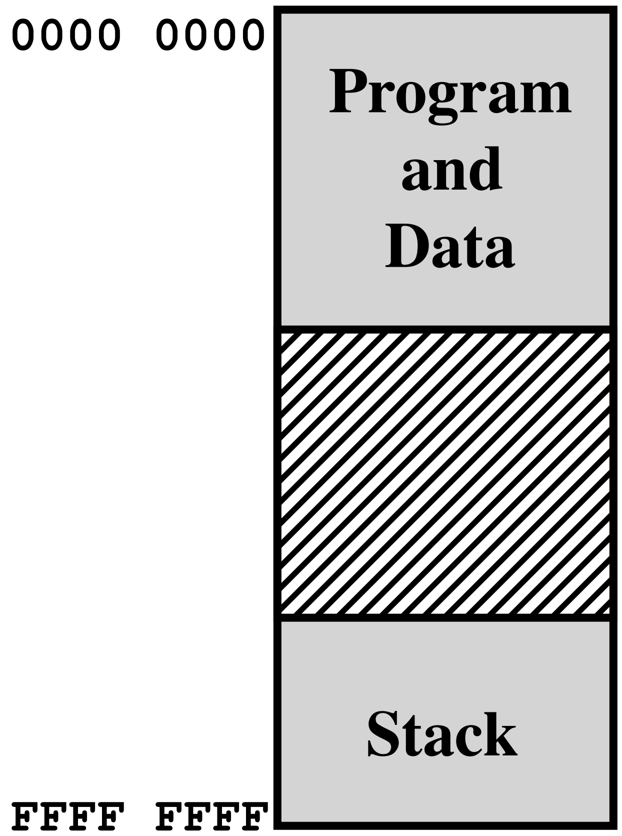
Overview of the Kernel and Shell

Outline:

- User Processes
- Kernel
- Virtual Address Space
- User Mode / System Mode
- Syscall Interface
- A Simple Shell

User Processes

“Virtual Address Space”
“Logical Address Space”
“Core Image”



User Processes

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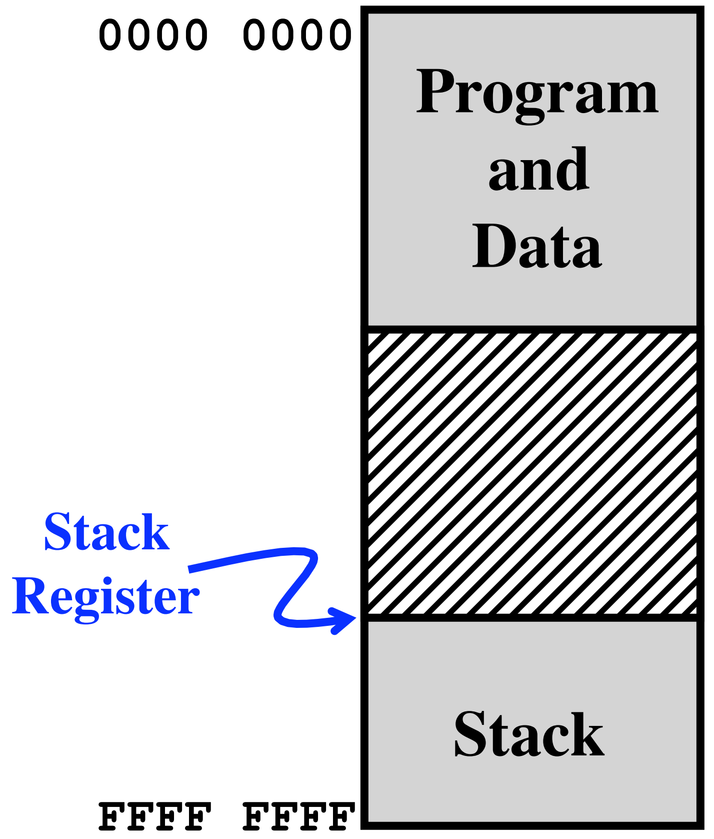
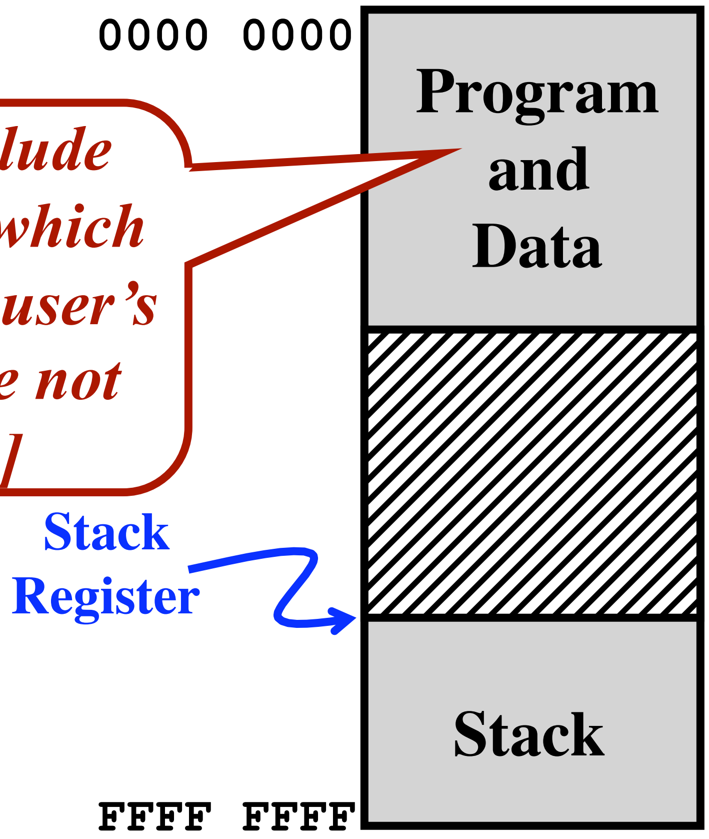
"Logical Address Space"
"Core Image"



User Processes

"Virtual Address Space"
"Logical Address Space"
"Core Image"

Will usually include library routines, which are "linked" into user's code. [These are not kernel code!]



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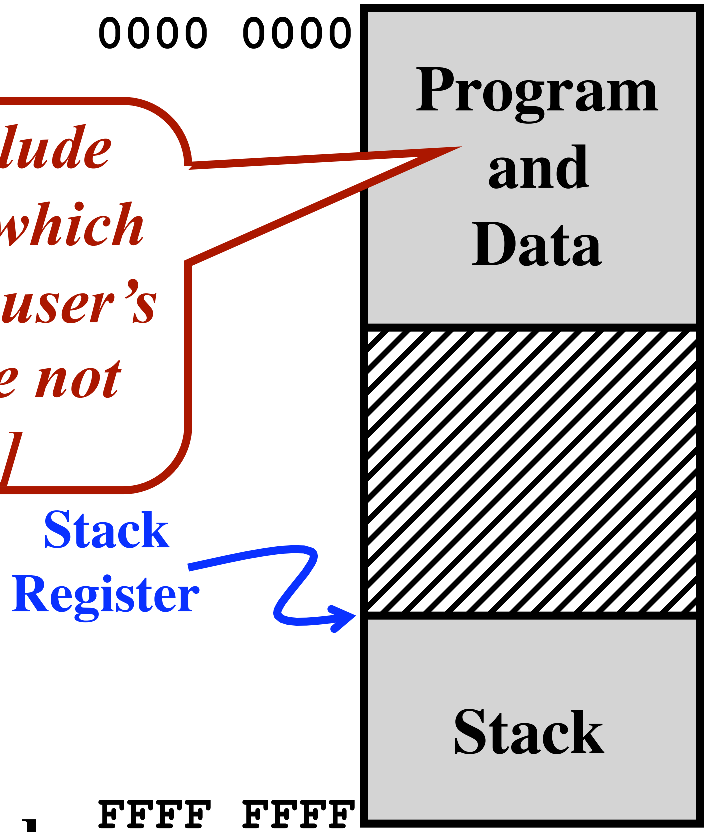
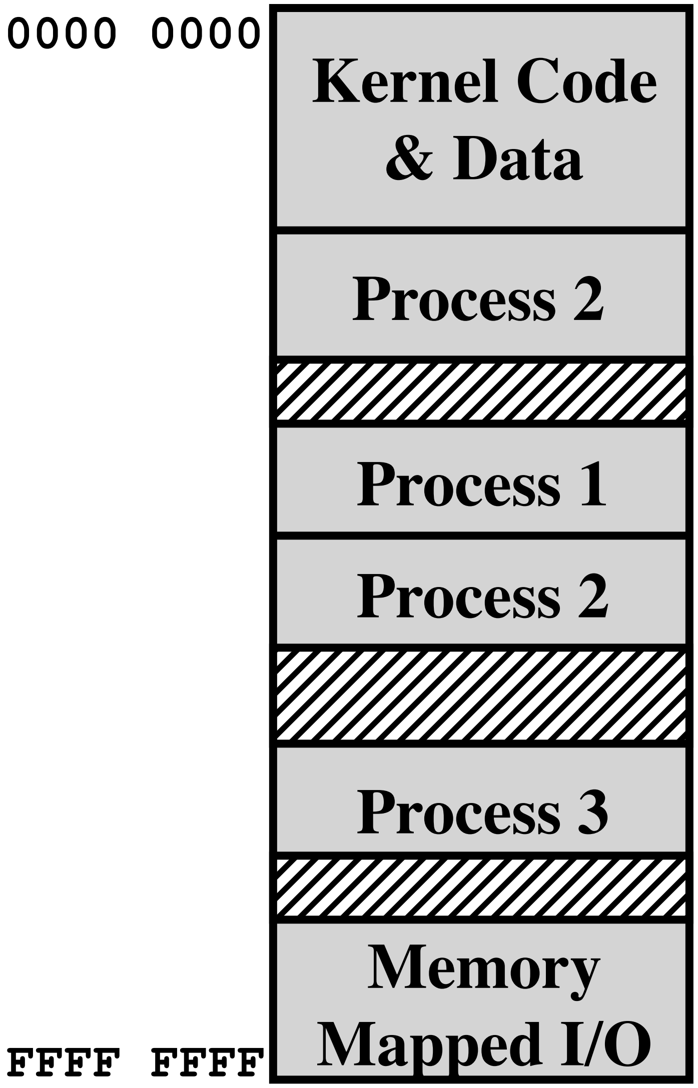


Has its own set of registers.
Cannot even see the memory of
  kernel or other processes.
Runs in "*user mode*".
  Some instructions are disallowed.
  (I/O, page table, etc.)
Has a single "*thread of execution*".
  Has its own PC ("program counter")

The Kernel

“*Physical Address Space*”
(actual installed main memory)

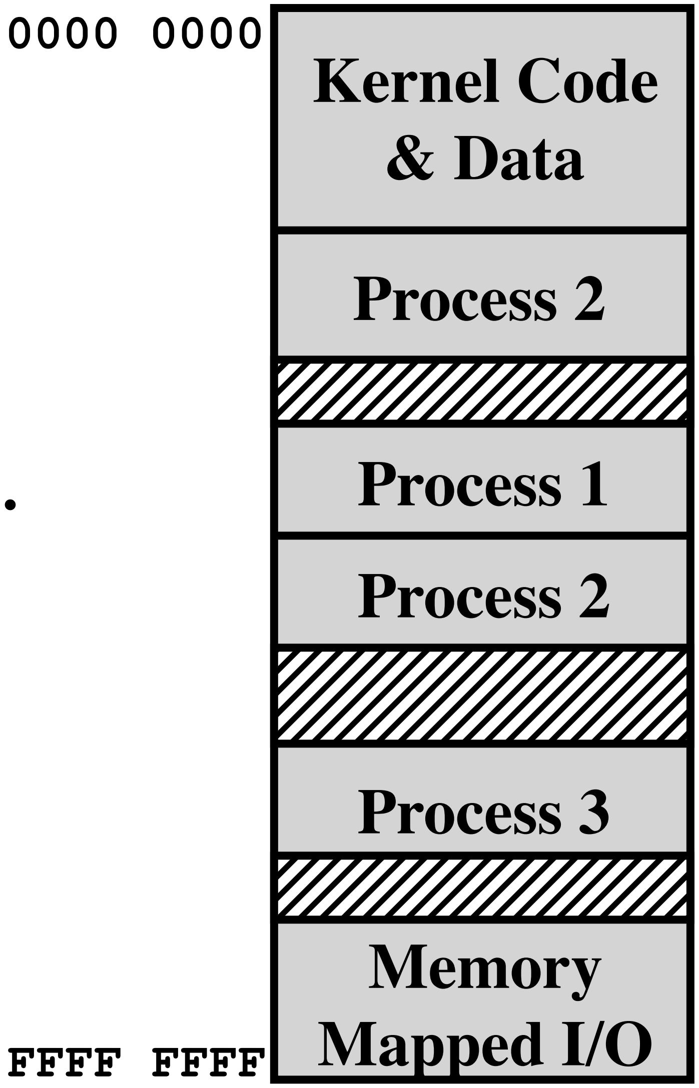


The Kernel

"*Physical Address Space*"
(actual installed main memory)

Process 2's Address Space
... is all over physical memory,
... and partly on disk,
... and shared with other processes.

We'll discuss:
"Virtual Memory Management"
"PAGE TABLE hardware"



The Kernel

"*Physical Address Space*"
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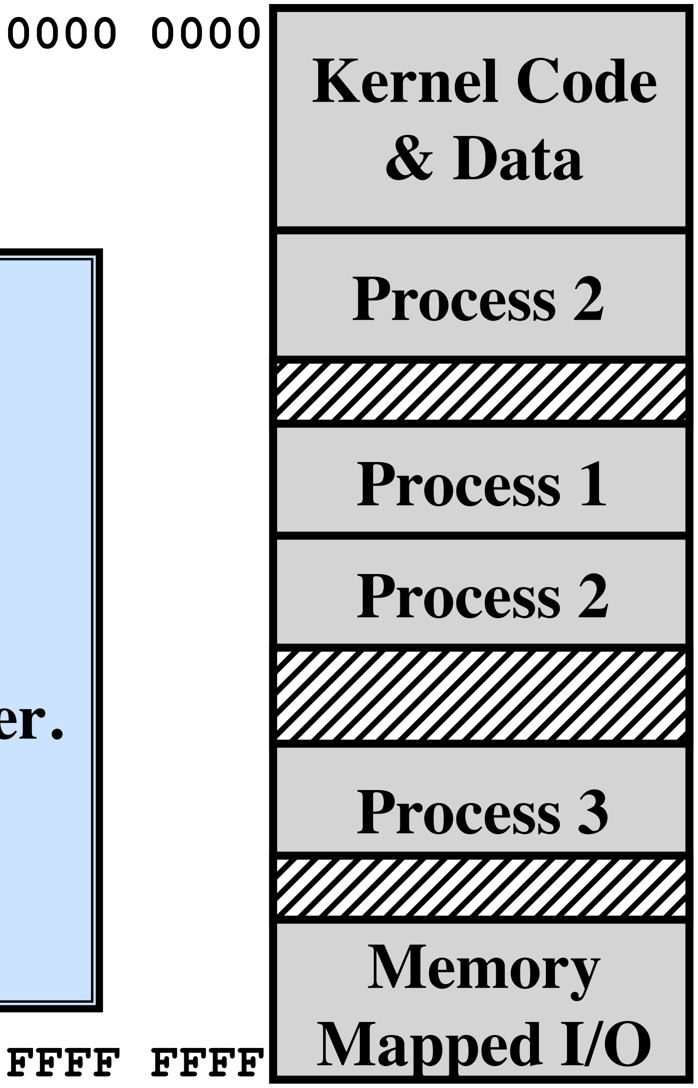


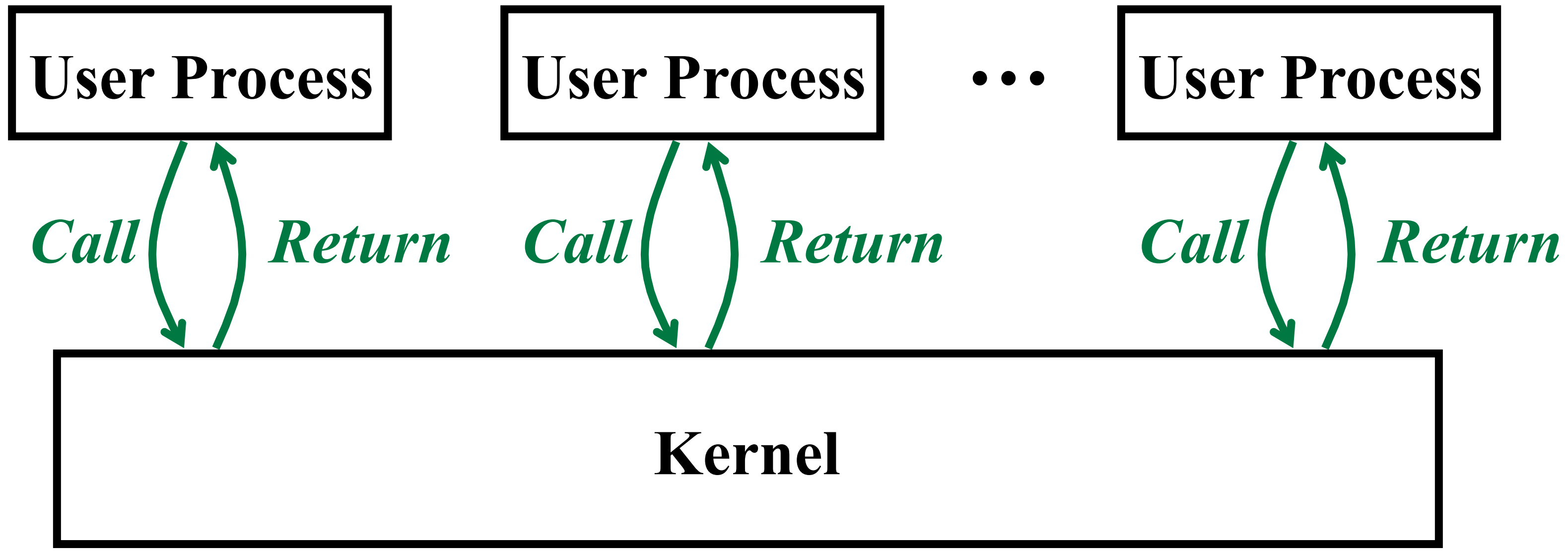
Kernel runs in "*System Mode*".

Must manage user processes.
  Page Tables --> Virtual Memory

Switches from one process to another.
  Time-slicing / multitasking

Must manage I/O devices.

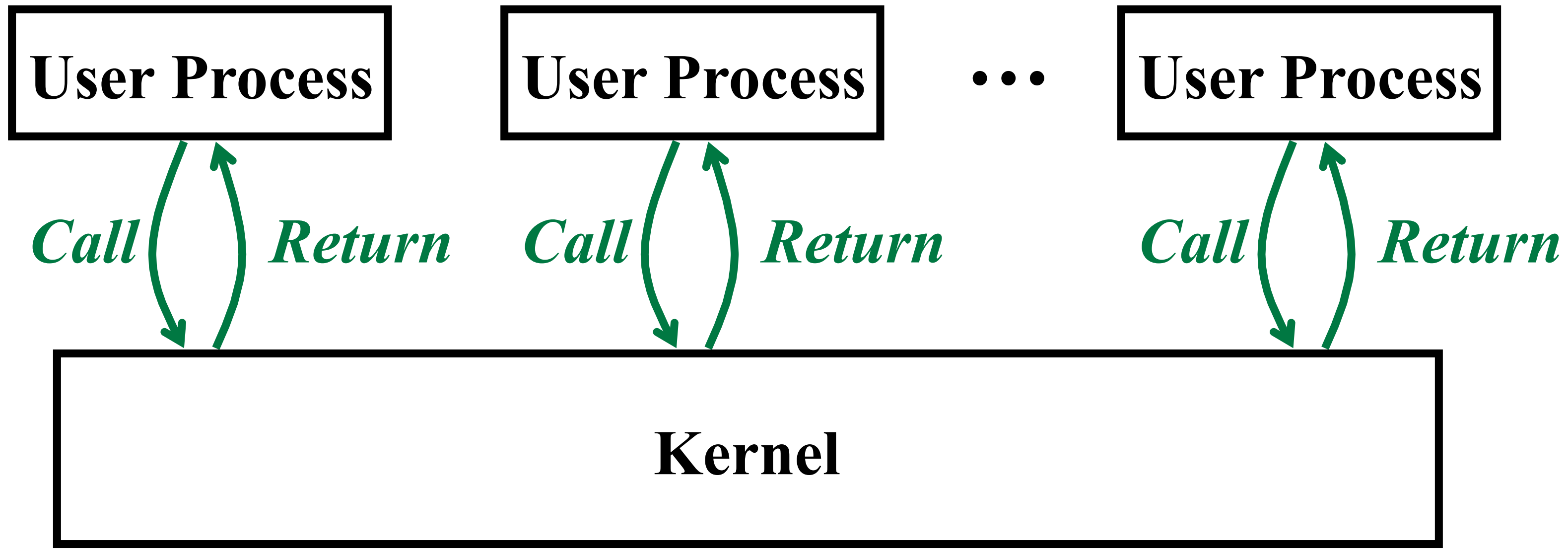
System Calls



User Process

- Runs in its own separate address space
- Runs in "User Mode"
- Can't use a normal CALL instruction

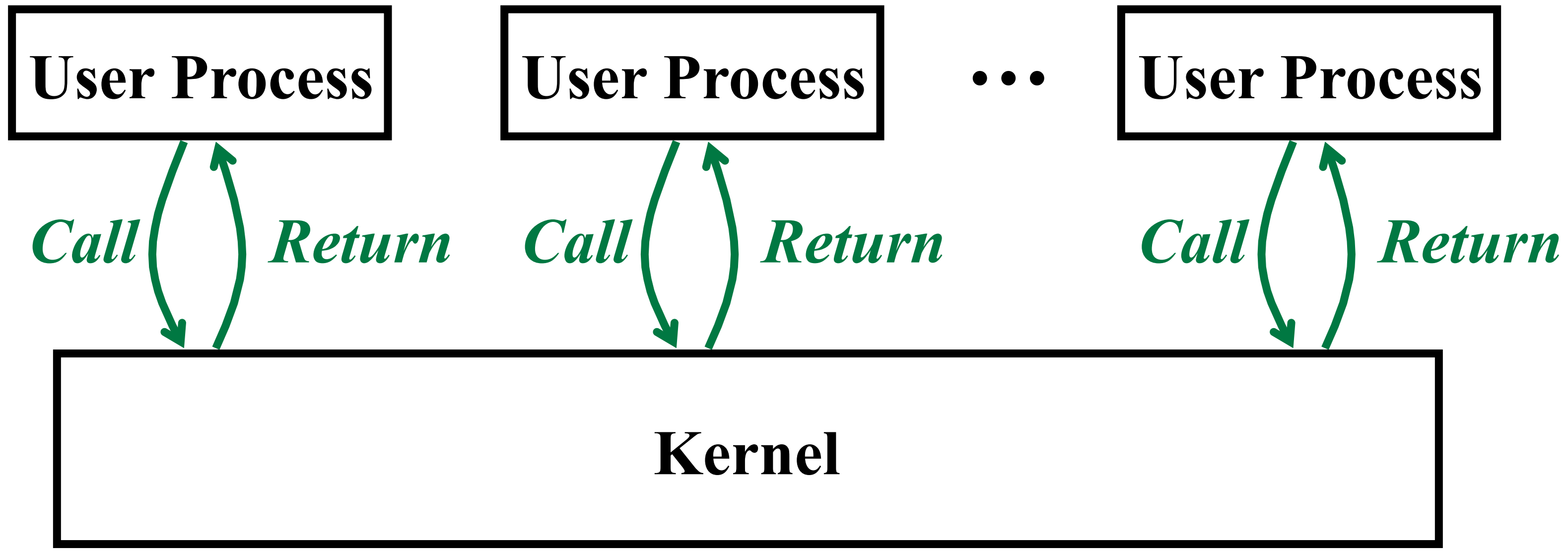
System Calls



The* SYSCALL *Instruction

- **Invoked by user code**
- **Switches into "System Mode"**
- **Transfers control to a kernel routine**
- **Args may be passed to kernel (including a function code)**

System Calls



The Return-From-Interrupt (RETI) Instruction

- Invoked by kernel code
- Switches back to “User Mode”
- Transfers control back to just after the SYSCALL

The “POSIX” Standard Interface

A set of SYSCALL functions
Implemented in all UNIX/LINUX kernels

File Management

```
  fd = open (filename, how, ...)
  x = close (fd)
  n = read (fd, buffer, numBytes)
  n = write (fd, buffer, numBytes)
  position = lseek (fd, offset, whence)
  s = stat (filename, bufferAddr)
```

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For each, there is a "stub routine".

- **Included from library**
- **Coded in assembly**
- **Move args into registers**
- **Execute a SYSCALL**
- **After return from kernel, return**

The “POSIX” Standard Interface

Directory Management

```
s = mkdir (name, mode)
s = rmdir (name)
s = link (name1, name2)
s = unlink (name)
s = mount (special, name, flag)
s = unmount (special)
```

The “POSIX” Standard Interface

Misc Syscalls

```
s = chdir (directoryName)
s = chmod (fileName, newModeBits)
s = kill (pid, signalType)
```

Send a “Signal” to a user process.

Somewhat like an “interrupt”.

```
seconds = time (&seconds)
```

Get the current date and time.

The “POSIX” Standard Interface

Misc Syscalls

```
pid = fork ()

s = execve (filename, argv, environp)

exit (status)

pid = waitpid (pid, &statloc, options)
```

The “POSIX” Standard Interface

Misc Syscalls

```
pid = fork ()
s = execve   filename, argv, environp)
exit (status
pid = waitpid         &statloc, options)
```

- Used to create a new process.
- Executed by the “*parent*” process.
- Create a new process, called the “*child*”.
- Make a new copy of parent’s address space.
- In parent, return “*process id*” of the child.
- In child, return 0.

The “POSIX” Standard Interface

Misc Syscalls

```
pid = fork ()
s = execve (filename, argv, environp)
exit (st  tus)
pid = w    oid (pid, &statloc, options)
```

- Read from a new program in from a file.
- Replace this process’s memory image.
- Begin executing the new program.
- Never returns, except when errors.

The “POSIX” Standard Interface

Misc Syscalls

```
pid = fork ()

s = execve (filename, argv, environp)

exit (status)

pid = waitpid (pid, &statloc, options)
```

- Terminate this process.
- Pass “***exit status***” (an integer) to the parent process.
- No return from this syscall!

The “POSIX” Standard Interface

Misc Syscalls

```
pid = fork ()
s = execve (filename, argv, environp)
exit (status)
pid = waitpid (pid, &statloc, options)
```

- Wait for a child to exit.
  (Option: wait for a specific child or any child.)
- Save the child’s “*exit status*” in statloc.
- If the child terminated earlier,
  then return its exit status immediately.

A UNIX Shell Program

```
while (TRUE) {
  type_prompt ();
  read_command (command, parameters);
  if (fork () != 0) {
      waitpid (-1, &status, 0);
  } else {
      execve (command, parameters, 0);
  }
}
```

A UNIX Shell Program

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while (TRUE) {
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  if (fork () != 0) {
      waitpid (-1, &status, 0);
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```

Parent's Code

Child's Code

Wait for any child