Computer Architecture and Operating Systems
MONSOON SEMESTER 2019

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Custom System Call

To find and print content from the task_struct of a process from its "pid" and save it to a file.

Synopsis of Implementation:

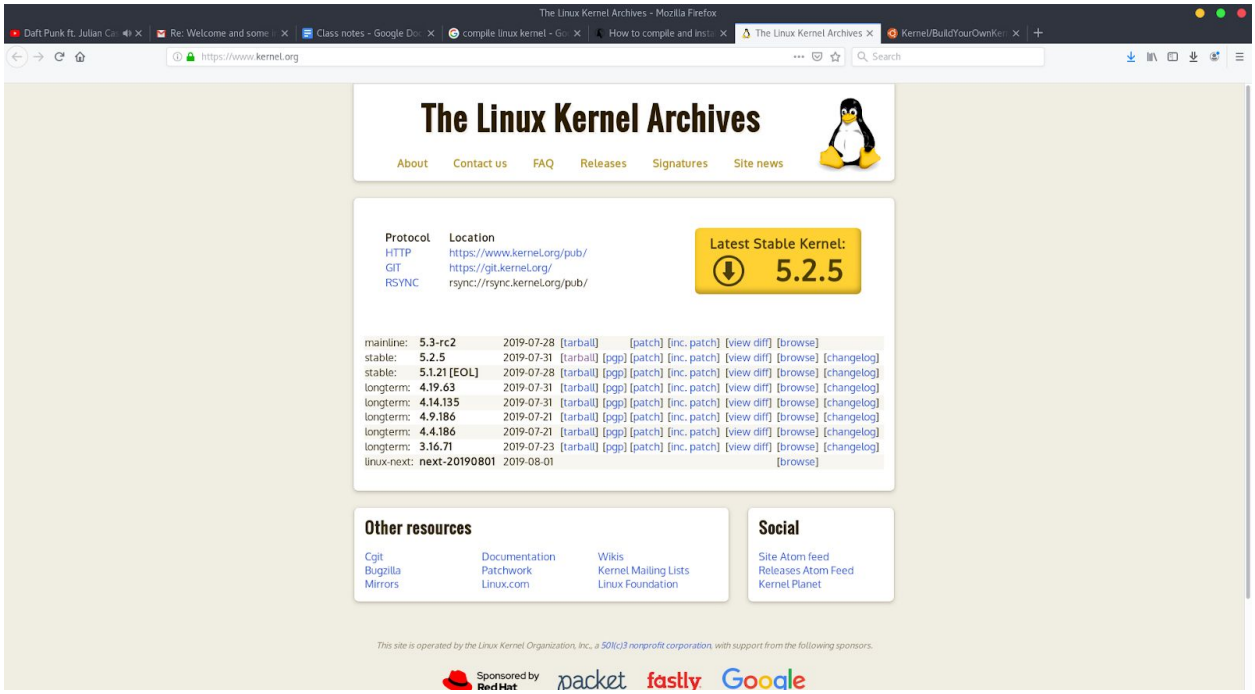
The /kernel/pid.c has defined the method pid_task which can be used to retrieve the task_struct of a process.

```
struct task_struct *pid_task(struct pid *pid, enum pid_type
type)

{

        //

}
```

The input process is then loaded in the task struct. The task struct loads from the */include/linux/sched.h*. Any of the parameters of the task_struct specified in *sched.h* can be printed.

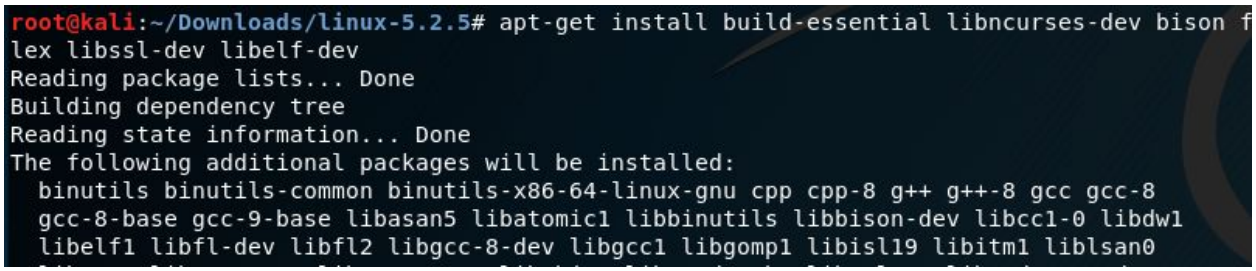
Since only other kernel system calls can be used in a system call, hence to write content to a file, a pointer to array of pointers of long is passed in the system call which is then populated by parameters of *task_struct* using the *copy_from_user* and *copy_to_user* syscalls.

Step 1: Start by downloading the linux kernel from kernel.org.



Step 2: Extract the kernel and make a copy of it.

Step 3: Install the necessary development tools and GCC.



Step 4: Create a new directory in one of the copies of the extracted linux kernel. Create the system call in this dir.

Step 5: Using asmlinkage, we tell compiler to look on the CPU stack for the function parameters, instead of registers.

Step 6: We pass the pid(int), the filename(char*) and a buffer(long) as parameters for the system call.**

Step 7: Using *find_vpid*, we search for our valid pid in the task_struct. If the struct value returns NULL, then the pid is not valid.

Step 8: Since, only other system calls can be used, we use *printk* to print messages from the kernel which can be checked using *dmesg*.

Step 9: To populate our buffer, we use the *copy_from_user* and *copy_to_user* syscalls.

Step 10: Compile the syscall with the Makefile and fix any error that shows up.

Step 11: The custom syscall is added to the systemcall table located at /arch/x8/entry/syscalls/syscall_64.tbl. Add the syscall at a new id.

```
333   common     sys_sh_task_info           sys_sh_task_info
```

Step 12: The custom syscall is to be now added to syscalls.h which is located at /include/linux/syscalls.h. Add the syscall before the #endif.

```
asmlinkage long sys_sh_task_info(int pid,char *filename,long **buf);

#endif
```

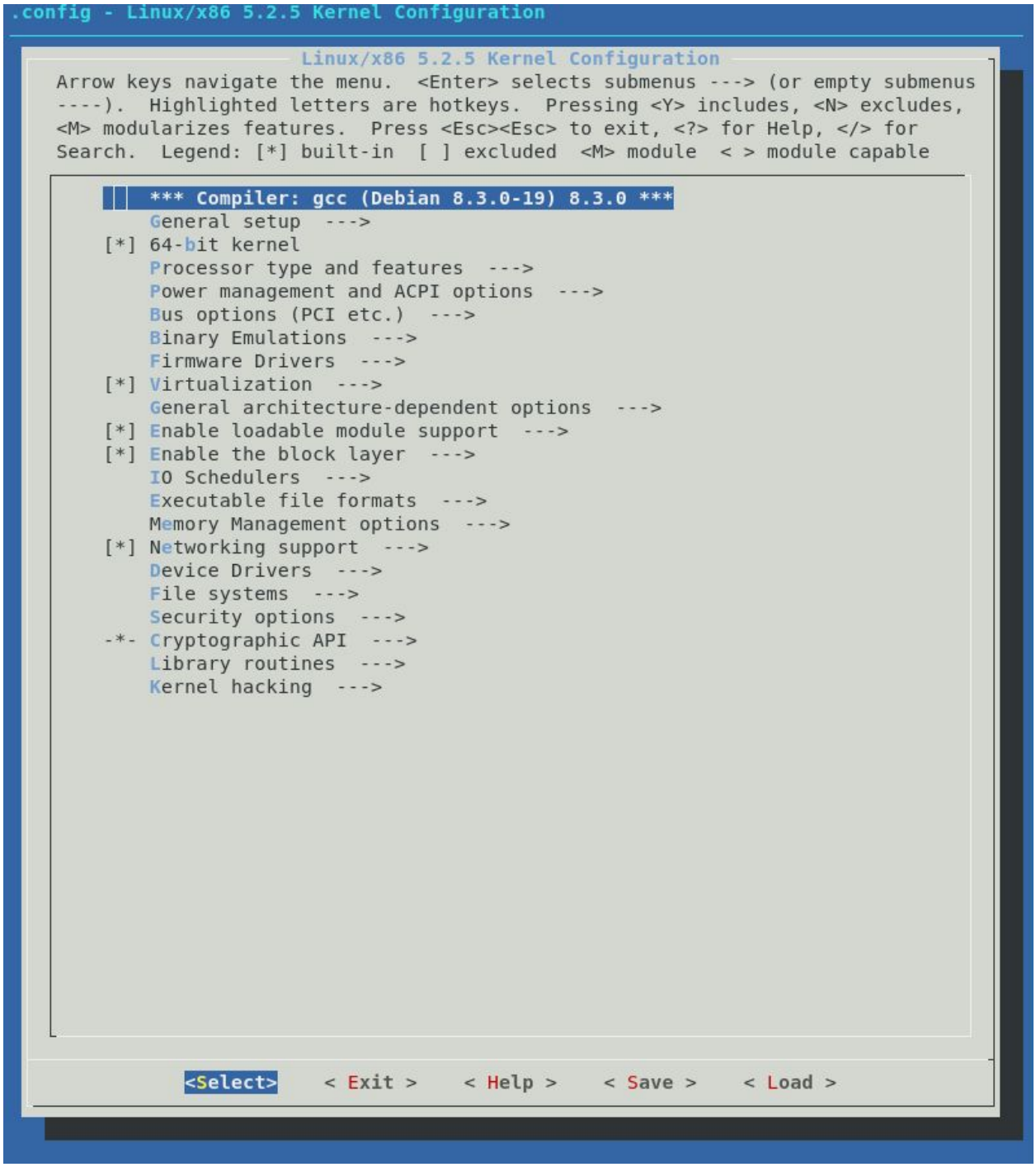
Step 14: Configure the Makefile of the kernel located at the parent directory. Find the below string:

```
 core-y          += kernel/ certs/ mm/ fs/ ipc/ security/ crypto/
block/
```

And Replace it with :

```
core-y          += kernel/ certs/ mm/ fs/ ipc/ security/ crypto/
block/ <directory with custom syscall>
```

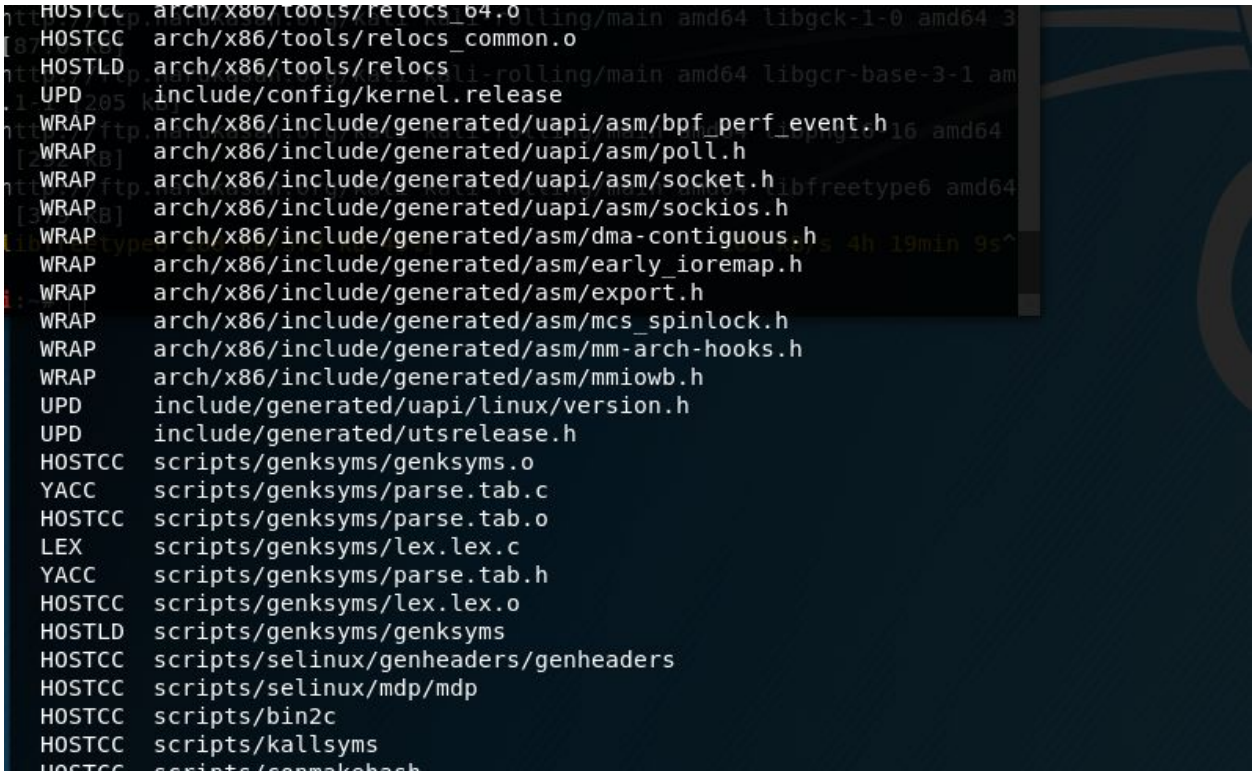
Step 15: Compile the linux kernel. Save the .config file using *make menuconfig* command.



Step 16: Customize the kernel at the menuconfig.

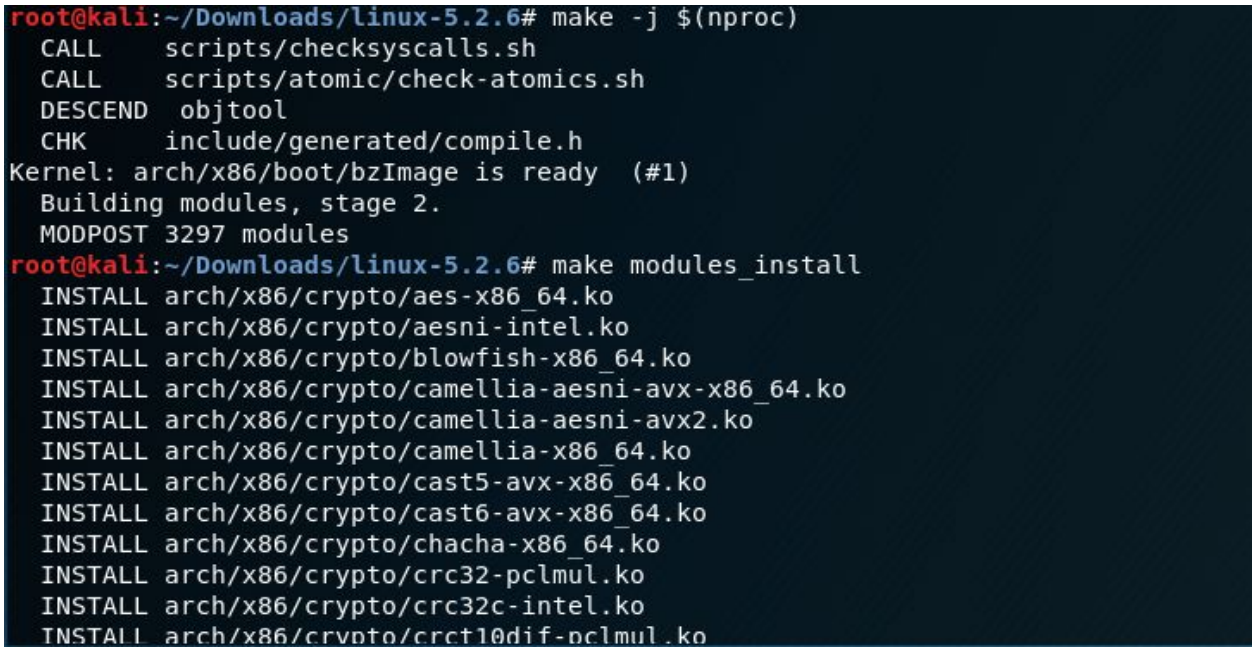
Step 17: Compile the kernel.

Command: **make -j $(nproc)**



Step 18: On successful compilation, install the modules.

Command: **make modules_install**



Step 19: Install the kernel and reboot.

Command: **make install**

```
root@kali:~/Downloads/linux-5.2.6#  sudo make install
sh ./arch/x86/boot/install.sh 5.2.6 arch/x86/boot/bzImage \
        System.map "/boot"
run-parts: executing /etc/kernel/postinst.d/apt-auto-removal 5.2.6 /boot/vmlinuz
-5.2.6
run-parts: executing /etc/kernel/postinst.d/initramfs-tools 5.2.6 /boot/vmlinuz-
5.2.6
update-initramfs: Generating /boot/initrd.img-5.2.6
WARNING: Setting CRYPTSETUP in /etc/initramfs-tools/initramfs.conf is deprecated
 and will stop working in the future. Use /etc/cryptsetup-initramfs/conf-hook in
stead.
run-parts: executing /etc/kernel/postinst.d/unattended-upgrades 5.2.6 /boot/vmli
nuz-5.2.6
run-parts: executing /etc/kernel/postinst.d/zz-update-grub 5.2.6 /boot/vmlinuz-5
.2.6
Generating grub configuration file ...
Found background image: /usr/share/images/desktop-base/desktop-grub.png
Found linux image: /boot/vmlinuz-5.2.6
Found initrd image: /boot/initrd.img-5.2.6
Found linux image: /boot/vmlinuz-4.15.0-kali2-amd64
Found initrd image: /boot/initrd.img-4.15.0-kali2-amd64
done
```

A custom Linux has been successfully installed.

Step 20: Check the custom syscall in a test C file.

FIN!

Files: sys_task_info.c

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

#include<linux/init.h>

#include<linux/sched.h>

#include<linux/syscalls.h>

#include<linux/sched.h>

#include <linux/slab.h>

asmlinkage long sys_sh_task_info(int pid,char *filename,long **buf)

{

  struct task_struct *task;

  struct pid *pid_str;

  pid_str=find_vpid(pid);

  task=pid_task(pid_str, PIDTYPE_PID);

  if (task == NULL)

  {

    printk(KERN_ERR "No Process with given PID\n");

    return 3;

  }

  else

  {

    long buf_kernel[50];
```

```
    long *user_ptrs[50];
    unsigned long res;
    int i;
    printk(KERN_ERR "Process: %s\n",  task->comm);
    printk(KERN_ERR "PID: %ld\n",  (long)task_pid_nr(task));
    printk(KERN_ERR "Process State: %ld\n",  (long)task->state);
    printk(KERN_ERR "Priority: %ld\n",  (long)task->prio);
    printk(KERN_ERR "Process Exit State: %ld\n",
(long)task->exit_state);
    printk(KERN_ERR "Process Exit Code: %ld\n",
(long)task->exit_code);
    printk(KERN_ERR "Process Exit Signal: %ld\n",
(long)task->exit_signal);
    printk(KERN_ERR "Process RT Priority: %ld\n",
(long)task->rt_priority);
    printk(KERN_ERR "Process Static Priority: %ld\n",
(long)task->static_prio);
    printk(KERN_ERR "Process Normal Priority: %ld\n",
(long)task->normal_prio);
    printk(KERN_ERR "Creating File....");
    buf_kernel[0]=(long)task_pid_nr(task);
    buf_kernel[1]=(long)task->state;
    buf_kernel[2]=(long)task->prio;
```

```
    buf_kernel[3]=(long)task->exit_state;
    buf_kernel[4]=(long)task->exit_code;
    buf_kernel[5]=(long)task->exit_signal;
    buf_kernel[6]=(long)task->rt_priority;
    buf_kernel[7]=(long)task->static_prio;
    buf_kernel[8]=(long)task->normal_prio;
    res = copy_from_user(user_ptrs,buf,sizeof(long *)* 50);
    for (i=0; i<50; i++)
    {
      res=copy_to_user(user_ptrs[i],&buf_kernel[i],sizeof(long));
    }
    return 0;
  }
}
```

Makefile for System Call

```
obj- y:= sys_sh_task_info.o

all:

	make -C /lib/modules/$(shell uname -r)/build M=$(PWD)
modules

clean:

	make -C /lib/modules/$(shell uname -r)/build M=$(PWD) clean
```

Test C file for System Call

```
#include <stdio.h>

#include <linux/kernel.h>

#include <sys/syscall.h>

#include <unistd.h>

#include <stdlib.h>


#define sys_sh_task_info 333


int main()

{


      const int size = 10;

      long **buf = malloc(sizeof(long *) * size);

      for(int i=0; i<size; i++) buf[i] = malloc(sizeof(long));




      int sys = syscall(sys_sh_task_info,"232145","lol.txt",buf);

      printf("%d\n", sys);

      if (sys==3)

      {
```

```
        printf("Error Code: %ld\n", sys);
        printf("Error Name: ESRCH 3 No such process.PID Wrong!");

    }

    else if(sys==-1)
    {
        printf("Error Code: %ld\n", sys);
        printf("Error Name: EIO 5 Input/output error");
    }

    else
    {
        printf("PID: %ld\n",  *buf[0]);
        printf("Process State: %ld\n",  *buf[1]);
        printf("Priority: %ld\n",  *buf[2]);
        printf("Process Exit State: %ld\n",  *buf[3]);
        printf("Process Exit Code: %ld\n",  *buf[4]);
        printf("Process Exit Signal: %ld\n",  *buf[5]);
        printf("Process RT Priority: %ld\n",  *buf[6]);
        printf("Process Static Priority: %ld\n",  *buf[7]);
```

```
        printf("Process Normal Priority: %ld\n",  *buf[8]);


        printf("Creating File....\n");
        FILE *fp = fopen("lol.txt", "ab+");


        fprintf(fp, "-------------\n");
        fprintf(fp, "PID: %ld\n",  *buf[0]);
        fprintf(fp,"Process State: %ld\n",  *buf[1]);
        fprintf(fp,"Priority: %ld\n",  *buf[2]);
        fprintf(fp,"Process Exit State: %ld\n",  *buf[3]);
        fprintf(fp,"Process Exit Code: %ld\n",  *buf[4]);
        fprintf(fp,"Process Exit Signal: %ld\n",  *buf[5]);
        fprintf(fp,"Process RT Priority: %ld\n",  *buf[6]);
        fprintf(fp,"Process Static Priority: %ld\n",  *buf[7]);
        fprintf(fp,"Process Normal Priority: %ld\n",  *buf[8]);
        fclose(fp);

}
```

```
    // printf("%ld", *buf[0]);

    return 0;

}
```