Lecture 2: Abstraction

CSCE 2610 Computer Organization

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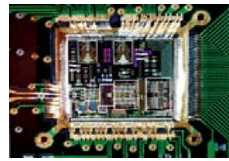
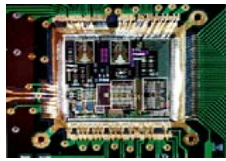


What is a digital Computer ?

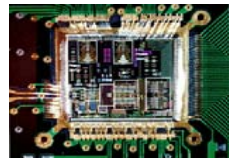
A fast electronic machine that accepts digitized input information, processes it according to a list of internally stored instruction, and produces the resulting output information.

List of instructions → Computer program

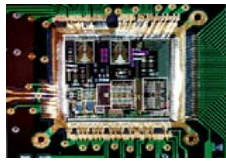
Internal storage → Memory



A Desktop Computer

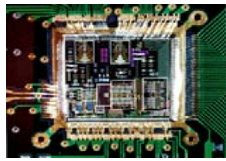


A Desktop Computer: Inside

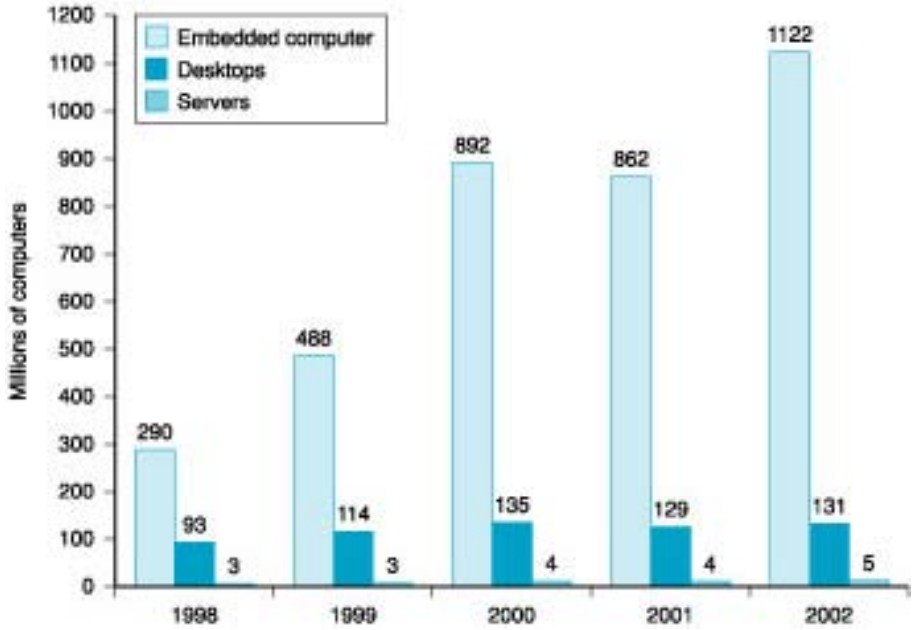


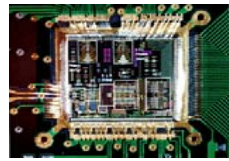
Different Types and Forms of Computer

- Personal Computers (Desktop PCs)
- Notebook computers (Laptop computers)
- Handheld PCs
- Pocket PCs
- Workstations (SGI, HP, IBM, SUN)
- ATM (Embedded systems)
- Supercomputers
- …..

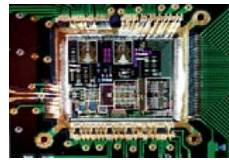


Number of Different Processors Sold (by type)





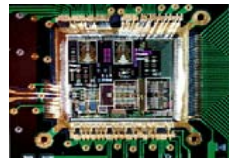
Hardware / Software Layers



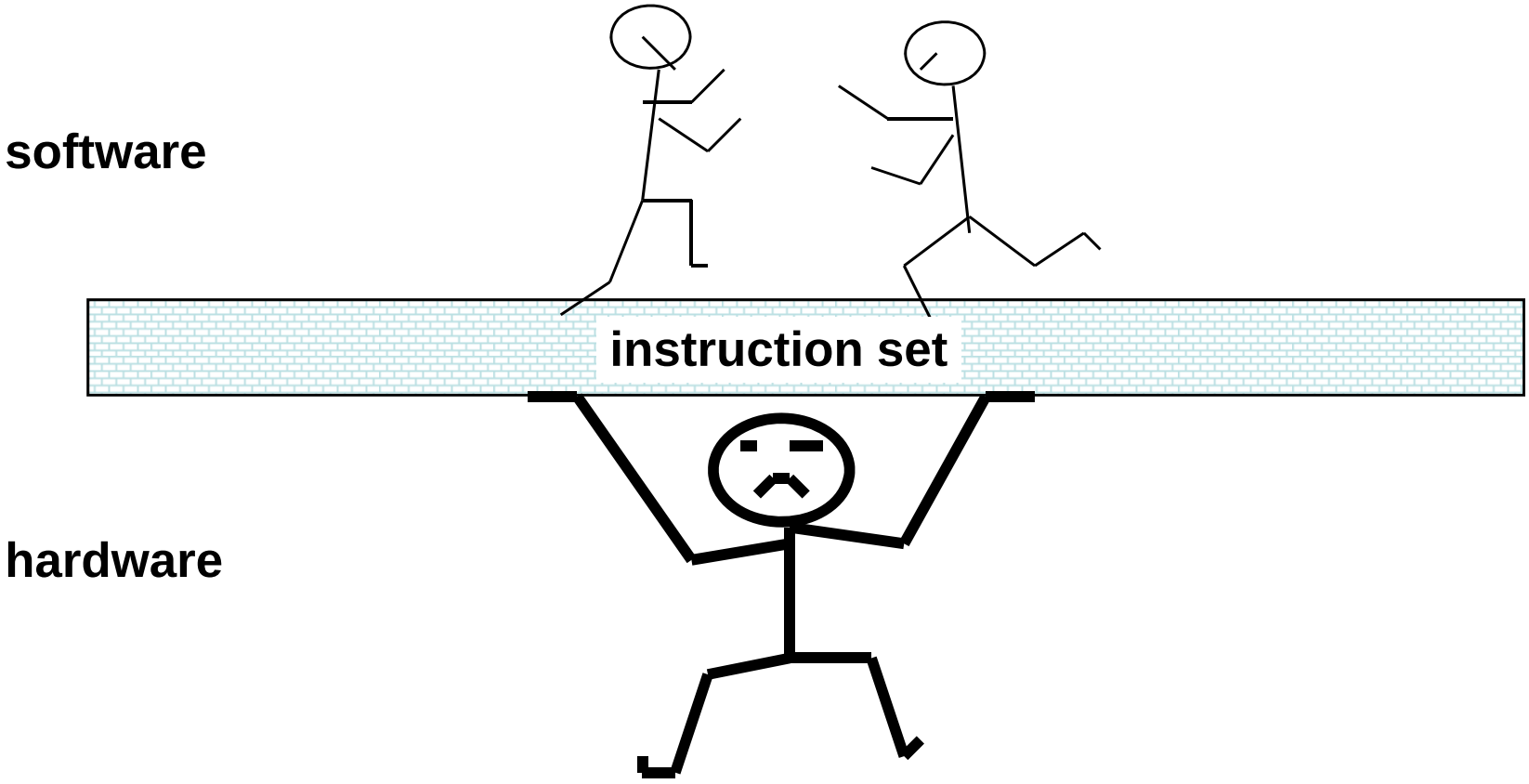
Instruction Set Architecture

... 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

- **Organization of Programmable Storage**
- **Data Types & Data Structures: Encodings & Representations**
- **Instruction Set**
- **Instruction Formats**
- **Modes of Addressing and Accessing Data Items and Instructions**
- **Exceptional Conditions**

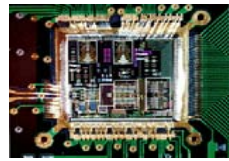


The Instruction Set: a Critical Interface



Example Instruction Set Architectures

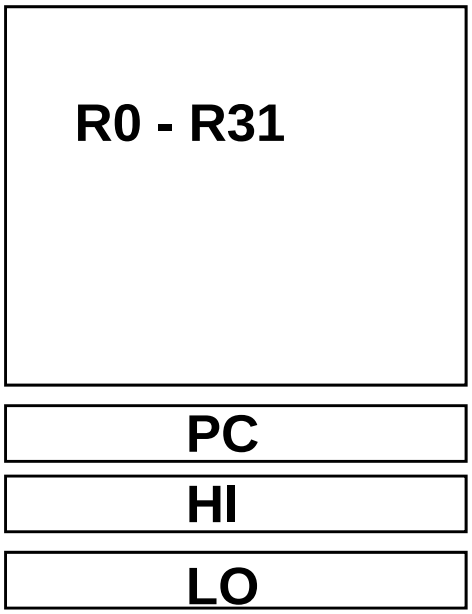
- Digital Alpha (v1, v3) 1992-97
- HP PA-RISC (v1.1, v2.0) 1986-96
- Sun Sparc (v8, v9) 1987-95
- SGI MIPS (MIPS I, II, III, IV, V) 1986-96
- Intel (8086,80286,80386, 80486,Pentium, MMX, ...) 1978-96



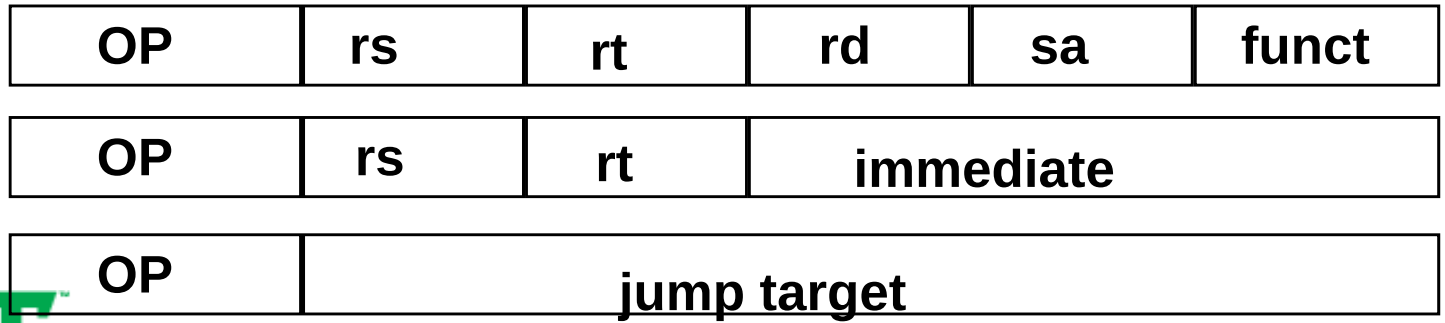
MIPS R3000 Instruction Set Architecture

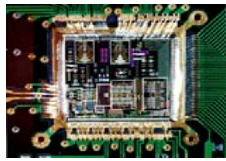
- Instruction Categories
  - Load/Store
  - Computational
  - Jump and Branch
  - Floating Point
    - coprocessor
  - Memory Management
  - Special

Registers

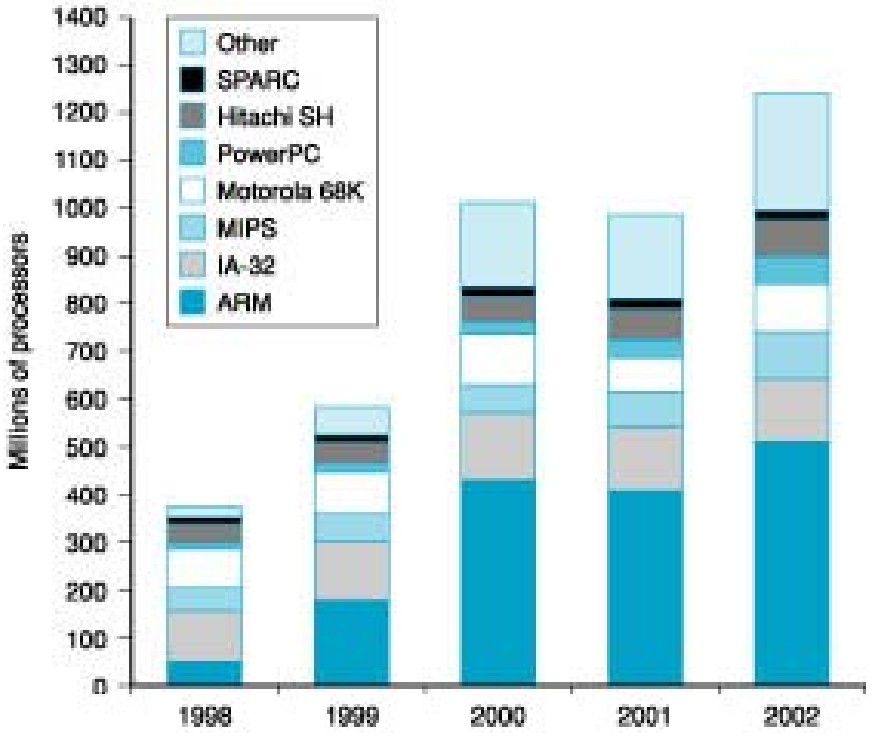


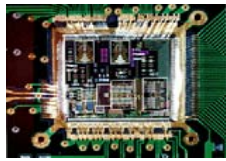
3 Instruction Formats: all 32 bits wide





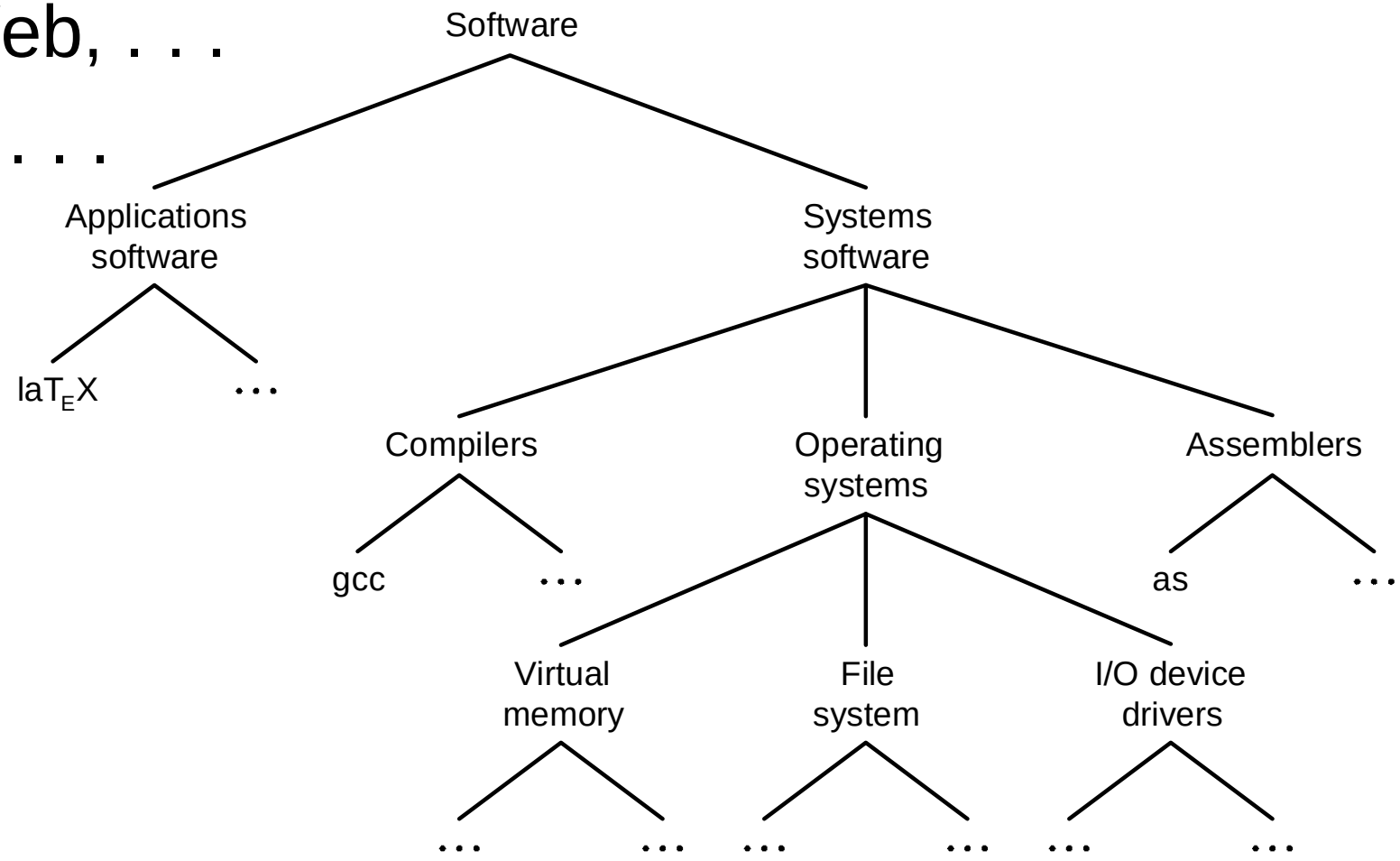
Number of Different Processors Sold (By ISA)

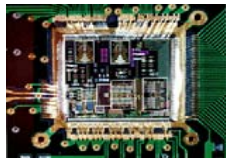




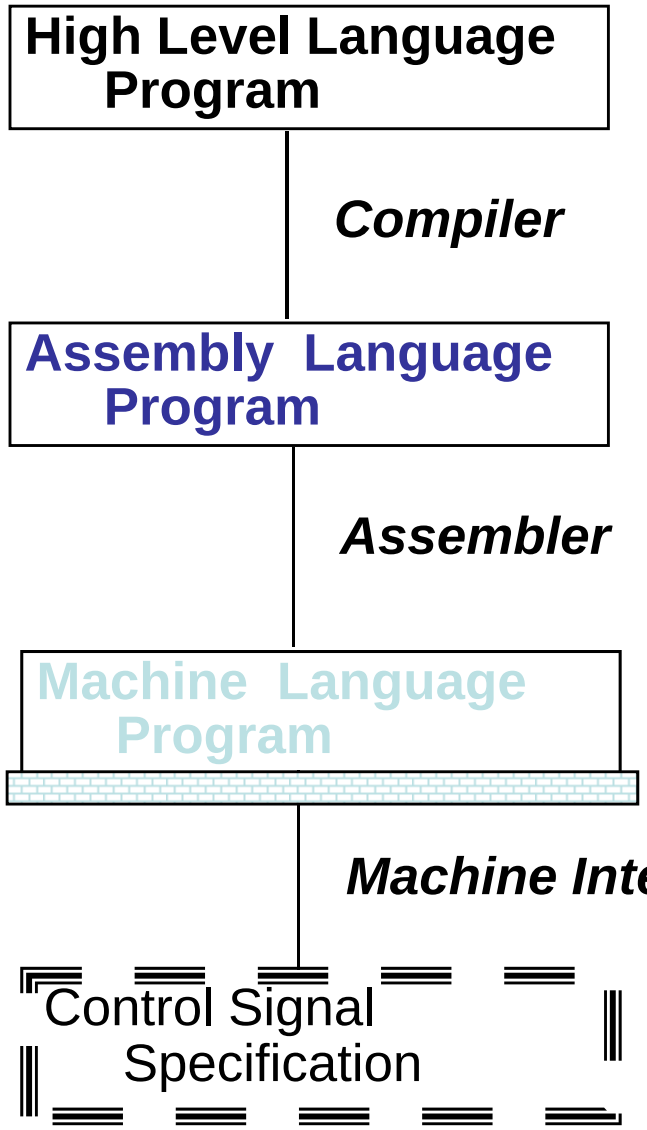
Applications and Languages

- CAD, CAM, CAE, . . .
- Multimedia, . . .
- The Web, . . .
- JAVA, . . .
- ???





Levels of Representation

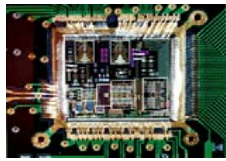



```
temp = v[k];
v[k] = v[k+1];
v[k+1] = temp;
```

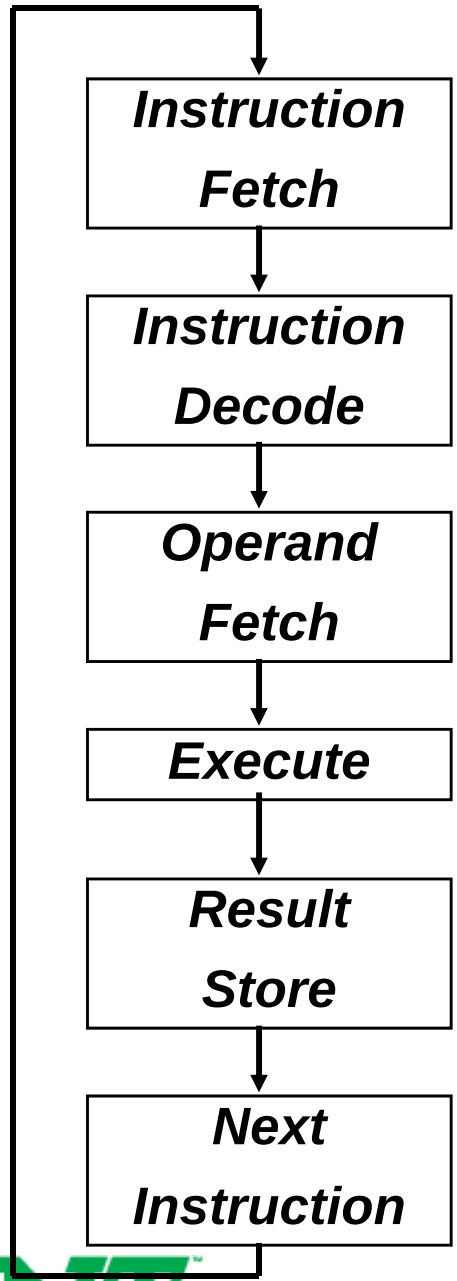
```
lw$15,0($2)
lw$16,4($2)
sw    $16,0($2)
sw    $15,4($2)
```

```
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
```

ALUOP[0:3] <= InstReg[9:11] & MASK



Execution Cycle



Obtain instruction from program storage

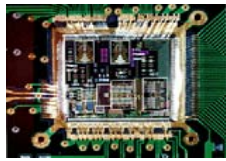
Determine required actions and instruction size

Locate and obtain operand data

Compute result value or status

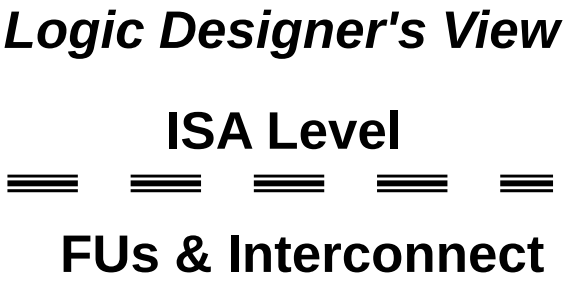
Deposit results in storage for later use

Determine successor instruction

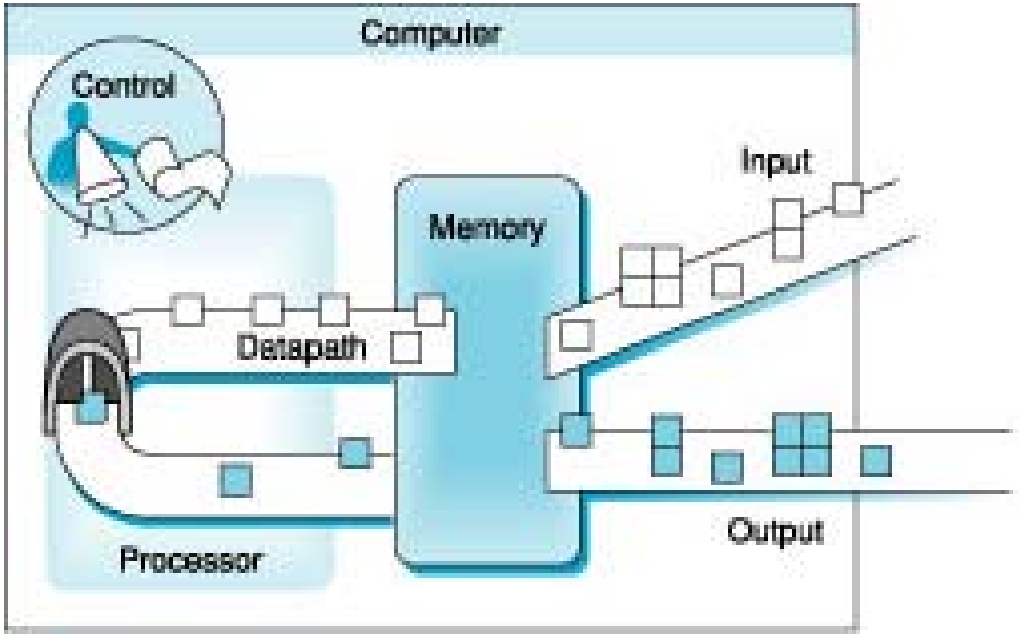


Computer Organization

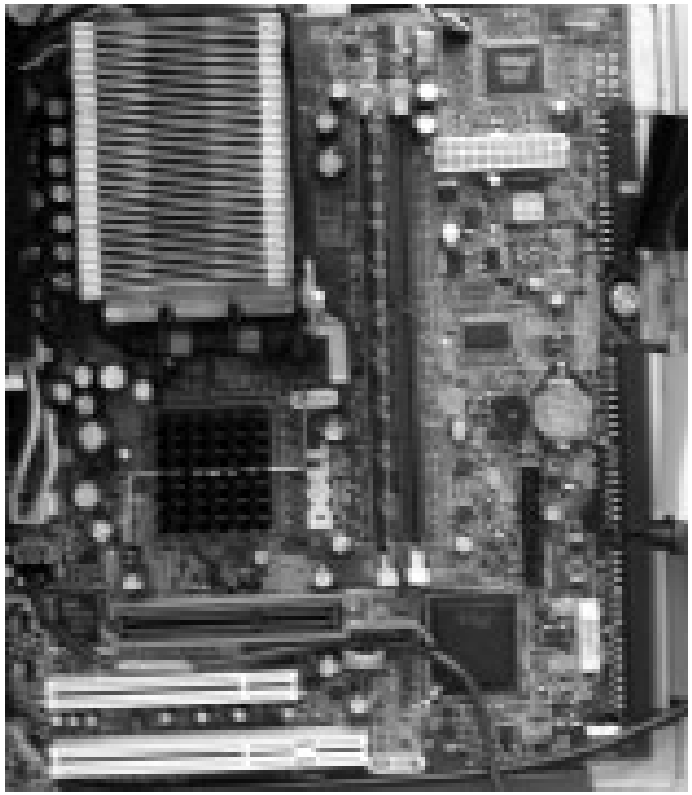
- Capabilities & Performance Characteristics of Principal Functional Units
  - (e.g., Registers, ALU, Shifters, Logic Units, ...)
- Ways in which these components are interconnected
- Information flows between components
- Logic and means by which such information flow is controlled.
- Choreography of FUs to realize the ISA
- Register Transfer Level (RTL) Description

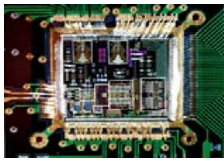


Computer Organization: 5 Components

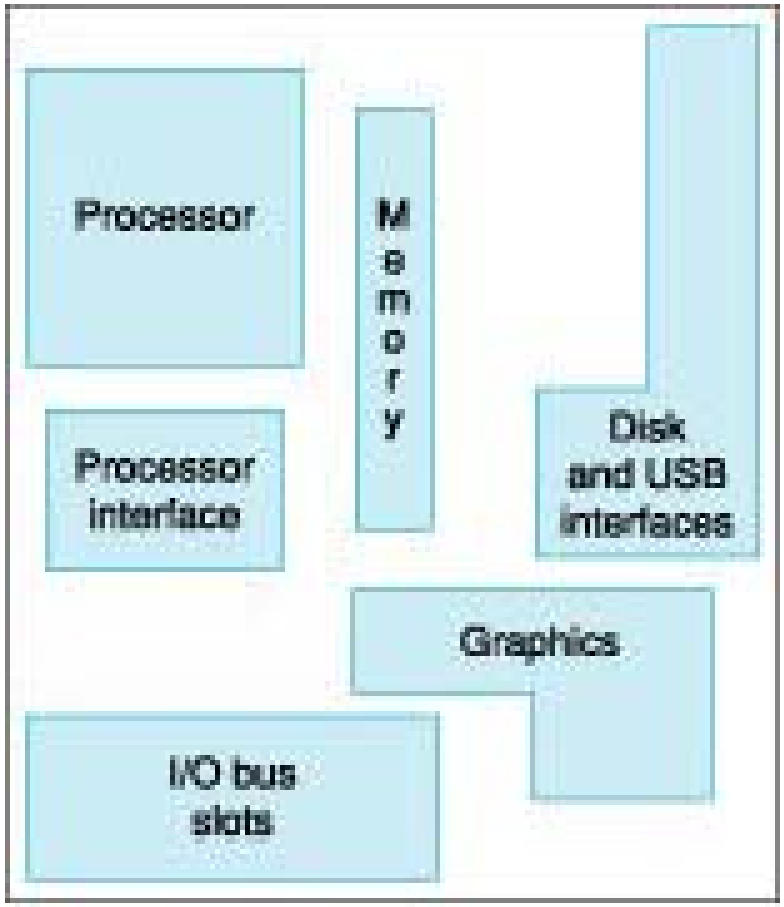


Motherboard





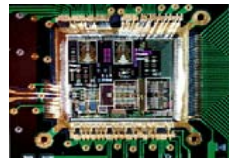
Motherboard: Major Components



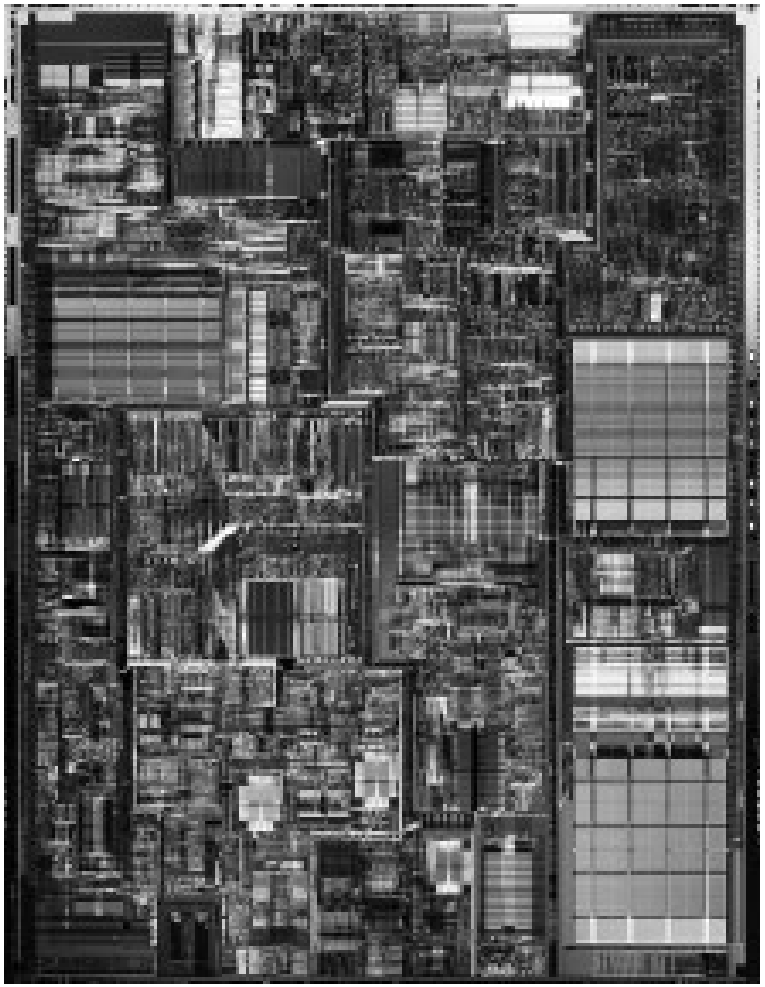
What is a Microprocessor ?

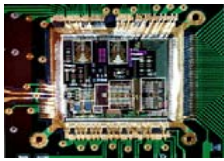
- Simply speaking, microprocessor is the CPU on a single chip. CPU stands for “central processing unit” also known as processor.

- Processor can be “general purpose” or “special purpose”. A special purpose processor is also known as “application specific integrated circuit” (ASIC).

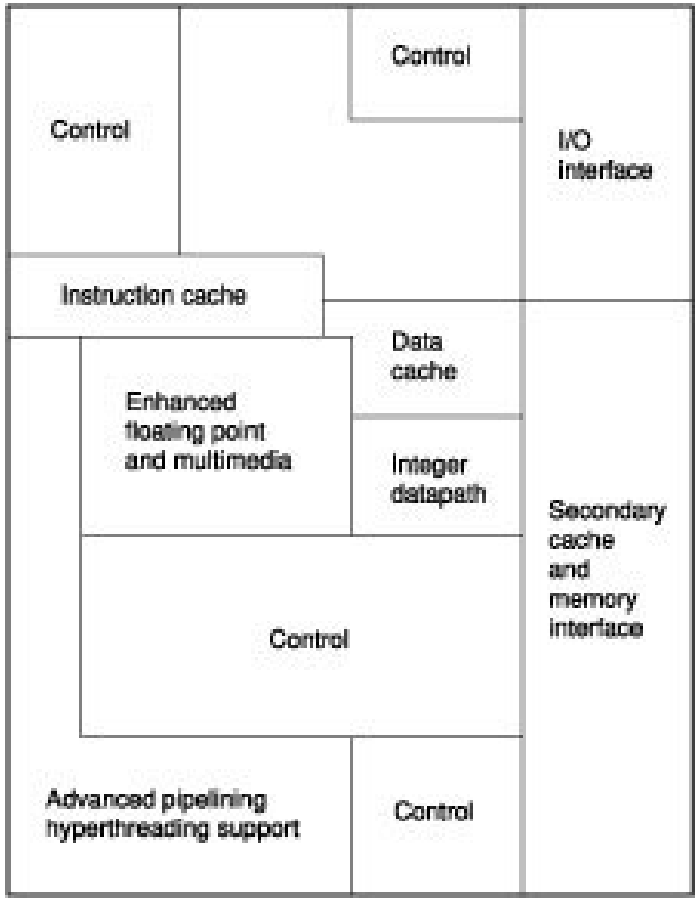


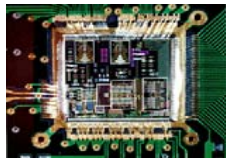
Microprocessor: Pentium 4 Layout



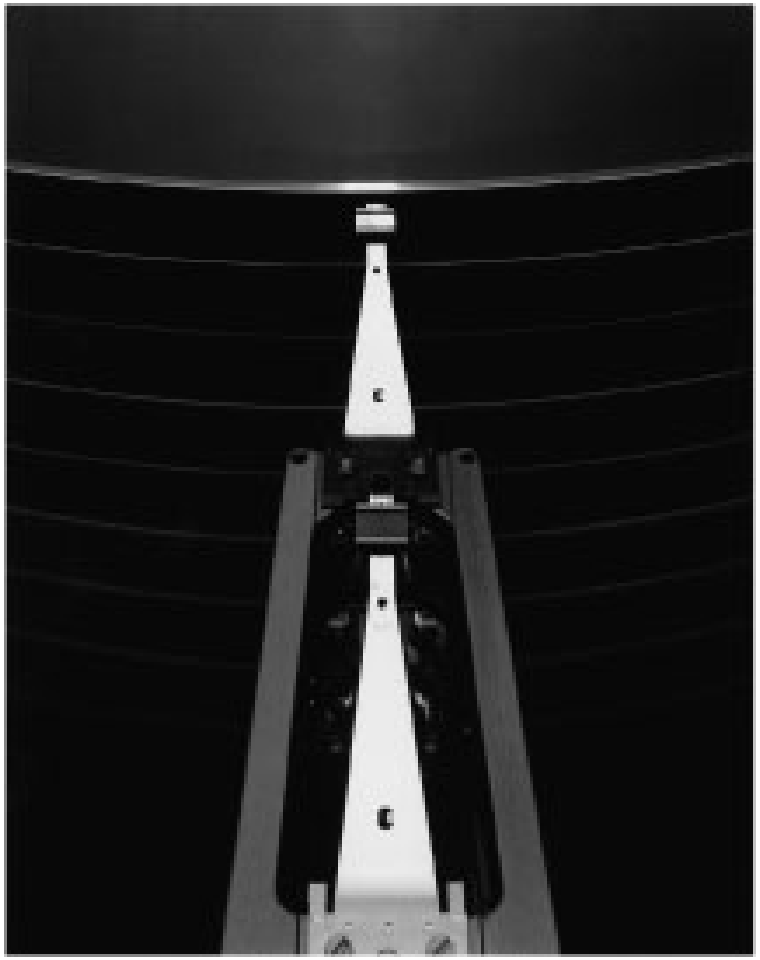


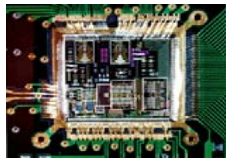
Microprocessor: Major Blocks





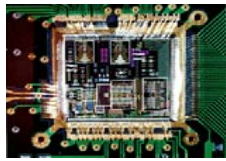
Disk with Platters and Head





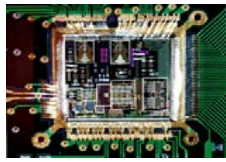
Technology => dramatic change

- Processor
  - logic capacity: about 30% per year
  - clock rate: about 20% per year
- Memory
  - DRAM capacity: about 60% per year (4x every 3 years)
  - Memory speed: about 10% per year
  - Cost per bit: improves about 25% per year
- Disk
  - capacity: about 60% per year

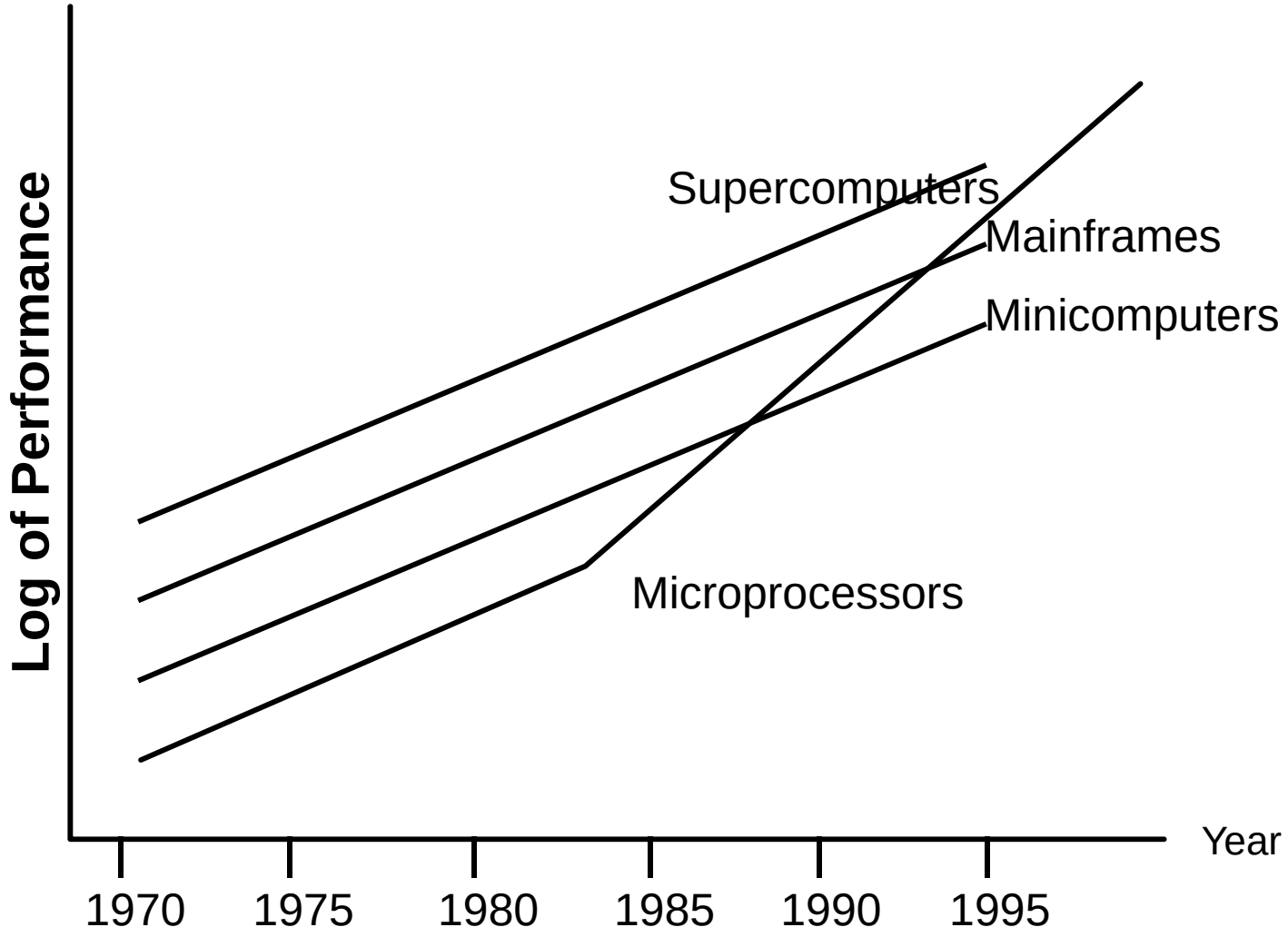


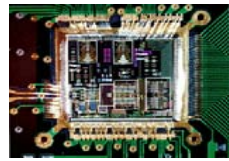
Moore's Law

- 1965: Gordon Moore plotted transistor on each chip
  - Transistor counts have doubled every 26 months
- Many other factors grow exponentially
  - clock frequency
  - processor performance

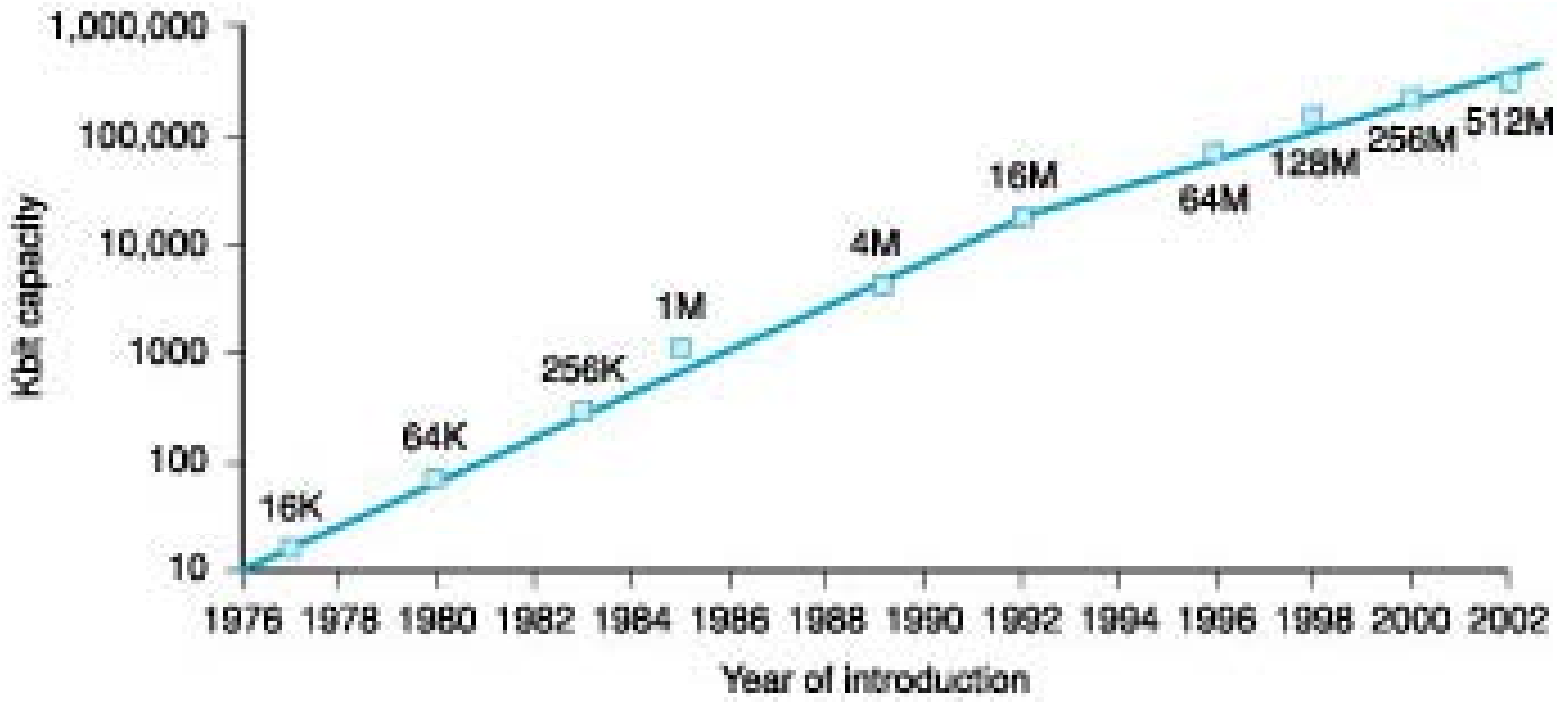


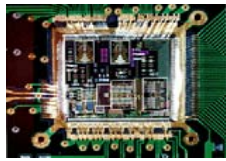
Performance Trends



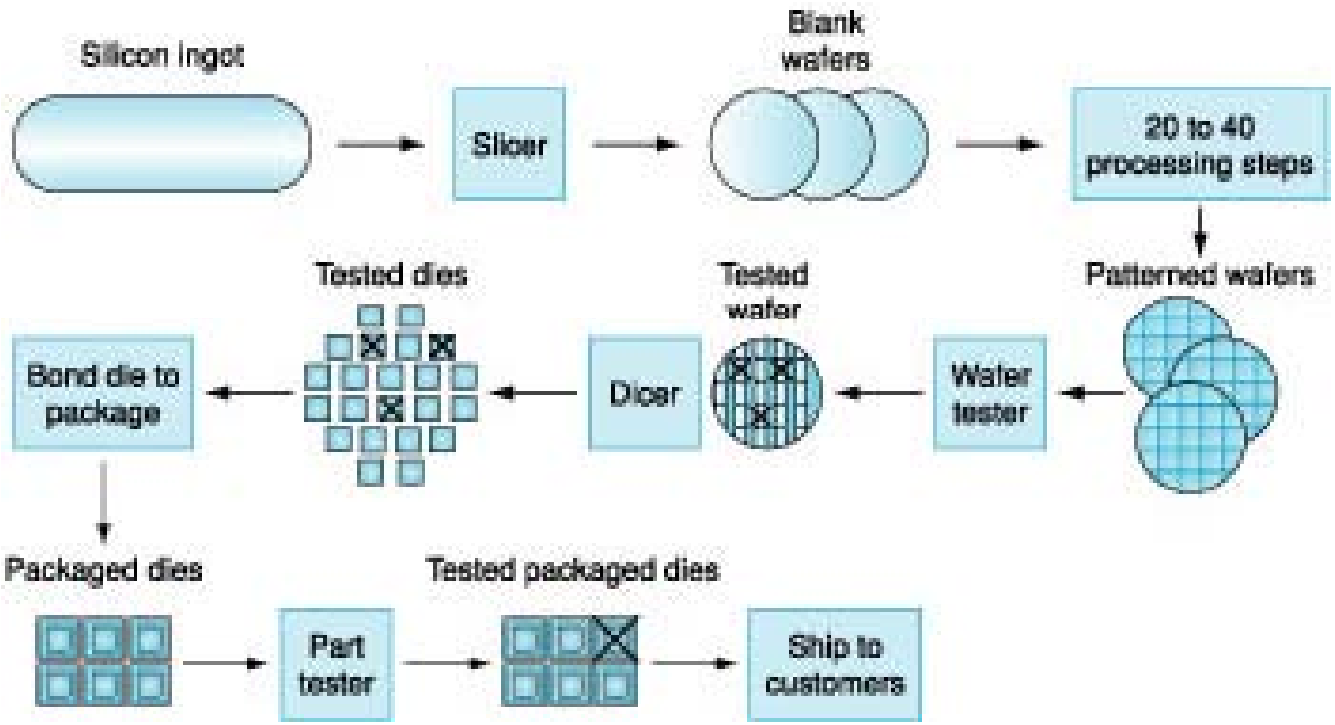


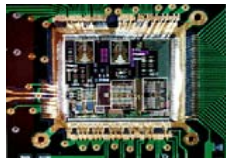
Growth of DRAM Chip Capacity



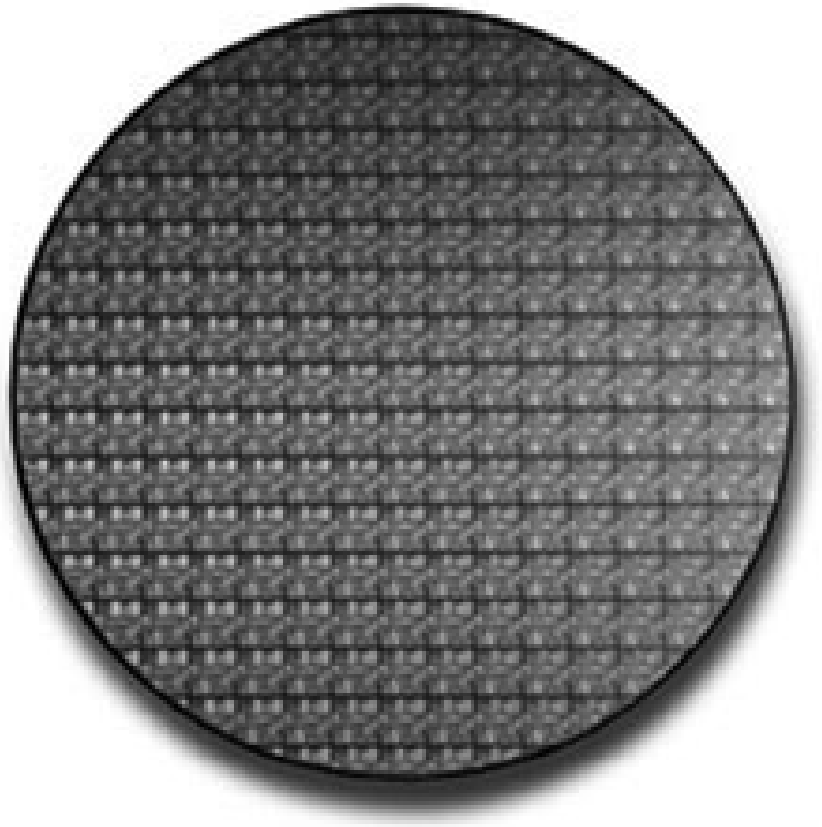


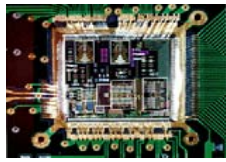
The Chip Manufacturing Process





Wafer of Pentium 4: 8 inch diameter





Pentium 4: on a Heat Sink