Operating Systems

Part 9

Operating Systems

- Master controller for all of the activities that take place within a computer
- Basic Duties:
  - manage the physical resources of the system
  - load and execute programs
  - controlling I/O devices

What *is* an operating system?

- The operating system is simply another program executing on the processor
- However it…
  - knows about all the hardware in the computer
  - runs in *privileged (or supervisor) mode*
  - which gives it the ability to run special instructions
  - other programs run in *user mode*

Multiprogrammed operating system

- Most computers support *multiprogramming* (aka *multitasking*)
- Presents the illusion that multiple programs are running simultaneously on a computer
  - each program executes for a fixed amount of time, known as a *timeslice*
  - user programs do not know if other programs are running on the system

Context Switch

- When a program's time slice ends…
  - operating system stops it
  - copies the contents its register file into memory
  - removes it from the processor
  - copies the next program's register file out of memory and into the register file
  - loads next program into the processor
- This process known as a *context switch*

Multiuser computers

- *Multiuser* systems allow more than one user to be logged in to the computer at one time
- Operating system must…
  - protect programs from accessing other program's data
  - prevent users from accessing other user's private data

Interact with Applications

- Necessary for multi-programmed systems
- Application Program Interface
  - application can tell the OS to perform a task
  - makes applications faster and smaller
  - also makes the system more secure since apps do not directly talk to IO
  - Application → Operating System → IO

Vector Tables

How software and hardware "talk"

Vector Tables

- Often an application (or a piece of hardware) needs to talk to the operating system
- Examples:
  - software needs the OS to output data
  - USB port notifies the OS that a device was plugged in

Vector Tables

- But how does this happen?
- The processor can be *interrupted* - alerted that something must be handled
- Each type interrupt has a unique number – which identifies the type of alert

Vector Table

- When interrupted, the processor looks up the number in the *"vector table"*
- Table contains the address of the subroutine to execute
- The interrupt number is an index into this table

How it Works

- When interrupted, the processor uses the interrupt number (index into the table) and looks up the address
- It then executes that address *(like a function you call in your Java programs)*

How it Works

- These subroutines belong to the *kernal* – the core of the operating system
- So, software can interrupt itself with a specific number (designated for software to use) when it needs to talk to the operating system

Instruction: Interrupt

- Interrupt Instruction allows your program to "interrupt" itself and pass information to the operating system *kernal*
- How you use it
  1. fill registers with values that will tell Linux what do to
  2. call Linux by using interrupt 0x80 (or a special *software interrupt* instruction)

Instruction: Interrupt (32-bit)

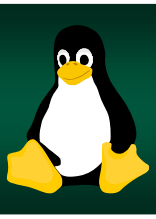
0x80

```
INT number
```


Instruction: syscall (64-bit)

```
SYSCALL
```

Calls vector reserved for OS

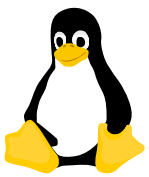


Linux System Calls

How software and hardware "talk"

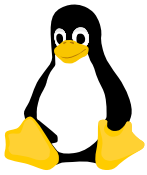
Interrupts on the Linux

- Linux, like other operating systems communicate with applications using *interrupts*
- Applications do not know where (in memory) to contact the kernal – so they ask the processor to do it



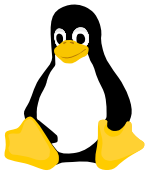
How It Works

1. Fill the registers
2. Interrupt using 0x80 (or a special *software interrupt* instruction)
3. Any results will be stored in the registers



Kernals are Simple!

- Linux only has **1** write and **1** read system call
- The location, number of bytes, and device only change
- It basically states *"write x many bytes from y to device z"*
- So, writing to the screen, a file, a port, etc…use the same call!



How to Call Linux – 32 bit

- In the 32-bit version of Linux, the kernal uses eax to identify the system call
- Each call has a unique constant
- Interrupt 0x80 activates the kernal (well, the code that handles app requests)

How to Call Linux – 32 bit

- Often a system call needs additional information to work
- Registers ebx, ecx, edx, etc… will contain this information

Linux 32 – Sys Write

```
mov   $4, %eax        Linux 32 call for WRITE
mov   $1, %ebx        1 = Screen
mov   $address, %ecx
mov   length, %edx
int   $0x80           Call Linux
```


Linux 32: Sys Read

```
mov   $3, %eax        Linux 32 call for READ
mov   $0, %ebx        0 = Keyboard
mov   $address, %ecx
mov   maxBytes, %edx  Maximum number of bytes to read
int   $0x80           Call Linux
```

How to Call Linux – 64 bit

- The 64-bit version of Linux changed the system calls
- The rax register still holds the system call number
- However, the system call numbers, themselves, are different now
- There are 329 total calls

How to Call Linux – 64 bit

- Different registers are used to hold data
- The order is also quite different: *rdi, rsi, rdx, r10, r8*
- The new instruction syscall talks to the OS

Some Linux 64 Calls

System Call	rax	rdi	rsi	rdx
read	0	fd (device)	address	max bytes
write	1	fd (device)	address	count
open	2	address	flags	mode
close	3	fd (device)		
get pid	39			
exit	60	error code		

Linux 64: Sys Write

```
mov   $1, %rax
mov   $1, %rdi
mov   $address, %rsi
mov   length, %rdx
syscall
```

Linux command for WRITE

1 = Screen

Call Linux

Linux 64: Sys Read

```
mov   $0, %rax
mov   $0, %rdi
mov   $address, %rsi
mov   maxBytes, %rdx
syscall
```

Linux command for READ

0 = Keyboard

Maximum number of bytes to read

Call Linux