

Topics in computer architecture

Overview

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Agenda

- Overview
- Modelling, benchmarks, SP.4 project
- VHSIC Hardware Description Language (VHDL)
- Computer organization and design
 - Synthesis from architecture
 - Modular design, timing and control
 - Micropipelines and self-timed systems
 - Microprogramming
- Current state of technology
- Introduction to VLSI systems
 - CMOS logic circuits
 - CMOS electrical behavior
 - CMOS process, design rules and layout
 - VLSI constraints on architecture
- History, von Neumann model, balancing
- Compilers and architecture
- Reduced instruction set computers
 - SPARC
 - Compiling for SPARC
 - SunOS on SPARC
 - MIPS vs. SPARC
- Dataflow computing
 - Recursive machines
 - Data-driven dataflow
 - Demand-driven dataflow
- Functional programming, reduction machines
- occam and Transputers
- Superscalar and the Intel i860
- Connection machine
- Fault tolerant computing

Themes

- Technology
 - Very Large Scale Integration (VLSI)
 - VLSI is and will be the dominant technology
 - Architects must accept and exploit VLSI
- Problems and languages
 - Cannot directly execute "solution" on hardware
 - Solution is expressed in programming language
 - Compiled programs direct operation of machine
 - Language "shapes" the machine
 - How should machine "shape" language?
 - Operating system concerns
- Engineering concerns
 - Cost, reliability, performance
 - Time to market
 - The "sociology" of design
- Mapping HLL program to execution in silicon
 - Balance of static and dynamic concerns
 - Bandwidth requirements
 - Exploit all hardware available
 - Simple (easy to construct?) compiler
 - No wasted microcycles (resources)
 - Static
 - Push "scheduling" into compiler
 - Simplify hardware by eliminating runtime decisions
 - Dynamic
 - Simple compiler
 - Let hardware find best use of resources

Projects

- Modelling and measurement of SP.4
 - Write simulator for SP.4 ISA
 - Write and execute benchmark (10 x 10 matrix multiply)
 - Measurements
 - Dynamic instruction execution frequency
 - Stack depth
 - Locality (instructions and data)
 - Weight: 45%
 - Deadline: 6 March 1990
- Data-driven dataflow simulation
 - Write simulator for Davis Data Driven Nets (DDN)
 - Write and execute benchmark (solve for roots)
 - Measure potential concurrency
 - Weight: 30%
 - Deadline: TBA
- Functional programming
 - Write application in Backus FP
 - FP interpreter to be provided (Unix™ and PC versions)
 - Weight: 15%
 - Deadline: TBA
- occam / Transputer dataflow implementation
 - Implement DDN's in occam
 - Discuss performance implications on Transputer
 - Weight: 10%
 - Deadline: 24 April 1990 (last day of class)