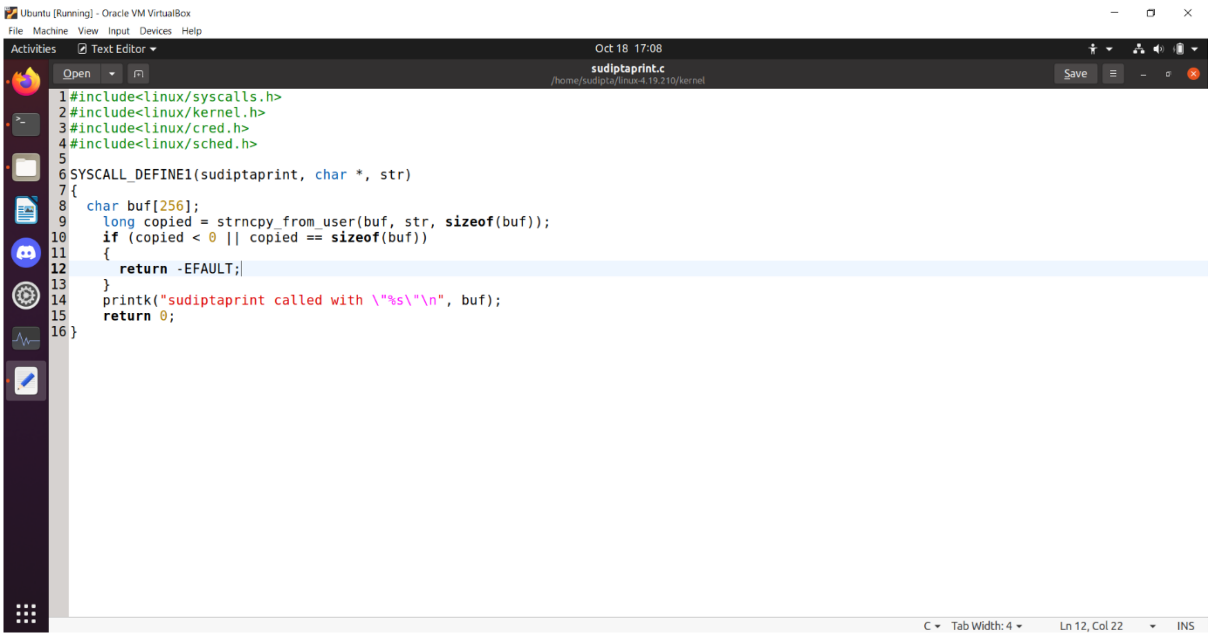
```
extern long do_sys_open(int dfd, const char __user *filename, int flags,
                umode_t mode);

static inline long ksys_open(const char __user *filename, int flags,
                 umode_t mode)
{
    if (force_o_largefile())
        flags |= O_LARGEFILE;
    return do_sys_open(AT_FDCWD, filename, flags, mode);
}

extern long do_sys_truncate(const char __user *pathname, loff_t length);

static inline long ksys_truncate(const char __user *pathname, loff_t length)
{
    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;
}

asmlinkage int sudiptahello(void);
asmlinkage int sudiptaprint(char *);
asmlinkage int sudiptaprocess(void);
asmlinkage int sudiptagetpid(void);

#endif
```

Step 8: add four .c files in /kernel

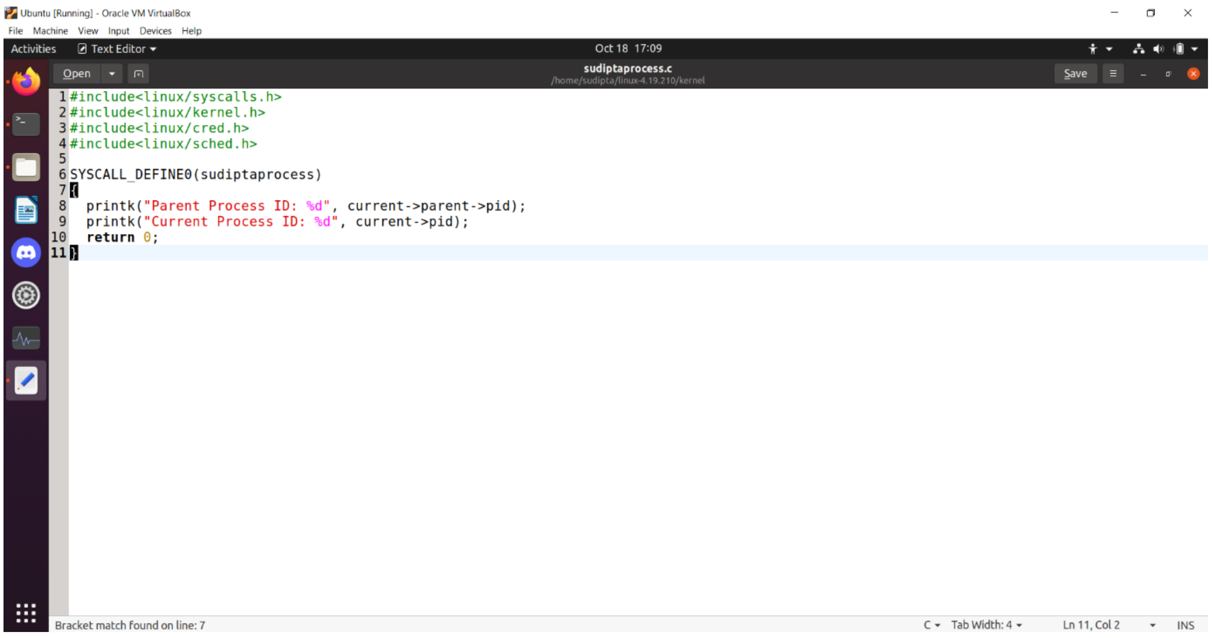
```
cd kernel

sudo gedit kernel/sudiptahello.c

sudo gedit kernel/sudiptaprint.c

sudo gedit kernel/sudiptaprocess.c

sudo gedit kernel/sudiptagetpid.c
```


Ubuntu [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities
Text Editor
Oct 18 17:08
Open
sudiptahello.c
/home/sudipta/linux-4.19.210/kernel
Save
C
Tab Width: 4
Ln 8, Col 35
INS

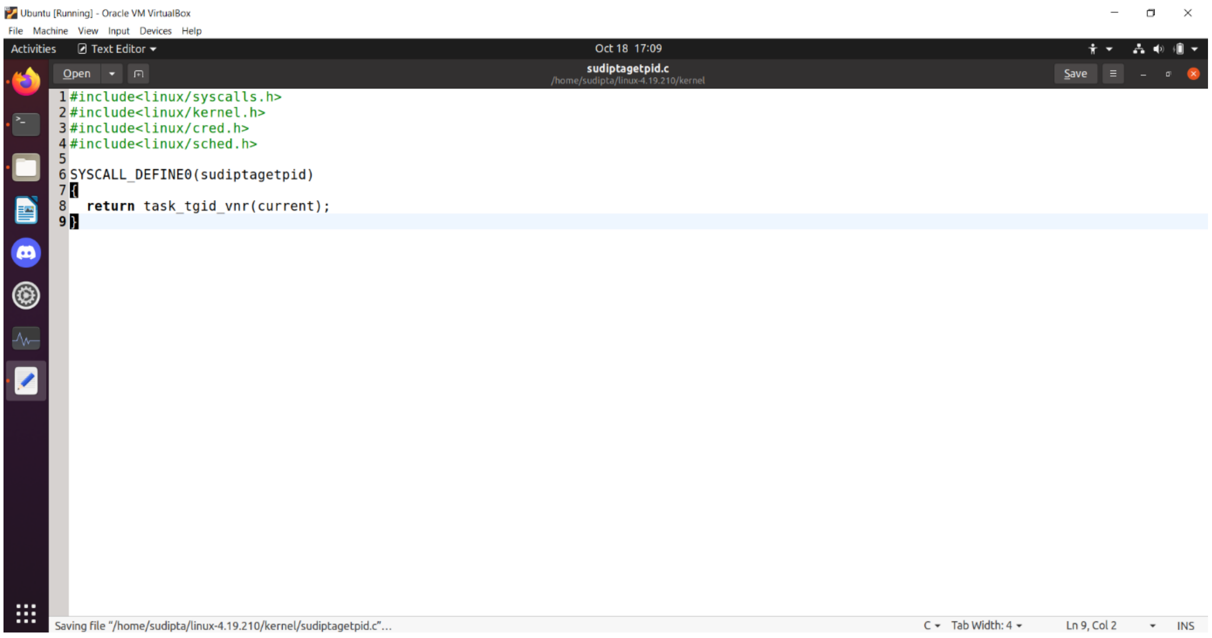
```c
#include<linux/syscalls.h>
#include<linux/kernel.h>
#include<linux/cred.h>
#include<linux/sched.h>

SYSCALL_DEFINE0(sudiptahello)
{
  printk("Hello World Sudipta..");
  return 0;
}
```


Ubuntu [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities
Text Editor
Oct 18 17:08
Open
sudiptaprint.c
/home/sudipta/linux-4.19.210/kernel
Save
C
Tab Width: 4
Ln 12, Col 22
INS

```c
#include<linux/syscalls.h>
#include<linux/kernel.h>
#include<linux/cred.h>
#include<linux/sched.h>

SYSCALL_DEFINE1(sudiptaprint, char *, str)
{
  char buf[256];
    long copied = strncpy_from_user(buf, str, sizeof(buf));
    if (copied < 0 || copied == sizeof(buf))
    {
      return -EFAULT;
    }
    printk("sudiptaprint called with \"%s\"\n", buf);
    return 0;
}
```


Ubuntu [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities
Text Editor
Oct 18 17:09
Open
Save
sudiptaprocess.c
/home/sudipta/linux-4.19.210/kernel
Bracket match found on line: 7
C
Tab Width: 4
Ln 11, Col 2
INS

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

SYSCALL_DEFINE0(sudiptaprocess)
{
  printk("Parent Process ID: %d", current->parent->pid);
  printk("Current Process ID: %d", current->pid);
  return 0;
}
```


Ubuntu [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities
Text Editor
Oct 18 17:09
Open
Save
sudiptagetpid.c
/home/sudipta/linux-4.19.210/kernel
Saving file "/home/sudipta/linux-4.19.210/kernel/sudiptagetpid.c"...
C
Tab Width: 4
Ln 9, Col 2
INS

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

SYSCALL_DEFINE0(sudiptagetpid)
{
  return task_tgid_vnr(current);
}
```

The codes are written in zip folder

Step 9: cp –v/boot/config-$(uname-r).config

Step 10: sudo gedit .config

Perform the below operation:

CONFIG_SYSTEM_TRUSTED_KEYS=””;

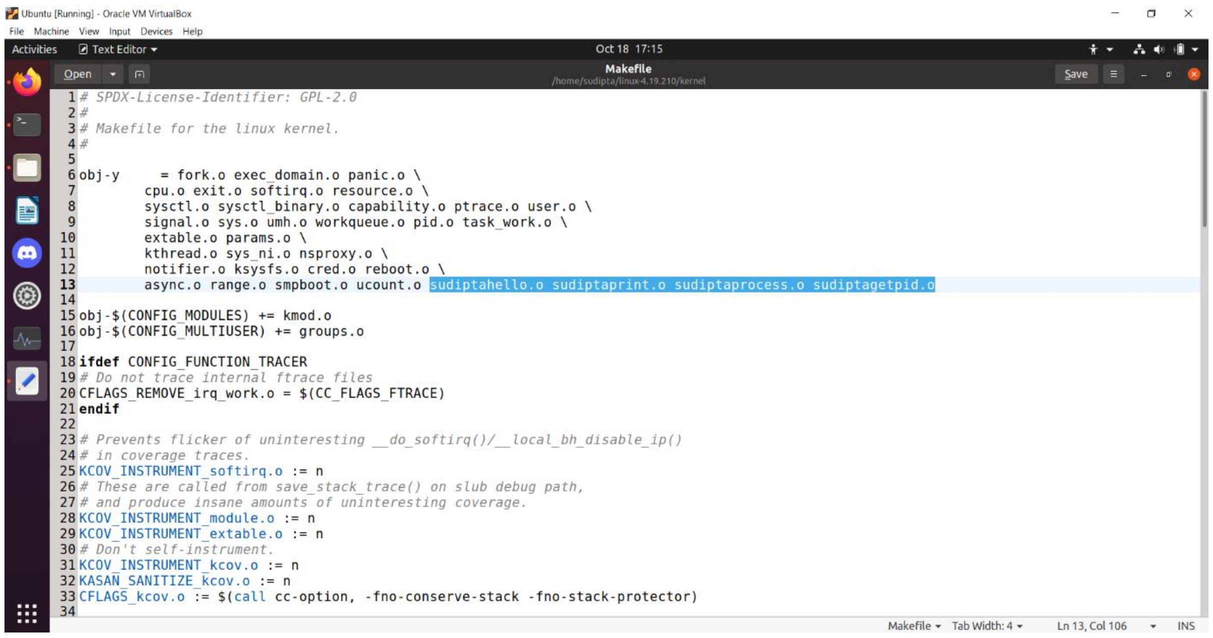
Step 11: sudo make olddefconfig

Step 12: change in makefile in kernel

sudo gedit kernel/Makefile

Append sudiptahello.o sudiptaprint.o sudiptaprocess.o sudiptagetpid.o at the end of obj-y :=

This is to ensure that the .c files are compiled and included in the kernel source code.


Ubuntu [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities
Text Editor
Oct 18 17:15
Open
Makefile
/home/sudipta/linux-4.19.210/kernel
Save
Makefile
Tab Width: 4
Ln 13, Col 106
INS

```
# SPDX-License-Identifier: GPL-2.0
#
# Makefile for the linux kernel.
#

obj-y     = fork.o exec_domain.o panic.o \
	    cpu.o exit.o softirq.o resource.o \
	    sysctl.o sysctl_binary.o capability.o ptrace.o user.o \
	    signal.o sys.o umh.o workqueue.o pid.o task_work.o \
	    extable.o params.o \
	    kthread.o sys_ni.o nsproxy.o \
	    notifier.o ksysfs.o cred.o reboot.o \
	    async.o range.o smpboot.o ucount.o sudiptahello.o sudiptaprint.o sudiptaprocess.o sudiptagetpid.o

obj-$(CONFIG_MODULES) += kmod.o
obj-$(CONFIG_MULTIUSER) += groups.o

ifdef CONFIG_FUNCTION_TRACER
# Do not trace internal ftrace files
CFLAGS_REMOVE_irq_work.o = $(CC_FLAGS_FTRACE)
endif

# Prevents flicker of uninteresting __do_softirq()/__local_bh_disable_ip()
# in coverage traces.
KCOV_INSTRUMENT_softirq.o := n
# These are called from save_stack_trace() on slub debug path,
# and produce insane amounts of uninteresting coverage.
KCOV_INSTRUMENT_module.o := n
KCOV_INSTRUMENT_extable.o := n
# Don't self-instrument.
KCOV_INSTRUMENT_kcov.o := n
KASAN_SANITIZE_kcov.o := n
CFLAGS_kcov.o := $(call cc-option, -fno-conserve-stack -fno-stack-protector)
```

Step 13: sudo make prepare

Step 14: sudo make –j4

Step 15: sudo make –j4 modules_install

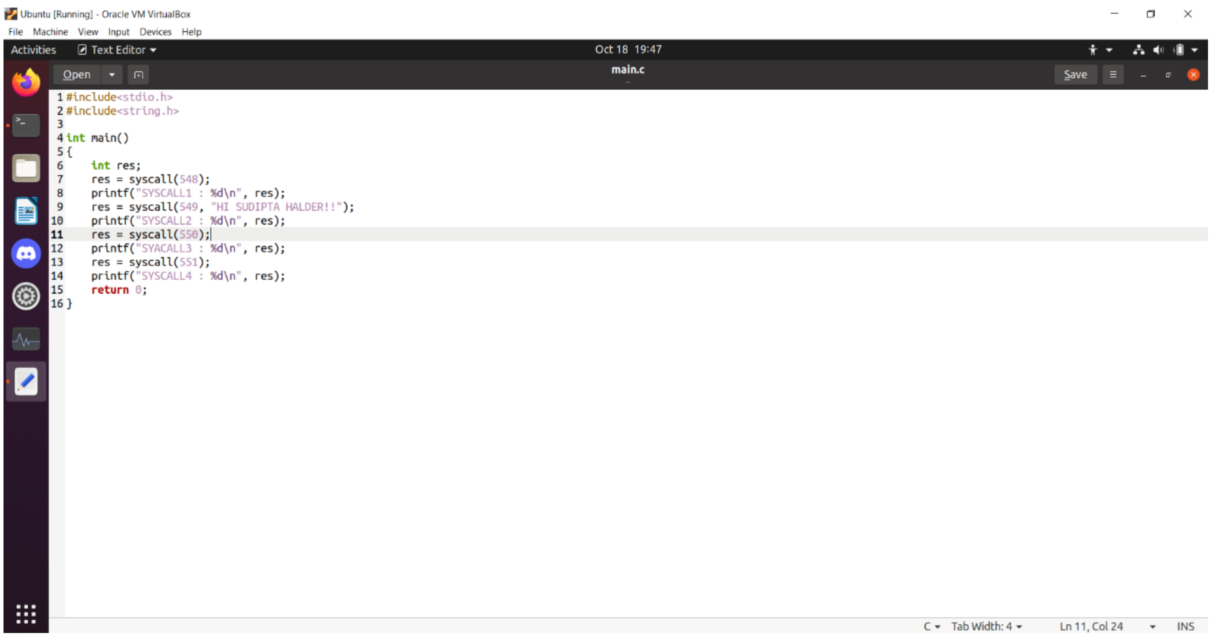
Step 16: sudo make install

Step 17: sudo reebot

Step 18: Then make a main.c file to test program

```
#include<stdio.h>

#include<string.h>

int main()

{

	int res;
```

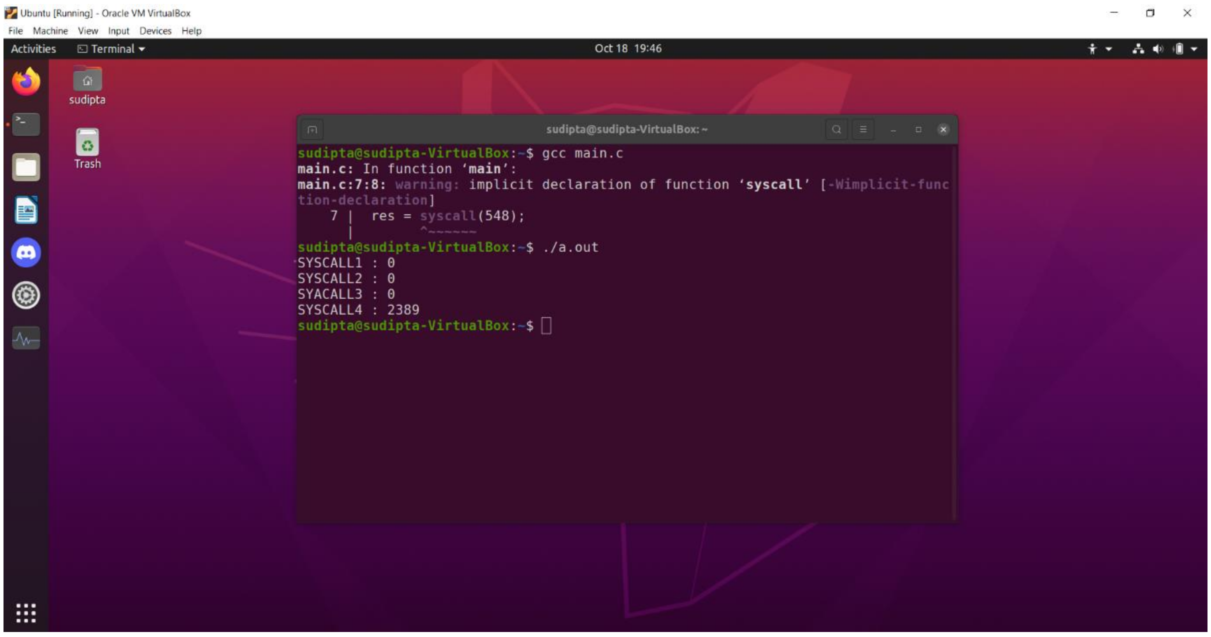
```
        res = syscall(548);
            printf("SYSCALL1 : %d\n", res);
            res = syscall(549, "HI SUDIPTA HALDER!!");
            printf("SYSCALL2 : %d\n", res);
            res = syscall(550);
            printf("SYSCALL3 : %d\n", res);
            res = syscall(551);
            printf("SYSCALL4 : %d\n", res);
            return 0;
}
```



```
#include<stdio.h>
#include<string.h>

int main()
{
    int res;
    res = syscall(548);
    printf("SYSCALL1 : %d\n", res);
    res = syscall(549, "HI SUDIPTA HALDER!!");
    printf("SYSCALL2 : %d\n", res);
    res = syscall(550);
    printf("SYACALL3 : %d\n", res);
    res = syscall(551);
    printf("SYSCALL4 : %d\n", res);
    return 0;
}
```

Compile the program: gcc main.c

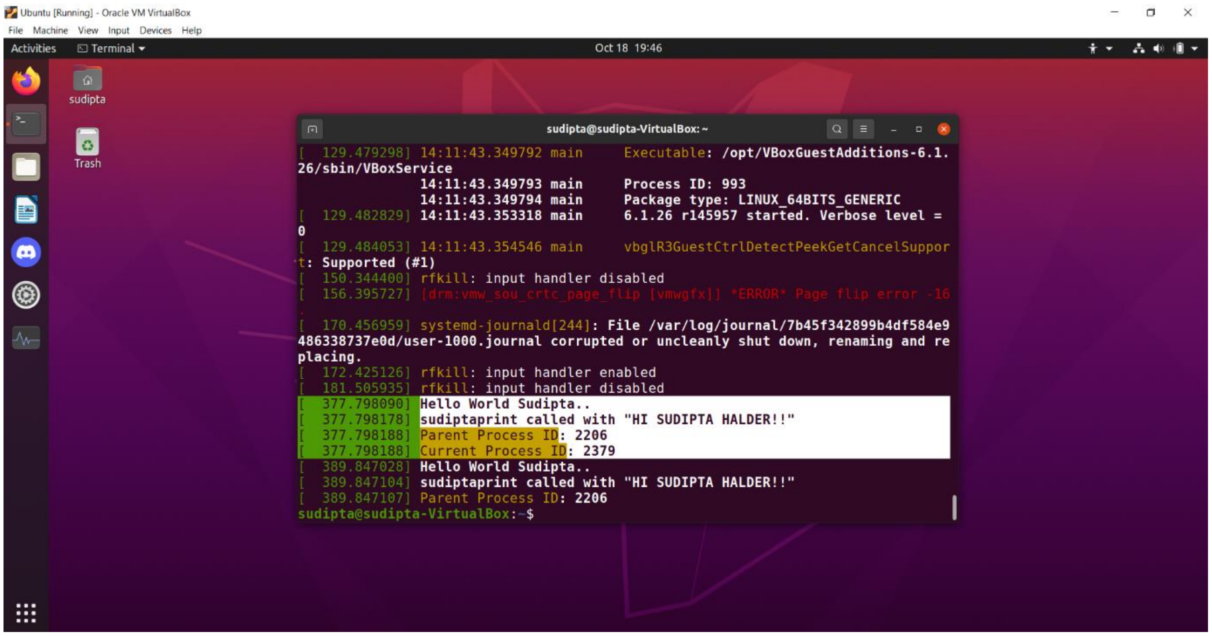
Execute the program: ./a.out


Ubuntu [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities
Terminal
Oct 18 19:46
sudipta
Trash
sudipta@sudipta-VirtualBox: ~

```
sudipta@sudipta-VirtualBox:~$ gcc main.c
main.c: In function ‘main’:
main.c:7:8: warning: implicit declaration of function ‘syscall’ [-Wimplicit-func
tion-declaration]
    7 |   res = syscall(548);
      |         ^~~~~~~
sudipta@sudipta-VirtualBox:~$ ./a.out
SYSCALL1 : 0
SYSCALL2 : 0
SYACALL3 : 0
SYSCALL4 : 2389
sudipta@sudipta-VirtualBox:~$ 
```

Step 19: type in terminal ‘dmesg’ to check the output written in kernel.

The output is visible in the screenshot below.


Ubuntu [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities
Terminal
Oct 18 19:46
sudipta
Trash
sudipta@sudipta-VirtualBox: ~

```
[  129.479298] 14:11:43.349792 main     Executable: /opt/VBoxGuestAdditions-6.1.
26/sbin/VBoxService
               14:11:43.349793 main     Process ID: 993
               14:11:43.349794 main     Package type: LINUX_64BITS_GENERIC
[  129.482829] 14:11:43.353318 main     6.1.26 r145957 started. Verbose level =
0
[  129.484053] 14:11:43.354546 main     vbglR3GuestCtrlDetectPeekGetCancelSuppor
t: Supported (#1)
[  150.344400] rfkill: input handler disabled
[  156.395727] [drm:vmw_sou_crtc_page_flip [vmwgfx]] *ERROR* Page flip error -16
.
[  170.456959] systemd-journald[244]: File /var/log/journal/7b45f342899b4df584e9
486338737e0d/user-1000.journal corrupted or uncleanly shut down, renaming and re
placing.
[  172.425126] rfkill: input handler enabled
[  181.505935] rfkill: input handler disabled
[  377.798090] Hello World Sudipta..
[  377.798178] sudiptaprint called with "HI SUDIPTA HALDER!!"
[  377.798188] Parent Process ID: 2206
[  377.798188] Current Process ID: 2379
[  389.847028] Hello World Sudipta..
[  389.847104] sudiptaprint called with "HI SUDIPTA HALDER!!"
[  389.847107] Parent Process ID: 2206
sudipta@sudipta-VirtualBox:~$
```