CSCI 3753 Operating Systems Summer 2017

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CSCI 3753 Announcements

- About Me
- Review of syllabus
- Logistics of moodle
  - Establish your account on moodle.cs.colorado.edu
  - Enrollment key is *kernel* for OS Summer 2017
- Read chapters 1, 2 and 13 in the textbook
- Programming Assignment #1 released soon, due in two weeks
- Introduction to Operating Systems

What is an Operating System?

- Name some OSs:
  - Windows, Linux, Mac OS X, Google Android, …
  - >600 at http://www.operating-system.org/betriebssystem/_english/os-liste.htm
  - >600 versions of Linux! i.e. over 600 distributions of Linux.

- What is common across these OSs?

Applications
Operating System
Hardware

- An operating system is a layer of software between applications and hardware that provides useful services to applications
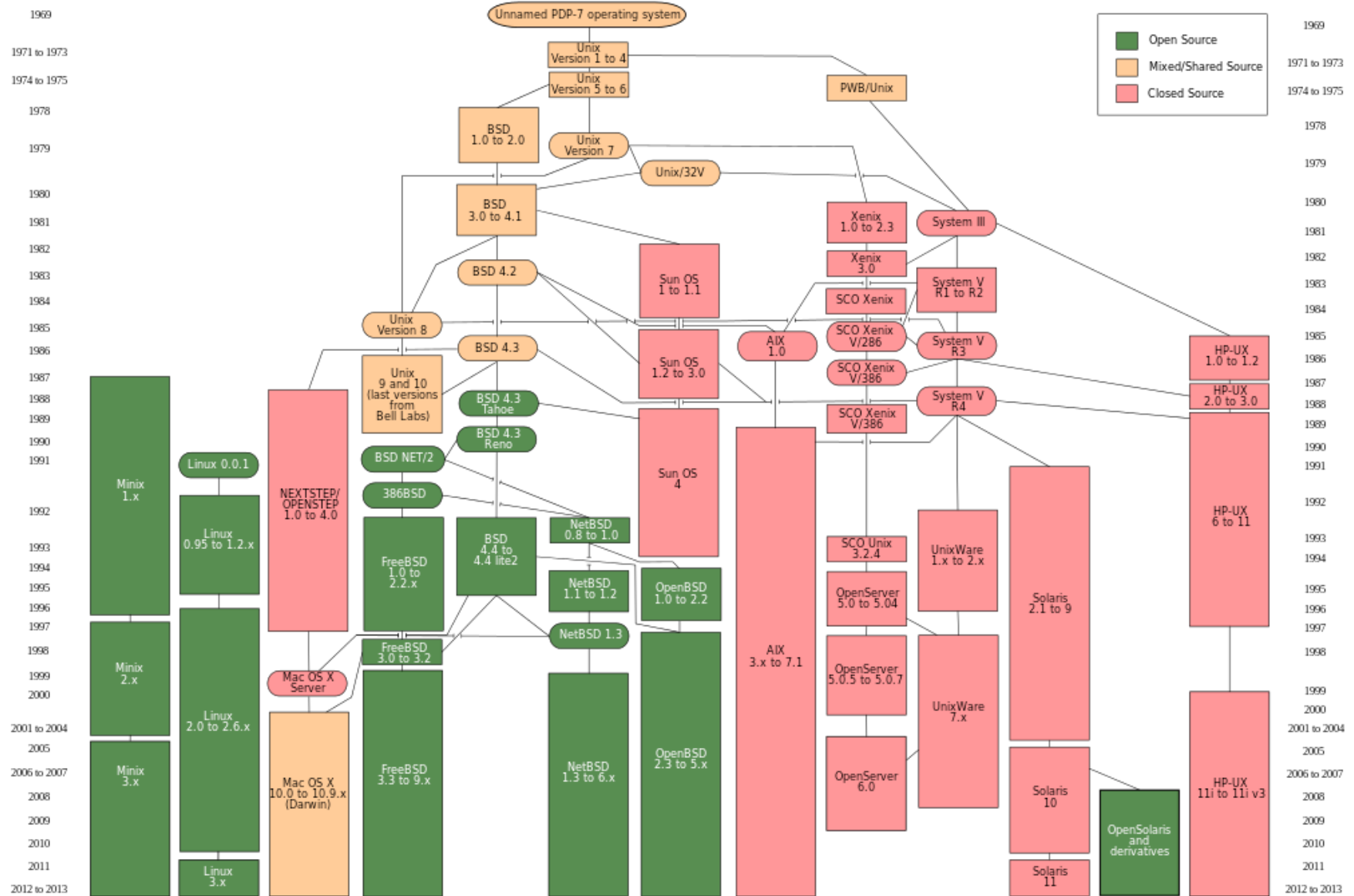
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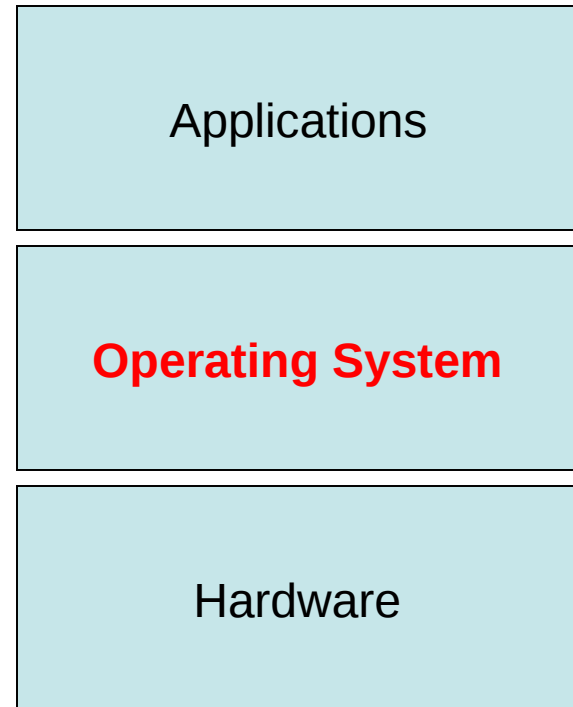
OS Historical Timeline

- 1930s/40s – electronic digital computers arise (ENIAC 1946 is 1st general-purpose programmable digital computer)
- 1950s – 1st OSs begin to emerge
- 1961 – MIT's CTSS is the first time-sharing system
- 1966 – IBM System/360 mainframe OS
- 1969 - UNIX for mainframes and minicomputers
- 1981 – MS-DOS OS for personal computers
- 1982 – 4.2 BSD Unix with TCP/IP networking
- 1984 – Mac OS with windowing GUI
- 1991 – Linux open source OS for PC
- Late 1990s/early 2000s – virtual machines arise like VMWare, Xen, …
- 2007 – iOS for iPhone

http://www.informit.com/articles/article.aspx?p=24972

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UNIX OS Family Tree

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What is an Operating System? (2)

- Name some types of applications
  - Web browers, video players, games, Office apps, …

- Name different kinds of Input/Output (I/O) devices
  - Mouse, keyboard, display, disk, …

App1

App2

App3

Operating System

| Disk/ Flash | Memory | CPU | Display | Mouse | GPU | more I/O … |
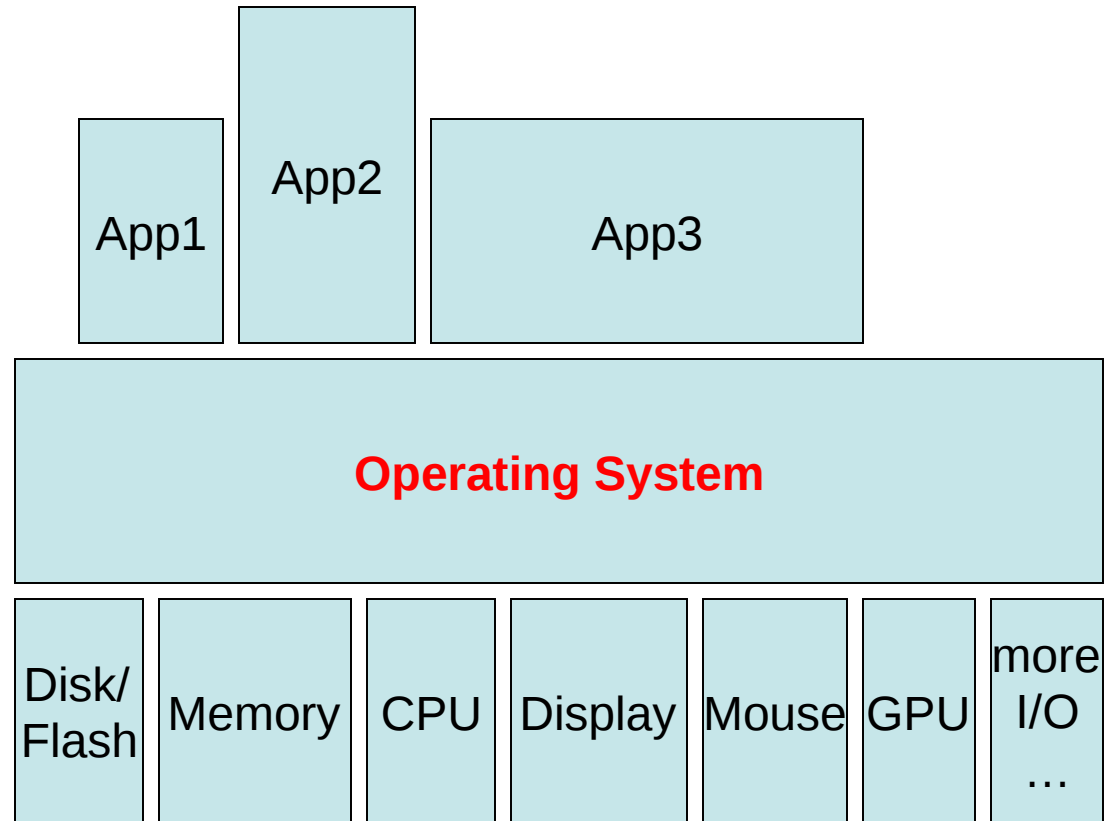
Other devices include: wired network card, WiFi, camera, microphone, audio output, keyboard, DVD/CD, USB, etc.
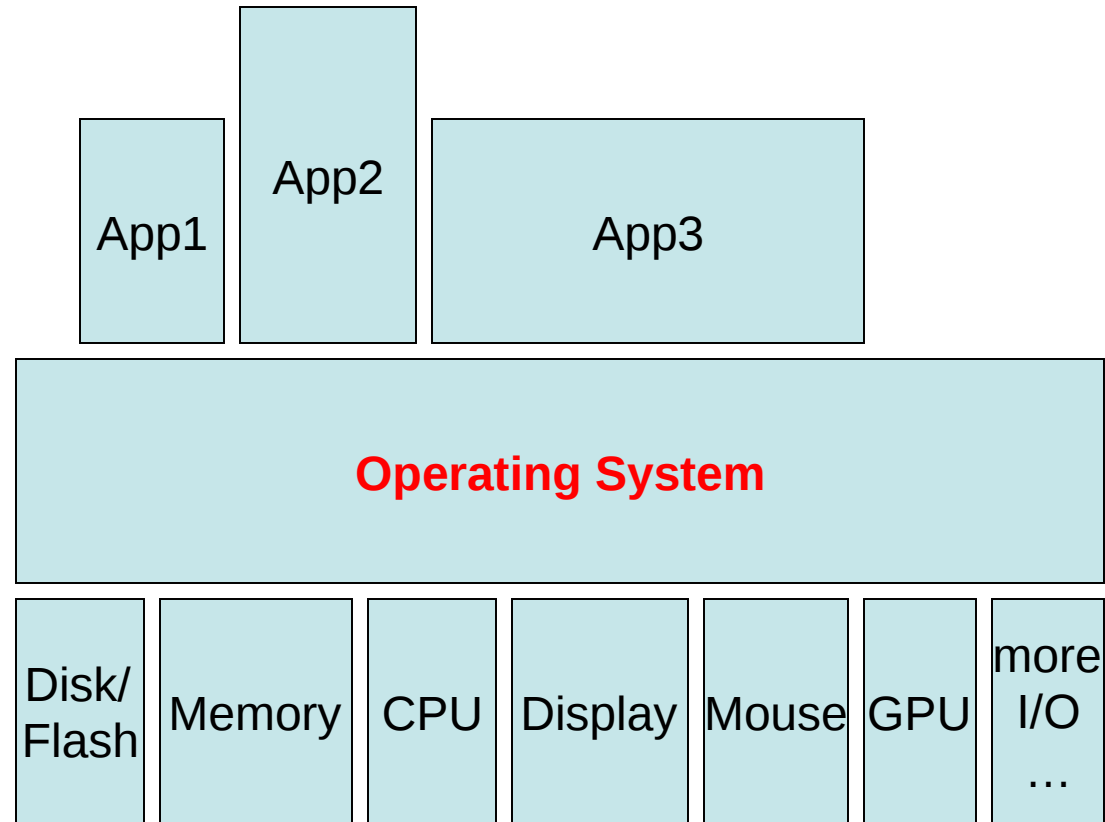
What is an Operating System? (3)

- An operating system is a layer of software between *many* applications and *diverse* hardware that

  1. *Provides a hardware abstraction* so an application doesn't have to know the details about the hardware.

     - So an application saving a file to disk doesn't have to know how the disk operates

App1	App2	App3

Operating System

| Disk/ Flash	Memory	CPU	Display	Mouse	GPU	more I/O ...

Other devices not shown

What is an Operating System? (4)

2. Arbitrates access to resources among multiple applications:
   - *Sharing* of resources
3. Provides Protection:
   - *Isolation* protects app's from each other
   - Isolation also to protect the OS from applications
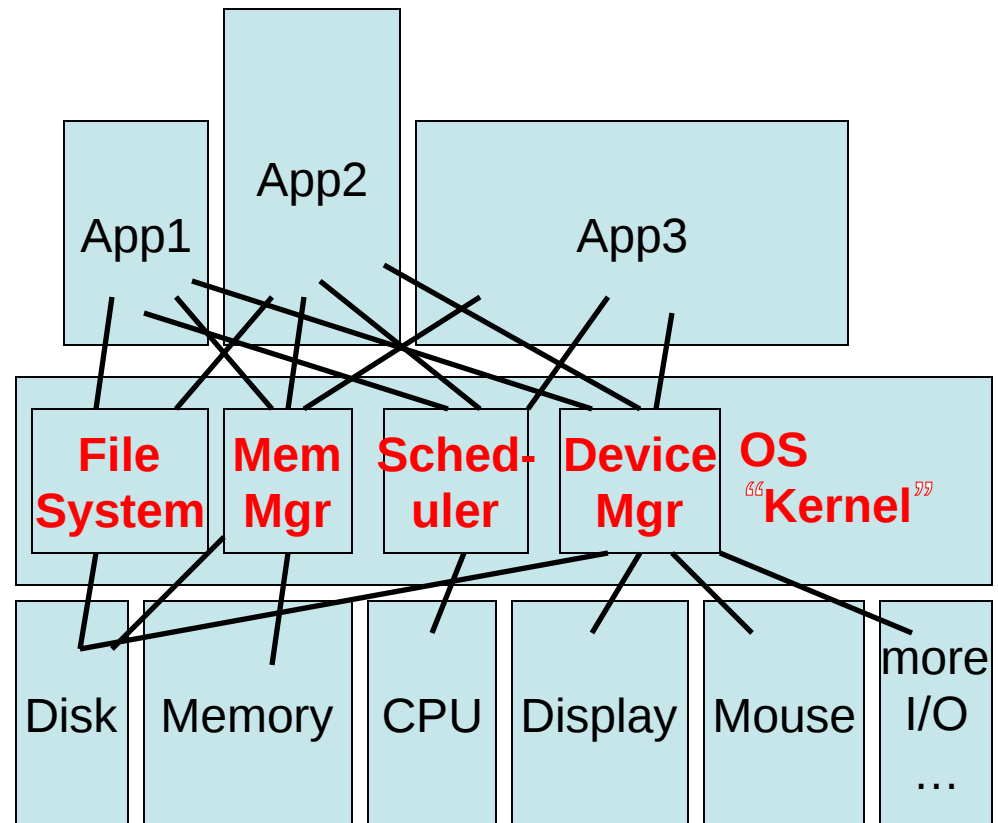   - Isolation to limit resource consumption by any one app

App1

App2

App3

Operating System

| Disk/Flash | Memory | CPU | Display | Mouse | GPU | more I/O ... |
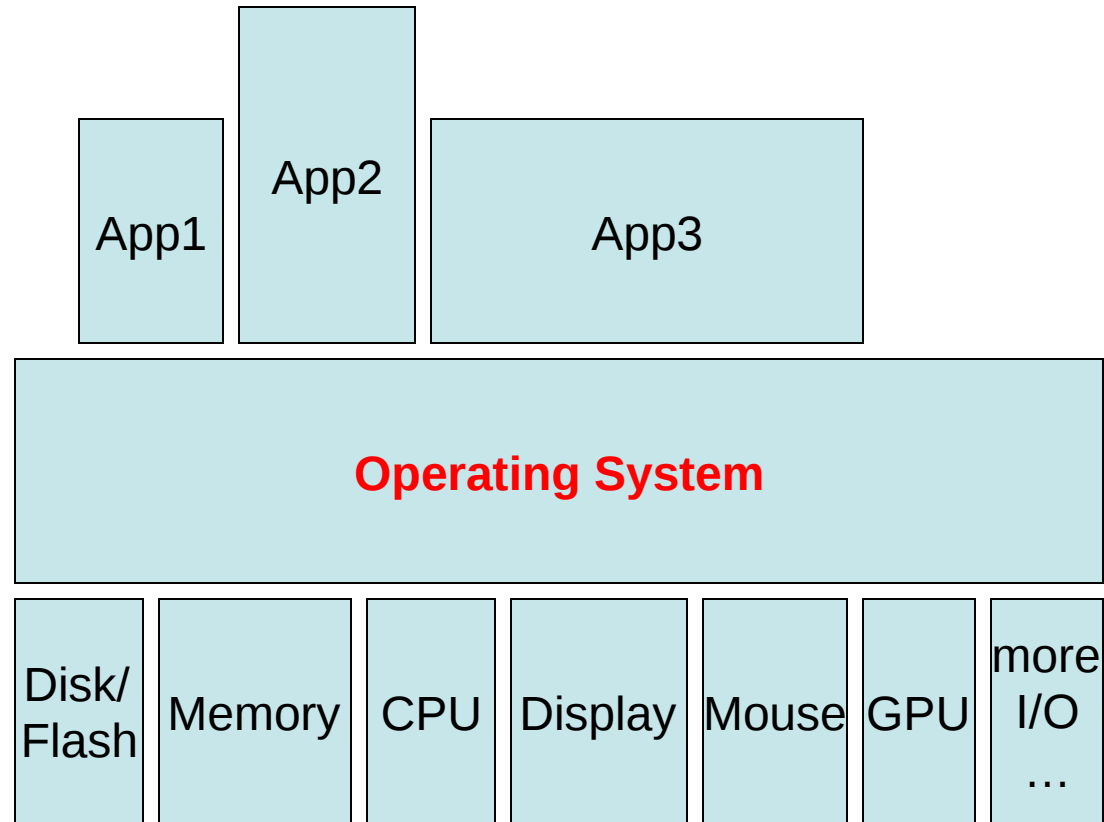
Other devices not shown

Operating System Components

- A typical operating system consists of multiple components
  - A process manager with a scheduler, thread management, and atomic synchronization
  - Memory management (virtual memory) system
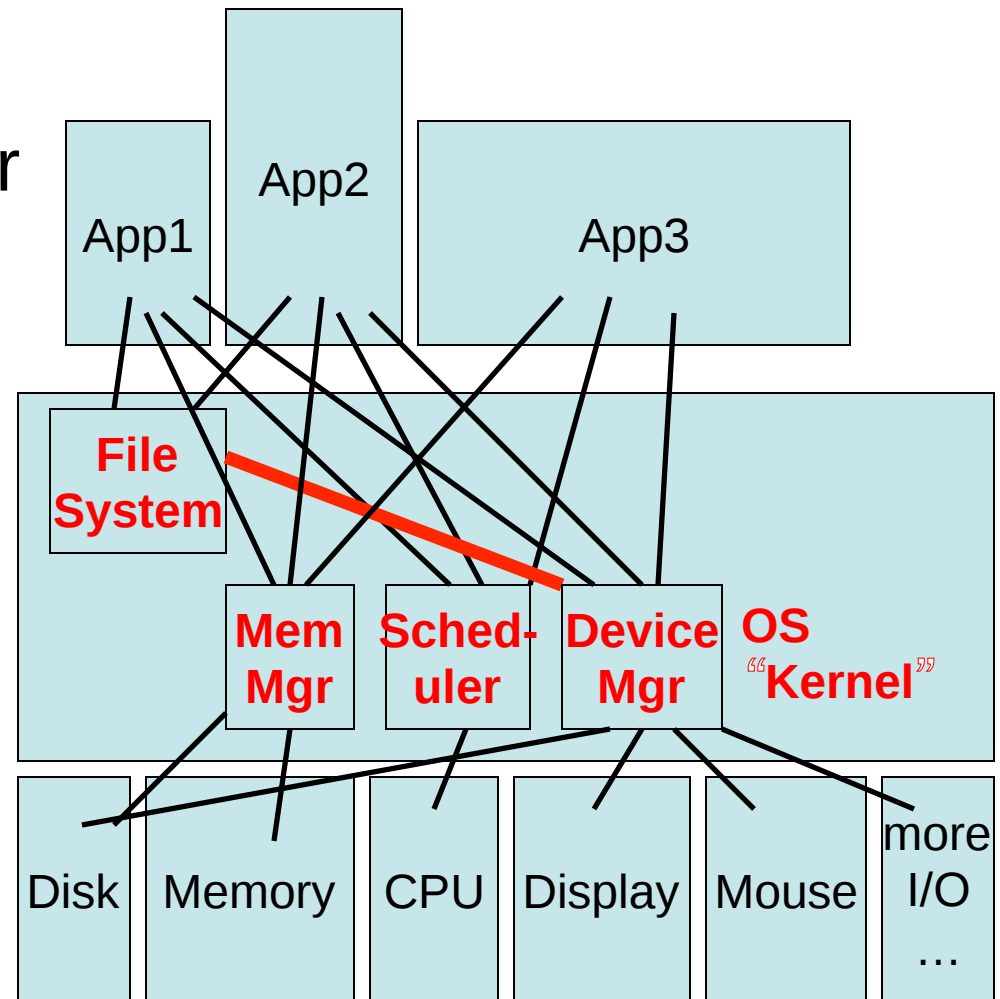 - file system
  - device management
  - other...

App1

App2

App3

File System | **Mem Mgr** | **Sched-uler** | **Device Mgr** | **OS "Kernel"**

Disk | Memory | CPU | Display | Mouse | more I/O ...

Not pictured above in the OS: the network stack manager, etc.

Operating System Hierarchy

- OS components may be built on top of other OS components
  - The file system is usually built on top of the device manager
    - File system supports high level abstraction/ concept of files
    - Device manager handles low level interaction with devices

App2

App1

App3

File System

Mem Mgr

Sched-uler

Device Mgr

OS "Kernel"

Disk | Memory | CPU | Display | Mouse | more I/O …

Not pictured above in the OS: the network stack manager, etc.

Are System Libraries/Tools part of an OS?

OS?

Posix, Win32, Java, C library API

App1

App2

App3

System Libraries and Tools (Compilers, Shells, GUIs)

System call API

– >300 in Linux 3.1

File System

Mem Mgr

Sched-uler

Device Mgr

OS "Kernel"

Device driver "API"

Note: different OS kernels can support the same system call API

Disk

Memory

CPU
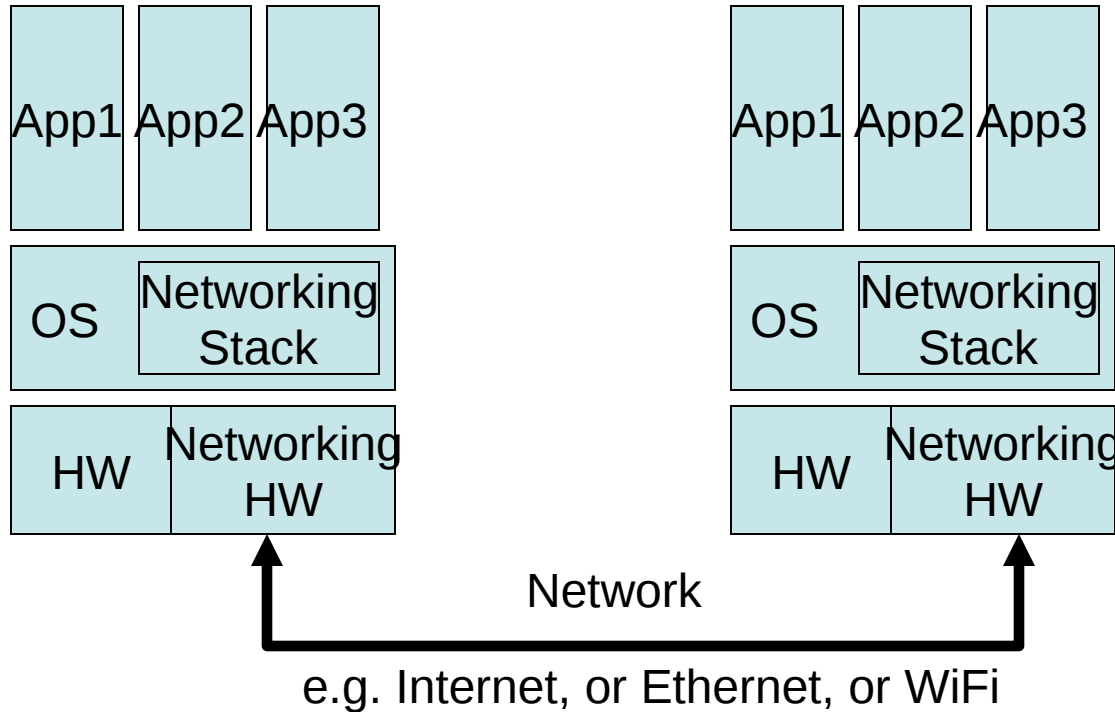
Display

Mouse

more I/O …
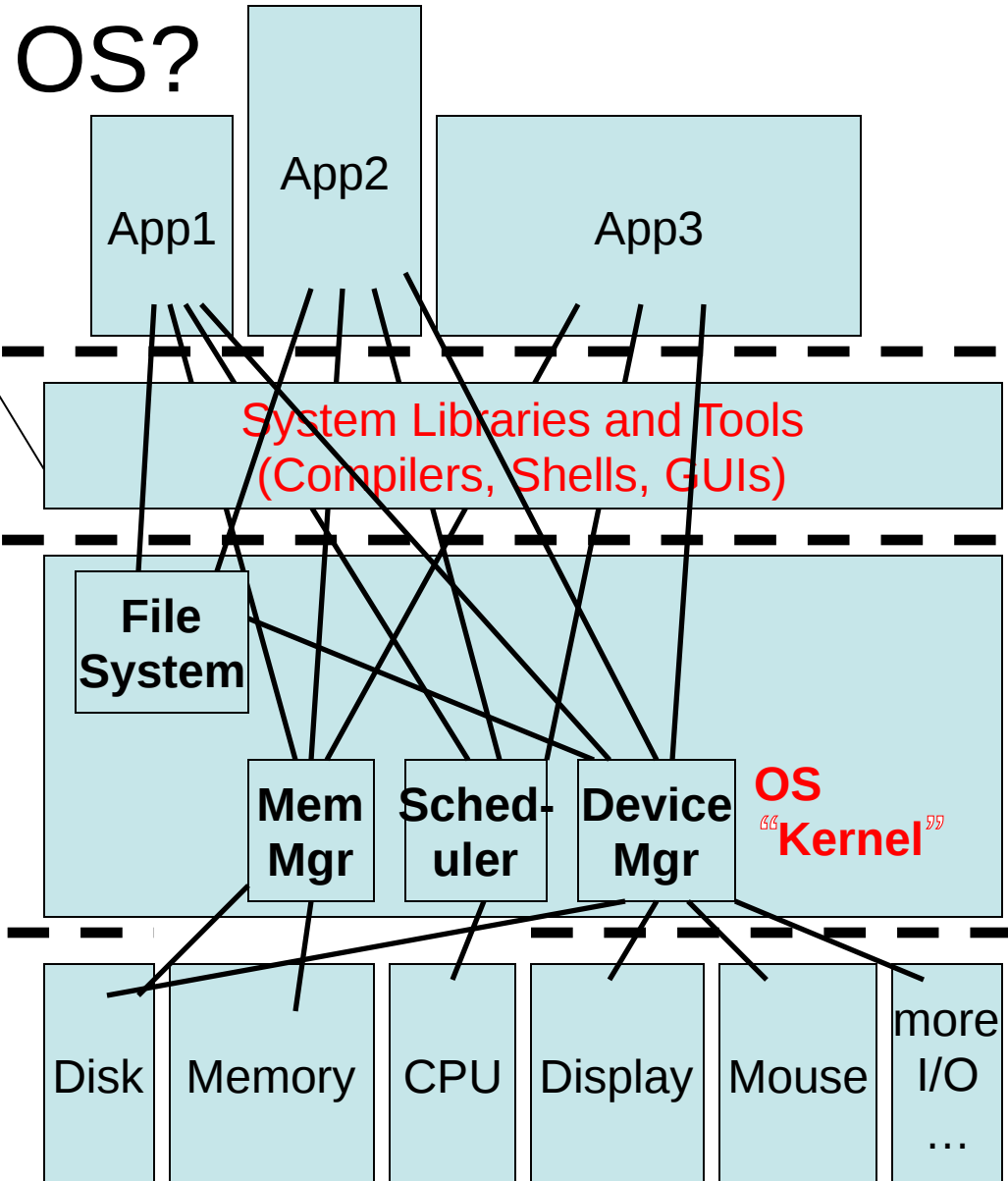
What's in an OS? Monolithic vs Microkernel OS Architectures

- Linux has a monolithic kernel
  - The kernel is highly complex and contains many components
- Mach OS has a *microkernel*
  - The kernel has minimal functionality, perhaps only virtual memory, scheduler, and IPC message passing
    - All other components are viewed as outside the OS, and communicate via message passing.
  - Advantage: bug in a component doesn't crash whole kernel, arguably easier to manage
  - Disadvantage: message passing was slow
- Mac OSX is a hybrid of Mach and BSD Unix

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Distributed Operating Systems

App1	App2	App3

OS	Networking Stack

HW	Networking HW

App1	App2	App3

OS	Networking Stack

HW	Networking HW

Network

e.g. Internet, or Ethernet, or WiFi

- Example 1: Distributed File System
  - OS adds TCP/IP Network Stack
  - Device driver support for networking cards
  - Files can now be written/read remotely

- Example 2:
  - App1 is a distributed client server app, e.g. App1 on left is Web browser, App1 on right is Web server
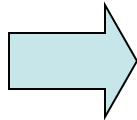
Operating System Trends

- Hardware has evolved quickly - OS must adjust
  - Moore's Law roughly applies to CPU speed and/or memory size: doubles every 18 months => exponential!
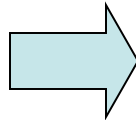   - Enables complex modern operating systems like Linux, Windows, UNIX, OS X
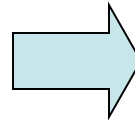
Storage Evolution:

??

Punch card stores code 1950s-80s

Tape Drive 1950s-80s

Disk Drive 1960s-2000s

Flash Drive already at 32 GB @ $16=> OS disk scheduling obsolete??

But Moore's Law doesn't apply to disk access speed or to battery life

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Operating System Trends

- Diversification of OS's to many different target environments
  - Energy-efficient cell phone OSs - scaling down
    - iPhone's iOS, Google's Android, …
  - Multi-processor OSs - scaling up
    - Adapting Linux and Windows to multiple cores. Massively parallel supercomputers.
  - Real-Time OS for Embedded and Multimedia Systems
    - VXWorks, robotic OSs, …

Operating System Trends

- Virtualization – Virtual Machines (VMs)
  - Running a Windows VM inside a Linux OS, and vice versa.
  - More layers of abstraction
- Cloud computing rents VMs on racks of PCs at a massive scale

Google Data Center in The Dalles, Oregon

Size of football field

University

Outline of the OS course

1. Hardware support, user/supervisor mode, system calls, trap table, device I/O, interrupts, DMA, mem-mapped I/O

2. Processes, threads, scheduling, synchronization, deadlock

3. Memory management, paging, virtual memory

4. File system design, allocation, networked file systems

5. Security: authorization, access control

6. Networked OSs: distributed file systems

7. Virtual machines