

Portland State University  
ECE 587/687

# RISC Architectures

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# RISC I

- RISC: Reduced Instruction Set Computer
- Alternative to Complex Instruction Set Computer (CISC)
- Simple instructions and addressing modes
  - ◆ High effective throughput (low CPI)
    - Effective pipeline: Most instructions execute in one cycle
  - ◆ Short cycle time
  - ◆ Short design cycle
- But larger programs
  - ◆ 2x larger than VAX 11/780

# RISC Instruction Format

- Most instructions execute in one cycle
- Fixed size (32-bits)
- Only loads and stores access memory
  - ◆ Two cycle instructions (compare current latencies)
  - ◆ Rest of instructions operate between registers
- Support high level languages (HLL)
- Paper: Instruction format and addressing modes

# RISC I Design Approach

- New architectures should be designed for HLL
- Does not matter which part of the system is in hardware and which is in software
- Architecture tradeoffs to build a cost-effective system:
  - ◆ Which language constructs are used frequently?
  - ◆ What is the distribution of various instructions?
  - ◆ Dedicate available area for the most frequent constructs and operations (Paper: Tables)
    - Remember Amdahl's law

# Amdahl's Law

$$Speedup = \frac{1}{1 - P + P/S}$$

P = proportion of computation improved  
S = improvement speedup

Example: Parallel Execution

P: Parallel portion, S: Serial portion = 1-P

N: Number of Cores

$$Speedup = \frac{1}{S + P/N} = \frac{1}{1 - P + P/N}$$

# RISC I Performance Features

- Large number of registers addressable by instructions
  - ◆ 32 general purpose registers (GPRs)
  - ◆ R0 is always zero ( to support addressing modes)
- Register windows for fast call and return operations (Paper)
- Delayed branch

# Delayed Branch

Static Program:            I1  
                                 Jump Target  
                                 I2

                 Target:        I3

Branch execution sequence: I1, I3

Delayed branch execution sequence: I1,I2,I3

- Question: Which modern machine still supports delayed branches?
- Question: What is the downside for delayed branches?

# Reading Assignment

- D. James Smith and Gurindar Sohi, “The Microarchitecture of Superscalar Processors,” Proceedings of IEEE, Dec 1995
- Review due before class on Monday