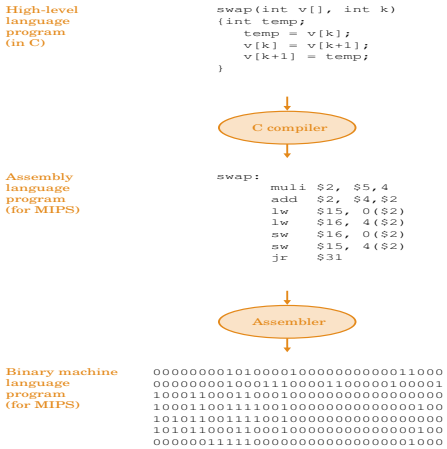
Outline

- Introduction & software hierarchy
- Fundamental concepts and abstractions

Below your Program 1/4

- First programmers communicated in Binary
- Assembler-symbolic notation to binary
- High Level programming languages-C++, Fortran
  - Compiler
  - Assembler



Below your Program 2/4

MIPS

Million Instructions Per Second, measure for computer performance

MIPS processor, MIPS hardware means it is capable of performing in terms of MIPS

MIPS RISC architecture

RISC (example PowerPC by Apple, IBM, Motorola)

Reduced Instruction Set Computer (20% of instructions performed 80% of the work)

Smaller number of instructions in instruction set (means simpler hardware to implement instructions)

Term coined by Patterson (one of the textbook authors)

CISC (example Intel's Pentium)

Complex Instruction Set Computer (Large number of instructions, with complex instructions)

RISC replaces a complex instruction with a number of simpler instructions

Below your Program 3/4

Advantages of high level programming languages

•Think in a more natural language using English words and algebraic notation

•Languages can be designed according to use

✓Fortran Scientific computation

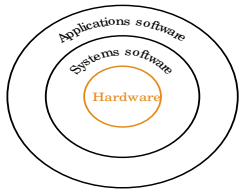
✓Lisp symbolic notation

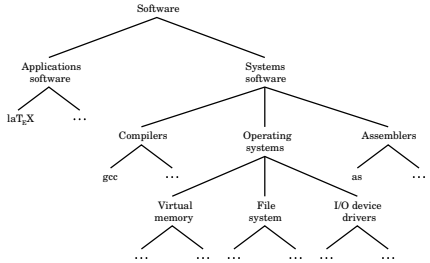
•Improved programmer productivity (fewer lines)

•Allow programs to be independent of computer on which they are developed

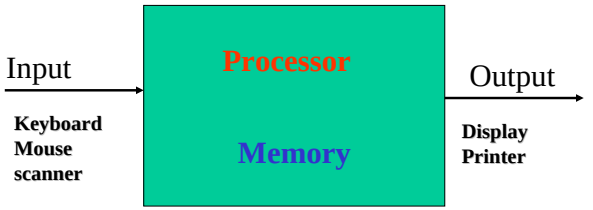
Below your Program4/4

- Software reuse (subroutine libraries)
- Operating systems (Programs to manage computer resources)
- Hierarchical layers: hardware at center to user-centered applications
- Software categorized by its use





Computer Components1/6



Five classic components of a computer:

Input, Output, Memory, Data path, Control

Processor

- Processor gets instructions and data from memory
- Control sends signals that determine operation of data path (performs arithmetic operations), memory, input and output

Computer Components2/6

I/O devices in focus

✓Mouse (invented by Doug Engelbart around 1967)

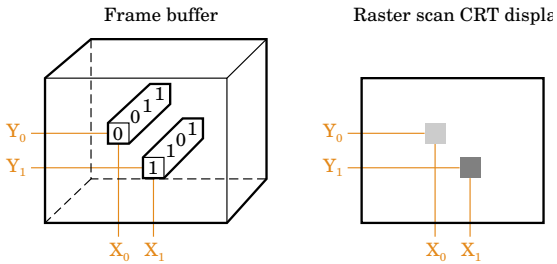
✓Graphics Display

- CRT (Cathode ray tube)
  - Scan image one line at a time 30 to 75 times per second (*refresh rate*)
  - Image composed of matrix of picture elements called *pixels* (matrix of bits: *bit map*)
  - 1 bit/pixel black or white, 8 bits/pixel gray-scale, 24 bits/pixel (8 bits for each RGB)
- LCD (Liquid crystal displays)
  - Thin, low-power display

Computer Components3/6

✓Hardware support for graphics

- Frame buffer (raster refresh buffer) to store bit map
- Bit pattern per pixel read to display at refresh rate



Computer Components 4/6

Processor (CPU Central processor unit)

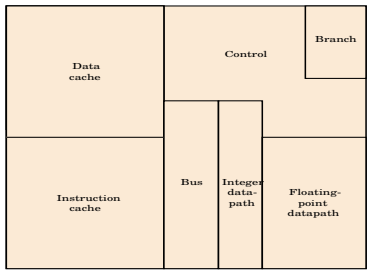
Data path performs arithmetic operations

Control instructs data path, memory and I/O devices of what to do according to program instructions

Major blocks of a sample processor

(Intel Pentium)

3.3 million transistors with almost 1 million for cache



Computer Components 5/6

What is meant by a 400 MHz processor?

MHz is Mega Hertz

Every computer governed by a clock

Set of operations occur every clock cycle (clock period)

Frequency of the clock is = 1/clock cycle

Frequency measured in Hertz. 1 Hertz = 1 cycle/sec

400 MHz imply the clock cycle is 2.5 nanoseconds?

Clock cycle = $1/(400 * 10^{6}) = 2.5 * 10^{-9}$ sec/cycle = 2.5 nanoseconds

Computer Components 6/6

Memory

✓Primary memory (volatile)

- DRAM (Dynamic random access memory) What is sequential access?
  - Contain instruction and data of a program
  - memory access takes the same amount of time no matter what portion is accessed
- Cache (Small fast memory, acts as buffer for DRAM)

✓Secondary memory (non volatile)

- Magnetic disks (floppy disk, hard disk) (rotating platters on a spindle with read/write head)
- CD (Compact disk, optical, cheaper but slower than magnetic)
- Disks have slower access time, cheaper per MB than DRAM

Principal of Abstraction

Software and Hardware can be viewed as a hierarchy of levels

- Each lower-level contains additional detail than the higher-level (lower-level details are hidden to offer a simple model at higher levels)
- Simplest level is topmost level
- Use of such layers is called *Abstraction*

Examples of abstractions?

Instruction Set Architecture of a machine is an abstraction

Interface between the hardware and the lowest-level software

Instruction Set Architecture (ISA)

•Includes anything that programmers need to know to make a binary machine program work correctly, including

- ✓Instructions (categories, format, ..)
- ✓I/O devices, # of registers, memory access schemes , …

•Allows focus on "Functions" independently from hardware performing the functions

•Different architecture implementations can run the same identical software because they have the same architecture abstraction

•Examples of ISA

- •Intel's (8086, 80286, 80386, 80486, Pentium, MMX, …)
- •Sun SPARC
- •SGI MIPS

Q: What is the impact of changing ISA between implementations?

Old programs might not run on the new ISA and vice versa

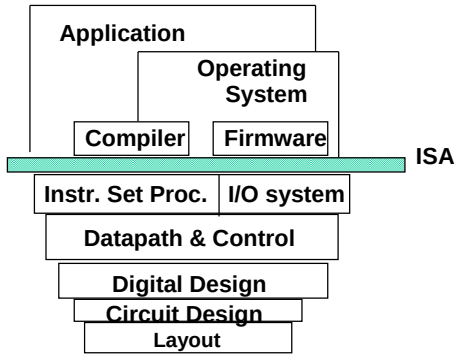
A Due Q: What is Computer architecture?

Computer architecture is

Instruction set architecture + machine organization

Machine organization

Capabilities and performance characteristics of the principal functional units (registers, ALU, logic units, ..), the ways in which they are interconnected, how information flows between components and the logic and ways in which the information flow is controlled



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