CS 211: Mid-semester Review

• Technology trends
  – Speed/density doubles every 18 months
  – Interconnect delays getting longer than transistor switching delays
    • Suggests need for simpler architecture

• System Performance thumb rules/principles
  – Amdahl’s law
  – Locality – spatial and temporal
  – Make common case fast – most programs use small portion of code
  – AAA rule

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• Scalar Processor Design
  – Putting a processor together by picking components and designing datapath and control path.

• Pipelining as a first step to boosting performance
  – Overlap operations, but issue one operation each cycle
  – Instruction pipeline: overlap the fetch, decode, execute, writeback process of typical instruction execution
  – Hazards limit the performance: data, control, structural
    • Internal forwarding solves some of the data hazards
    • Branch delay/prediction needed to address control hazards

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• ILP Processors: Superscalar and EPIC
  – Explicitly issue multiple operations in a single cycle
  – Hazards are again key: data, control, structural

• Superscalar processors
  – Parallelism extracted by hardware
  – Dependence checking done by hardware
  – Data hazards addressed by register renaming process
  – Control hazards addressed by branch prediction methods
    • Finite state machine based branch predictors – a FSM is a branch prediction algorithm
    • Tomasulo Dynamic scheduling algorithm

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• EPIC Processors
  – Parallelism extracted statically at compile time
    • Need optimizing compilers
  – Hardware support provided for some key concepts
  – Speculation
    • Execute instructions before they are needed
      – Do a speculative check to make sure the instructions are valid
    • Can speculative control flow or just advanced loads
      – Advanced loads hide memory latency
  – Predication
    • All instructions are predicated on predicate registers
      – Predicate register set by a condition
    • Note difference between Predication and Branch Prediction
      – Hardware support for loop unrolling – software
CS 211: Mid-term exam

• 2 hours, October 26th
• Closed book/notes
• Mix of multiple choice, short questions and some detailed questions
• All material upto (including) EPIC processors