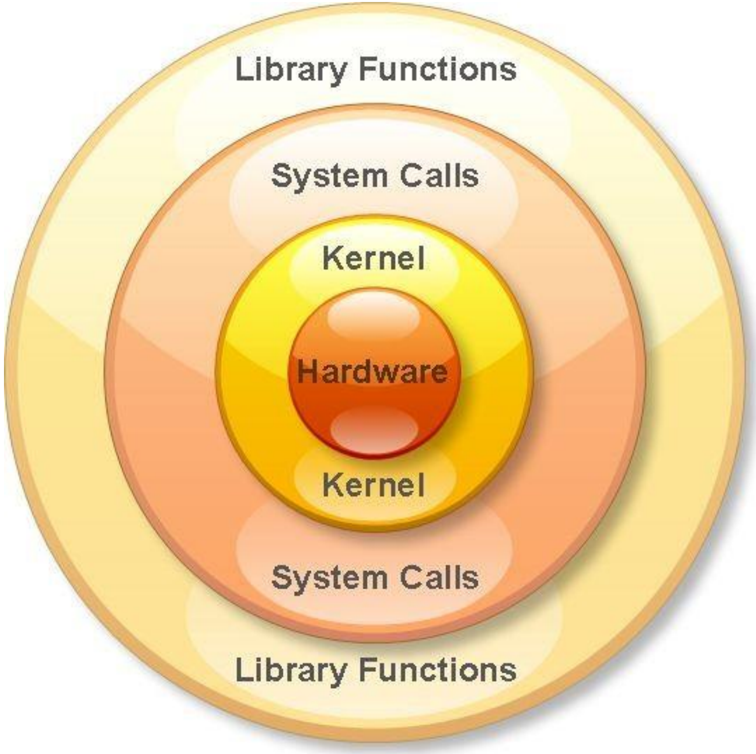
System Calls
(Φροντιστήριο για την 3η σειρά)

Michalis Pachilakis

mipach@csd.uoc.gr

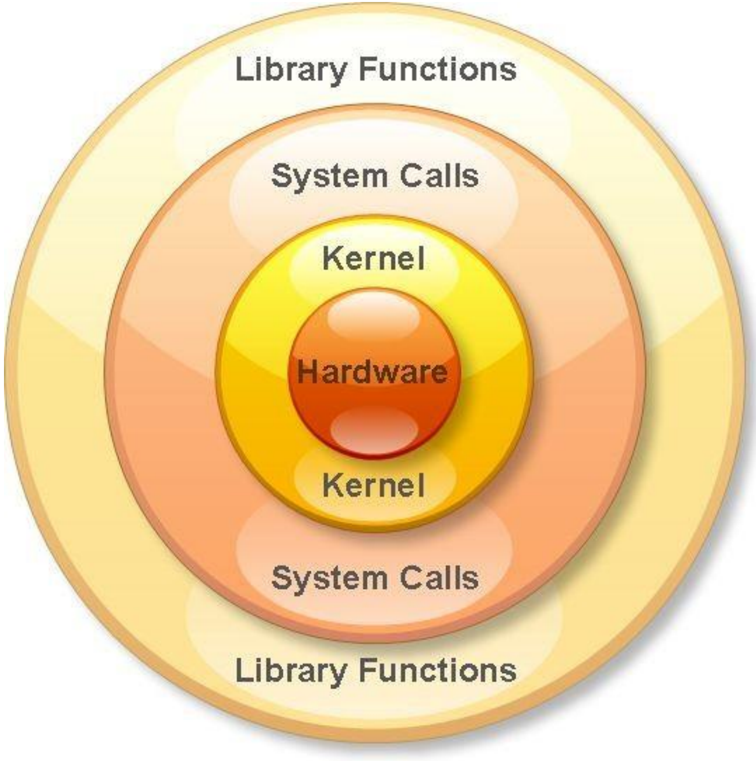
Kernel

- Core of the operating system
- Mediates access to computer resources
  - CPU, RAM, I/O
- Memory Management
- Device Management
- System Calls



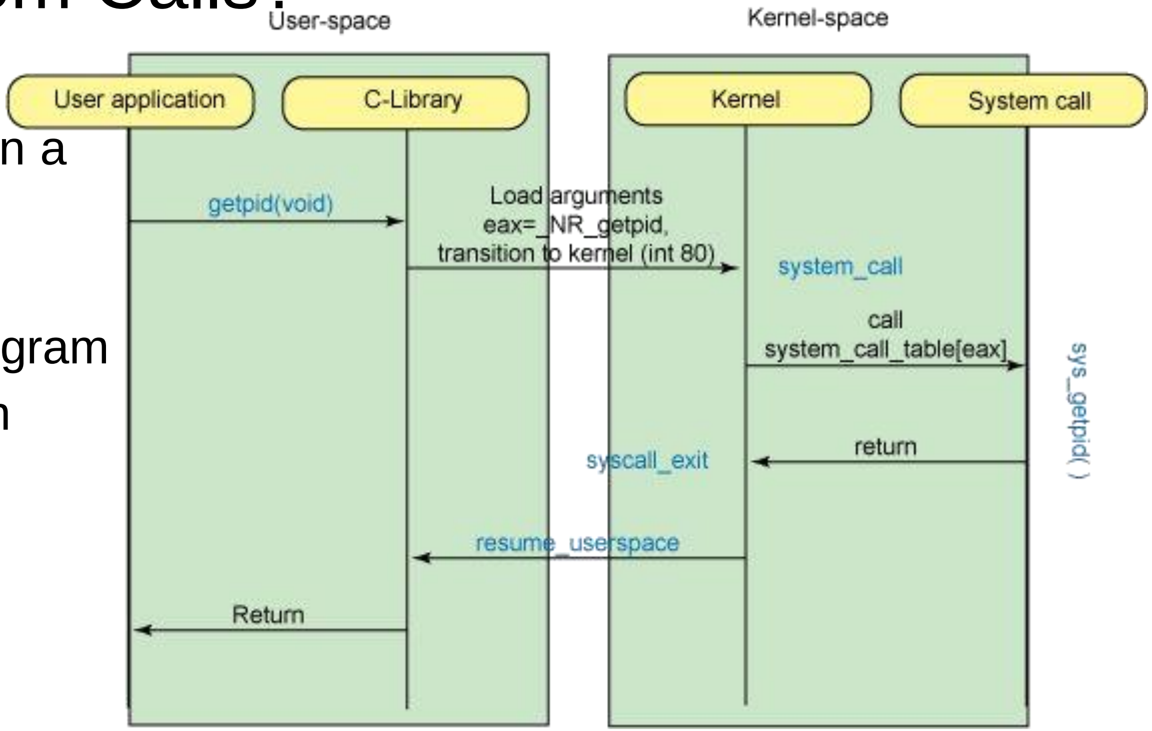
What is a System Call?

- The system call is the fundamental interface between an application and the Linux kernel



Why we need System Calls?

- System calls provide an essential interface between a process and the operating system
- A system call is how a program requests a service from an operating system's kernel



What can System Calls do?

- File management
  - create, open, delete..
- Process control
  - exec, kill, wait..
- Device management
  - request, release..
- Information maintenance
  - get time, set time..
- Communication
  - sockets, send, receive..

How do we use System Calls?

- sys/syscall.h is a small library that implements
  long syscall(long number, …);

- This function invokes the system call that corresponds to “number” while “...” corresponds to the rest of the arguments

Using Qemu

- Load the image and start the guest OS

```
$ cp ~hy345/qemu-linux/hy345-linux.img .
$ qemu-system-i386 -hda hy345-linux.img
```

- Load the image and start the guest OS with the new kernel

```
$ qemu-system-i386 -hda hy345-linux.img -append "  root=/dev/hda" -kernel
linux-2.6.38.1/arch/x86/boot/bzImage -curses
```

Getting the Linux Kernel src code

```
$ cd /spare
$ mkdir <username>
$ chmod 700 <username>
$ cd <username>
$ cp ~hy345/qemu-linux/linux-2.6.38.1.tar.bz2
.
$ tar -jxvf linux-2.6.38.1.tar.bz2
```

Implementing a new System Call

1. Define a system call number
2. Define a function pointer
3. Define a function
4. Implement the system call

Define a System Call number

- Every system call has an invocation number

- Edit: linux-2.6.38.1/arch/x86/include/asm/unistd_32.h
    - Define the new system call number at the bottom of the list
        - e.g. #define__NR_dummy_sys 341
    - Update the number of system calls
        - #define NR_syscalls 342

Define a function pointer

- The Kernel needs to have a function pointer pointing to the new system call

- Edit: linux-2.6.38.1/arch/x86/kernel/syscall_table_32.S

- Define the function pointer at the bottom of the list
  - e.g. .long sys_dummy_sys /* 341 */

Define a function

- We have to define the function signature in syscalls.h file
- Edit: linux-2.6.38.1/include/asm-generic/syscalls.h
- At the bottom of the file add:

```
#ifndef sys_dummy_sys
    asmlinkage long sys_dummy_sys(int arg0);
#endif
```

Implement the System Call part 1

- Touch and edit: linux-2.6.38.1/kernel/dummy_sys.c as such:

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

asmlinkage long sys_dummy_sys(int arg0)
{
      printk("Called system call dummy_sys with argument: %d\n", arg0);
      return ((long)arg0 * 2);
}
```

Implement the System Call part 2

- Edit: linux-2.6.38.1/kernel/Makefile
- Add: obj-y += dummy_sys.o
- Now you are ready to compile the Kernel with your new system call!

Compile the Linux Kernel

```
$ cd linux-2.6.38.1
```

Edit kernel source code to implement the new system calls

```
$ cp ~hy345/qemu-linux/.config .
```

Edit .config, find CONFIG_LOCALVERSION="-hy345", and append to the kernel's version name your username and a revision number

```
$ make ARCH=i386 bzImage
```

Simple demo program

```
#include <stdio.h>
#include <unistd.h>
#include <errno.h>
#define __NR_dummy_sys 341

int
main(void)
{
        printf("Trap to kernel level\n");
        syscall(__NR_dummy_sys, 42); /* you should check return value for errors */
        printf("Back to user level\n");
        return 0;



}
```

Test the system call

- **Start the VM using the new kernel**
  - $ qemu-system-i386 -hda hy345-linux.img -append "root=/dev/hda" -kernel linux-2.6.38.1/arch/x86/boot/bzImage -curses

- **Transfer the test file into the VM**
  - $ scp [username]@10.0.2.2:/path/to/thest/test.c . **<< Mind the dod!!**

- **Compile the test**
  - $ gcc -o test test.c

- **Run the test**
  - $ ./test

- **Check the kernel log**
  - $ dmesg | tail

What a process does

- A process declares a deadline and a computation time
- The process should be able to set **ONLY** its own parameters or the ones of its child process

What the kernel does

- At each scheduling interval the kernel first calculates the remaining computation time of each process and decides which process will run next.
- If a process exceeds it’s deadline the kernel kills it.
- If there is no process that has exceeded it’s deadline then we calculate which process will run next.

Implementation

- For this assignment you have to implement the following system calls
    - set_deadlines(int pid, unsigned long deadline,unsigned long computation_time);

Implementation

- Add 2 new fields in task_struct
  - unsigned long deadline;
  - unsigned int computation_time;