CS 3305A

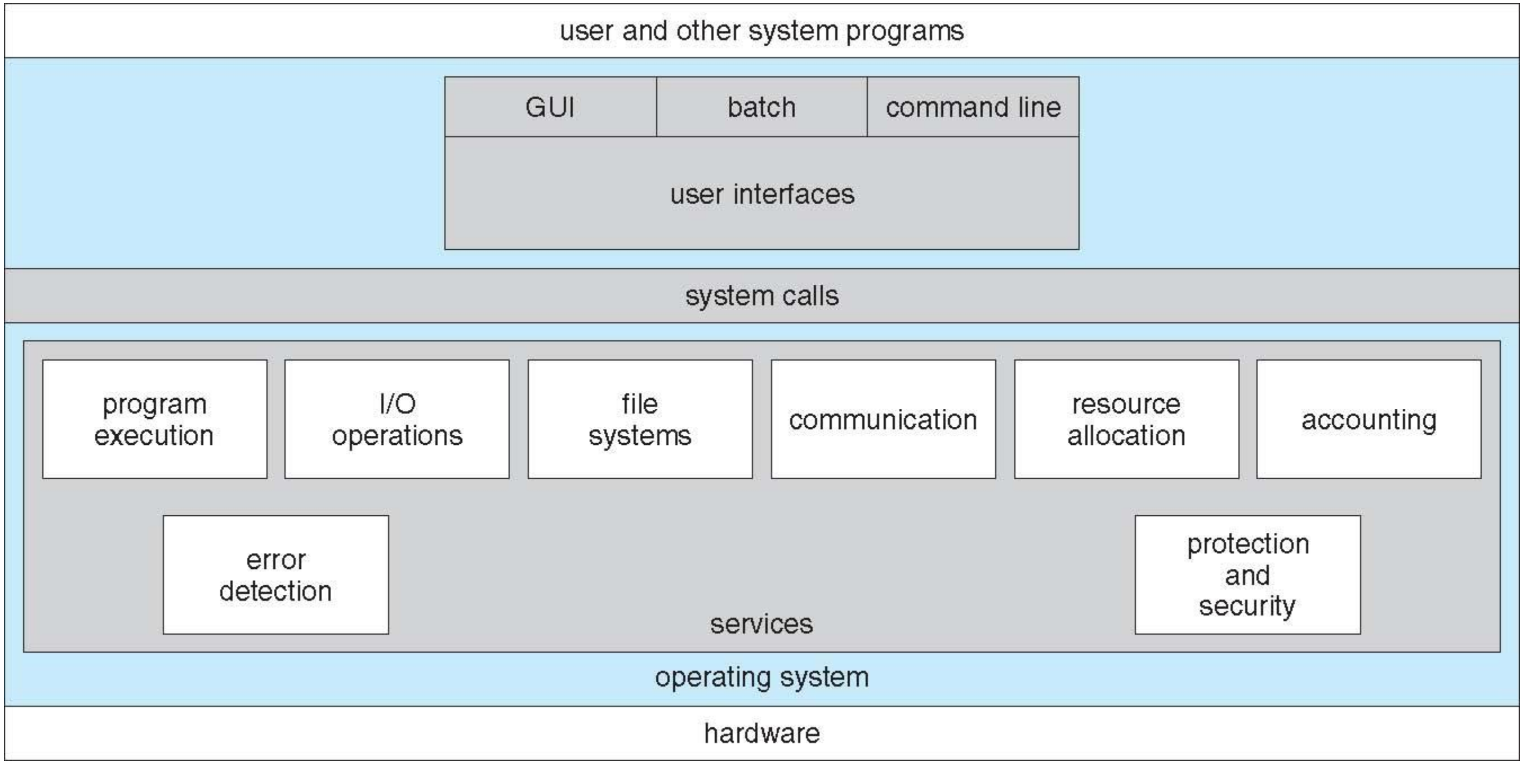
System Calls

Lecture 6
Sept 25th 2019

Interface to the OS

- All operating systems have an interface to OS that is accessible by users/user programs
- We had a discussion of shells which allows a user to interface with the operating system through the command line
  - A second strategy is through a graphical user interface (GUI)
- We had seen how system functions (such as fork()) can communicate with OS

A View of Operating System Services



Interface to the OS

- System calls provide an interface to OS services
  - Program passes relevant information to OS
  - OS performs the service if
    - The OS is able to do so
    - The service is permitted for this program at this time
- System calls are typically written in C and C++
  - Tasks that require hardware to be accessed directly may be written using assembly language

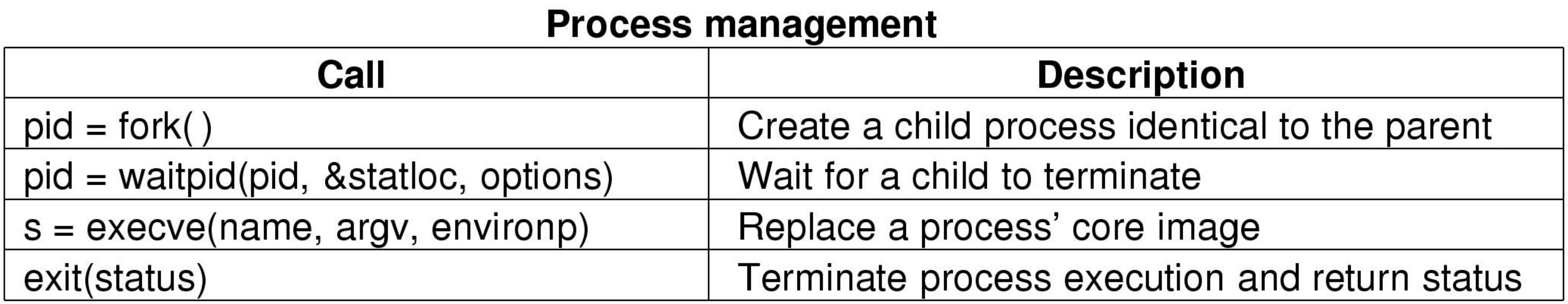
Application Programmer Interface (API)

- Programmers call a function (system function) in a library which invokes system calls
- The programmer only needs to understand the system function by understanding its parameters and results
- Example
  - Programmer API: count = read(fd, buf,nbytes)
  - System calls Used: sys_read()
  - System call code is part of the kernel (Core OS)

Examples:Other System Calls

- Linux Examples:
  - sys_fork, sys_pipe()
- Note: We have been using system call loosely
  - Could be referring to the system function
  - System function and System call are two different entities
    - System function: used by user / programmer (API)
    - System call: Part of OS Kernel

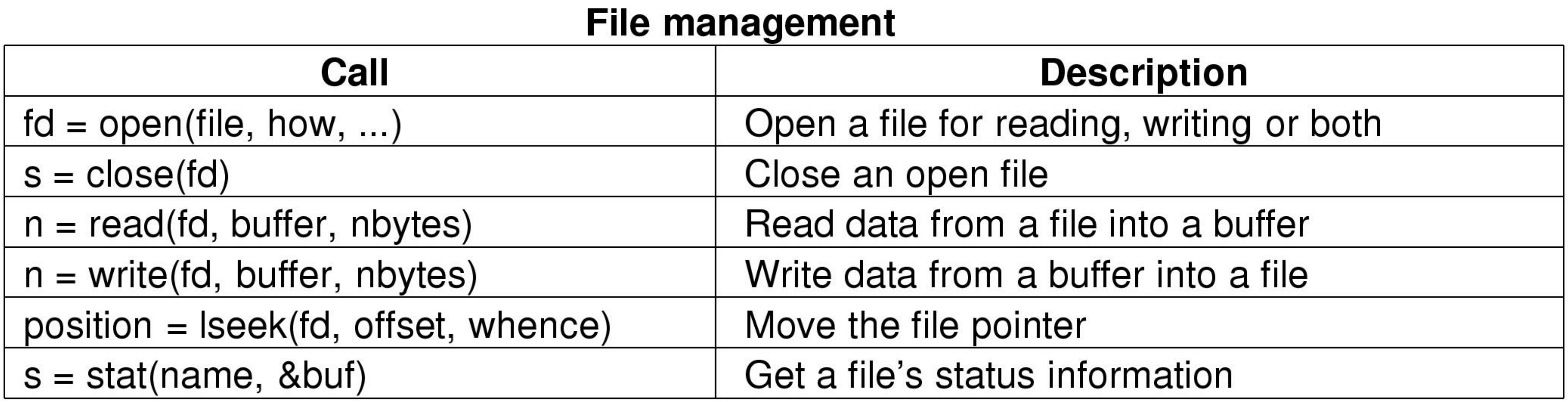
Some System Functions For Process Management



Process management

Call	Description
pid = fork( )	Create a child process identical to the parent
pid = waitpid(pid, &statloc, options)	Wait for a child to terminate
s = execve(name, argv, environp)	Replace a process’ core image
exit(status)	Terminate process execution and return status

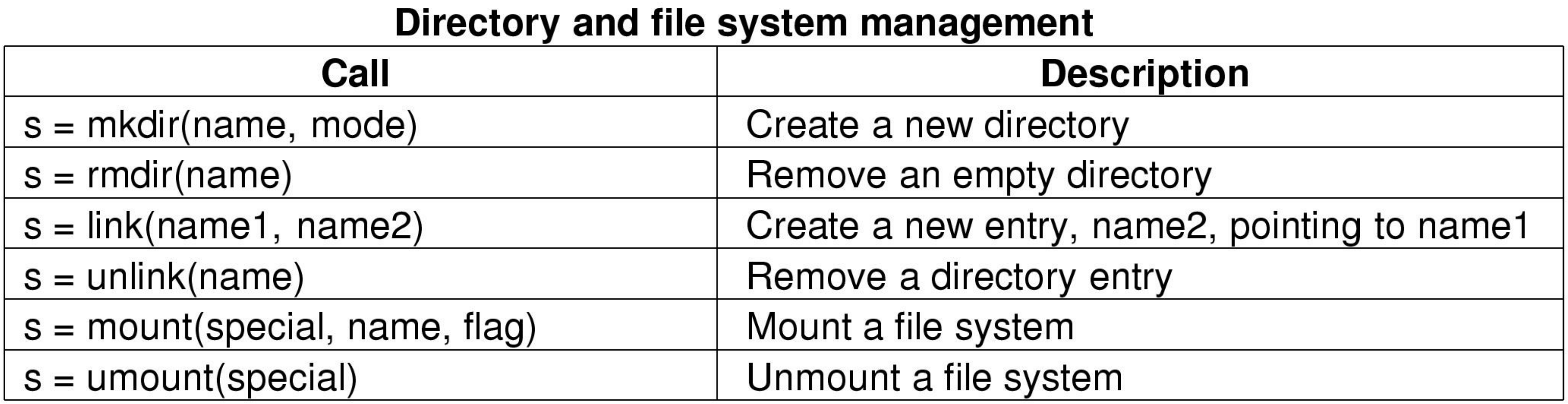
Some System Functions For File Management



File management

Call	Description
fd = open(file, how, ...)	Open a file for reading, writing or both
s = close(fd)	Close an open file
n = read(fd, buffer, nbytes)	Read data from a file into a buffer
n = write(fd, buffer, nbytes)	Write data from a buffer into a file
position = lseek(fd, offset, whence)	Move the file pointer
s = stat(name, &buf)	Get a file's status information

Some System Functions For Directory Management



Directory and file system management

Call	Description
s = mkdir(name, mode)	Create a new directory
s = rmdir(name)	Remove an empty directory
s = link(name1, name2)	Create a new entry, name2, pointing to name1
s = unlink(name)	Remove a directory entry
s = mount(special, name, flag)	Mount a file system
s = umount(special)	Unmount a file system

APIs

- Let's say that a user program has the following line of code: read(fd, buf,nbytes)
- This program needs the operating system to access the file and read from it.
- Some issues to be addressed:
  - How are parameters passed?
  - How are results provided to the user program?
  - How is control given to the system call and the operating system?

System Call Parameter Passing

- Three general methods used to pass parameters to the OS
  - Registers: Pass the parameters in registers
    - In some cases, there may be more parameters than registers
  - Block: Parameters stored in a block, or table, in memory, and address of block passed as a parameter in a register
    - This approach taken by Linux and Solaris
  - Stack: Parameters placed, or pushed, onto the stack by the program and popped off the stack by the operating system
- Block and stack methods do not limit the number or length of parameters being passed

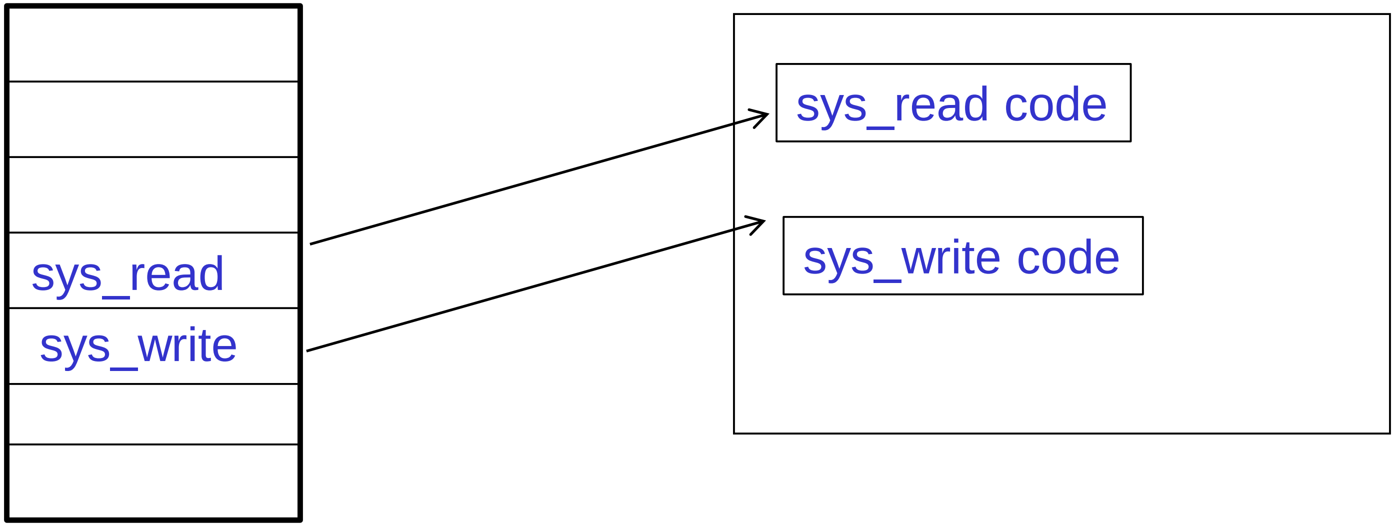
Linux: Parameter passing

- System calls with fewer than 6 parameters passed in registers

- If 6 or more arguments
  - Pass pointer to block structure

System Call Table

- A system call number is associated with each system call
- The OS maintains a system call handler table which is indexed according to the system call numbers
- Entry in table points to code



System Calls and Traps

- TRAP switches CPU to supervisor (kernel) mode
  - The state of the user process is saved so that the OS instructions needed can be executed (system call)
  - When the system handler finishes execution then the user process can execute

Making a System Call

- System function call:

  count = read (fd,buffer,length)
- Step 1: The input parameters are passed into registers or to a block
- Step 2: TRAP (execution of system call) is executed
  - The state of the user process is saved T
  - System call number for read() is sent to system call handler
  - This code/number tells the OS what system call handler (kernel code) to execute
  - This causes a switch from the user mode to the kernel mode

Making a System Call

- Step 3: System call handler code is executed
- Step 4: After execution control returns to the library procedure (system function)

System Call

- The system call handler will have to actually wait for data from the disk
- Reading data from disk is much slower than memory
- We do not want the CPU to be idle while waiting for data from the disk
  - Most operating systems allow for another executing program to use the CPU
  - This is called multiprogramming – more later
- How does a process find out about reading being completed?
  - Interrupt