Arch: Fundamentals

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Contents

1 What is Arch

Structure of computer

1. Topics
   - Single Processor, Single Computer
     - ISA (Instruction Set Architecture): Interface between software and hardware
     - Design Hardware running this ISA: pipeline, superscalar, reordering, prediction, hazard, speculation
     - Memory Hierarchy: L1, L2, L3 Cache, DRAM (latency from low to high), I/O storage (non-volatile)
   - Multi-processors, Parallel System and Distributed System
     - Shared memory

    - Messaging
    - Networking
2. Big Picture
    - Close the gap between application and hardware (abstractions)
    - Program - Runtime System - ISA - Micro-architecture - Circuits - Electrons
    - Abstraction hides details of lower levels. For example, OS makes user program thinks as if it were the only program on the computer. ISA hides implementation of the circuit, therefore makes life easier for OS programmers.
3. Andy and Bill's law

   Whatever Andy gives, Bill takes away. Upgrades retain compatibility.
4. Hardware Trend Refer to textbook.
5. Software Trend Refer to textbook.

2 How to design Arch?

2.1 Features

1. Functional
    - Correctness: hardware is difficult to upgrade after deployment
    - What functions should be supported?
2. Reliable
    - Perform correctly even when failure
    - Hard / Transient
    - Different level of reliability
3. High Performance
    - Impossible for every program
4. Low cost
    - Wafer cost
    - Mask cost (first chip)
    - Design cost
5. Low Power / Energy
    - Energy inside (battery life, electricity)
    - Energy out (cooling device)

2.2 Application Areas

1. Mobile
    - Low power
2. Embedded
    - Low cost

2.3 Challenges

1. Balancing
    - e.g. General Purpose / Domain Specific
    - Our Focus: performance upon cost, power and reliability

3 Why to study Arch?

1. Goals
    - Understand where computers will be
    - Understand high-level design concepts
    - Understand computer performance