# Contents



# 1 Overview

## 1.1 What Operating Systems Do

| | | | |
|---|---|---|---|
| hardware, software, data | Computer System | Hardware | CPU (Central Processing Unit) |
| | | | Memory |
| | | | I/O (Input/Output) Devices |
| | | Application Programs | defines how resources are used |
| | | **Operating System** | controls and coordinates hardware |

Components of a Modern Computer System

An **operating system** is a software that
- manages and controls a computer's hardware;
- coordinates and optimizes utilization of hardware;
- provides a basis for application programs.

An operating system is similar to a *government*, who performs no useful function, but provides an environment within which other programs can do useful work.

| | | |
|---|---|---|
| User View | **Ease of Use** | One user monopolizes all resources. |
| | **Maximizing Utilization** | Multiple users utilize resources simutaneously. |
| | **Compromise** | OS assigns and shares resources to different users. |
| | **Little or no User View** | |
| System View | **Resource Allocator** | processes numerous and possibly conflicting requests. |
| | **Control Program** | manages the execution of user programs |

## 1.2 Computer-System Organization

### 1.2.1 Computer-System Operation

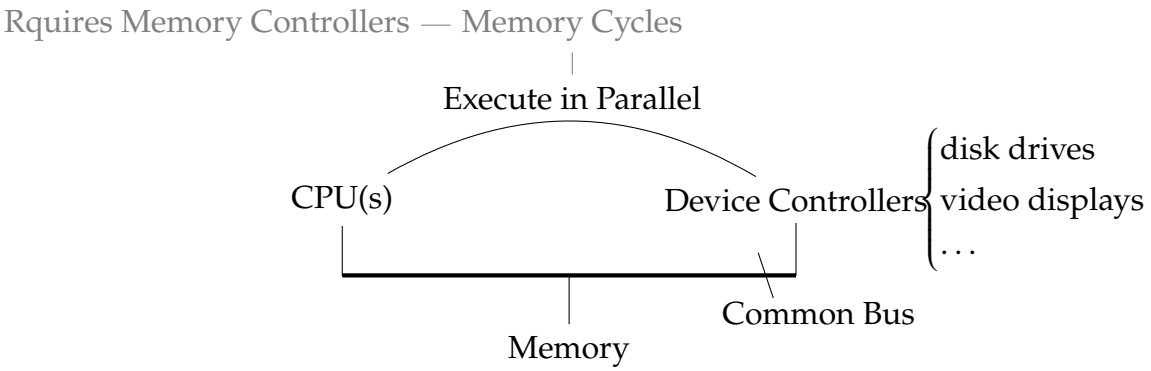
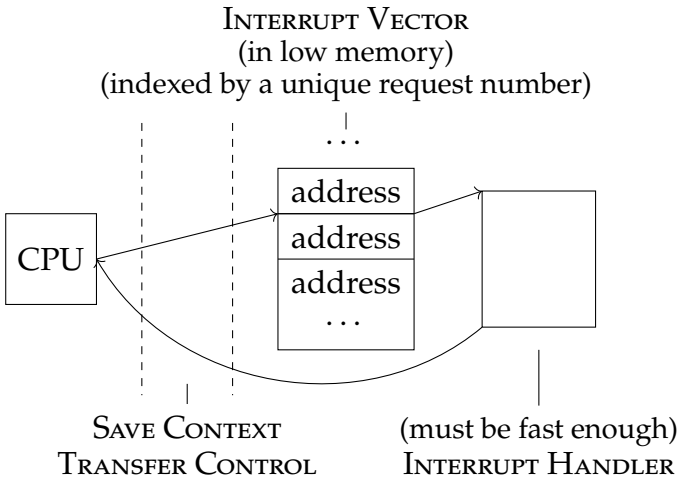



Figure: Components of Modern General-Purpose Computer

For a computer to start running, it

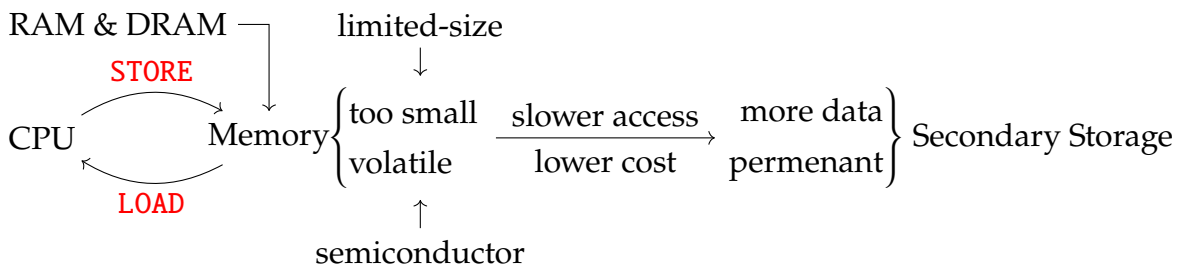
1. runs **bootstamp program**, which
   - tends to be simple.
   - is stored in **read-only memory** (ROM), or Electrically Erasable Programmable ROM
   - initializes all aspects of the OS, from CPU registers to device controllers to memory.
   - locates the operating system and loads it to memory (⇐ know how to load and start)
2. loads service programs (**system daemons**: outside kernel, loaded at boot, runs entire time)

The event is signaled by an **interrupt** from either hardware or software.




### 1.2.2 Storage Structure

All forms of memory provide **an array of bytes**. Each byte has its own address.



Other types of memory:

- Cache: stores data to reduce time cost of further request for that data.
- ROM: cannot be changed ⇒ ONLY static programs (e.g., bootstamp program).
- EEPROM: change is slow ⇒ mostly static programs (e.g., factory-installed programs).

| Hierarchy | Magnitude | Volatility | Implementation |
|---|---|---|---|
| Registers | bytes | √ | MOSFET |
| Cache | 16KB ~ 50MB | √ | MOSFET |
| Main Memory | 8GB ~ 64GB | √ | MOSFET |
| **Solid-state Disks** | ≥ 100 GB | ◯ / × | Flash Memory |
| **Magnetic Disks** | ≥ 500 GB | × | Magnetic Poles |
| **Optical Disks** | | × | Pits & Lands |
| **Magnetic Tapes** | TB | × | Magnetic Memory |

Table: Information and Hierarchy of Storage
(higher in hierarchy ⟹ larger capacity, more expensive, and faster)

### 1.2.3 I/O Structure

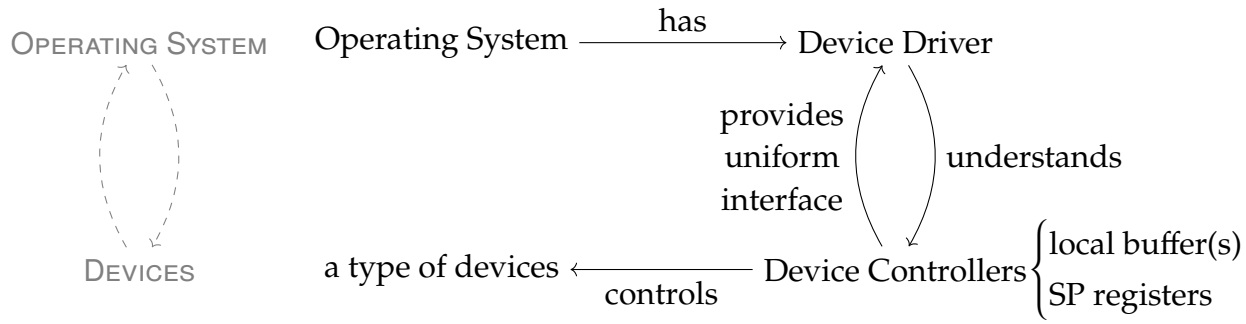



Figure: I/O Structure

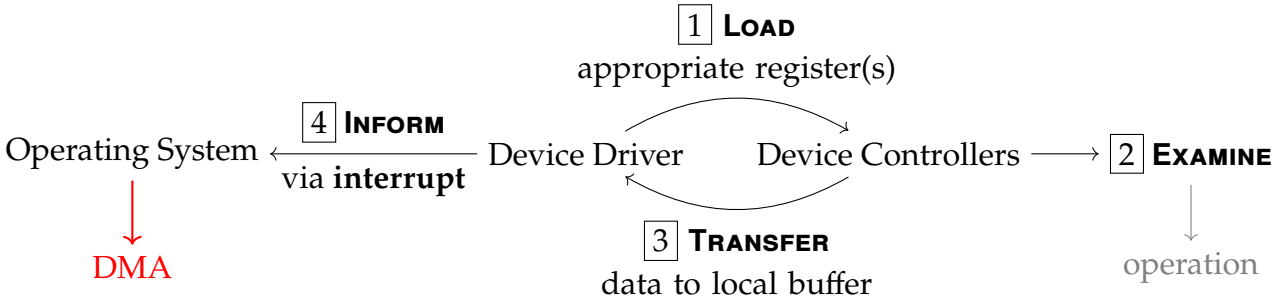



Figure: I/O Operation

This form creates overhead when bulk and/or frequent data movement, like disk and keyboard. By **direct memory access** (DMA), the driver fires only one interrupt and transfers a block of data from its local buffer the main memory, without CPU's intervention.

## 1.3 Computer-System Architecture

### 1.3.1 Single-Processor Systems

S.P.S. {
- 1 GP CPU & GP registers — GP instruction set — runs user program
- SP registers (from processors) — limited SP instruction set — { is managed by OS / only autonomously
}

### 1.3.2 Multiprocessor Systems

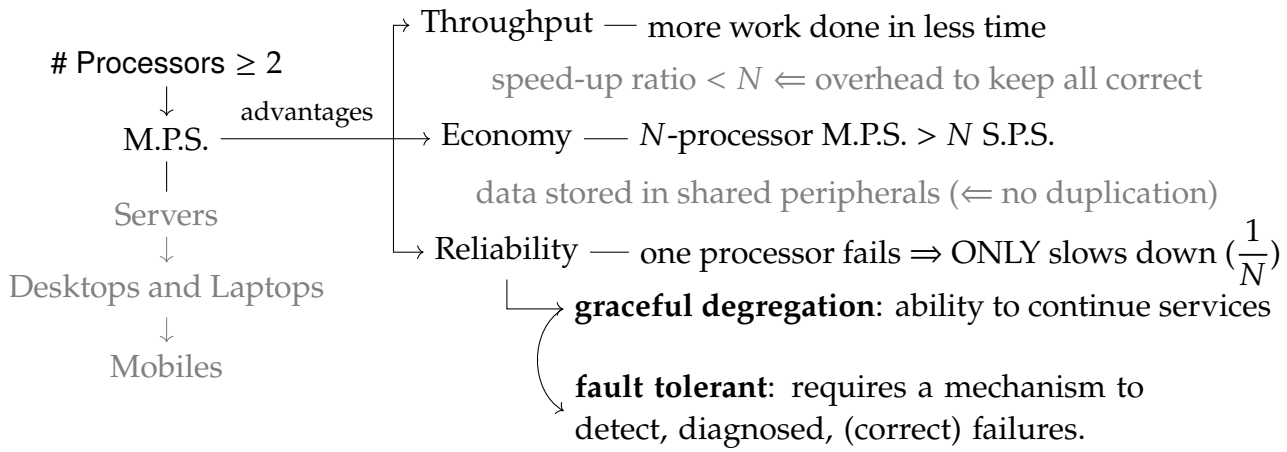



Figure: Multiprocessor System Concepts

- M.P.S.
  - asymmetric MP
    - boss — controls the system
    - worker — looks for boss instruction or haspredefined tasks
  - (different implementation in hardware and/or software)
  - symmetric MP
    - peer-to-peer relationships
    - Each CPU owns registers and caches; CPU shares memory.
    - ensures I/O data to reach the appropriate processor.
    - one is overloaded, some others are idle ⇒ dynamically shares

Types of Multiprocessor System

**Multicore**: includes multiple computing cores (owns registers and local cache) on a single chips; on-chip communication is faster and uses significantly less power than between-chip communication.

### 1.3.3 Clustered Systems

A **clustred sytem** are composed of two or more individual systems, or nodes, joined together.

- **Clustering**
  - provides
    - high-availability service (one fails ⇒ continues) ⇐ Redundancy
    - high-performance computing environment ⇐ Parallelization
  - type
    - assymmetric
      - hot-standby — does nothing, monitors active server
      - fails ⇒ becomes another active server
      - other — runs applications
    - symmetric: ≥2 machines run and monitor each other.

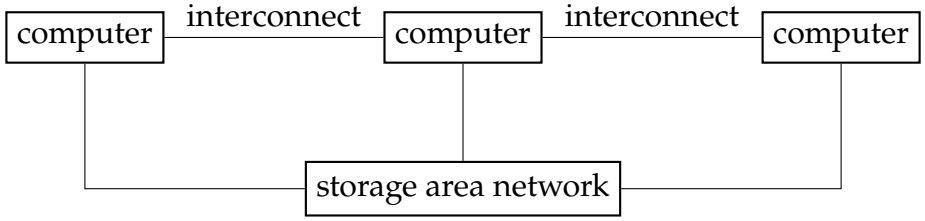



Figure: General structure of a clustered system

**Parallelization**: divides a program into separate components to run on individual computers in the cluster $\Longrightarrow$ much greater computational power (significantly greater than multiple single-processor systems or even symmetric multiprocessor systems).
**Parallel clusters**: multiple hosts to access data on shared storage $\Rightarrow$ access control and locks

## 1.4 Operating-System Structure