CAO: Lecture 13
RISC, CISC and their comparison

Topics Covered

- Instruction Format
- Instruction Representation
- CISC
- CISC Attributes
- CISC Characteristics

Instruction Format

- Instruction word should have the complete information required to fetch and execute the instruction
- Fields of an instruction word
  - Opcode of the operation to be carried out
    - Varying length (CISC)
    - Fixed length (RISC)
  - Size of the operands:
    - Byte, Word, Longword, Quadword for integer operands
    - Float, Double for real operands
  - Addressing mode (AM) of each operand
  - Specification of each operand involves specifying one or more of the following:
    - General purpose register
    - Value of an immediate operand
    - Address of operand
    - Base register
    - Index register
    - Displacement

Instruction Representation

- 3-operand CISC instruction format:

  ADD dst, src1, src2

Opcode	Size of operands	AM of dst	Specification of dst	AM of src1	Specification of src1	AM of src2	Specification of src2

Opcode	Size of operands	AM of dst	Specification of dst	AM of src1	Specification of src1	AM of src2	Specification of src2

0011	01	000	00011	101	00001	00000	110	0011 0010	00010

Instruction Representation

- Examples of RISC instructions:

ADD.w R2, R0, R1

Opcode	Size of operands	Specification of dst	Specification of src1	Specification of src2
000111	01	00010	00000	00001

LOAD.w R2, [R1][R0]

Opcode	Size of operands	Specification of dst	AM of src	Specification of src	
010011	01	00010	101	00001	00000

Introduction: CISC

- CISC means Complex Instruction Set Computer chips that are easy to program and which make efficient use of memory. Since the earliest machines were programmed in assembly language and memory was slow and expensive, the CISC philosophy was commonly implemented in large computers as the PDP-11 and the DECsystem 10 and 20 machines.
- Most common microprocessor designs such as the Intel 80x86 and Motorola 68K series followed the CISC philosophy.
- CISC was developed to make compiler development simpler. It shifts most of the burden of generating machine instructions to the processor. For example, instead of having to make a compiler write long machine instructions to calculate a square-root, a CISC processor would have a built-in ability to do this.

CISC Attributes

CISC instructions sets have some common characteristics:

- A 2-operand format, where instructions have a source and a destination. Register to register, register to memory, and memory to register commands.
- Variable length instructions where the length often varies according to the addressing mode
- Instructions which require multiple clock cycles to execute.

E.g. Pentium is considered a modern CISC processor

Most CISC hardware architectures have several characteristics in common:

- Complex instruction-decoding logic, driven by the need for a single instruction to support multiple addressing modes.
- A small number of general purpose registers. This is the direct result of having instructions which can operate directly on memory and the limited amount of chip space not dedicated to instruction decoding, execution, and microcode storage.
- Several special purpose registers. Many CISC designs set special registers for the stack pointer, interrupt handling, and so on.
- A 'Condition code'' register which is set as a side-effect of most instructions. This register reflects whether the result of the last operation is less than, equal to, or greater than zero and records if certain error conditions occur.

At the time of their initial development, CISC machines used available technologies to optimize computer performance.

- Microprogramniing is as easy as assembly language to implement, and much less expensive than hardwiring a control unit.
- The ease of microcoding new instructions allowed designers to make CISC machines upwardly compatible: a new computer could run the same programs as earlier computers because the new computer would contain a superset of the instructions of the earlier computers.
- As each instruction became more capable, fewer instructions could be used to implement a given task. This made more efficient use of the relatively slow main memory.
- Because microprogram instruction sets can be written to match the constructs of high-level languages, the compiler does not have to be as complicated.

Complex Instruction Set Computer (CISC) Characteristics

- Major characteristics of a CISC architecture
  - 1) A large number of instructions - typically from 100 to 250 instruction
  - 2) Some instructions that perform specialized tasks and are used infrequently
  - 3) A large variety of addressing modes - typically from 5 to 20 different modes
  - 4) Variable-length instruction formats
  - 5) Instructions that manipulate operands in memory (RISC in register)