HCMC University Of Technology

Faculty Of Computer Science & Engineering

Course: Operating System

Assignment #1 – System Call

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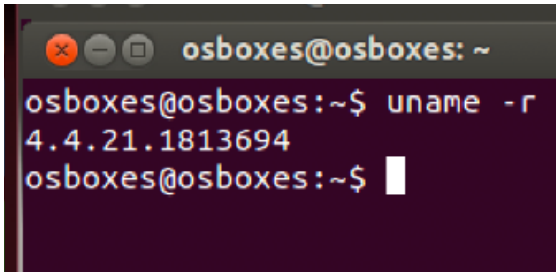
0. Preparation:

The first thing to in this assignment is prepare new kernel. Our mission is following the instruction in file PDF, dowloading , installing and compiling a new kernel. Before installing and compiling , we rename the new kernel version with student ID:

QUESTION: Why we need to install kernel-package ?

ANSWER: Because kernel-package is a package contains many kernel version, one of them will be suitable for your OS's configuration. Besides that, kernel-package is also used to compile and install a custom kernel. In this assignment, we gonna create a new system call and add it into kernel, make this kernel become unique.



QUESTION: Why we have to use another kernel source from the server such as http://www.kernel.org, can we compile the original kernel (the local kernel on the running OS) directly ?

ANSWER: There are some advanteges of using a new kernel form server such as http://www.kernel.org :

- Process some special requirement or process or handle conflict between hardware and default kernel.
- Using many kernel options which is not supported for default kernel.
- Optimize kernel.
- Running kernel version for developer.

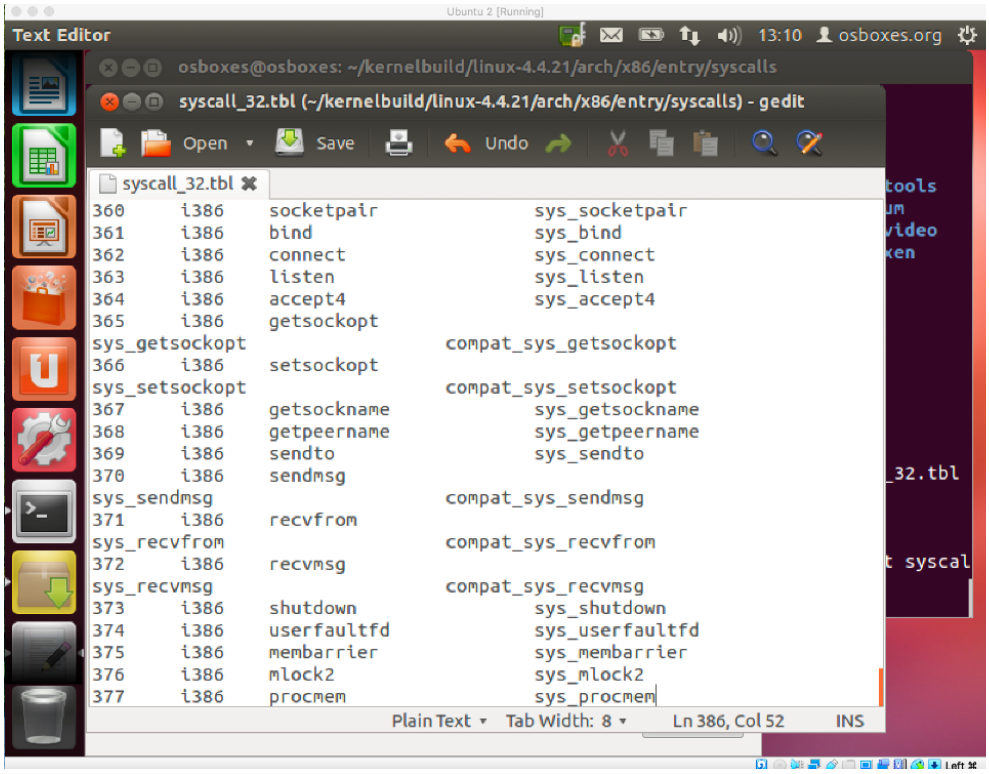
Yes, we can also compile the original kernel but we have to check to make sure the kernel version is compatible to our configuration and in case we have problem while working with original kernel, system crash can happen. If we use original kernel, make sure there is nothing wrong.

1. Adding new system call

In this assignment we will try to create a new system call whose mission is sumary the information of a process in kernel mode and then send it to a variable in user mode. We will create a new struct .And prototype of system call is :

```
long procmem(int pid, struct prog_segs * info);
```

The first thing to do is adding the new system call to the kernel. Go to ~/kernelbuild/linux-4.4.21/arch/x86/entry/syscalls to edit syscall_32.tbl file and add system at the end of the file :

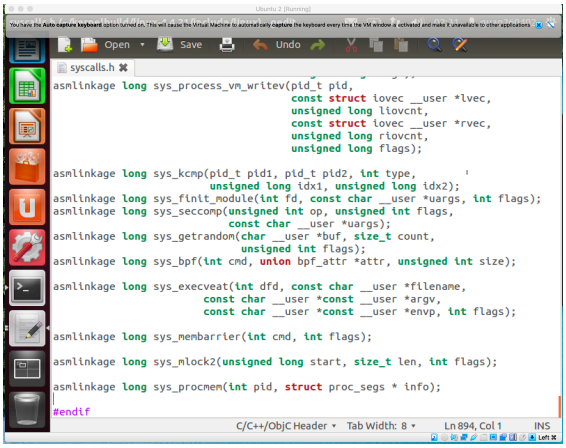


QUESTION: What is the meaning of the other parts, i.e. i386, procmem, sys_procmem ?

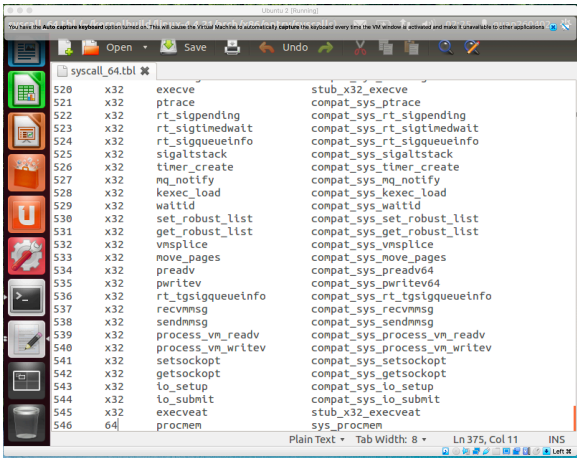
ANSWER :

- [number] : all syscall defined by a number to call the system call.
- [i386] : is an Aplication Binary Interface (ABI)
- [procmem]: this is the name of out system call.
- [sys_procmem]: the entry point , the name of function called to process the system call. The rule to name is " sys_[name] ". For example, " sys_procmem ".

Then save it and to the same thing with syscall_64.tbl :



After that, explicitly define this system call. To do so, we must add necessary information to kernel's header files. Open the file include/linux/syscalls.h and add the following line to the end of this file:



QUESTION: What is the meaning of each line above?

ANSWER :

struct proc_segs; // declare a struct of arguement which using in function
asmlinkage long sys_procmem(int pid, struct proc_segs * info);

A system call return long variable. The first arguement pid is the process ID which the user want to get the information .The second arguement info "asmlinkage" is a tag which is defined to notice to gcc compilers that this system call is not looking forward to find out any arguements in registers in common but in stack of CPU.All systemcall which is defined by tag 'asmlinkage' tag find their arguement in stack.

2. System call implement

Now we implement our system call. We will create a new source file named sys_procmem.c in arch/x86/kernel directory. The first thing to do in this file is declare new struct. And then implement system call.To get information of process, Linux data structure provide us a task_struct which describes a process or task in the system.

- We can see, task_struct have a component is struct mm_struct mm (mm means memory).

- Let take a detail look about struct mm_struct. They have all component have the same meaning with the component of struct proc_segs of us. So we will declare a variable which is belong to **struct task_struct.**

Then we will use for_each_process for searching process have the same pid. We have some condition to make sure the pid is valid:

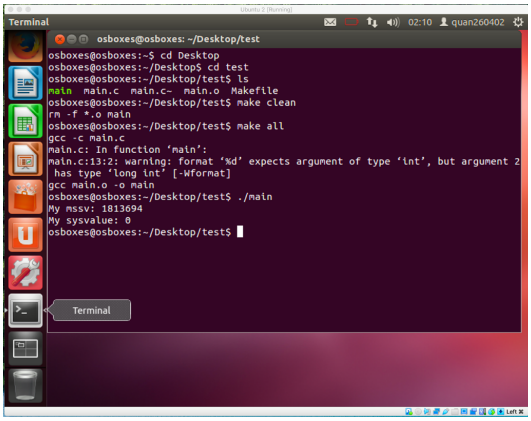
```
for_each_process(proc){
        if( proc->pid == pid){
                if(proc->mm != NULL){
                        //Do the code
                }
        }
}
```

Inside of the code, we declare a buffer variable belong to **struct proc_segs.** which will contains the value of memory of process's information. And then we use copy_to_user to copy *buff* (in kernel mode) to *info* (in user mode).
We will add an condition to make this copy process will do right thing or not.

```
int flag = copy_to_user(info,&buff,sizeof(buff);
if(flag != 0) return -1;
else return 0;
```

3. Compilation and Installation Process

Then we recompile and reinstall just like step 2 in and create a small C program to check it work



QUESTION : Why this program could indicate whether our system works or not?

ANSWER : This program can make sure that our system works or not because in this program, we call syscall([number_32],1,info) , it will call the system call in syscall_32.tbl or syscall_64.tbl and return value into sysvalue.
If sysvalue == 0 mean it worked else sysvalue == -1 it mean it have something wrong.
We can also check the result by info[0], if it work, it will return my Student ID.

4. Making API for System Call

After that, we create a procmem.h and copy it to /usr/include.

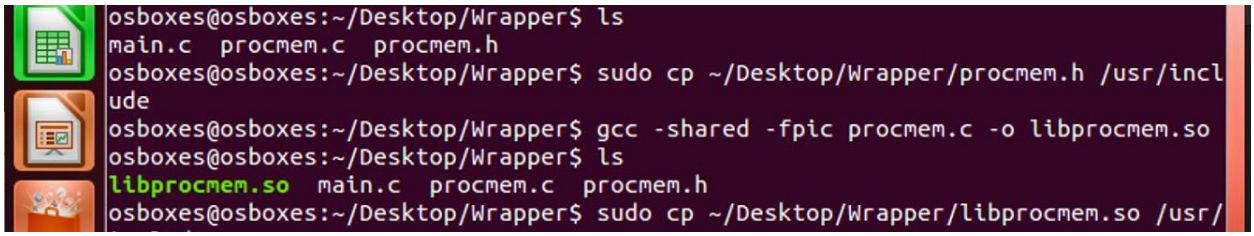
QUESTION: Why we have to re-define proc segs struct while we have already defined it inside the kernel?

ANSWER: The last we define proc_segs when it still in kernel mode, now we are in user mode so to do it conveniently, we define it one again.

Next step, we create a file named procmem.c to hold source code file for wrapper.
In this file, we just declare a long sysvalue to contain the value of system call and return sysvalue.

We then compile our source code as a shared object to allow user to integrate our system call to their applications. To do so, run the following command:

$ gcc -shared -fpic procmem.c -o libprocmem.so



Then copy libprocmem.so to /usr/lib.

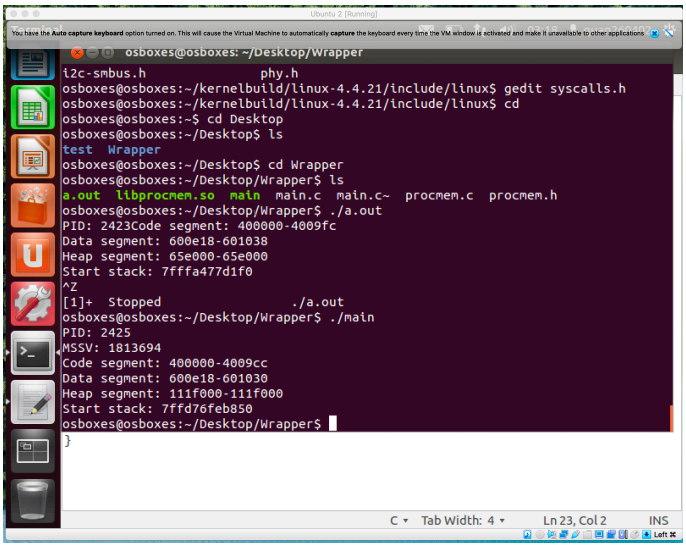
QUESTION: Why root privilege (e.g. adding sudo before the cp command) is required to copy the header file to /usr/include?

ANSWER: /usr is a child directory of root so to work with this data, we have to allocate permission for every single command line. We can see if we do not add “sudo” before command line, it will return a noctice that permission is denied. Clearly, sudo mean “super user do”, we use “sudo” to work with administrative applications .

Final step, we write a program as below and compile it with option *-lprocmem*:

Compile with -lprocmem option

$ gcc -o main main.c lprocme



- Thank you for reading -