

Stony Brook University CSE/ISE 311: Systems Administration

Operating Systems and Hardware Overview

Portions of this material from U. Manitoba

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Components of a Computer System

- A computer system consists of both hardware and software
- Many different types:
 - Tablets, laptops
 - Desktops, workstations
 - Embedded systems
 - Servers
 - Mainframes
 - Super Computers

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Inside a Computer Case

Components inside a Computer (Wires not shown)

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Hardware Components

- Processor
- Main memory
- Secondary memory
 - hard disk, optical disks, tapes, ...
- Input devices
 - keyboard, mouse, microphone, ...
- Output devices
 - monitor, printer, speaker, ...

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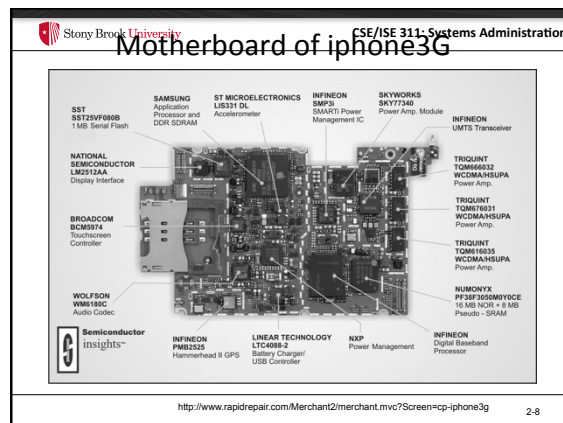
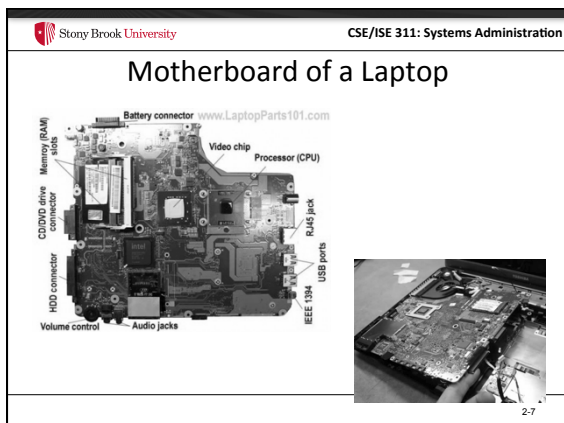
Processors

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Main Memory

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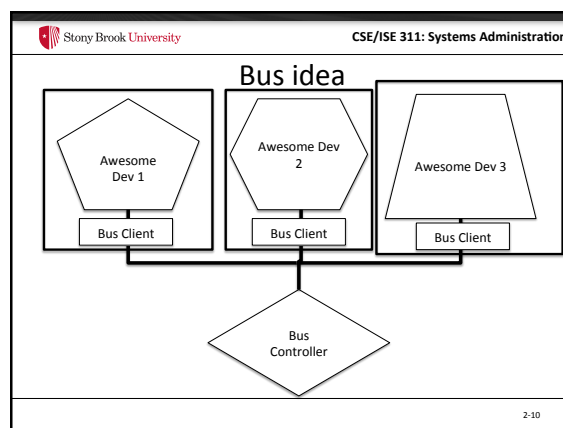


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Buses

- Key abstraction for hardware
- A hardware-level messaging system for components
- A lot of EE-type specifications about clock rate, voltage, etc.
- You mostly need to know that the specs for all components have to agree

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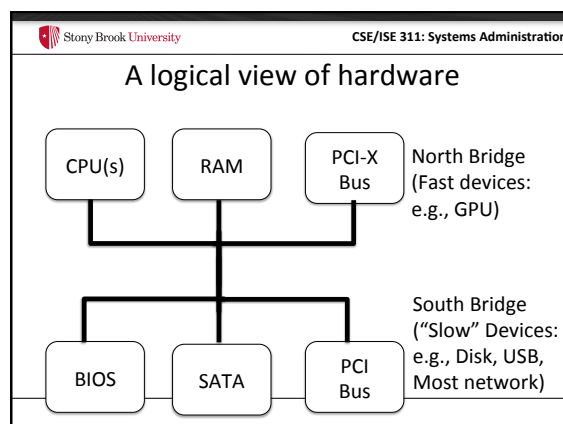


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Bus Intuition

- For a given device type, the bus client speaks the protocol over the wire
- Encapsulates low-level device implementation

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Buses galore

- Memory Bus: connects Northbridge components (CPU, RAM, GPU, Southbridge controller)
- Disk buses:
 - Controller on the motherboard
 - Often on south bridge
 - Speaks to disks
 - SATA, IDE, SCSI, etc
- USB, Firewire, etc. are all bus protocols

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Fewer Bridges

- Newer system organizations are moving more devices to the North bridge, and consolidating more things on the CPU itself.

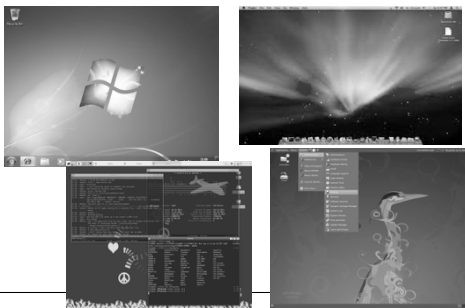
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So what is an OS?

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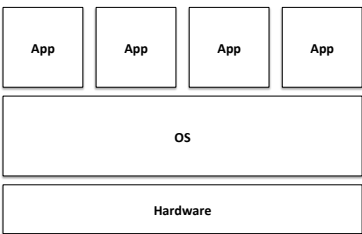
One view of an OS



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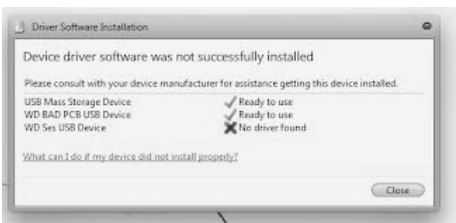
Another simple view of an OS



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A less happy view of an OS



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So which one is right?

- They all are

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An OS serves three masters

1. Give users a desktop environment
2. Give applications a more usable abstraction of the hardware
3. Give hardware manufacturers an abstraction of the applications

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Background (1)

- CPUs have 2 modes: user and supervisor
 - Sometimes more, but whatevs
- Supervisor mode:
 - Issue commands to hardware devices
 - Power off, Reboot, Suspend
 - Launch missiles, Do awesome stuff
- User mode:
 - Run other code, hardware tattles if you try anything reserved for the supervisor

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OS architecture

```

graph TD
    subgraph Apps
        direction LR
        A1[App]
        A2[App]
        A3[App]
        A4[App]
    end
    Apps --- OS[OS]
    OS --- Hardware[Hardware]
  
```

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OS architecture

```

graph TD
    subgraph User
        direction LR
        A1[App]
        A2[App]
        A3[App]
        A4[App]
    end
    User --- Libraries[Libraries]
    Libraries --- Kernel[Kernel]
    Kernel --- Hardware[Hardware]
    subgraph Super-visor
        Hardware
    end
  
```

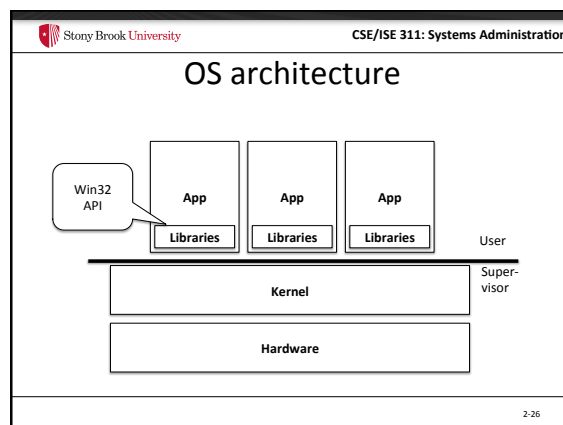
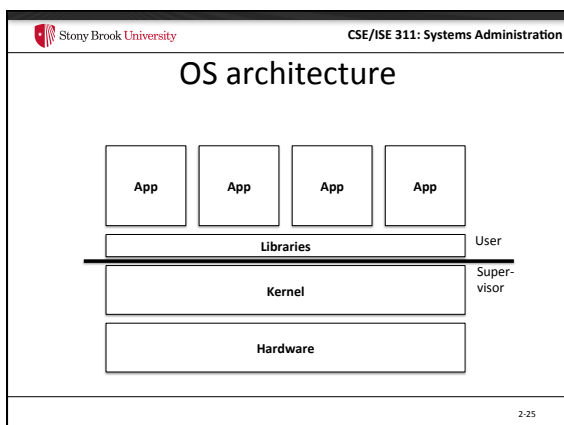
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Master #2: Applications

- Application Programming Interface (API)
 - Win32 (Windows)
 - POSIX (Unix/Linux)
 - Cocoa/Cocoa Touch (Mac OS/iOS)
- Application-facing functions provided by libraries
 - Injected by the OS into each application

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Famous libraries, anyone?

- Windows: ntdll.dll, kernel32.dll, user32.dll, gdi32.dll
- Linux/Unix: libc.so, ld.so, libpthread.so, libm.so

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Caveat 1

- Libraries include a lot of code for common functions
 - Why bother reimplementing sqrt?
- They also give high-level abstractions of hardware
 - Files, printer, dancing Homer Simpson USB doll
- How does this work?

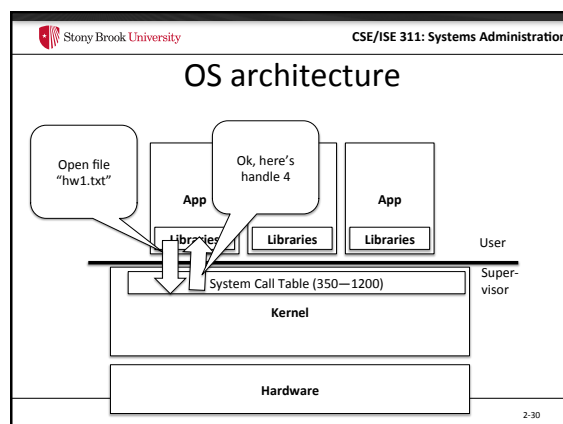
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System Call

- Special instruction to switch from user to supervisor mode
- Transfers CPU control to the kernel
 - One of a small-ish number of well-defined functions
- How many system calls does Windows or Linux have?
 - Windows ~1200
 - Linux ~350

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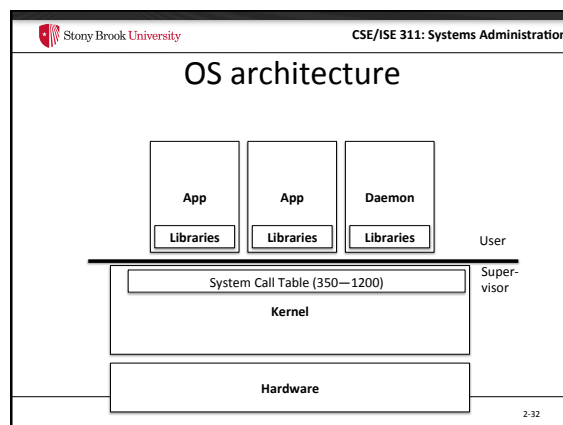


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Caveat 2

- Some libraries also call special apps provided by the OS, called a **daemon (or service)**
 - Communicate through kernel-provided API
- Example: Print spooler
 - App sends pdf to spooler
 - Spooler checks quotas, etc.
 - Turns pdf into printer-specific format
 - Sends reformatted document to device via OS kernel

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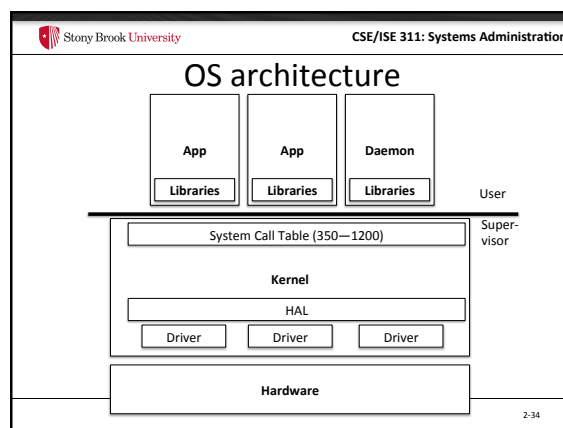


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Master 3: Hardware

- OS kernels are programmed at a higher low level of abstraction
 - Disk blocks vs. specific types of disks
- For most types of hardware, the kernel has a “lowest common denominator” interface
 - E.g., Disks, video cards, network cards, keyboard
 - Think Java abstract class
 - Sometimes called a hardware abstraction layer (HAL)
- Each specific device (Nvidia GeForce 600) needs to implement the abstract class
 - Each implementation is called a **device driver**

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What about Master 1

- What is the desktop?
- Really just a special daemon that interacts closely with keyboard, mouse, and display drivers
 - Launches programs when you double click, etc.
 - Some program libraries call desktop daemon to render content, etc.

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An OS serves three masters

- Give users a desktop environment
 - Desktop, or window manager, or GUI
- Give applications a more usable abstraction of the hardware
 - Libraries (+ system calls and daemons)
- Give hardware manufacturers an abstraction of the applications
 - Device Driver API (or HAL)

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So what is Linux?

- Really just an OS kernel
 - Including lots of device drivers
- Conflated with environment consisting of:
 - Linux kernel
 - Gnu libc
 - X window manager daemon
 - CUPS printer manager
 - Etc.

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So what is Ubuntu? Centos?

- A **distribution**: bundles all of that stuff together
 - Pick versions that are tested to work together
 - Usually also includes a software update system

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OSX vs iOS?

- Same basic kernel (a few different compile options)
- Different window manager and libraries

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What is Unix?

- A very old OS (1970s), innovative, still in use
- Innovations:
 - Kernel written in C (first one not in assembly)
 - Co-designed C language with Unix
 - Several nice API abstractions
 - Fork, pipes, everything a file
- Several implementations: *BSDs, Solaris, etc.
 - Linux is a Unix-like kernel

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What is POSIX?

- A standard for Unix compatibility
- Even Windows is POSIX compliant!


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RTFM

- man pages are your friend!
 - (not a dating service)
 - Ex: 'man malloc', or 'man 3 printf'
 - Section 3 is usually where libraries live - there is a command-line utility printf as well
- Use 'apropos term' to search for man entries about *term*
- Windows has MSDN online, which is good

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<h2>Summary</h2>	
<ul style="list-style-type: none">• Understand basic hardware terminology• Understand what an OS is<ul style="list-style-type: none">– Three masters– Nomenclature• Questions?	
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