Instruction Set Architecture

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Computer Organization & Architecture

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Instruction Set Architecture

• Instruction set architecture is the structure of a computer that a machine language programmer must understand to write a correct (timing independent) program for that machine.

• The instruction set architecture is also the machine description that a hardware designer must understand to design a correct implementation of the computer.
Interface Design

A good interface:

- Lasts through many implementations (portability, compatibility)
- Is used in many different ways (generality)
- Provides *convenient* functionality to higher levels
- Permits an *efficient* implementation at lower levels
Evolution of Instruction Sets

Single Accumulator (EDSAC 1950)

Accumulator + Index Registers
(Manchester Mark I, IBM 700 series 1953)

Separation of Programming Model from Implementation

High-level Language Based
(B5000 1963)

Concept of a Family
(IBM 360 1964)

General Purpose Register Machines

Complex Instruction Sets
(Vax, Intel 432 1977-80)

Load/Store Architecture
(CDC 6600, Cray 1 1963-76)

RISC
(Mips, Sparc, HP-PA, IBM RS6000, PowerPC ... 1987)

LIW/"EPIC"?
(IA-64 ... 1999)
Evolution of Instruction Sets

• Major advances in computer architecture are typically associated with landmark instruction set designs
  – Ex: Stack vs GPR (System 360)

• Design decisions must take into account:
  ➢ technology
  ➢ machine organization
  ➢ programming languages
  ➢ compiler technology
  ➢ operating systems

• And they in turn influence these
What Are the Components of an ISA?

• Sometimes known as *The Programmer’s Model* of the machine

• Storage cells
  - General and special purpose registers in the CPU
  - Many general purpose cells of same size in memory
  - Storage associated with I/O devices

• The machine instruction set
  - The instruction set is the entire repertoire of machine operations
  - Makes use of storage cells, formats, and results of the fetch/execute cycle
  - i.e., register transfers
What Are the Components of an ISA?

• The instruction format
  - Size and meaning of fields within the instruction

• The nature of the fetch-execute cycle
  - Things that are done before the operation code is known
Instruction

• C Statement
  \[ f = (g+h) - (i+j) \]

➤ Assembly instructions
  add t0, g, h
  add t1, l, j
  sub f, t0, t1

• Opcode/mnemonic, operand, source/destination
Thank You