

0117401: Operating System

计算机原理与设计

Chapter 1-2: OS History

陈香兰

xlanchen@ustc.edu.cn

<http://staff.ustc.edu.cn/~xlanchen>

Computer Application Laboratory, CS, USTC @ Hefei
Embedded System Laboratory, CS, USTC @ Suzhou

March 6, 2023

温馨提示：



为了您和他人的工作学习，
请在课堂上**关机或静音**。

不要在课堂上接打电话。

Outline

History of Operating Systems

操作系统的发展动力

1945~1955, 无操作系统

1955~1965, 批处理系统

1965~1980, 引入分时

1980~present, PC时代, 百花齐放

1990~present, 移动计算时代

其他操作系统

Personal-Computer Systems

Parallel Systems

Distributed Systems

Embedded System

小结

Outline

History of Operating Systems

操作系统的发展动力

1945~1955, 无操作系统

1955~1965, 批处理系统

1965~1980, 引入分时

1980~present, PC时代, 百花齐放

1990~present, 移动计算时代

其他操作系统

Personal-Computer Systems

Parallel Systems

Distributed Systems

Embedded System

小结

操作系统的发展动力

- ▶ 操作系统形成至今(1956 GM OS & GM-NAA I/O-), 出现了上百种操作系统
 - ▶ 大型机、小型机、微机、嵌入式、实时、分布等等
- ▶ 推动操作系统发展的主要动力有4个方面【汤】：
 1. 不断提高计算机资源利用率的需要
 2. 方便用户
 3. 器件的不断更新换代
 4. 计算机体系结构的不断发展
- ▶ 历程：
 - ▶ 无OS时代→批处理系统→分时系统→实时系统→PC→分布式和并行系统→
嵌入→移动系统→ ...

操作系统的发展动力

- ▶ 操作系统形成至今(1956 GM OS & GM-NAA I/O-), 出现了上百种操作系统
 - ▶ **List of operating systems:**
 - ▶ FMS (FORTRAN Monitor System, FORTRAN监控系统)
 - ▶ OS/360 (IBM为系列机360配备的操作系统)
 - ▶ CTSS (Compatible Time Sharing System)
 - ▶ MULTICS (MULTiplexed Information and Computer Service)
 - ▶ UNIX类、Linux
 - ▶ CP/M
 - ▶ Windows、Macintosh
 - ▶ Mach
 - ▶ VxWorks、嵌入式Linux系列、uC/OS-II、RTEMS
 - ▶ (List of OSes)
- ▶ 推动操作系统发展的主要动力有4个方面【汤】：
 1. 不断提高计算机资源利用率的需要
 2. 方便用户
 3. 器件的不断更新换代
 4. 计算机体系结构的不断发展
- ▶ 历程：
 - ▶ 无OS时代→批处理系统→分时系统→实时系统→PC→分布式和并行系统→
嵌入→移动系统→ ...

操作系统的发展动力

- ▶ 操作系统形成至今(1956 GM OS & GM-NAA I/O-), 出现了上百种操作系统
- ▶ 推动操作系统发展的主要动力有4个方面【汤】：
 1. 不断提高计算机资源利用率的需要
 2. 方便用户
 3. 器件的不断更新换代
 4. 计算机体系结构的不断发展
- ▶ 历程：
 - ▶ 无OS时代→批处理系统→分时系统→实时系统→PC→分布式和并行系统→
嵌入→移动系统→ ...

操作系统的发展动力

- ▶ 操作系统形成至今(1956 GM OS & GM-NAA I/O-), 出现了上百种操作系统
- ▶ 推动操作系统发展的主要动力有4个方面【汤】：
 1. 不断提高计算机资源利用率的需要
 2. 方便用户
 3. 器件的不断更新换代
 4. 计算机体系结构的不断发展
- ▶ 历程：
 - ▶ 无OS时代→批处理系统→分时系统→实时系统→PC→分布式和并行系统→
嵌入→移动系统→ ...

History of Operating Systems

► Reading: Modern operating systems (4th edition) , 1.2

1. 1945~1955, 无操作系统时期

History of Operating Systems

► Reading: Modern operating systems (4th edition) , 1.2

1. 1945~1955, 无操作系统时期
2. 1955~1965, 批处理系统

History of Operating Systems

- ▶ Reading: Modern operating systems (4th edition) , 1.2
- 1. 1945~1955, 无操作系统时期
- 2. 1955~1965, 批处理系统
 - 2.1 单道批处理系统(simple batch processing)

History of Operating Systems

► Reading: Modern operating systems (4th edition) , 1.2

1. 1945~1955, 无操作系统时期

2. 1955~1965, 批处理系统

2.1 单道批处理系统(simple batch processing)

2.2 多道批处理系统(multiprogramming system)

History of Operating Systems

► Reading: Modern operating systems (4th edition) , 1.2

1. 1945~1955, 无操作系统时期
2. 1955~1965, 批处理系统
 - 2.1 单道批处理系统(simple batch processing)
 - 2.2 多道批处理系统(multiprogramming system)
3. 1965~1980, 分时系统(Time-sharing system)

History of Operating Systems

► Reading: Modern operating systems (4th edition) , 1.2

1. 1945~1955, 无操作系统时期
2. 1955~1965, 批处理系统
 - 2.1 单道批处理系统(simple batch processing)
 - 2.2 多道批处理系统(multiprogramming system)
3. 1965~1980, 分时系统(Time-sharing system)
4. 1980~, PC时代 (微型计算机, microcomputer)
 - 百花齐放

History of Operating Systems

► Reading: Modern operating systems (4th edition) , 1.2

1. 1945~1955, 无操作系统时期
2. 1955~1965, 批处理系统
 - 2.1 单道批处理系统(simple batch processing)
 - 2.2 多道批处理系统(multiprogramming system)
3. 1965~1980, 分时系统(Time-sharing system)
4. 1980~, PC时代 (微型计算机, microcomputer)
 - 百花齐放
 - 实时系统(Real-Time system)

History of Operating Systems

- ▶ Reading: Modern operating systems (4th edition) , 1.2
- 1. 1945~1955, 无操作系统时期
- 2. 1955~1965, 批处理系统
 - 2.1 单道批处理系统(simple batch processing)
 - 2.2 多道批处理系统(multiprogramming system)
- 3. 1965~1980, 分时系统(Time-sharing system)
- 4. 1980~, PC时代 (微型计算机, microcomputer)
 - ▶ 百花齐放
 - ▶ 实时系统(Real-Time system)
 - ▶ 其他操作系统: 分布式、并行、安全、...
- 5. 1990~, 移动计算

Outline

History of Operating Systems

操作系统的发展动力

1945~1955, 无操作系统

1955~1965, 批处理系统

1965~1980, 引入分时

1980~present, PC时代, 百花齐放

1990~present, 移动计算时代

其他操作系统

Personal-Computer Systems

Parallel Systems

Distributed Systems

Embedded System

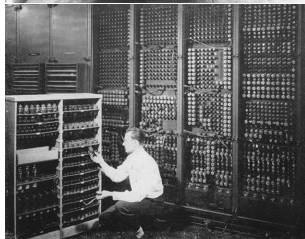
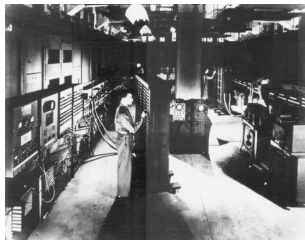
小结

History of the OS (1945~1955, 无操作系统)

▶ Tube-based (电子管)

▶ ENIAC

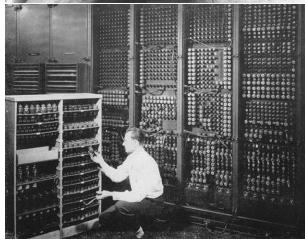
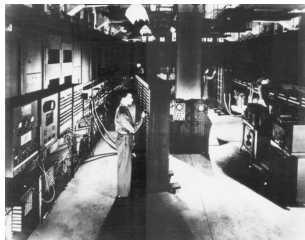
- ▶ 17,468 vacuum tubes
- ▶ 5,000 additions/sec,
- ▶ 1800 square feet, 30 tons



Replacing a bad tube meant checking among ENIAC's 19,000 possibilities.

History of the OS (1945~1955, 无操作系统)

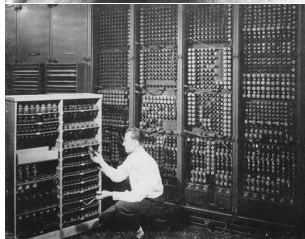
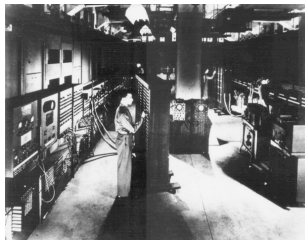
- ▶ Tube-based (电子管)
- ▶ Program are hardwired on plug boards
- ▶ One program at a time, Need professional operator
 - ▶ User VS. operator
- ▶ Only useful to Numerical calculations



Replacing a bad tube meant checking among ENIAC's 19,000 possibilities.

History of the OS (1945~1955, 无操作系统)

- ▶ Tube-based (电子管)
- ▶ Program are hardwired on plug boards
- ▶ One program at a time, Need professional operator
- ▶ Only useful to Numerical calculations
- ▶ No OS at all !
 - ▶ Manual system (人工操作)



Replacing a bad tube meant checking among ENIAC's 19,000 possibilities.

Outline

History of Operating Systems

操作系统的发展动力

1945~1955, 无操作系统

1955~1965, 批处理系统

1965~1980, 引入分时

1980~present, PC时代, 百花齐放

1990~present, 移动计算时代

其他操作系统

Personal-Computer Systems

Parallel Systems

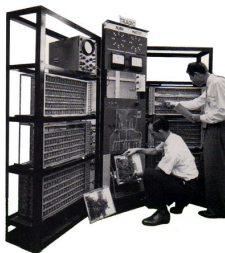
Distributed Systems

Embedded System

小结

History of the OS (1955~1965, 批处理系统)

- ▶ Transistor based (晶体管)
- ▶ Jobs on cards or tapes
 - ▶ Job (作业)
 - ▶ Control cards
- ▶ Language:
 - ▶ ASM
 - ▶ High level language
 - ▶ FORTRAN, ALGOL, COBOL
- ▶ Applications
 - ▶ Scientific APPs & Engineering APPs
- ▶ Batch system



1954年, 美国贝尔实验室, 第一台晶体管计算机
TRADIC



TX-0, MIT林肯实验室, 1956, 它将键盘、打印机、磁带阅读机和打孔机集成在一起, 操作员可以通过键盘编程, 生成印好的磁带后直接输入机器: 配有一台可编程序显示器。

专题1: Batch system, 批处理系统

- ▶ 批处理系统概述
- ▶ 专题1.1: 单道批处理系统
- ▶ 专题1.2: 脱机IO
- ▶ 专题1.3: 多道批处理系统

批处理系统的工作方式

1. 用户 (user) 将作业 (job) 交给系统操作员 (operator)
2. 系统操作员将许多用户的作业组成一批作业，输入到计算机系统中，
在系统中形成一个自动转接的连续的作业流
 - ▶ 作业是成批的 (batched)
3. 启动操作系统
4. 系统自动、依次执行每个作业
5. 由操作员将作业结果交给用户

批(batch)的含义：

- ▶ 供一次加载的磁带或磁盘，通常由若干个作业组装而成，在处理中使用一组相同的系统软件

- ▶ 批处理系统中作业的组成：
 - ▶ 用户程序 + 数据 + 作业说明书（作业控制语言）
- ▶ 批作业处理：对批作业中的每个作业进行相同的处理
 - ▶ 从磁带读入用户作业和编译链接程序，编译链接用户作业，生成可执行程序；启动执行；执行结果输出

批处理系统

批处理系统经历了两个阶段

1. Simple batch systems, 单道批处理系统
2. Multiprogramming systems, 多道批处理系统

专题1.1：单道批处理系统

- ▶ 单道批处理系统简介
- ▶ 单道批处理系统的工作过程
- ▶ 单道批处理系统的分析

单道批处理系统(simple batch system)

- ▶ **Input devices:** card readers, tape drives
- ▶ **Output devices:** line printers, card punches and tape drives
- ▶ Operator **BATCH** similar jobs to speed up processing
 - ▶ User VS. operator
 - ▶ Compare to : Manual system
- ▶ **Monitor** (OS) , load program and execute
 - ▶ Always resident in memory
 - ▶ **FIFO:** Transfer control automatically from one job to the next
- ▶ **Only One Job in Memory at a time**

单道批处理系统(simple batch system)

- ▶ **Input devices**: card readers, tape drives
- ▶ **Output devices**: line printers, card punches and tape drives
 - ▶ Line printers(行式打印机)
 - ▶ **Card punches(打孔机)**: A computer-actuated punch or a hand punch that punches holes in a punch card or punched card.
- ▶ Operator **BATCH** similar jobs to speed up processing
 - ▶ User VS. operator
 - ▶ Compare to : Manual system
- ▶ **Monitor** (OS) , load program and execute
 - ▶ Always resident in memory
 - ▶ **FIFO**: Transfer control automatically from one job to the next
- ▶ **Only One Job in Memory at a time**

单道批处理系统(simple batch system)

- ▶ **Input devices**: card readers, tape drives
- ▶ **Output devices**: line printers, card punches and tape drives
- ▶ Operator **BATCH** similar jobs to speed up processing
 - ▶ User VS. operator
 - ▶ Compare to : Manual system
- ▶ **Monitor** (OS) , load program and execute
 - ▶ Always resident in memory
 - ▶ **FIFO**: Transfer control automatically from one job to the next
- ▶ Only One Job in Memory at a time

单道批处理系统(simple batch system)

- ▶ **Input devices**: card readers, tape drives
- ▶ **Output devices**: line printers, card punches and tape drives
- ▶ Operator **BATCH** similar jobs to speed up processing
 - ▶ User VS. operator
 - ▶ Compare to : Manual system
- ▶ **Monitor** (OS) , load program and execute
 - ▶ Always resident in memory
 - ▶ **FIFO**: Transfer control automatically from one job to the next
- ▶ Only One Job in Memory at a time

单道批处理系统(simple batch system)

- ▶ **Input devices**: card readers, tape drives
- ▶ **Output devices**: line printers, card punches and tape drives
- ▶ Operator **BATCH** similar jobs to speed up processing
 - ▶ User VS. operator
 - ▶ Compare to : Manual system
- ▶ **Monitor** (OS) , load program and execute
 - ▶ Always resident in memory
 - ▶ **FIFO**: Transfer control automatically from one job to the next
- ▶ **Only One Job in Memory at a time**

单道批处理系统的工作过程

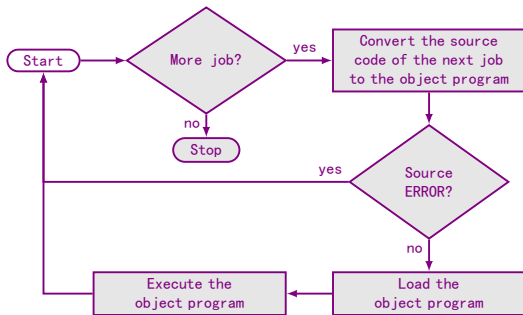
► 处理过程

- 监督程序 (monitor)
- 系统对作业的处理都是成批进行的、且内存中始终只保持一道作业。
- 批处理系统的引入是为了提高系统资源的利用率和吞吐量

► 特征

- 自动性、顺序性、单道性

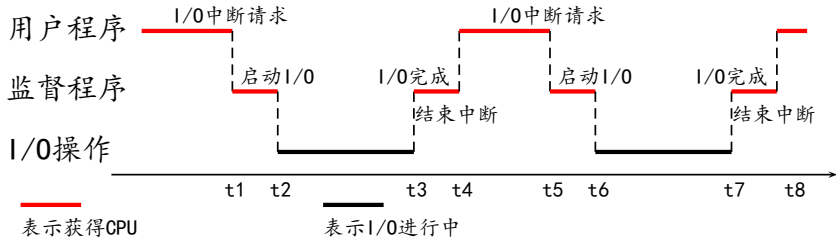
Monitor:



单道程序运行情况

用户进程的行为序列：

执行 \rightarrow I/O \rightarrow 执行 \rightarrow I/O \rightarrow ... \rightarrow 执行 \rightarrow I/O \rightarrow 执行



单道批处理系统分析

Analysis

- ▶ Serial Card reader: Jobs execute one by one
- ▶ Mechanical I/O device: poor speed
 - ▶ CPU速度与I/O速度之间的矛盾
 - ▶ CPU: thousands of instructions/sec VS. Card reader: 20 cards/sec
 - ▶ CPU is often idle→CPU utilization is LOW

解决问题的办法：引入的新技术和成果

- ▶ Off-line I/O (脱机I/O)
 - ▶ a cheaper system reads from cards into tapes
- ▶ 磁盘(Disk)
 - ▶ Allowed OS to keep all jobs on a disk
 - ▶ With direct access to several jobs
 - ▶ Could do Job scheduling to use resources and perform task efficiently
 - ▶ Multiprogramming (多道程序) →CPU utilization(利用率) ↑

单道批处理系统分析

Analysis

- ▶ Serial Card reader: Jobs execute one by one
- ▶ Mechanical I/O device: poor speed
 - ▶ CPU速度与I/O速度之间的矛盾
 - ▶ CPU: thousands of instructions/sec VS. Card reader: 20 cards/sec
 - ▶ CPU is often idle→CPU utilization is LOW

解决问题的办法：引入的新技术和成果

- ▶ Off-line I/O (脱机I/O)
 - ▶ a cheaper system reads from cards into tapes
- ▶ 磁盘(Disk)
 - ▶ Allowed OS to keep all jobs on a disk
 - ▶ With direct access to several jobs
Could do Job scheduling to use resources and perform task efficiently
 - ▶ Multiprogramming (多道程序) →CPU utilization(利用率) ↑

专题1.2：脱机I/O

脱机I/O

脱机I/O （时间：50年代末 ）

- ▶ 目的：解决人机矛盾和CPU与I/O设备之间速度不匹配的矛盾
- ▶ 方法：利用低速的外围机进行，纸带（卡片）→磁带（磁盘）

脱机I/O

脱机I/O （时间：50年代末 ）

- ▶ 目的：解决**人机矛盾**和**CPU与I/O设备之间速度不匹配的矛盾**
- ▶ **人机矛盾**：人工操作方式与机器利用率的矛盾
- ▶ 方法：**利用低速的外围机**进行，纸带（卡片）→磁带（磁盘）

脱机I/O

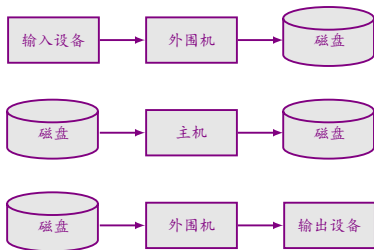
脱机I/O （时间：50年代末 ）

- ▶ 目的：解决人机矛盾和CPU与I/O设备之间速度不匹配的矛盾
- ▶ 方法：利用低速的外围机进行，纸带（卡片）→磁带（磁盘）

脱机I/O

脱机I/O （时间：50年代末）

- ▶ 目的：解决**人机矛盾**和**CPU与I/O设备之间速度不匹配的矛盾**
- ▶ 方法：**利用低速的外围机**进行，纸带（卡片）→磁带（磁盘）



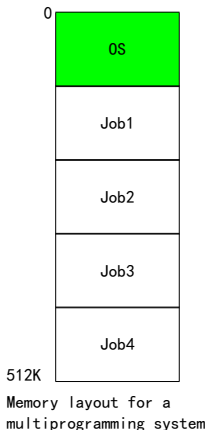
- ▶ 脱机的内涵：
程序和数据都在脱离主机控制下，
由**外围机**控制完成。

专题1.3：多道批处理系统

- ▶ 多道批处理系统的概念和工作过程
- ▶ 多道程序对操作系统的功能需求
- ▶ 多道批处理系统的分析

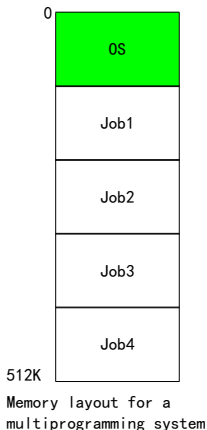
多道批处理系统(multiprogramming system)

- ▶ **多道**：系统中同时驻留多个作业
 - ▶ **共享内存**
 - ▶ **复用CPU**：
当一个作业因某个原因暂停运行时，
切换到另一个作业上运行
- ▶ 多道引入的优点：
 - ▶ 提高**CPU**利用率
 - ▶ 提高内存和I/O设备利用率
 - ▶ 提高了系统吞吐量
- ▶ **特征**
 1. 多道性、
 2. 无序性、
 3. 调度性（作业调度、进程调度）



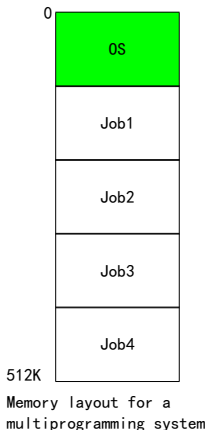
多道批处理系统(multiprogramming system)

- ▶ **多道**：系统中同时驻留多个作业
 - ▶ **共享内存**
 - ▶ **复用CPU**：
当一个作业因某个原因暂停运行时，
切换到另一个作业上运行
- ▶ 多道引入的优点：
 - ▶ 提高**CPU**利用率
 - ▶ 提高**内存**和**I/O**设备利用率
 - ▶ 提高了系统吞吐量
- ▶ **特征**
 1. 多道性、
 2. 无序性、
 3. 调度性（作业调度、进程调度）

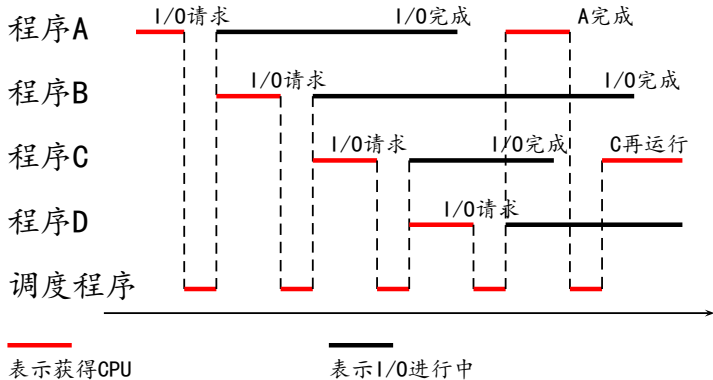


多道批处理系统(multiprogramming system)

- ▶ **多道**：系统中同时驻留多个作业
 - ▶ **共享内存**
 - ▶ **复用CPU**：
当一个作业因某个原因暂停运行时，
切换到另一个作业上运行
- ▶ 多道引入的优点：
 - ▶ 提高**CPU**利用率
 - ▶ 提高**内存和I/O**设备利用率
 - ▶ 提高了**系统吞吐量**
- ▶ **特征**
 1. **多道性**、
 2. **无序性**、
 3. **调度性**（作业调度、进程调度）



多道程序运行情况（四道时）



多道程序对操作系统的功能需求

- ▶ **Job Scheduling**
 - ▶ How many & which jobs entered memory
- ▶ **Memory management**
 - ▶ where & how much memory: the system must allocate the memory to several jobs.
 - ▶ Memory **protection** for each job
- ▶ **CPU scheduling**
 - ▶ Which job in memory(job pool) would get the CPU
 - ▶ Job and CPU scheduling makes up **2-phrase of scheduling**
- ▶ **I/O routine** supplied by the system.
- ▶ **Allocation of devices.**

多道批处理系统分析

- ▶ When the job have to wait for some task, such as an I/O op. to complete
 - ▶ Single Batch System: CPU→idle
 - ▶ Multiprogramming system: CPU→switch to another job and execute(CPU is never idle)
- ▶ **Advantages**
 - ▶ Higher CPU, I/O, Memory Utilization
 - ▶ Higher system throughput
- ▶ **Disadvantages**
 - ▶ No User interaction with computer
 - ▶ Job time too long (why?)
 - ▶ Simple batch system VS. Multiprogramming system

多道批处理系统分析

- ▶ When the job have to wait for some task, such as an I/O op. to complete
 - ▶ Single Batch System: CPU→idle
 - ▶ Multiprogramming system: CPU→switch to another job and execute(CPU is never idle)
- ▶ **Advantages**
 - ▶ Higher CPU, I/O, Memory Utilization
 - ▶ Higher system throughput
- ▶ **Disadvantages**
 - ▶ No User interaction with computer
 - ▶ Job time too long (why?)
 - ▶ Simple batch system VS. Multiprogramming system

Outline

History of Operating Systems

操作系统的发展动力

1945~1955, 无操作系统

1955~1965, 批处理系统

1965~1980, 引入分时

1980~present, PC时代, 百花齐放

1990~present, 移动计算时代

其他操作系统

Personal-Computer Systems

Parallel Systems

Distributed Systems

Embedded System

小结

History of the OS (1965~1980, 引入分时)

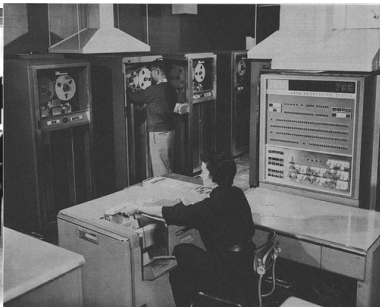
- ▶ IC circuits (集成电路)
 - ▶ LSI, VLSI
- ▶ UNIX
- ▶ More Applications
- ▶ OS
 - ▶ Multiprogramming batch systems ↑
 - ▶ Time-sharing systems (分时系统)

专题2：分时系统

- ▶ 分时系统的需求及其解决
- ▶ 经典案例
- ▶ 分时系统下的工作方式
- ▶ 关键技术、设计目标和实现



MIT CTSS



IBM709

Time-sharing system 分时系统

- ▶ 需求: User need interaction with computer
 - ▶ Response time < 1 sec
- ▶ 解决方法:
 - ▶ Share CPU by time pieces (时间片)
 - ▶ Time-sharing (multitasking)
- ▶ Users share Main frame
 - ▶ One main frame VS. Multi users & Multi terminal
- ▶ Time-sharing system is a logical extension of multiprogramming.
- ▶ 经典操作系统: MULTICS、UNIX

经典案例：UNIX

- ▶ 一群计算机迷 在贝尔实验室开发出UNIX
- ▶ 初衷：可以在一台无人使用的DEC PDP-7 小型计算机上玩星际探险游戏
- ▶ Ken Thompson, Dennis Ritchie 1983年图灵奖获得者 1999年4月美国国家技术金奖



汤普逊和里奇在DEC PDP-7计算机旁工作

分时系统下的工作方式

- ▶ 一台主机连接了若干个终端， 每个终端有一个用户在使用
 - ▶ 交互式的向系统提出命令请求
 - ▶ 系统接受每个用户的命令
 - ▶ 采用时间片轮转方式处理服务请求
 - ▶ 通过交互方式在终端上向用户显示结果
 - ▶ 用户根据上步结果发出下道命令

分时系统的关键技术

- ▶ Receive input in time (及时接收)
- ▶ Process in time (及时处理)
- ▶ 解决思路:
 - ▶ Mutual job (交互作业) always in memory
 - ▶ Time pieces
- ▶ 分时系统的特征
 - ▶ 多路性、独立性、及时性、交互性

分时系统的设计目标

- ▶ 分时操作系统所追求的设计目标：
 - ▶ 及时响应，其依据是响应时间
- ▶ 响应时间：
 - ▶ 从终端发出命令到系统给予回答所经历的时间
- ▶ 影响响应时间的因素：
 - ▶ 机器处理能力
 - ▶ 请求服务的时间长短
 - ▶ 系统中连接的终端数目
 - ▶ 服务请求的分布
 - ▶ 调度算法（时间片的选取）

分时系统的实现

- ▶ 单道与分时的结合：
 - ▶ 单道分时
- ▶ 分时与批处理相结合：
 - ▶ 原则：分时优先，批处理在后
 - ▶ 具有前后台的分时：
 - ▶ “前台”：需频繁交互的作业
 - ▶ “后台”：时间性要求不强的作业
- ▶ 分时与多道相结合
 - ▶ 多道分时

Outline

History of Operating Systems

操作系统的发展动力

1945~1955, 无操作系统

1955~1965, 批处理系统

1965~1980, 引入分时

1980~present, PC时代, 百花齐放

1990~present, 移动计算时代

其他操作系统

Personal-Computer Systems

Parallel Systems

Distributed Systems

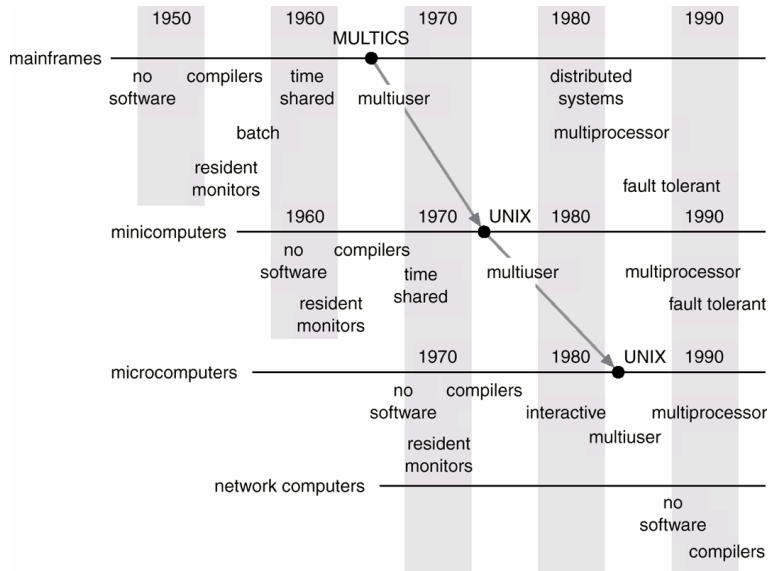
Embedded System

小结

History of the OS (1980~present, PC时代, 百花齐放)

- ▶ Development of Computer architecture (图)
 - ▶ 32bits→64bits
 - ▶ Workstations and PCs
 - ▶ Parallel processors
 - ▶ Computer networks
 - ▶ Cluster
- ▶ Special purpose computer system Types
 - ▶ Parallel systems
 - ▶ Real-time systems
 - ▶ Embedded systems
 - ▶ Distributed systems

Migration of OS Concepts and Features



专题3：实时系统

- ▶ 实时系统
- ▶ 实时任务的分类
- ▶ 实时系统的实现和应用
- ▶ 实时系统与批处理系统、分时系统的比较

实时系统

- ▶ 通常在一些专门的应用中，用来控制设备
 - ▶ 这种系统往往具有及时响应的时间限制
 - ▶ 严格 vs. 不严格
- ▶ 定义：

实时系统是指使计算机能及时响应外部事件的请求，在规定的严格时间内完成对该事件的处理，并控制所有实时设备和实时任务协调一致地工作的操作系统
- ▶ 按领域分类：
 - ▶ 第一类：实时过程控制
 - ▶ 第二类：实时通信（信息）处理

实时任务的分类

- ▶ 按任务执行是否呈现周期性来划分
 - ▶ 周期性的，有规律；
 - ▶ 非周期性的，无规律，但有截止时间
 - ▶ 开始截止时间 vs. 完成截止时间
- ▶ 根据对截止时间的要求来划分
 - ▶ 硬实时任务 vs. 软实时任务
- ▶ 实时操作系统追求的设计目标：
 - ▶ 满足实时性要求：
对外部请求在严格时间范围内作出反应
 - ▶ 高可靠性

实时系统的实现和应用

- ▶ 硬实时系统: Hard real-time system
 - ▶ Secondary storage limited or absent, data stored in short-term memory, or read-only memory (ROM)
 - ▶ Conflicts with time-sharing systems, not supported by general-purpose operating systems
- ▶ 软实时系统: Soft real-time system
 - ▶ Limited utility in industrial control or robotics
 - ▶ Useful in applications (multimedia, virtual reality) requiring advanced operating-system features
- ▶ 典型: VxWorks、QNX、RTEMS

实时系统与批处理系统和分时系统的区别

▶ 专用系统:

- ▶ 许多实时系统是专用系统，而批处理与分时系统通常是通用系统

▶ 实时控制:

- ▶ 实时系统用于控制实时过程，要求对外部事件的迅速响应，具有较强的中断处理机构

▶ 高可靠性:

- ▶ 实时系统用于控制重要过程，要求高度可靠，具有较高冗余（如双机系统）

▶ 事件驱动和队列驱动:

- ▶ 实时系统的工作方式：
接受外部消息，分析消息，调用相应处理程序进行处理。

实时、分时的比较

- ▶ 多路性：相同
- ▶ 独立性：相同
- ▶ 及时性：实时系统要求更高
- ▶ 交互性：分时系统交互性更强
- ▶ 可靠性：实时系统要求更高

专题小结

- ▶ 到目前为止，介绍了**三种最基本的操作系统类型**【汤】
 1. 批处理系统
 2. 分时系统
 3. 实时系统
- ▶ 一个实际的操作系统，往往兼有上述三种基本操作系统类型的功能
- ▶ 后面会简单介绍其他类型的操作系统

Outline

History of Operating Systems

操作系统的发展动力

1945~1955, 无操作系统

1955~1965, 批处理系统

1965~1980, 引入分时

1980~present, PC时代, 百花齐放

1990~present, 移动计算时代

其他操作系统

Personal-Computer Systems

Parallel Systems

Distributed Systems

Embedded System

小结

1990~present, 移动计算时代

- ▶ Today, mobile phone penetration is close to 90% of the global population.
- ▶ The first real smartphone: Nokia N9000
- ▶ OS:
 - ▶ ..., Symbian, Blackberry, iOS, Android, ...

Outline

History of Operating Systems

操作系统的发展动力

1945~1955, 无操作系统

1955~1965, 批处理系统

1965~1980, 引入分时

1980~present, PC时代, 百花齐放

1990~present, 移动计算时代

其他操作系统

Personal-Computer Systems

Parallel Systems

Distributed Systems

Embedded System

小结

Personal-Computer Systems, 个人计算机系统

- ▶ Personal computers (PCs)
 - ▶ 计算机为单用户服务
- ▶ I/O devices 键盘、鼠标、显示器、打印机
- ▶ PC系统所追求的设计目标是：
 - ▶ 界面友好，使用方便 (User convenience & responsiveness) , 有丰富的应用软件
 - ▶ 不必过于追求CPU利用率

常见的PC system用的操作系统

▶ OS

- ▶ MS-DOS

- ▶ OS/2

- ▶ Microsoft windows ...

 - ▶ NT, 95, 98, 2000, xp, windows me, Win7, Win8, windows vista

- ▶ Apple Macintosh

- ▶ Linux (...)

- ▶ ...

Outline

History of Operating Systems

操作系统的发展动力

1945~1955, 无操作系统

1955~1965, 批处理系统

1965~1980, 引入分时

1980~present, PC时代, 百花齐放

1990~present, 移动计算时代

其他操作系统

Personal-Computer Systems

Parallel Systems

Distributed Systems

Embedded System

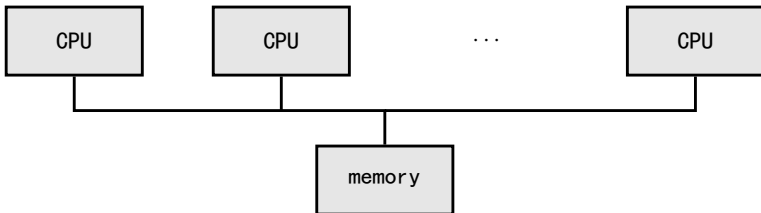
小结

并行系统 Parallel Systems

- ▶ Multiprocessor systems with more than one CPU in close communication
- ▶ Tightly coupled system 紧耦合系统
 - ▶ processors share memory and a clock; communication usually takes place through the shared memory
- ▶ 优点:
 - ▶ Increased throughput
 - ▶ Economical
 - ▶ Increased reliability
 - ▶ graceful degradation
 - ▶ fail-soft systems

并行系统(Cont.)

- ▶ Symmetric multiprocessing (SMP, 对称多处理器)
 - ▶ Each processor runs an identical copy of the operating system.
 - ▶ Many processes can run at once without performance deterioration.



- ▶ 现在的大多数通用操作系统都支持SMP，例如Linux、UNIX、Windows

并行系统(Cont.)

- ▶ Asymmetric multiprocessing 非对称多处理 ASMP
 - ▶ Each processor is assigned a specific task; master processor schedules and allocates work to slave processors.
 - ▶ More common in extremely large systems

Outline

History of Operating Systems

操作系统的发展动力

1945~1955, 无操作系统

1955~1965, 批处理系统

1965~1980, 引入分时

1980~present, PC时代, 百花齐放

1990~present, 移动计算时代

其他操作系统

Personal-Computer Systems

Parallel Systems

Distributed Systems

Embedded System

小结

Distributed Systems 分布式系统

- ▶ 分布式系统：处理和控制的分散
- ▶ Loosely coupled system 松耦合系统
 - ▶ each processor has its own local memory; processors communicate with one another through various communications lines, such as high-speed buses or telephone lines
- ▶ Advantages of distributed systems
 - ▶ Resources Sharing 资源共享
 - ▶ Computation speed up - load sharing 负载均衡
 - ▶ Reliability 可靠
 - ▶ Communications 通信

分布式系统上的操作系统

- ▶ Network Operating System 网络操作系统
 - ▶ provides file sharing
 - ▶ provides communication scheme
 - ▶ runs independently from other computers on the network
- ▶ Distributed Operating System 分布式操作系统
 - ▶ less autonomy between computers
 - ▶ gives the impression there is a single operating system controlling the network 单一映像

Outline

History of Operating Systems

操作系统的发展动力

1945~1955, 无操作系统

1955~1965, 批处理系统

1965~1980, 引入分时

1980~present, PC时代, 百花齐放

1990~present, 移动计算时代

其他操作系统

Personal-Computer Systems

Parallel Systems

Distributed Systems

Embedded System

小结

Embedded System

- ▶ 嵌入式系统是在各种设备、装置或系统中，完成特定功能的软硬件系统
 - ▶ 它们是一个大设备、装置或系统中的一部分，这个大设备、装置或系统可以不是“计算机”
 - ▶ 通常工作在反应式或对处理时间有较严格要求环境中
- ▶ 由于它们被嵌入在各种设备、装置或系统中，因此称为嵌入式系统
- ▶ 嵌入式系统具有最广泛的应用

- ▶ 嵌入式操作系统与通用操作系统有很大不同
 - ▶ Small size、Low power
 - ▶ Special environment, special function
 - ▶ 开发方式也不同
 - ▶ 交叉开发
 - ▶ Host, simulator VS. target
- ▶ 经典：VxWorks、嵌入式Linux系列、RTEMS、WindowsCE、PalmOS

小结

History of Operating Systems

操作系统的发展动力

1945~1955, 无操作系统

1955~1965, 批处理系统

1965~1980, 引入分时

1980~present, PC时代, 百花齐放

1990~present, 移动计算时代

其他操作系统

Personal-Computer Systems

Parallel Systems

Distributed Systems

Embedded System

小结

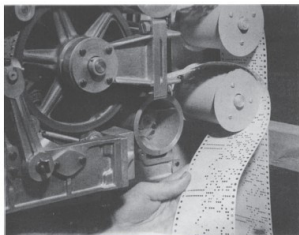
Thank you! Any question?

资料：穿孔卡片等

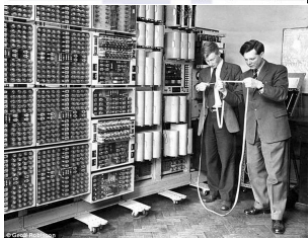


穿孔卡片(punched card)：在硬纸板上打孔以记录信息的工具。（图：IBM12行80列穿孔卡）

资料：穿孔纸带机等



img/密密麻麻的纸带.jpg



上世纪60年代，科学家在检查电脑“哈维尔”上的穿孔纸带
阅读“世界最老电脑”修后重启 比iphone慢800万倍

专题1.2: SP00Ling技术

SPooling技术

- ▶ 1961年，英国曼彻斯特大学，Atalas机
- ▶ **S**imultaneous **P**eripheral **O**peration **O**n-**L**ine
(同时的外围设备联机操作——假脱机技术)
- ▶ **基本思想：**
利用磁盘作缓冲，将输入、计算、输出分别组织成独立的任务流，
使I/O和计算真正并行

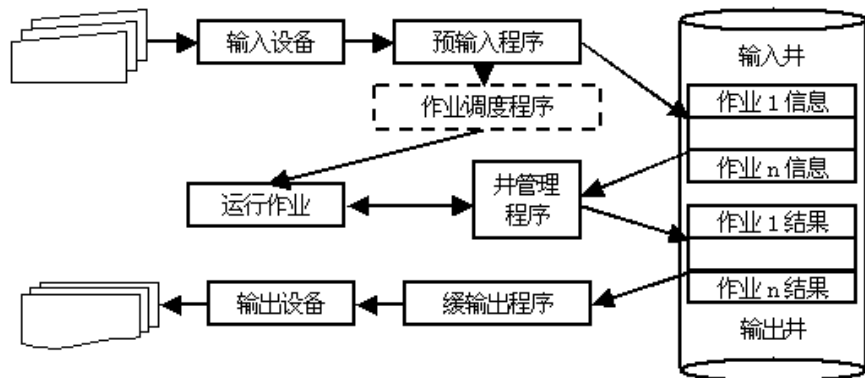
SPooling技术

- ▶ 1961年，英国曼彻斯特大学，Atalas机
- ▶ Simultaneous Peripheral Operation On-Line
(同时的外围设备联机操作——假脱机技术)
- ▶ 基本思想：
利用磁盘作缓冲，将输入、计算、输出分别组织成独立的任务流，
使I/O和计算真正并行

SP00Ling系统工作原理

- ▶ 作业进入到磁盘上的输入井
- ▶ 按某种调度策略选择几种搭配得当的作业，并调入内存
- ▶ 作业运行的结果输出到磁盘上的输出井
- ▶ 结果从磁盘上的输出井送到打印机
- ▶ 使用进程代替外围机

SP00Ling系统的组成示意图



(From: <http://course.cug.edu.cn/cug/OS2.0a/study/chapter7/7.6.htm>)