计算机系统结构

1.1 计算机系统结构的定义及课程介绍

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无所不在的各类计算机









计算机系统结构的定义

- 什么是计算机系统结构（Computer Architecture）？

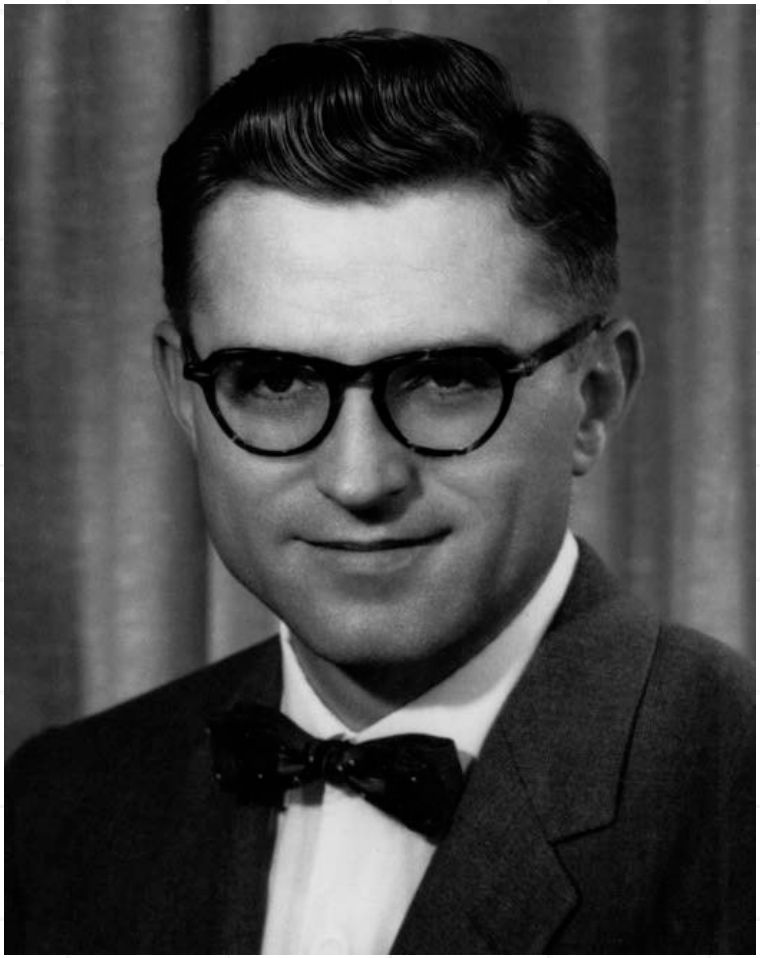
中国砖木建筑

欧洲石材建筑

现代钢结构玻璃建筑

建筑师用不同的材料设计建筑，计算机架构师用晶体管组成的部件设计计算机

计算机系统结构经典定义



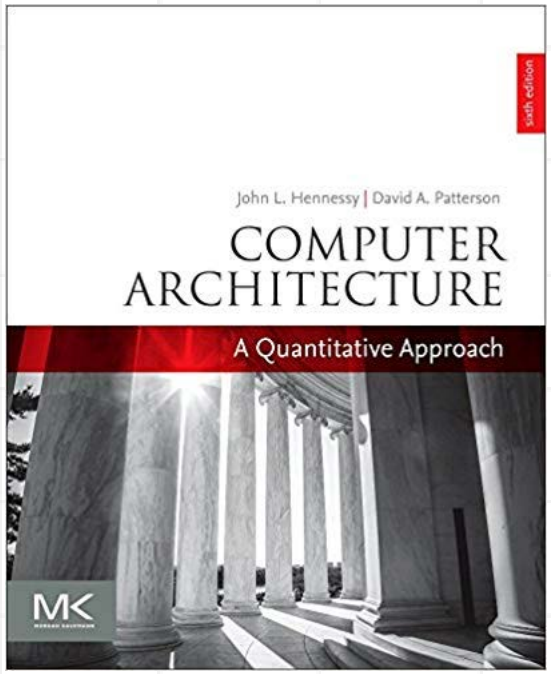
Gene Myron Amdahl

“……computer architecture is a computer programmer see attribute, namely the conceptual structure and functional characteristics.”

---- Amdahl,1964

Dr. Amdahl was cited in 1987 by the Eckert-Mauchly Award Committee for his “outstanding innovations in computer architecture, including pipelining, instruction lookahead, and cache memory.”

计算机系统结构广义定义



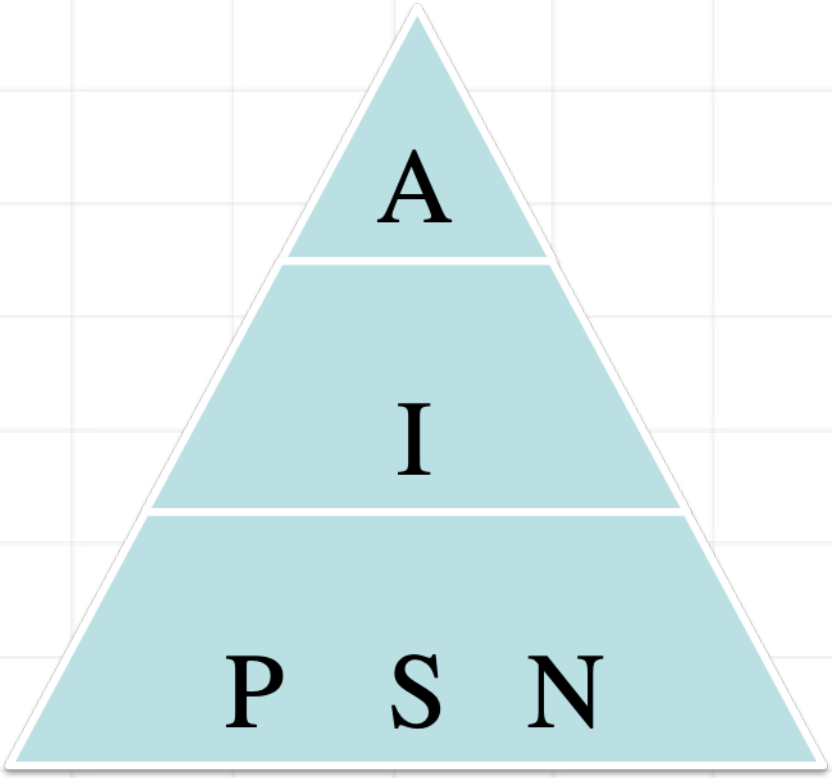
A New Golden Age for Computer Architecture

"…… architecture covers all three aspects of computer design —instruction set architecture, organization or microarchitecture, and hardware."

—Hennessy & Patterson,1990

本课程的“图腾”

- AIPSN金字塔



Architecture

- A: Acceleration, Amdahl
- I: Instruction, Interface
- P: Processing, Parallel
- S: Storage(Memory), System
- N: Network, coNnection

本课程的主要内容

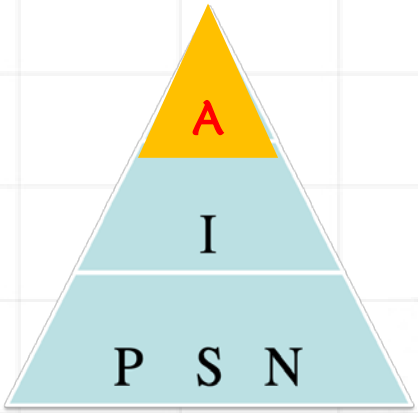
- “A” Acceleration, Amdahl
- （1）总目标：快！
- （2）总原理：加快经常性事件
- （3）量化原理：Amdahl定律

$$S_n = \frac{1}{(1 - F_e) + \frac{F_e}{S_e}}$$

- （4）CPU性能公式

CPU时间 = IC × CPI × 时钟周期时间

- （5）程序的局部性原理



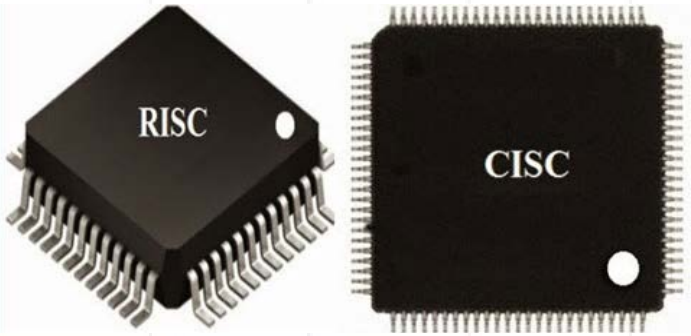
本课程的主要内容

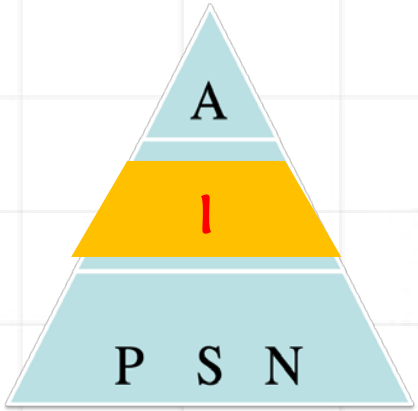
- “I” Instruction, Interface
  - （1）指令系统：用硬件实现的命令集

    软硬件的界面

操作码	操作数（寻址）

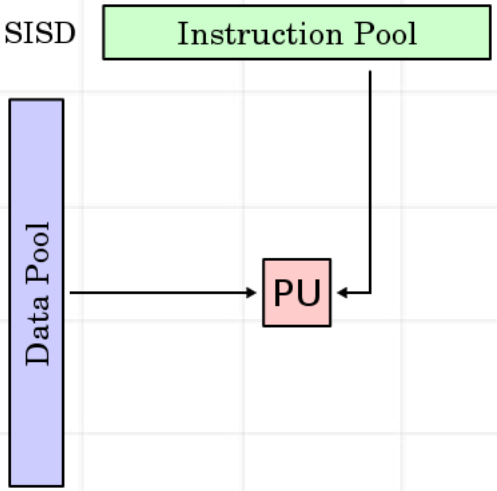
  - （3）CISC vs RISC

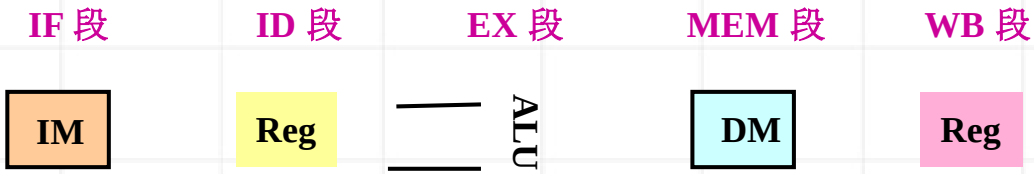


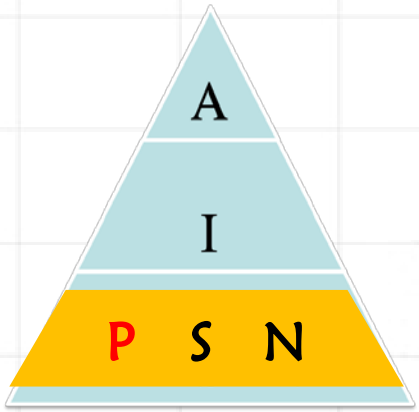


本课程的主要内容

- “P” Processing, Parallel
  - SISD（单指令流单数据流计算机）

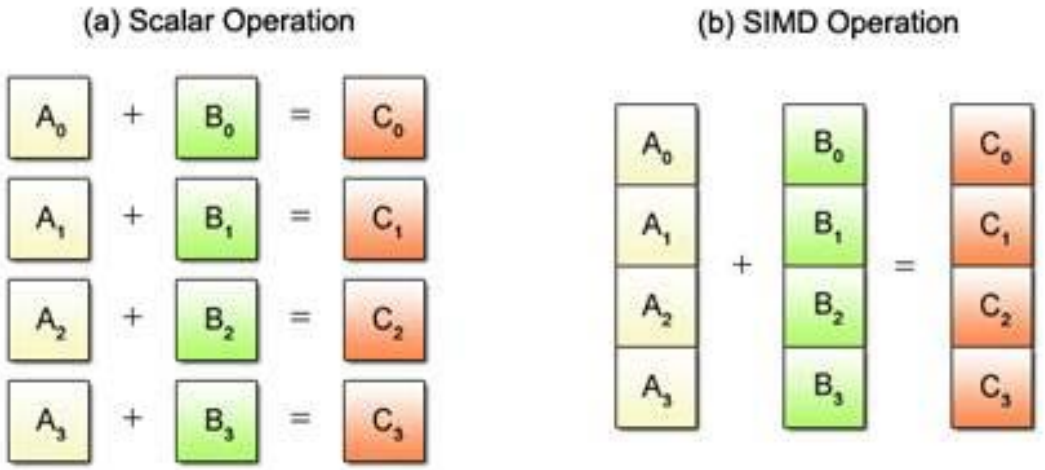


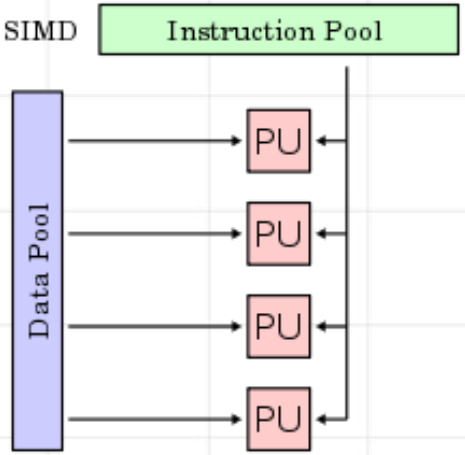


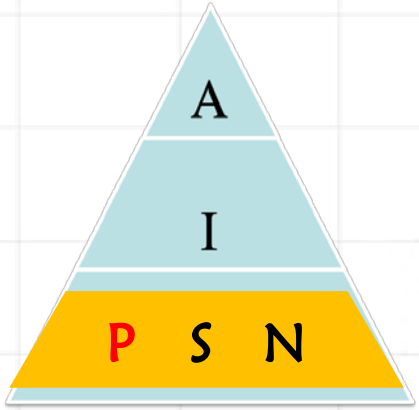


本课程的主要内容

- “P” Processing, Parallel
  - SIMD（单指令流多数据流计算机）

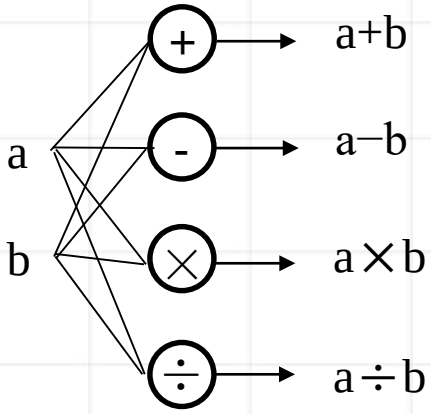


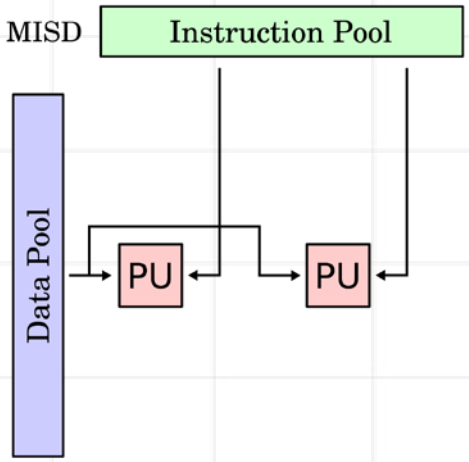


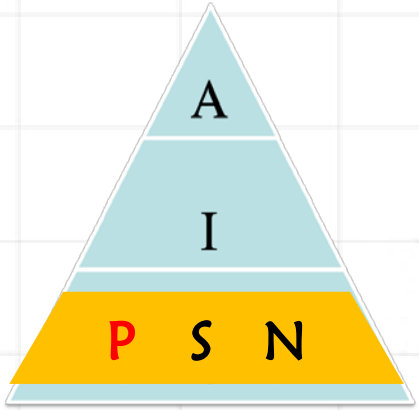


本课程的主要内容

- “P” Processing, Parallel
  - MISD（多指令流单数据流计算机）

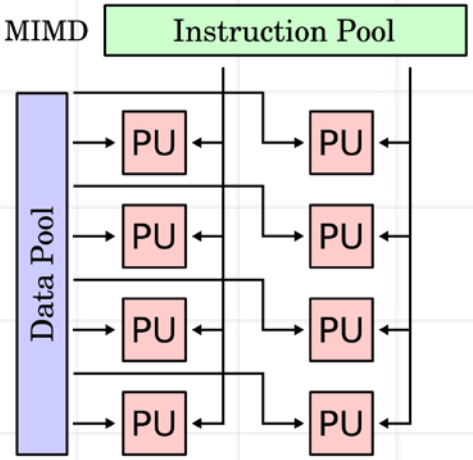


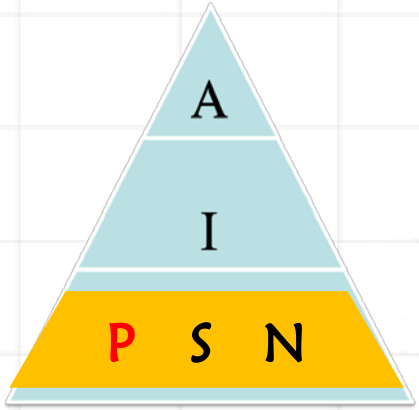




本课程的主要内容

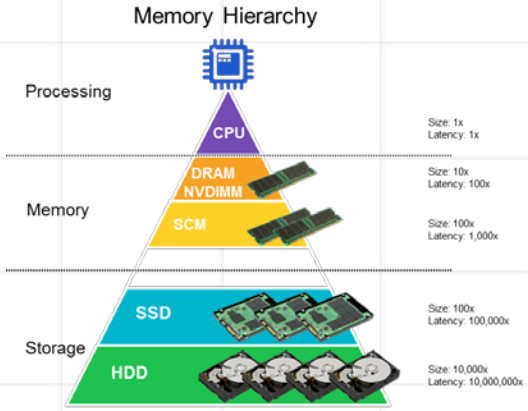
- “P” Processing, Parallel
  - MIMD（多指令流多数据流计算机）
- （1）应用场景
  - a) 多核处理器
  - b) 多处理器（服务器CPU）
  - c) 多计算机、仓储式计算机
- （2）异构多核
  - a) CPU+GPU
  - b) CPU+FPGA
  - c) CPU+AI加速

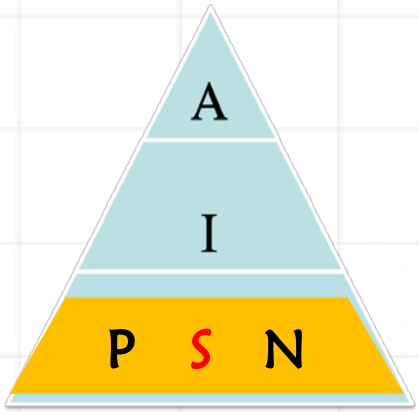




本课程的主要内容

- “S” Storage(Memory), System
  - 理想存储器
  - 局部性原理+加快经常性事件
  - 存储系统的层次结构





本课程的主要内容

- “N” Network, coNnection
- (1) 互联函数
- (2) 性能指标：延迟、带宽
- (3) 解决问题
  - a) 如何连？——总线、交叉开关、多级互连网络
  - b) 如何传？——电路交换、包交换