Introduction to Processor Architecture (EC2.204)

LECTURE 1 - INTRODUCTION TO COMPUTER SYSTEMS

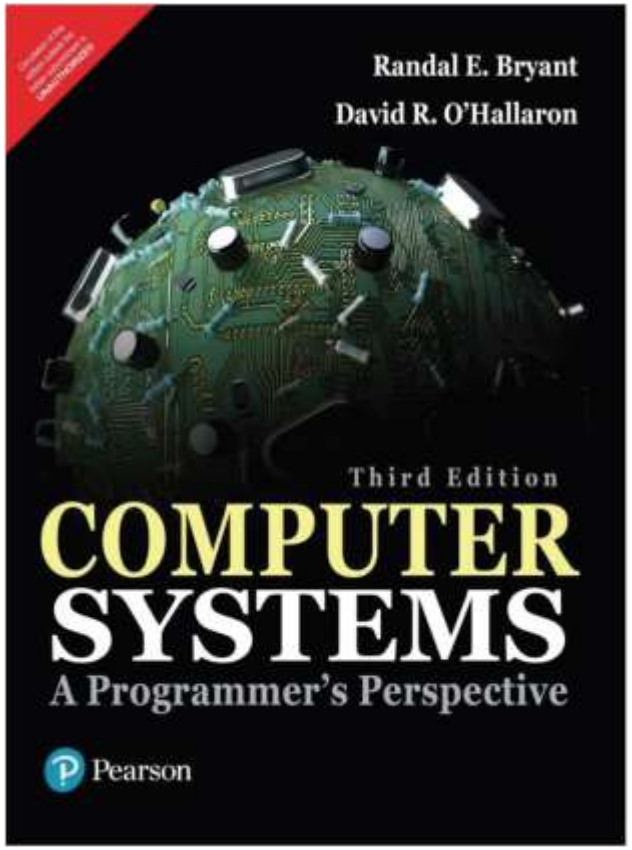
Deepak Gangadharan
Computer Systems Group (CSG), IIIT Hyderabad

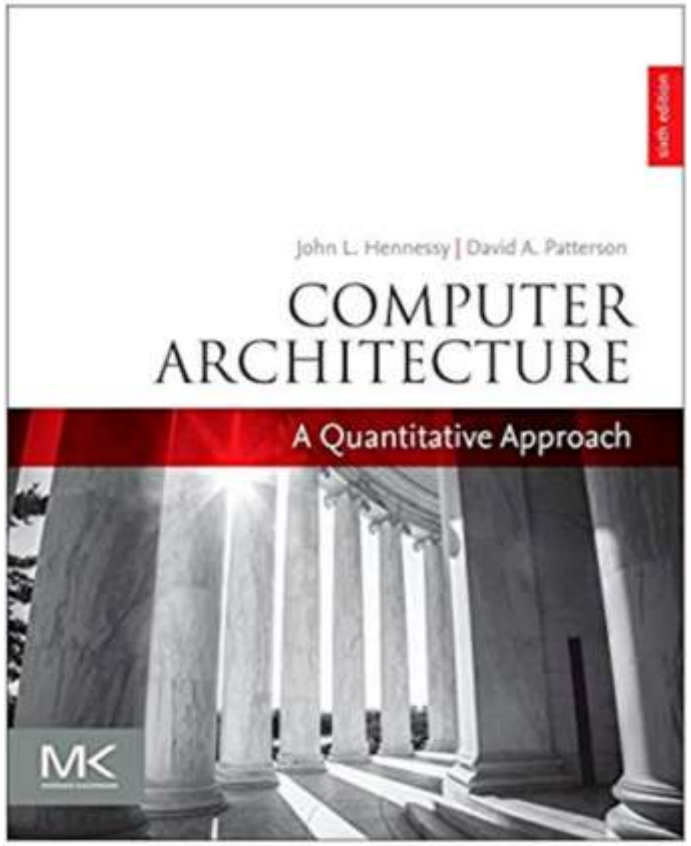
Slide Contents: Based on materials from text books and other public sources

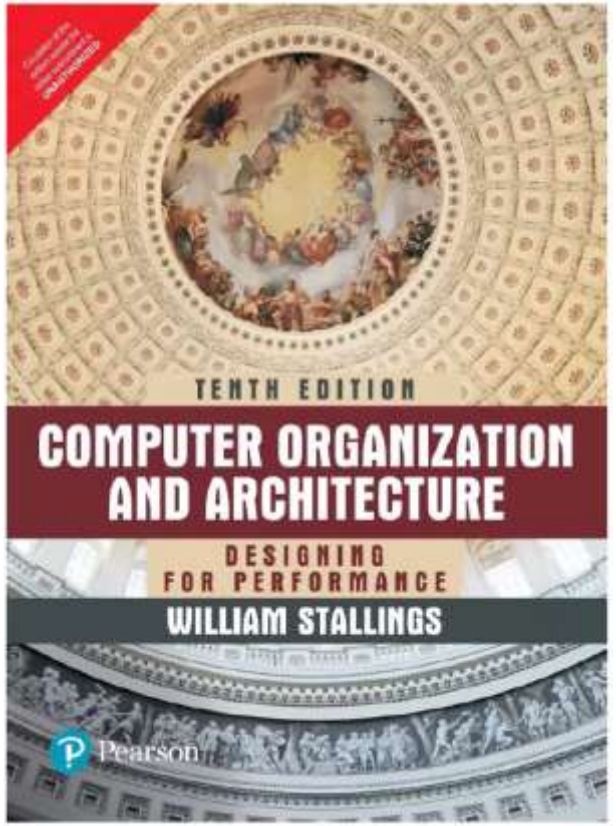
Course Outline

- Instruction Set Architecture
- Processor Architecture and Design
- Memory Hierarchy
- OS System Calls and Processes
- Virtual Memory

Reference Books







Administrivia

- Grade Distribution (Tentative)
  - Quiz: 10%, Exam: 40%, Project: 50% (1 quiz, 1 final exam, 1 Project)
- Teaching Assistants

Adithya Sunil Edakkadan - adithya.edakkadan@research.iiit.ac.in
Akshit Gureja - akshit.gureja@research.iiit.ac.in

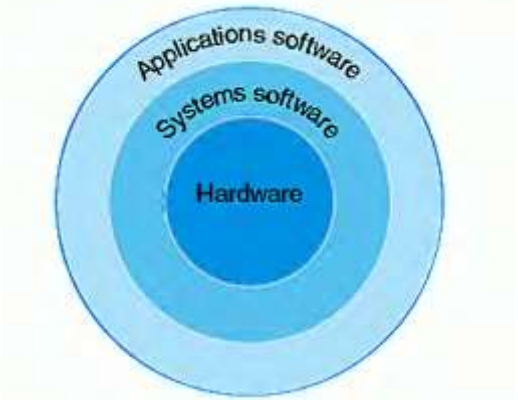
Tejah S S - tejah.ss@research.iiit.ac.in
K Pavan Kumar - pavan.kondooru@research.iiit.ac.in

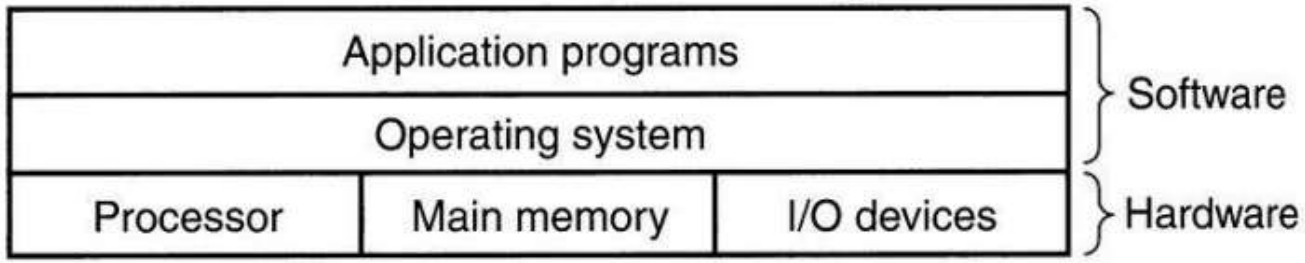
Expected Conduct

- Please be active and ask questions!
- **Plagiarism** will be penalized severely!
- Submission times are strict! Delays allowed only for genuine medical reasons.

Computer System = Hardware + System Software + Application Software

Source: H&P-3 (Hennesy & Patterson, 3rd Edition)

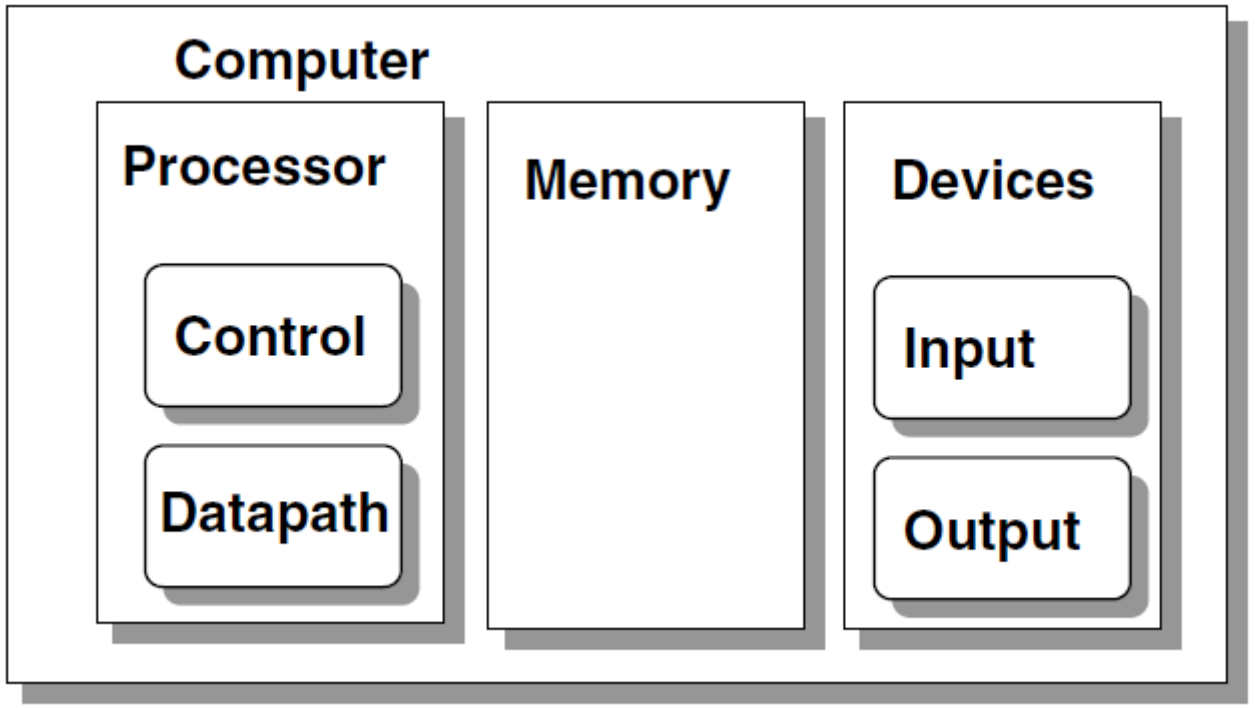




System Software: Operating System, Device Drivers, Loaders, Linkers, Compilers, Assemblers, ….

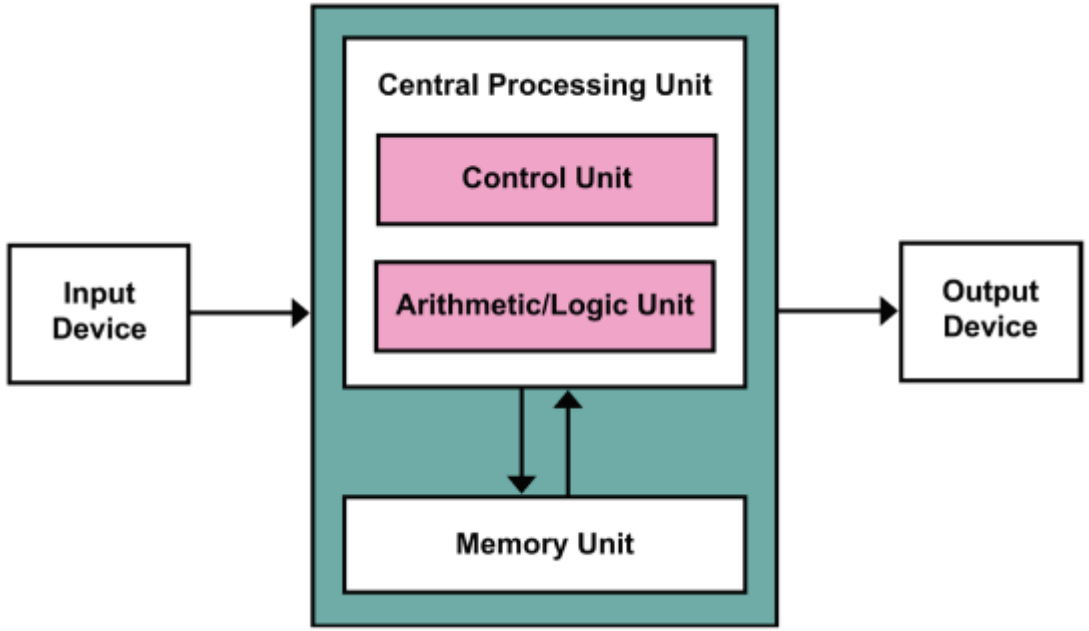
Application Software: Web browsers, user-specific applications, …..

Major Function Units

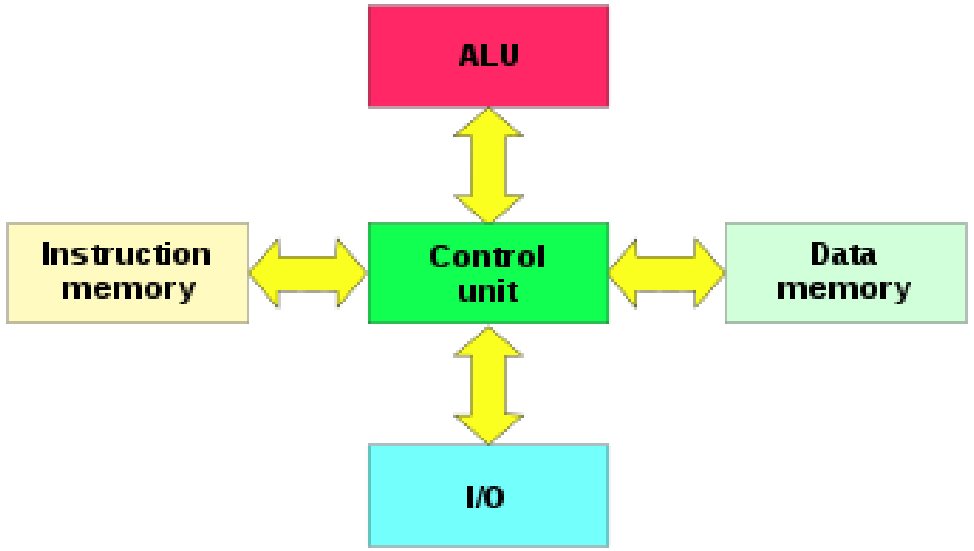


Source: Prof. Cheung's Course Notes (Imperial College, London)

Computer Architecture - Models



Von Neumann Architecture



Harvard Architecture

Source: Wikipedia

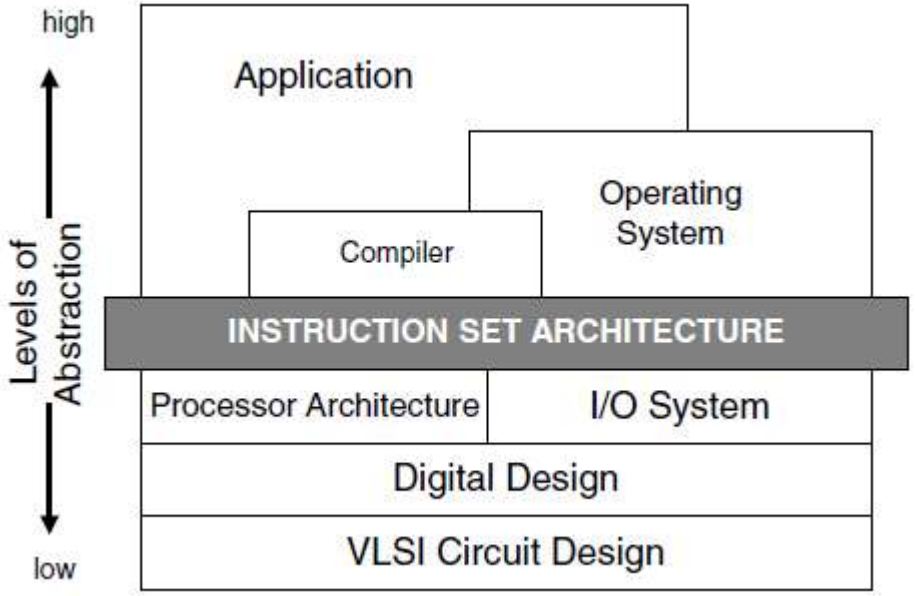
ISA: Hardware – Software Interface

Instruction Set Architecture (ISA)

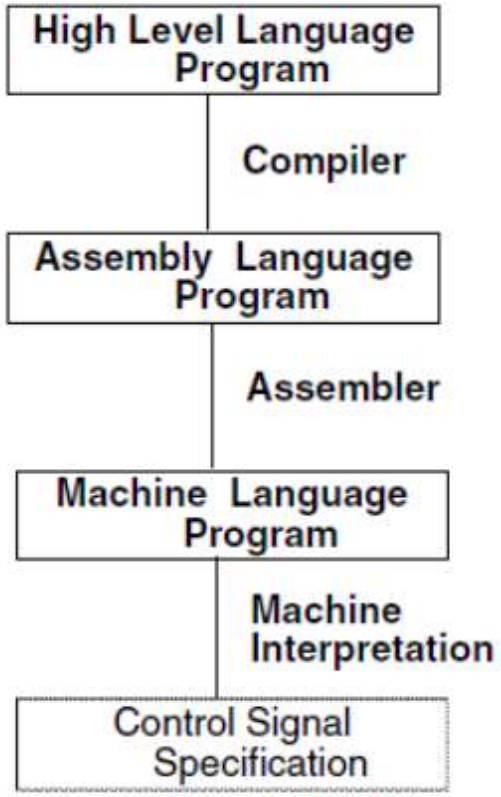
- ISA is an abstraction for the Software to interface with the Hardware.
- Advantage: Multiple implementations for the same ISA.
  - Example: AMD Opteron 64 and Intel Pentium 4 are different Implementations of the ISA.

"... the attributes of a [computing] system as seen by the programmer, i.e. the conceptual structure and functional behavior, as distinct from the organization of the data flows and controls the logic design, and the physical implementation."

➢Amdahl, Blaaw, and Brooks, 1964



ISA: Hardware – Software Interface




```
temp := v[k];
v[k] := v[k+1];
v[k+1] := temp;
```

```
lw   $15, 0($2)
lw   $16, 4($2)
sw   $16, 0($2)
sw   $15, 4($2)
```

MIPS Assemble Language

```
0000 1001 1100 0110 1010 1111 0101 1000
1010 1111 0101 1000 0000 1001 1100 0110
1100 0110 1010 1111 0101 1000 0000 1001
0101 1000 0000 1001 1100 0110 1010 1111
```

Programming Abstractions

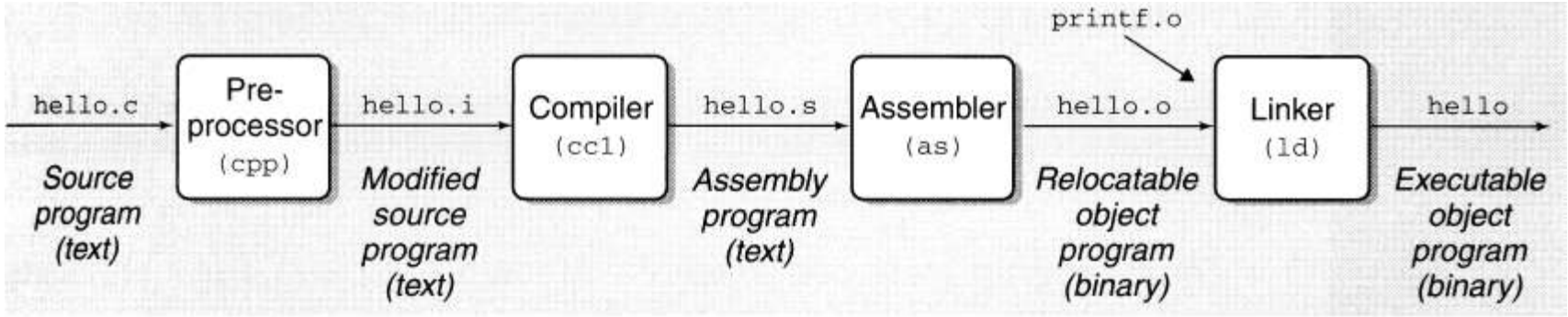
We can program a microprocessor using

- Instruction opcodes (also called Machine Code)
- Assembly language
- High level programming languages

- The level of abstraction increases from Top to Bottom.
- As the level of abstraction increases, ease of programmability also increases!
- But we may lose the fine-grained control over the underlying hardware?

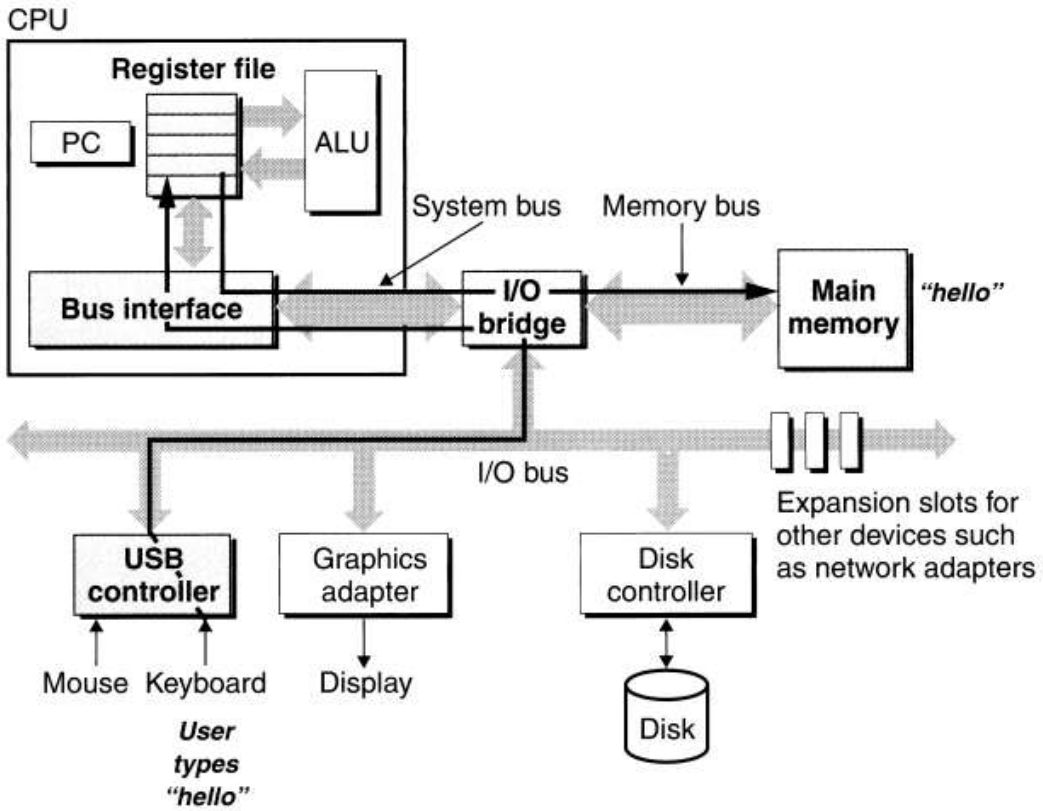
ISA: Hardware – Software Interface

```
gcc -o hello hello.c
```



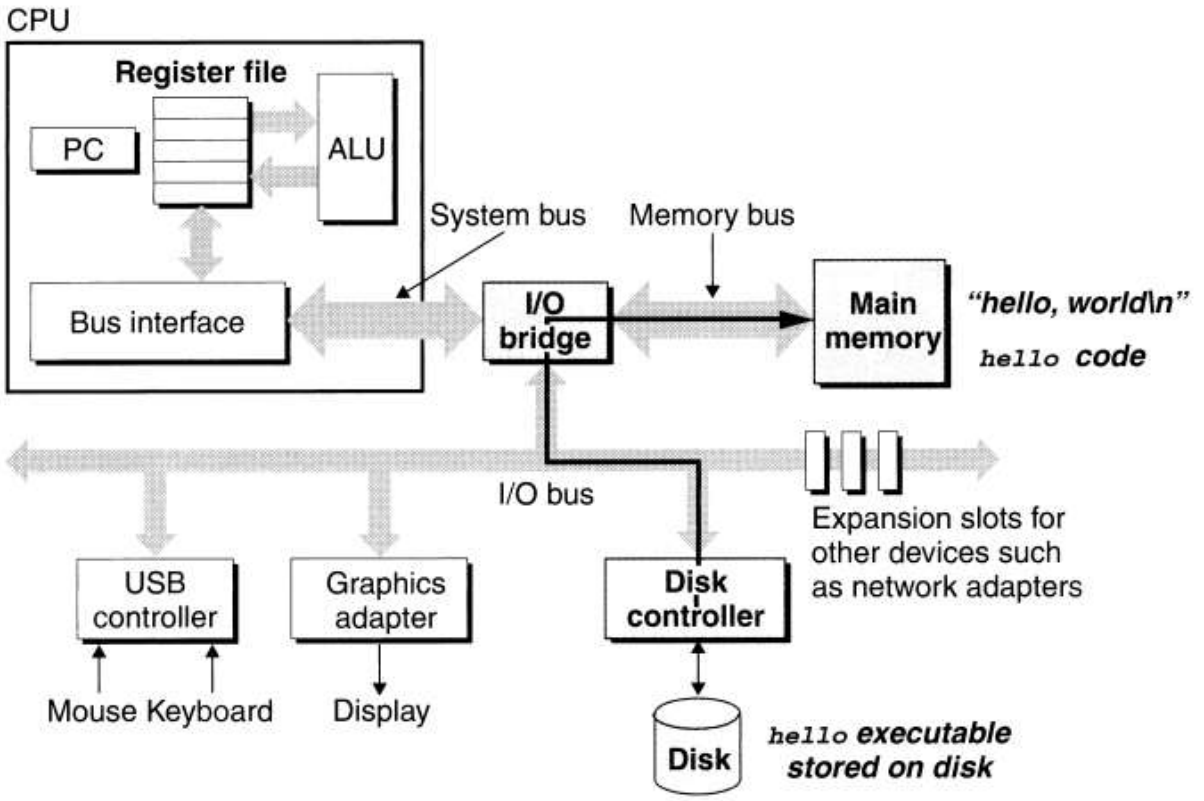
Source: Bryant & O'Hallaron

Running the “Hello World” Program



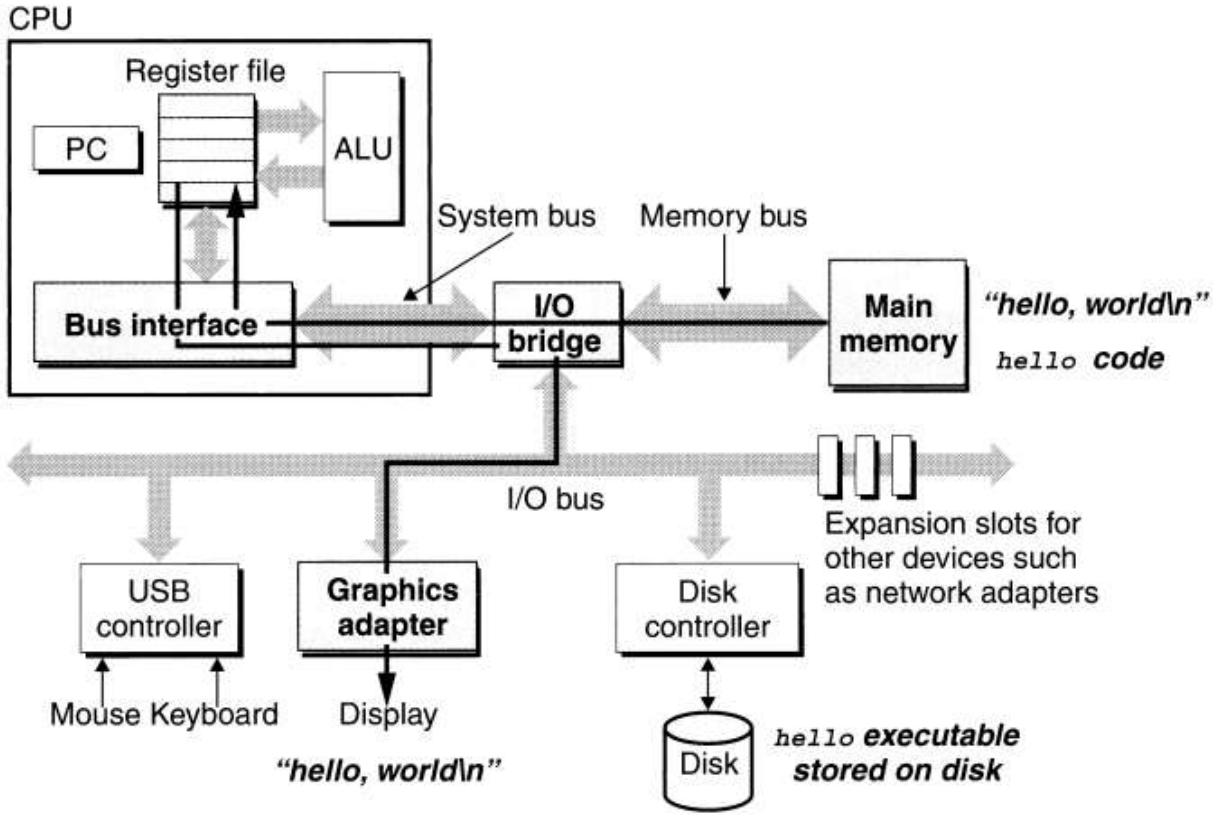
Source: Bryant & O’Hallaron

Running the “Hello World” Program



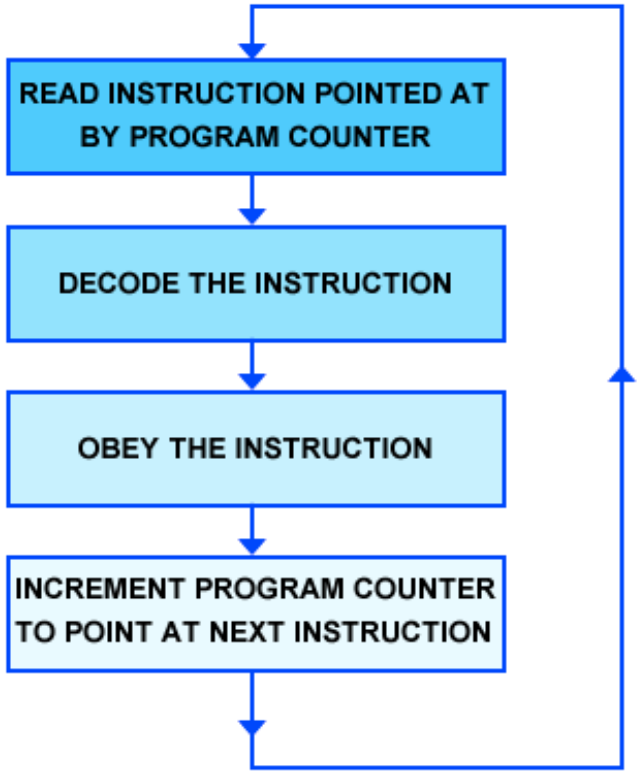
Source: Bryant & O’Hallaron

Running the “Hello World” Program



Source: Bryant & O’Hallaron

Basic Processor Model



Technologies for Building Processors and Memories

A transistor is simply an on/off switch controlled by electricity.

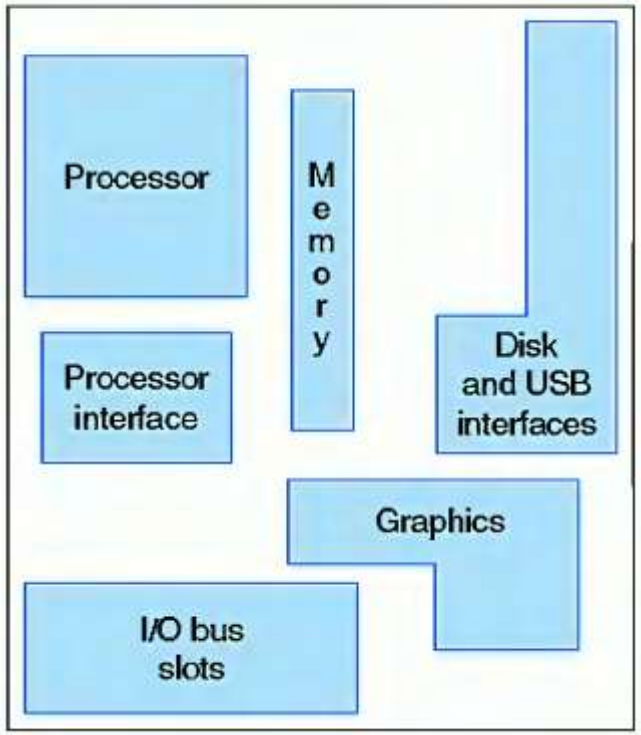
Year	Technology used in computers	Relative performance/unit cost
1951	Vacuum tube	1
1965	Transistor	35
1975	Integrated circuit	900
1995	Very large scale integrated circuit	2,400,000
2005	Ultra large scale integrated circuit	6,200,000,000

Source: H&P-3 (Hennesy & Patterson, 3rd Edition)

Inside a PC

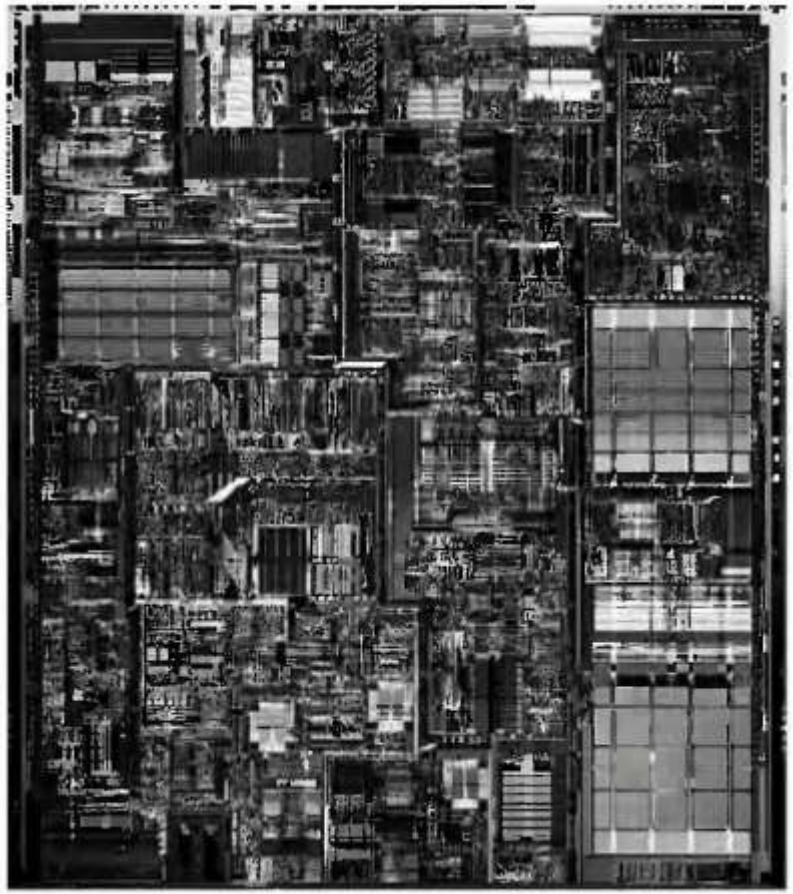
Source: H&P-3 (Hennesy & Patterson, 3rd Edition)

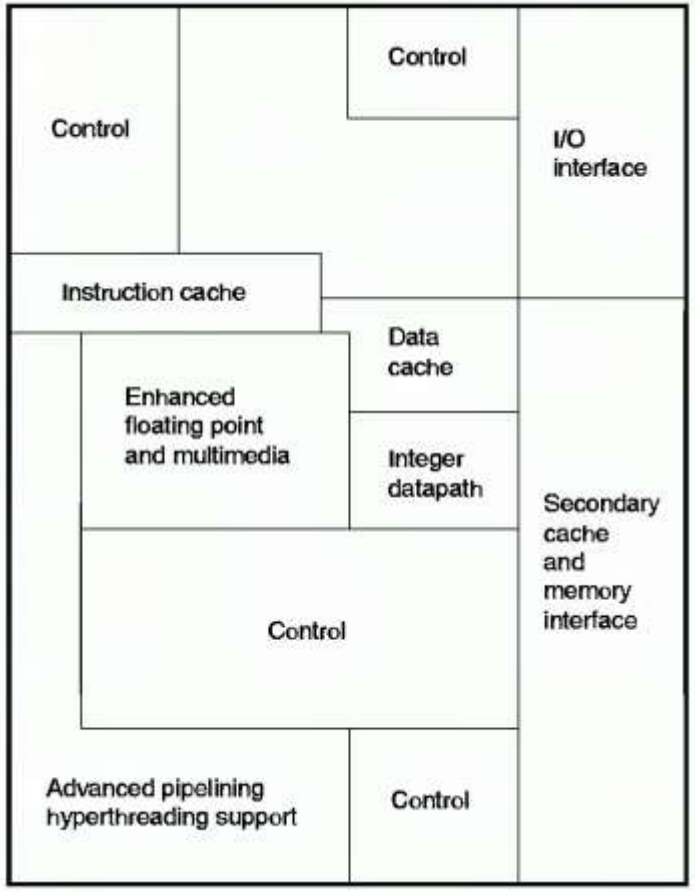
Close-up of Motherboard



Source: H&P-3 (Hennesy & Patterson, 3rd Edition)

Inside a Pentium 4 Processor





Source: H&P-3 (Hennesy & Patterson, 3rd Edition)

Thank You!