CS775: Computer Architecture

Lecture 1: Introduction and Review of Technology Trends

What is Computer Architecture?

- Functional operation of the individual HW units within a computer system, and the flow of information and control among them.

Course Objectives

- To evaluate the issues involved in choosing and designing instruction set.
- To learn concepts behind advanced pipelining techniques.
- To understand the “hitting the memory wall” problem and the current state-of-art in memory system design.
- To obtain an overview of vector and parallel computer architectures
- To understand the qualitative and quantitative tradeoffs in the design of modern computer systems
Computer Architecture Topics

Input/Output and Storage
- Disks, WORM, Tape
- RAID

Memory Hierarchy
- DRAM
- L2 Cache
- L1 Cache
- VLSI
- Pipelining, Hazard Resolution, Superscalar, Register, Prediction, Speculation, Vector, DSP

- Emerging Technologies
- Interlocking Bus protocols
- Coherence, Bandwidth, Latency
- Addressing, Protection, Exception Handling
- Pipelining and Instruction Level Parallelism

Shared Memory, Message Passing, Data Parallelism
- Network Interfaces

Processor/Memory-Switch
- Multiprocessors
- Networks and Interconnections
- Topologies, Routing, Bandwidth, Latency, Reliability

Measurement and Evaluation

Architecture is an iterative process:
- Searching the space of possible designs
- At all levels of computer systems
Issues for a Computer Designer

- Functional Requirements Analysis (Target)
  - Scientific Computing
  - Real-time Control
  - Business - transactional support/decimation

- General Purpose - balanced performance for a range of tasks
- Level of software compatibility
  - PL level
    - Flexible, need new compiler, portability an issue
  - Binary level (886 architecture)
    - Little flexibility, portability requirements minimal
- OS requirements
  - Address space issues, memory management, protection
- Conformance to Standards

Computer Systems: Technology Trends

- 1988
  - Supercomputers
  - Massively Parallel Processors
  - Minisupercomputers
  - Minis
  - Workstations
  - PC's

- 1998
  - Powerful PC's and SMP Workstations
  - Network of SMP Workstations
  - Mainframes
  - Supercomputers

Why Such Change in 10 years?

- Performance
  - Technology Advances
    - CMOS (complementary metal oxide semiconductor) VLSI dominates older technologies like TTL (transistor-transistor logic) in cost and performance
    - Computer architecture advances improve low-end
    - RISC supersede CISC..."
Technology Trends
(Summary)

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Speed (latency)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logic</td>
<td>2x in 3 years</td>
</tr>
<tr>
<td>DRAM</td>
<td>2x in 10 years</td>
</tr>
<tr>
<td>Disk</td>
<td>2x in 10 years</td>
</tr>
</tbody>
</table>

Processor Performance
(1.35X before, 1.55X now)

Performance Trends
(Summary)
- Workstation performance (measured in Spec Marks) improves roughly 50% per year (2X every 18 months)
- Improvement in cost performance estimated at 70% per year