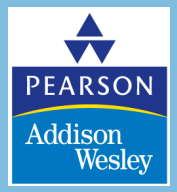
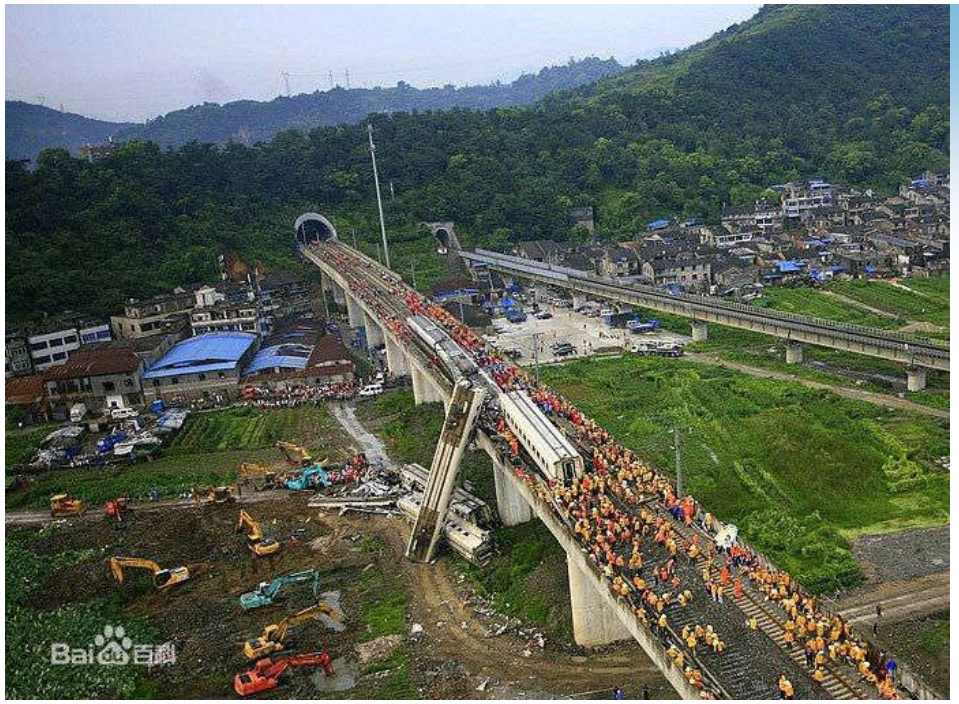
Chapter 3:
Operating Systems

Computer Science: An Overview
Tenth Edition

by

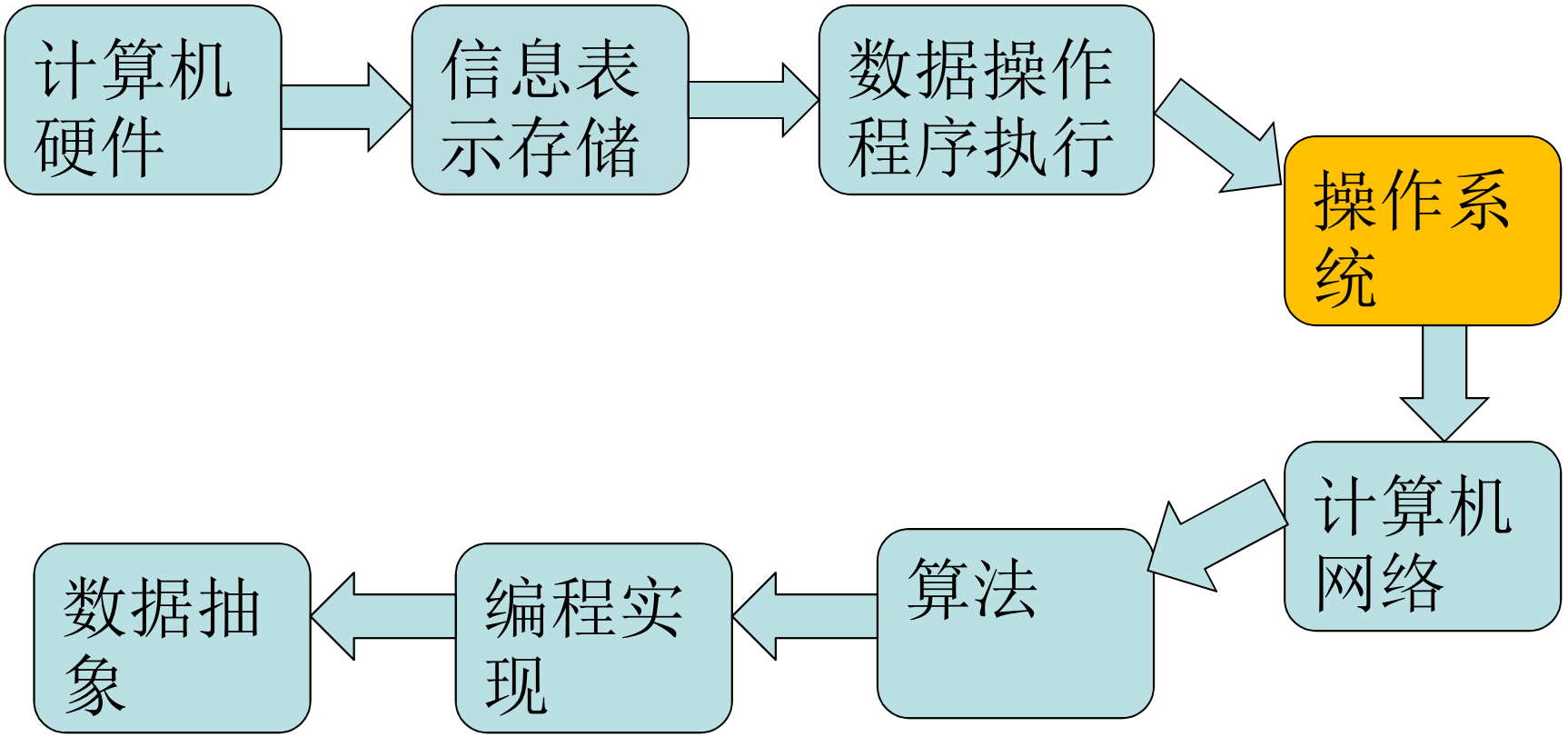
J. Glenn Brookshear





- Wenzhou train collision
- Shanghai metro line 10

从程序的角度了解计算机系统



- Who can get the microphone?

We Need a Chairperson!

- The chairperson decides who gets the microphone to speak next
- Two ways to schedule:
  - Let each speaker talk until he/she finishes
  - "Interrupts" the speaker to get back the microphone and turn to another speaker → time sharing

Suppose the computer runs only one program …

Full control of everything, e.g.
CPU

Manage everything

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In a single-processor computer, CPU is shared by all programs

Suppose the computer runs many programs …

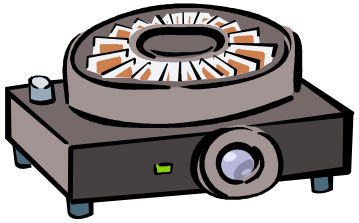
- How do they get executed?
- How do they get the most important resource – the CPU?

Chairperson Can Do More

- Which portion of blackboard a speaker can write?
  → memory management

Chairperson is OS

- Who can use 幻灯机 (projector)?
  - Device driver and management



How many operating systems do you know?

What is the role of the operating system?

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What is an Operating System?

Technical Definition: An OS is a collection of system software that coordinates between the hardware, provides a platform for software to run on and provides the user with an interface for command inputs.

The governmental systems like Postal system, Railway System are analogous to Operating Systems.

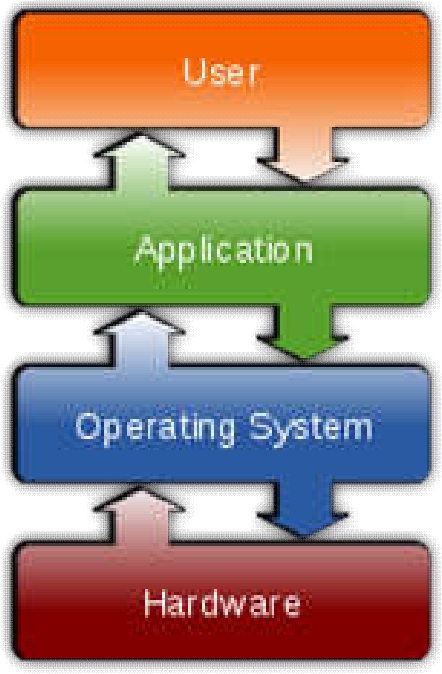
Chapter 3: Operating Systems

- 3.1 The History of Operating Systems
- 3.2 Operating System Architecture
- 3.3 Coordinating the Machine's Activities
- 3.4 Handling Competition Among Processes

- 操作系统种类:
  - 智能卡OS、实时OS 、传感器节点OS 、嵌入式OS 、个人计算机OS 、网络OS和大型机OS

Different operating systems

- Unix, Solaris, Chrome OS
- Windows, Dos, Mac OS, Linux
- 手机：iOS, Android, WindowsCE
- 嵌入式实时操作系统:μC/OS-II、嵌入式Linux、Windows Embedded、VxWorks



桌面OS

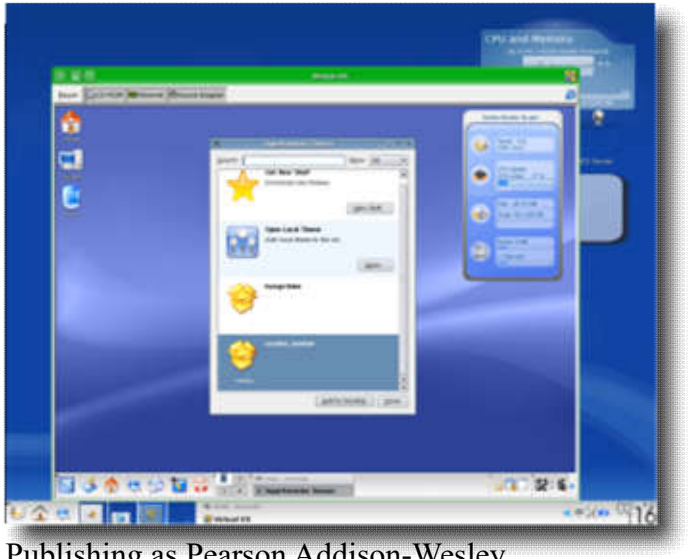
- 桌面操作系统主要用于个人计算机上。个人计算机从硬件架构上来说主要分为PC机与Mac机，从软件上可主要分为两大类，分别为类Unix操作系统和Windows操作系统
- 类Unix操作系统：Mac OS X，Linux发行版（如Debian，Ubuntu，openSUSE，Red Hat，）；
- Windows: Windows 98，Windows 2000，Windows XP，Windows Vista，Windows 7，Windows 8，Windows10

服务器OS

- 服务器操作系统一般指的是安装在大型计算机上的操作系统，比如Web服务器、应用服务器和数据库服务器等
- Unix系列：SUNSolaris，FreeBSD，OS X Server 等；
- Linux系列：Red Hat Linux，Debian，UbuntuServer等；
- Windows系列：Windows NT Server，Windows Server 2008，Windows server 2012，windows server technical
- 在服务器方面Linux、UNIX和Windows Server占据了市场的大部分份额。在超级计算机方面，Linux取代Unix成为了第一大操作系统

Unix

- 1969年在AT&T的贝尔实验室开发
- 稳定，可靠， 多用户，多任务
- 提供各种Internet服务的计算机运行的操作系统占很大比例的是Unix及Unix类操作系统



Solaris

- Sun Microsystems研发的计算机操作系统
- UNIX操作系统的衍生版本之一
- 多用于Sun工作站
- 稳定、性能高
- 商用、通信等领域

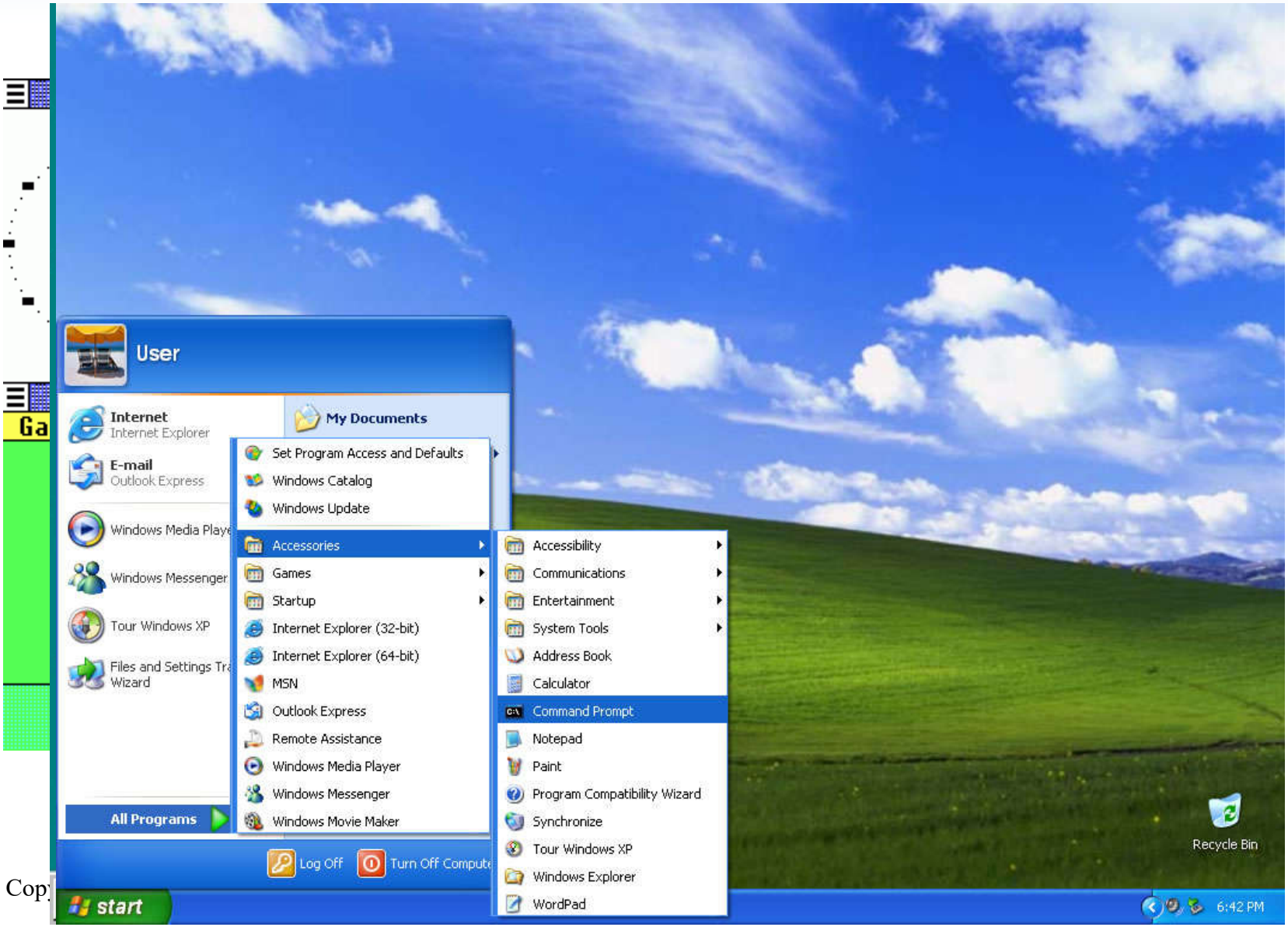
Chrome OS

- Google发布
- 互联网的云端操作系统
- 系统植基于谷歌浏览器及Linux内核

DOS (Disk Operation System)

single-user single-task

Windows (from 1985-present)



Mac OS (from 1984-present)

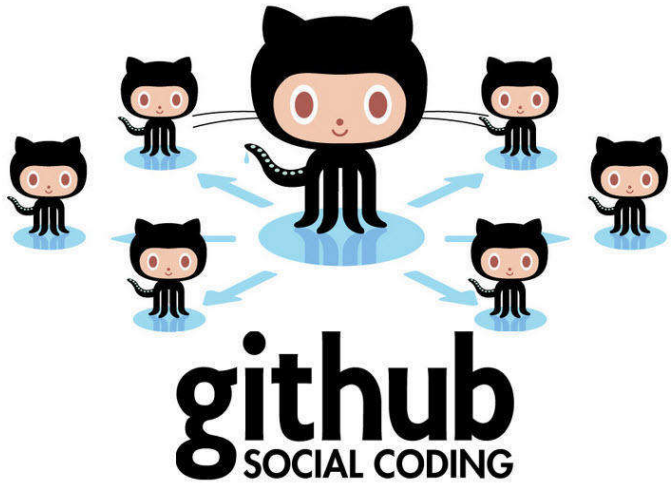
Linux

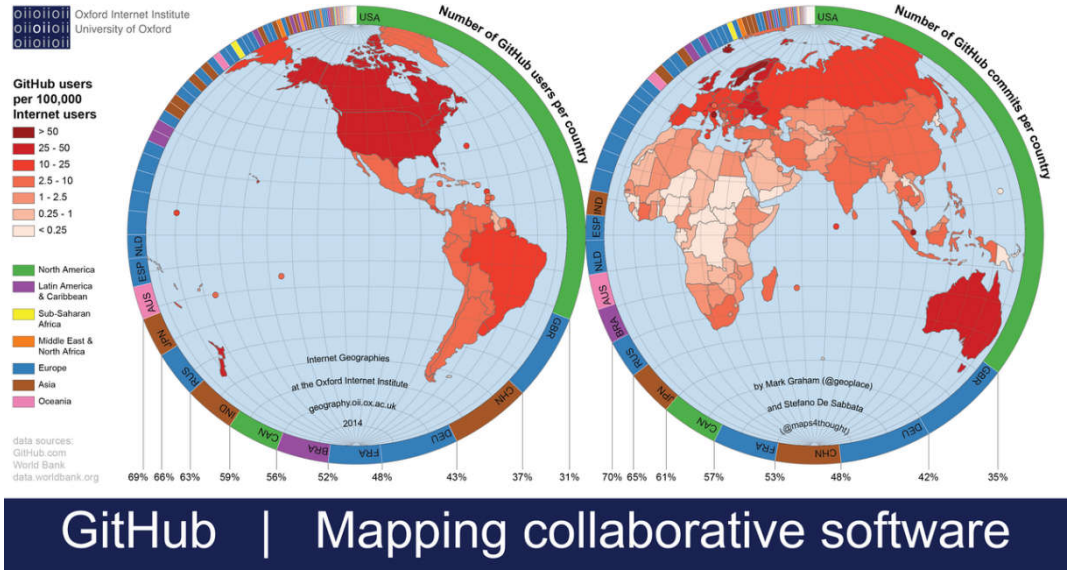
- First released on 5 October 1991 by Linus Torvalds

GNU

- A free software, mass collaboration project, announced on 27 September 1983, by Richard Stallman at MIT.
- 旨在开发一个类似 Unix，且为自由软件的完整操作系统GNU 系统
- GNU是一个自由软件操作系统，所用的典型内核是Linux
- Linux成为常见的GNU计划软件运行平台

- Git: 分布式版本控制系统
- Github：全球最大的社交编程及代码托管网站，为开源项目免费提供Git管理



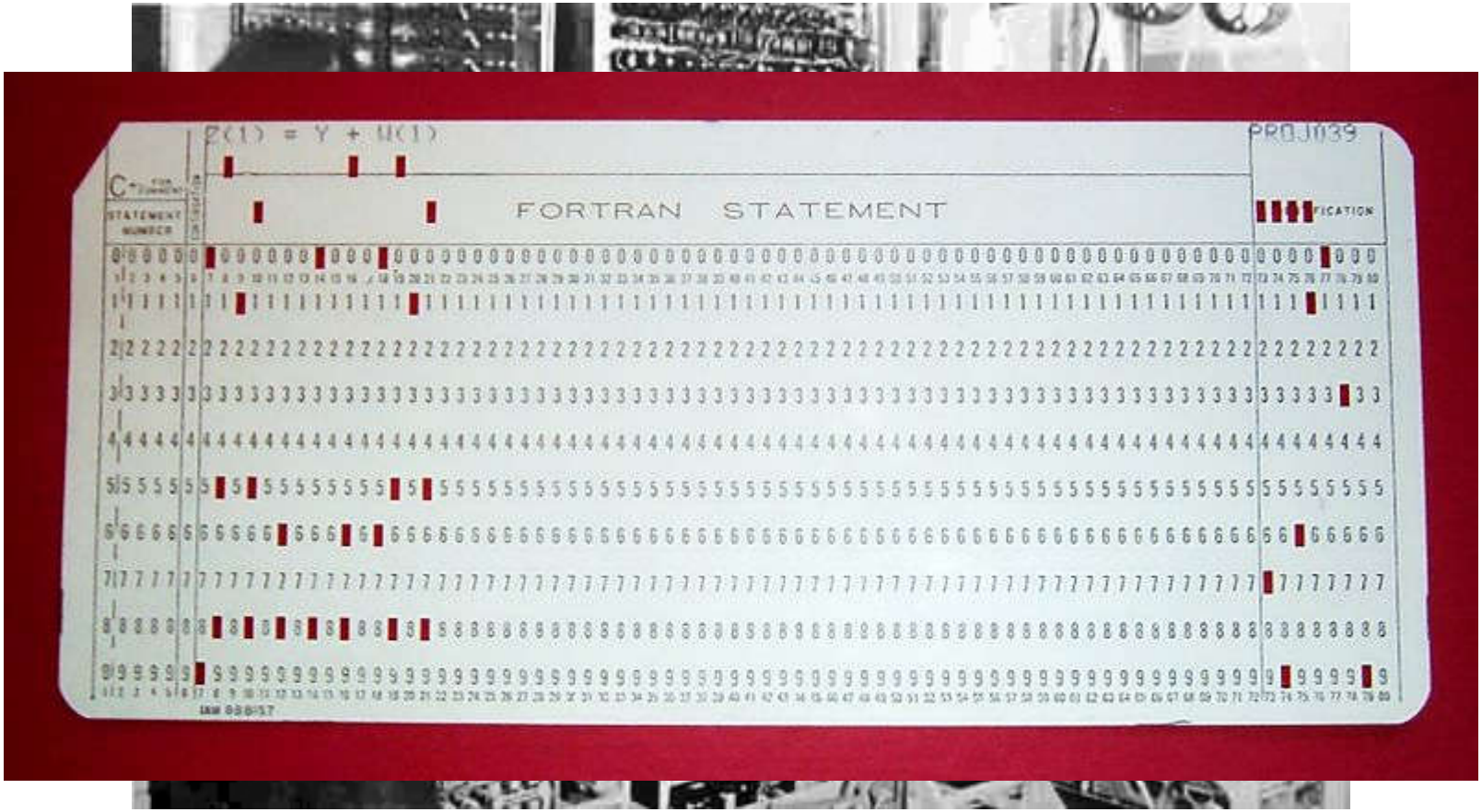


History of operating system

- Batch processing 批处理
- Interactive processing 交互处理
  - Requires real-time processing
- Time-sharing/Multitasking 时分/多任务
  - Implemented by Multiprogramming多道程序
- Multiprocessor machines 多处理器机器

The birth of OS

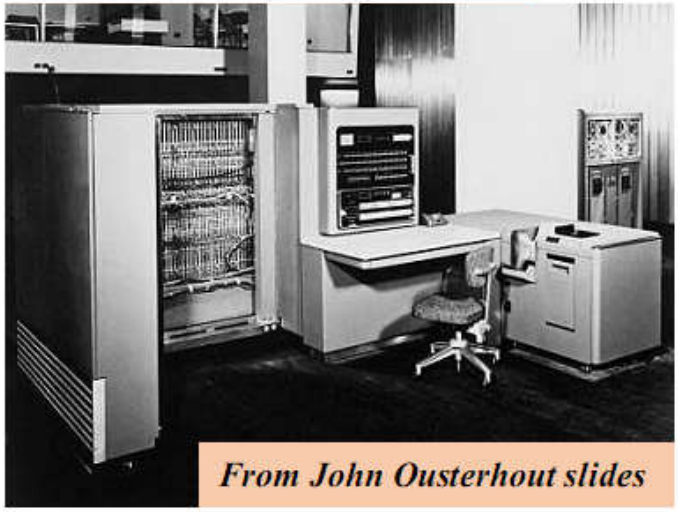
- Before OS was invented



Wikipedia

Early Systems - Bare Machine (1950s)

Hardware – *expensive* ; Human – *cheap*



From John Ousterhout slides

- Structure
  - Large machines run from console
  - Single user system
    - Programmer/User as operator
  - Paper tape or punched cards
- Early software
  - Assemblers, compilers, linkers, loaders, device drivers, libraries of common subroutines.
- Secure execution
- Inefficient use of expensive resources
  - Low CPU utilization, high setup time.

In The Beginning. . .

- 1949: First stored-program machine (EDSAC)
- to $\sim$ 1955: "Open Shop".
  - large machines with vacuum tubes.
  - I/O by paper tape / punch cards.
  - user = programmer = operator.
- To reduce cost, hire an *operator*:
  - programmers write programs and submit tape/cards to operator.
  - operator feeds cards, collects output from printer.
- Management like it.
- Programmers hate it.
- Operators hate it.

$\Rightarrow$ need something better.

Jobs

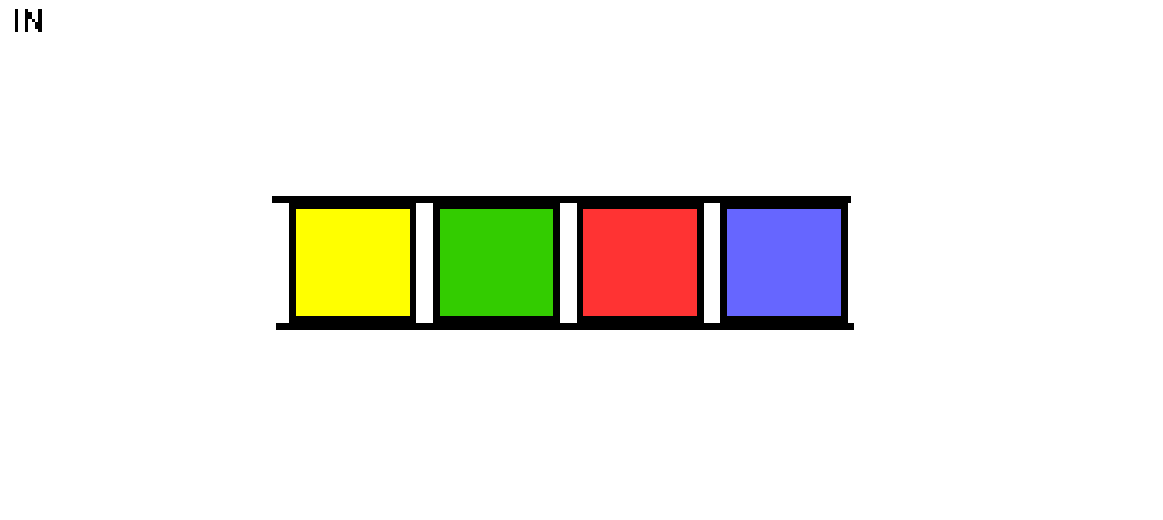
- Jobs queue

Significant set-up time to run programs -> Need for Batch systems

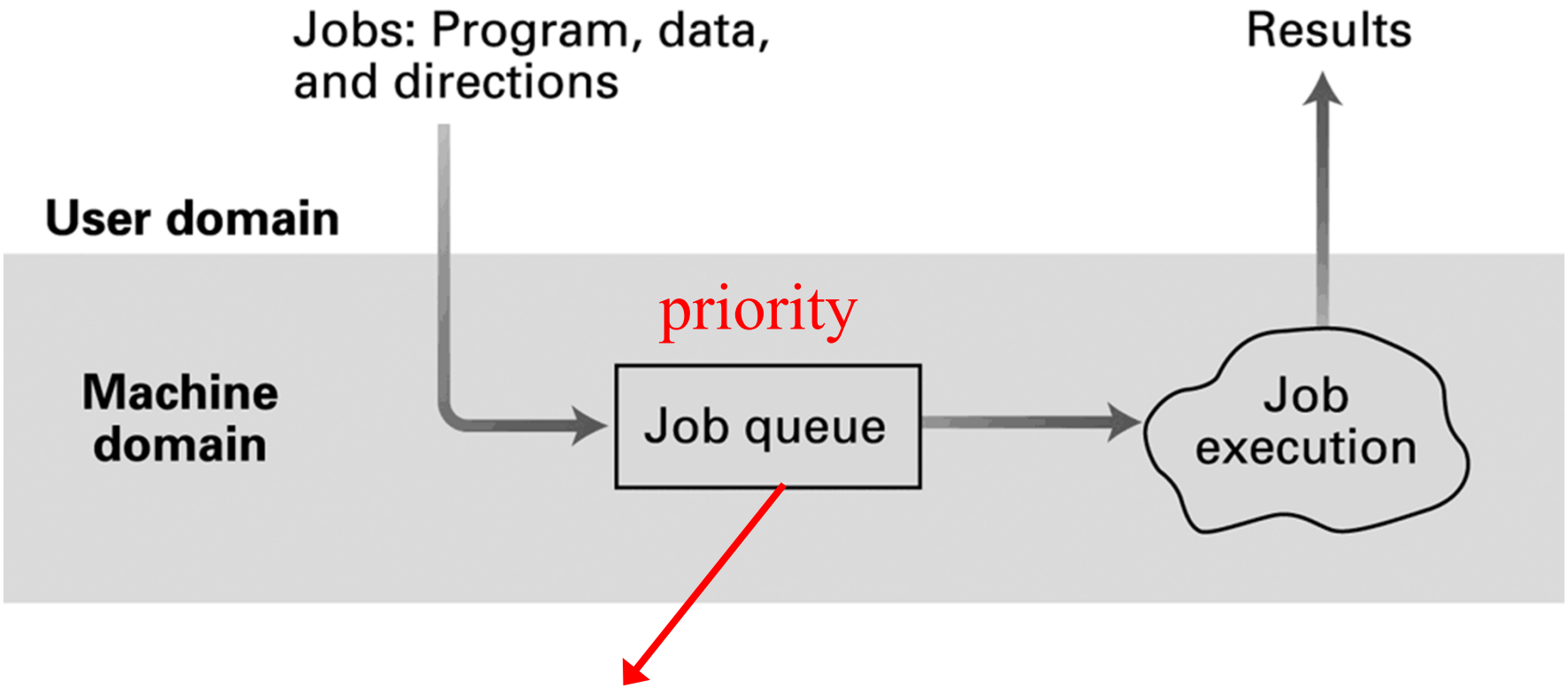
http://getlevelten.com/blog/ian-whitcomb/whats-wrong-project-application-queue

Queue

- FIFO



Batch processing



Batch Systems (1960's)

- Reduce setup time by batching jobs with similar requirements.
- Hire an operator
  - User is NOT the operator
- Automatic job sequencing
  - Forms a rudimentary OS.
  - Resident Monitor
    - Holds initial control, control transfers to job and then back to monitor.
  - Problem
    - Need to distinguish job from job and data from program.
    - Special cards indicate what to do.
    - User program prevented from performing I/O

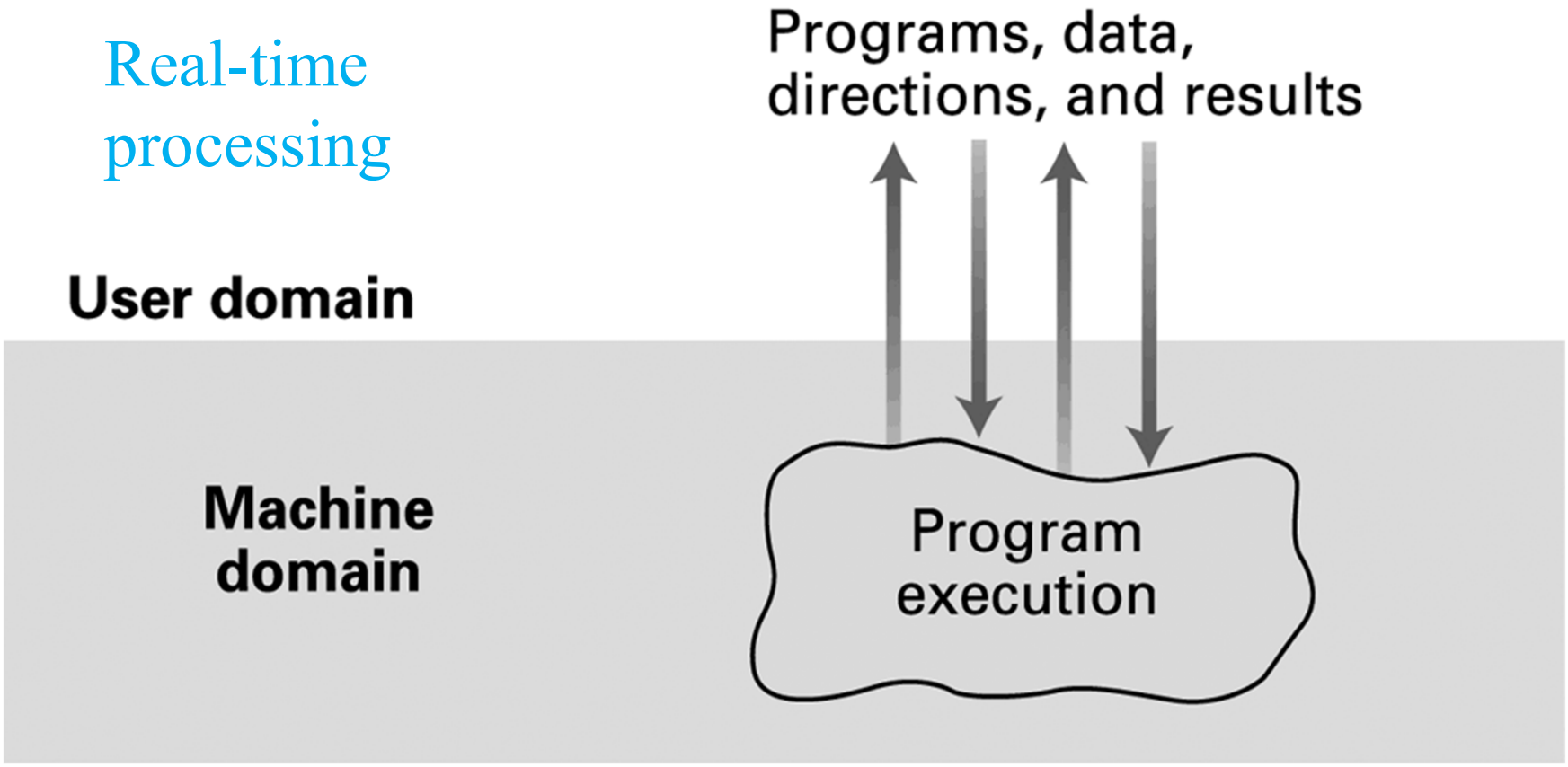

From John Ousterhout slides

Computer terminal

Wikipedia

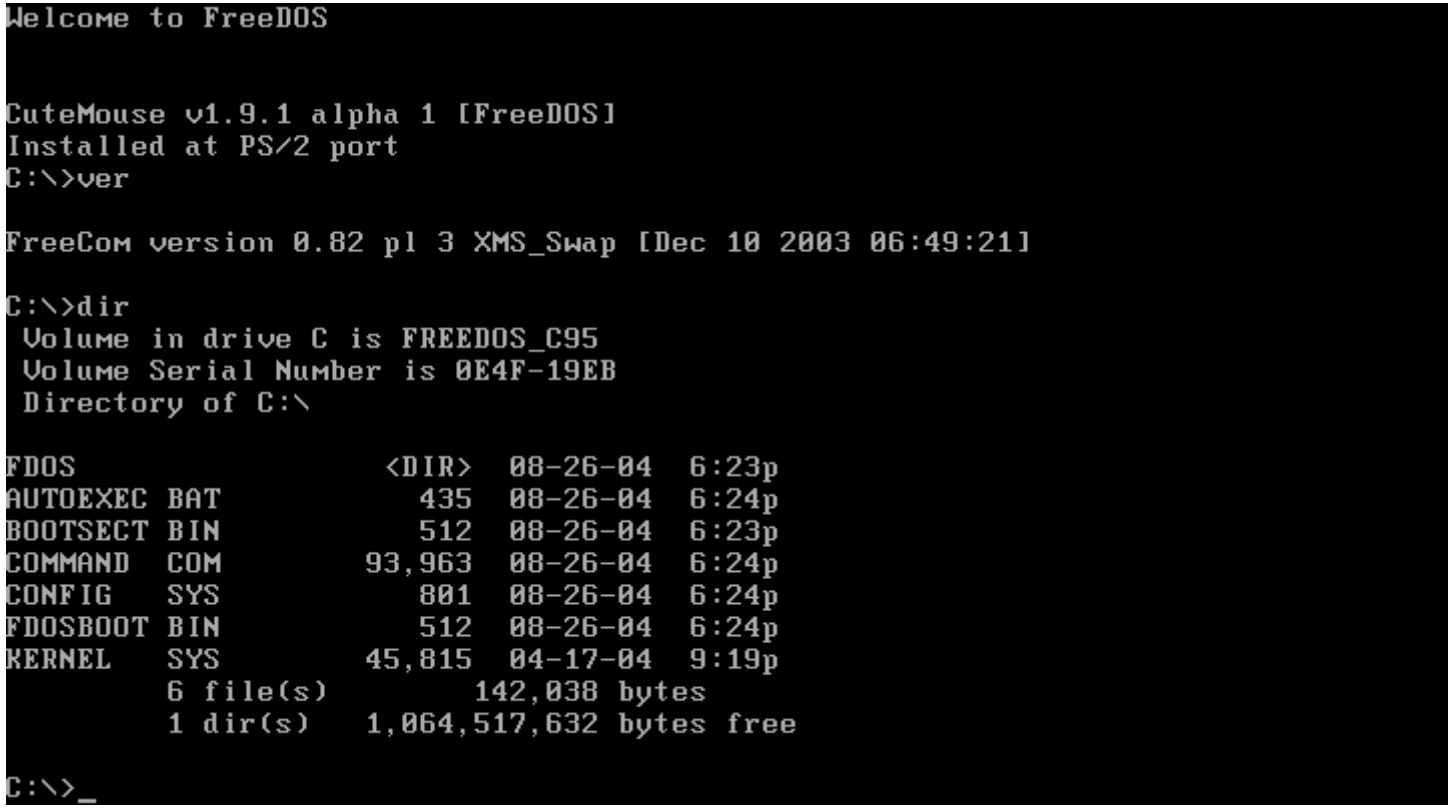
Interactive processing

Real-time processing



Text editing, music/movie playing, …

DOS (Disk Operation System)

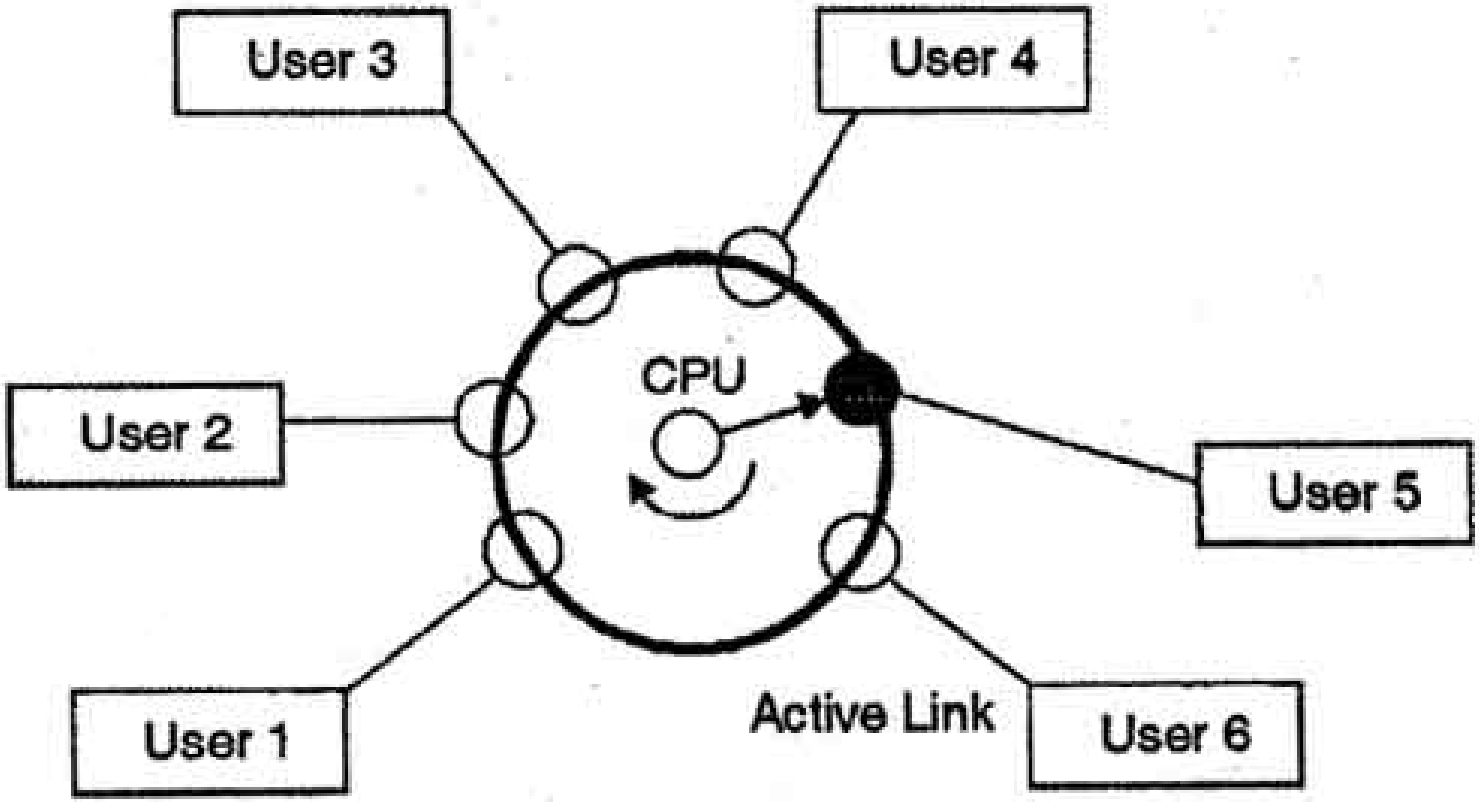


Multi-tasking

Multiprogramming (多道程序)

Time-sharing system （分时系统）

- 1960s – 1970s
- Although batch systems allow system resources to be used more efficiently, the user cannot interact with the job while it is executing
- One means of implementing time-sharing is multiprogramming (多道程序设计)
- CPU switches between jobs frequently to allow user interaction



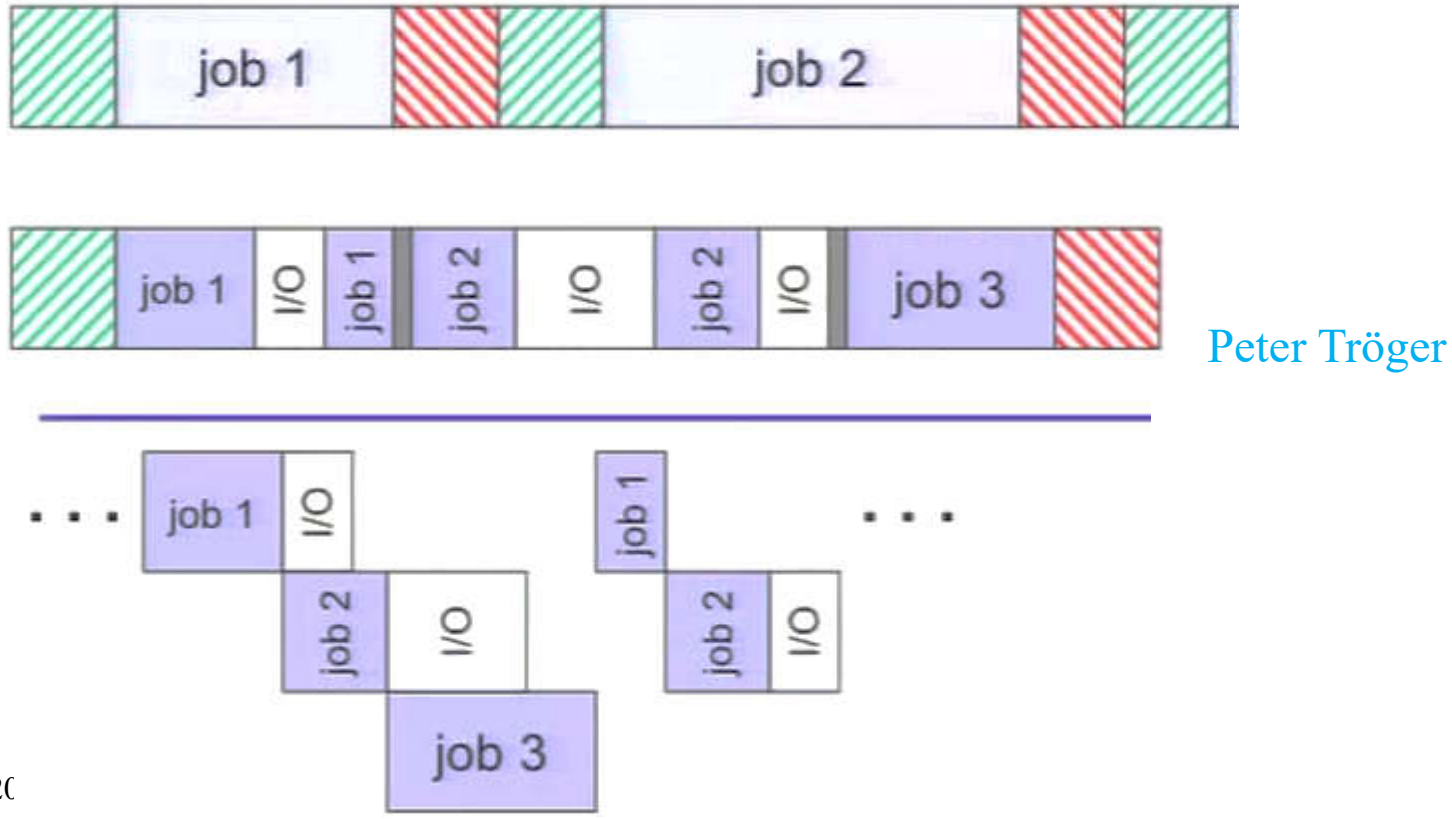
DINESH THAKUR

Time-sharing system （分时系统）

- Multiprogramming techniques are used in single-user as well as multiuser systems
- For single-user, multiprogramming is called multitasking (多任务)
- Multitasking: 一个用户同时执行多个任务
- Time-sharing:多个用户共享使用一个计算机

Multiprogramming (多道程序设计)

- Early mode of multitasking



Peter Tröger

Multiprogramming

- Use interrupts to run multiple programs simultaneously
  - When a program performs I/O, instead of polling, execute another program till interrupt is received.
- Requires secure memory, I/O for each program.
- Requires intervention if program indefinite loops.
- Requires CPU scheduling to choose the next job to run.

Timesharing

Hardware – *getting cheaper*; Human – *getting expensive*

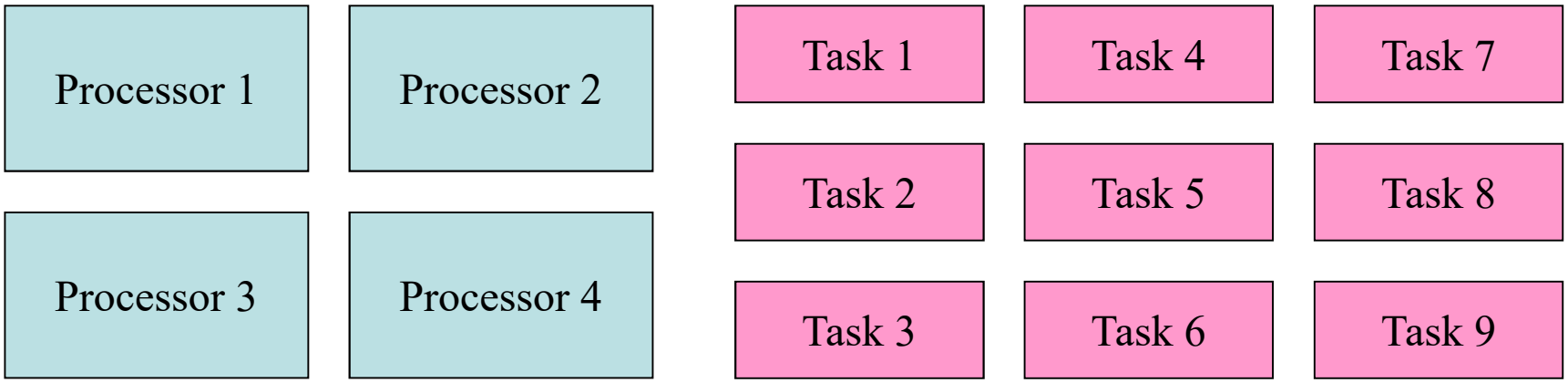
- Programs queued for execution in FIFO order.
- Like multiprogramming, but timer device interrupts after a quantum (timeslice).
  - Interrupted program is returned to end of FIFO
  - Next program is taken from head of FIFO

- 多道程序系统是在计算机内存中同时存放几道相互独立的程序，使它们在管理程序控制之下，相互穿插的运行。 两个或两个以上程序在计算机系统中同处于开始和结束之间的状态。这就称为多道程序技术运行的特征：多道、宏观上并行、微观上串行。各道程序轮流使用CPU，交替执行，现代计算机系统都采用了多道程序设计技术。

- 分时操作系统是使一台计算机同时为几个、几十个甚至几百个用户服务的一种操作系统。把计算机与许多终端用户连接起来，分时操作系统将系统处理机时间与内存空间按一定的时间间隔，轮流地切换给各终端用户的程序使用。由于时间间隔很短，每个用户的感觉就像他独占计算机一样。

- 分时操作系统是给不同用户提供程序的使用，而多道程序系统则是不同程序间的穿插运行。总之，分时操作系统主要是针对于多用户来说的，而多道程序系统主要是针对于多程序来说的

Multiprocessor Machines

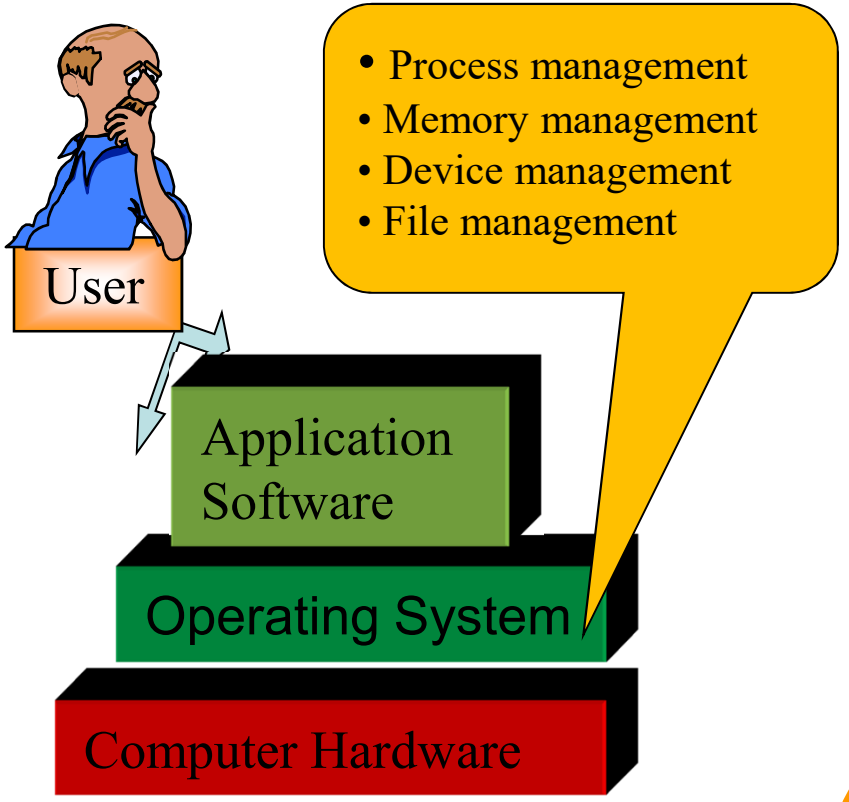


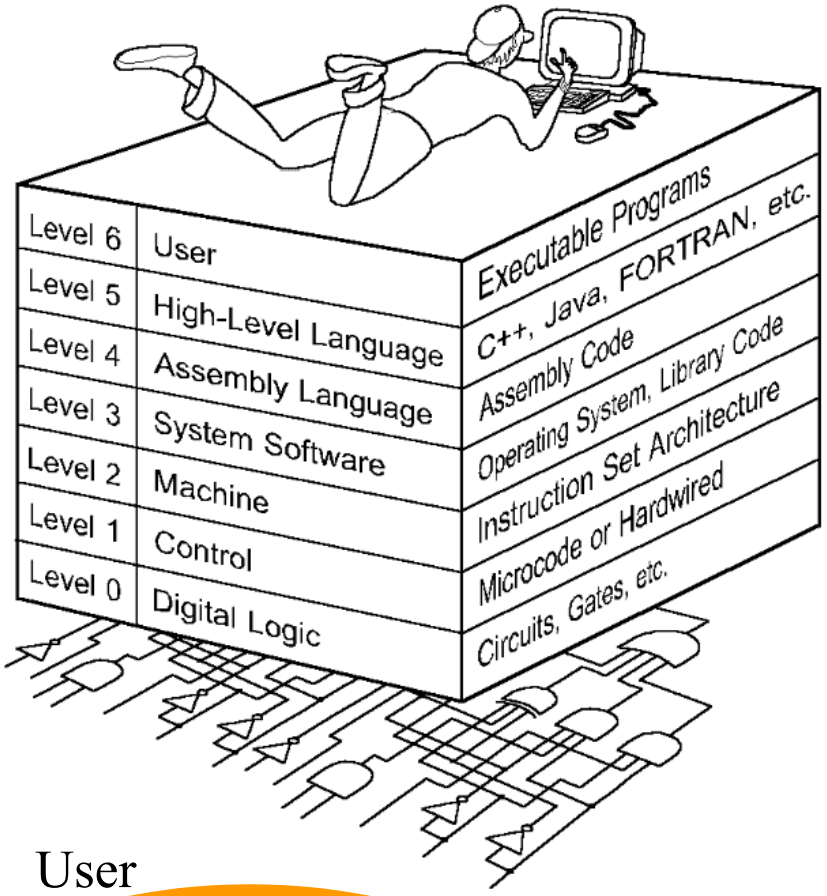
- How to assign tasks to processors?
  - Load balance problem
- How to use processors to handle one task?
  - Parallelization, scaling problem

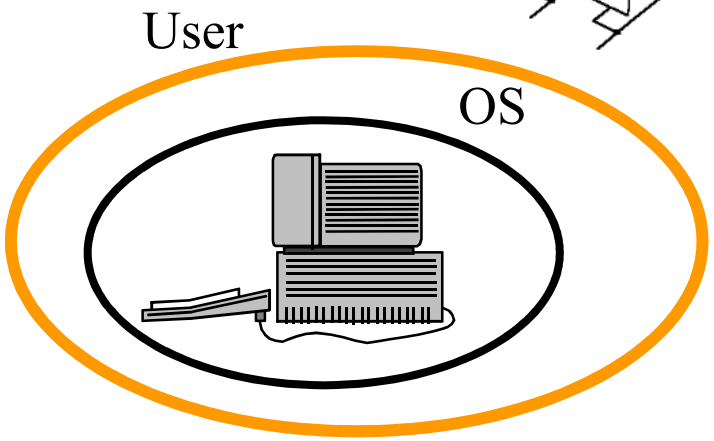
OS for Small Devices

- Embedded systems, PDA, mp3 player, cell phone, GPS,…
  - Limited storage, limited power,
  - Usually has real time requirement
- Turn key system: store all programs and data in a persistent memory
  - No BIOS and program loader

Microwave



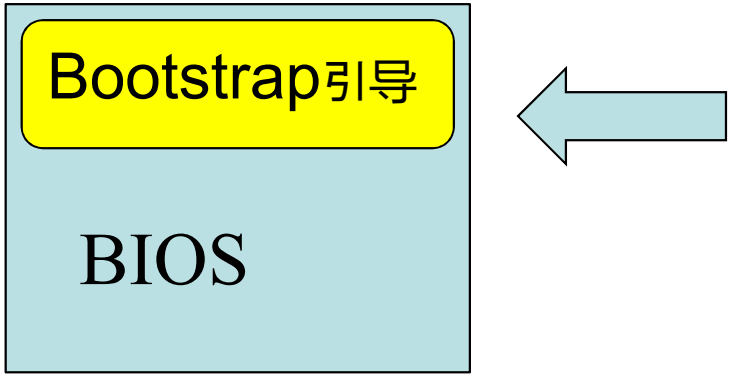




How does a computer start executing?

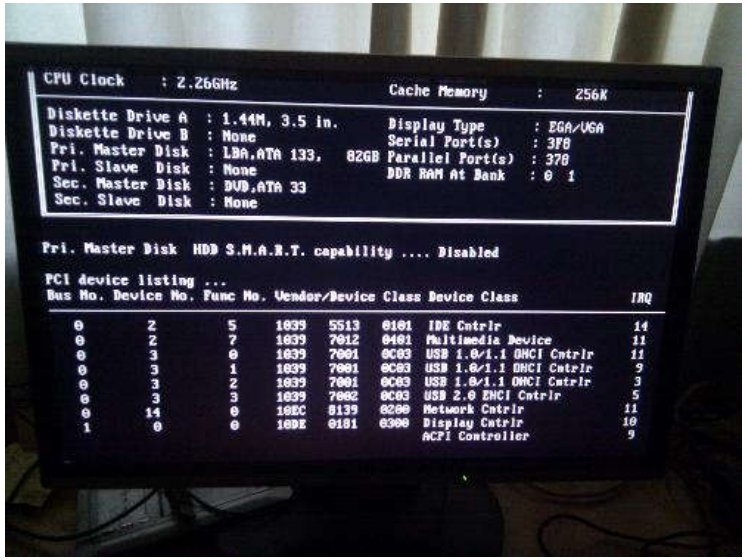
Simple Answer

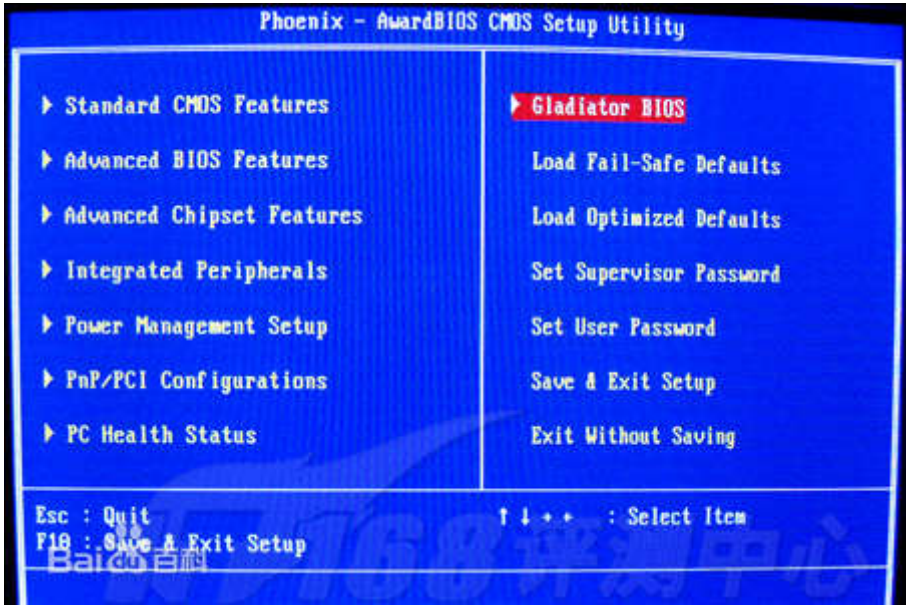
- The program counter is initiated with a particular address in a special memory when the computer is powered on
  - That address is start of a (special) program → to bring up other programs and the system
  - But DRAM is volatile!
  - So, we use read-only memory (ROM)



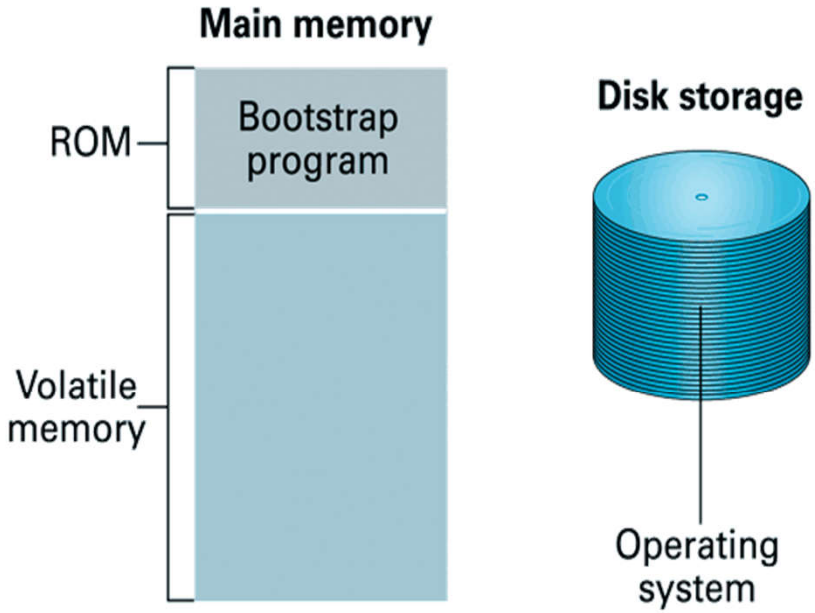
BIOS

BIOS是英文"Basic Input Output System"的缩略语，直译过来后中文名称就是"基本输入输出系统"。其实，它是一组固化到计算机内主板上一个ROM芯片上的程序，它保存着计算机最重要的基本输入输出的程序、系统设置信息、开机后自检程序和系统自启动程序。其主要功能是为计算机提供最底层的、最直接的硬件设置和控制

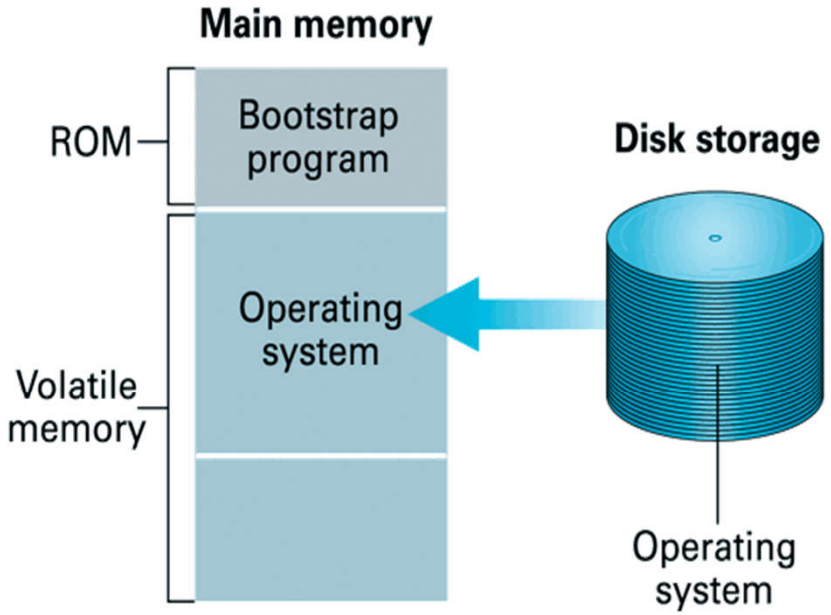




BIOS and Booting Process



Step 1: Machine starts by executing the bootstrap program already in memory. Operating system is stored in mass storage.



Step 2: Bootstrap program directs the transfer of the operating system into main memory and then transfers control to it.