

16 – OPERATING SYSTEMS ABSTRACTIONS

COMP256 – COMPUTING ABSTRACTIONS

DICKINSON COLLEGE

OPERATING SYSTEMS ABSTRACTIONS

- **Operating systems abstractions** bridge the gap between the physical hardware and the user / program experience.
 - A CPU runs one program a time but users run multiple programs concurrently.
 - Machine has one physical main memory but every program appears to have its own even larger memory.
 - Disks store blocks of bytes but users interact with files and directories (folders).
 - Screens display pixels but users create text and graphics.



Image from: <http://www.supinfo.com/articles/single/4344-introduction-to-operating-systems>

DEFINITION

- An **operating system** (OS) is a collection of software that makes the machine easier to use for humans (or programs) through *abstraction and management* (sharing and protecting) of resources (CPU, memory, I/O devices).

ENVIRONMENTS AND EXAMPLES

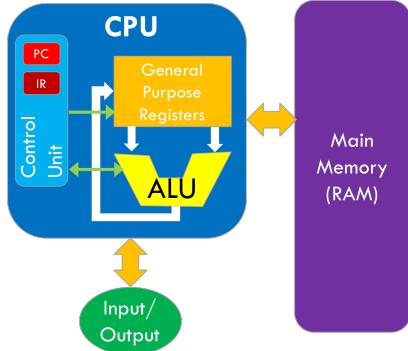
- Personal Computers
 - MacOS X, Windows 10, Linux/Unix, BeOS
- Mobile Devices
 - iOS, Android, Blackberry
- Servers and Mainframes
 - Linux/Unix, MVS, z/OS
- Game Consoles
 - Xbox One, es, Orbis OS



Image from: <https://freepngimg.com/png/69514-virtual-private-server-computer-operating-systems-linux>

OUR STARTING POINT

- Stored Program Architecture
 - Program instructions and data for running programs are stored in main memory (or cache).
- Instruction Cycle
 - Fetch / Decode / Execute
 - Program Counter (PC)
 - Instruction Register (IR)
- But... how does ~~a~~ program get into main memory in order to run?
the first



MEMORY ADDRESS SPACE

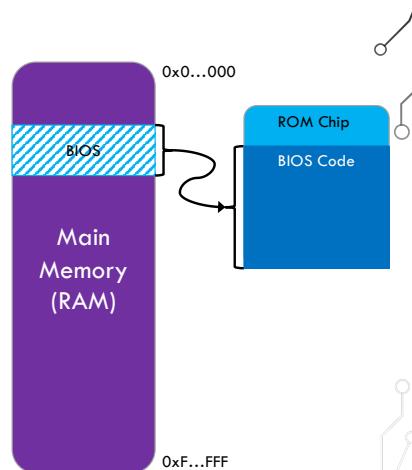
- The **memory address space** of a machine is the range of addresses that are accessible by a program.
 - Defined by the number of bits used by the hardware for memory addresses in:
 - The program counter
 - Machine language OpCodes.
 - An n-bit address space has 2^{n-1} addresses.
 - 32 bit machines
 - 64 bit machines
 - Often use 48 bit addresses.



$1\dots11_2 = 0xF\dotsFF = 2^{n-1}_{10}$

MEMORY (RE)MAPPING

- Remapped memory addresses are stored on non-volatile **read-only-memory (ROM)** on the motherboard.
 - The ROM contains the **Basic Input Output System (BIOS)**.
 - The BIOS is a collection of machine language functions that provide basic system services.
 - Sometimes called the *firmware*.



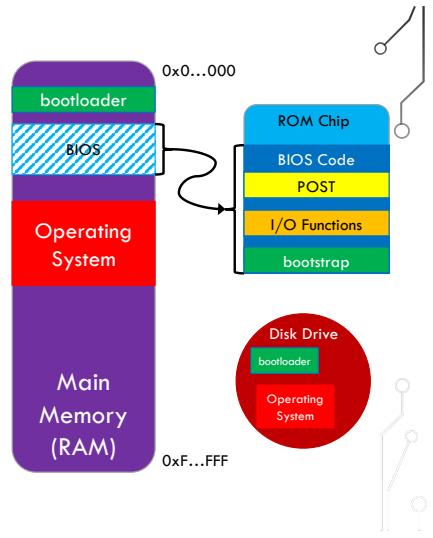
BIOS FUNCTIONS

- The **Basic Input Output System (BIOS)** provides necessary minimal functions for interacting with the machine hardware:
 - The Power On Self Test (POST) program
 - Performs hardware tests to make sure everything is working.
 - Optionally runs a configuration program (e.g. Press DEL or F2 to enter Setup).
 - Loads the operating system.
 - Functions for basic interactions with input/output devices:
 - Keyboard
 - Disk Drive
 - Text and simple graphics



BOOTSTRAPPING

- Booting or *bootstrapping* a computer is the process of loading and starting the operating system.
- When the computer is powered on:
 - The program counter is initialized to the (remapped) address of the POST program.
 - The POST program:
 - Performs the hardware checks.
 - JUMPs to the bootstrap program.
 - The bootstrap program:
 - CALLs BIOS functions to load a small program (bootloader) from a known location on disk into the main memory.
 - JUMPs to the address of the bootloader program
 - The bootloader program:
 - Finds the operating system on disk
 - Loads the OS into main memory
 - JUMPs to the address of the OS.



OPERATING SYSTEM SERVICES

- Once the operating system is running it ... makes the machine easier to use for humans (or programs) through *abstraction and management* (sharing and protecting) of resources (CPU, memory, I/O devices).
 - **Process Management:**
 - Mechanisms for starting/stopping programs; ensuring fair sharing of CPU time; providing programs access to shared resources (I/O devices: keyboard, mouse, graphics, disks, network, etc...).
 - **Memory Management:**
 - Mechanisms for abstracting and sharing main memory; protecting processes from each other.
 - **File Management:**
 - Mechanisms for abstracting, organizing and sharing disk space; enforcing file permissions.