

CS422

Computer Architecture

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Computer Architecture

- “Architecture”
 - The art and science of designing and constructing buildings
 - A style and method of design and construction
 - Design, the way components fit together
- Computer Architecture
 - The overall design or structure of a computer system, including the hardware and the software required to run it, especially the internal structure of the microprocessor

CS422 Prerequisites

- Computer organization (CS220)
 - Digital logic
 - Memory chips, number representation
 - Computer arithmetic, adders, ripple-carry...
 - I/O organization
 - Peripherals
 - Pipelining, RISC

CS422 Course Contents

- Performance and CPI, benchmarks, Amdahl's law
- Pipelining, hazards
- Instruction Level Parallelism: Scoreboarding, Tomasulo's algorithm
- Dynamic branch prediction, VLIW, software pipelining

CS422 Course Contents (continued)

- Cache and memory systems
- I/O systems, RAID, benchmarks
- Multiprocessors, cache consistency protocols
- Processor networks
- Vector processors

Course Evaluation

- Scribe notes: 5%
- Homework assignment(s): 20%
- Mid-sems: 30%
- End-sem: 45%
 - May give part of it as take-home

Course References

- **“Computer Architecture: A Quantitative Approach”**, 2nd edition, David A. Patterson and John L. Hennessy, Morgan Kaufmann Publishers.
- CS252, Graduate Computer Architecture, U.C.Berkeley

Computer Architecture

- Design aspects:
 - Instruction set
 - Cache and memory hierarchy
 - I/O, storage, disk
 - Multi-processors, networked-systems
- Criteria: performance, cost, end-applications, complexity

Technology Trends

- Since 1970s: Microprocessor-based
- Several PCs/Workstations put together can buy more cycles for the same cost
 - The Berkeley NOW project
- Transistor density: 50% per year
- DRAM density: 60% per year
- Magnetic disk density: 50% per year

Technology Trends (continued)

- Software:
 - More memory usage
 - High-level language
- Growth rate in CPU speed: 50% per year
 - Architectural ideas: pipelining, caching, out-of-order execution, sophisticated compilers
- Trends are important:
 - Product cycle is 4 years!
 - Also beware of technology thresholds

Cost Trends

- Cost depends on various factors:
 - Time, volume, competition
- Cost of IC:
 - Cost of die + Testing + Packaging
- Cost of die: $\text{Wafer-cost} / \text{Dies-per-wafer}$
- Yield is an important factor
- Cost proportional to Die-area^4

Upcoming Topics

- Performance metrics, CPI
- Amdahl's law