COMP-273

Introduction

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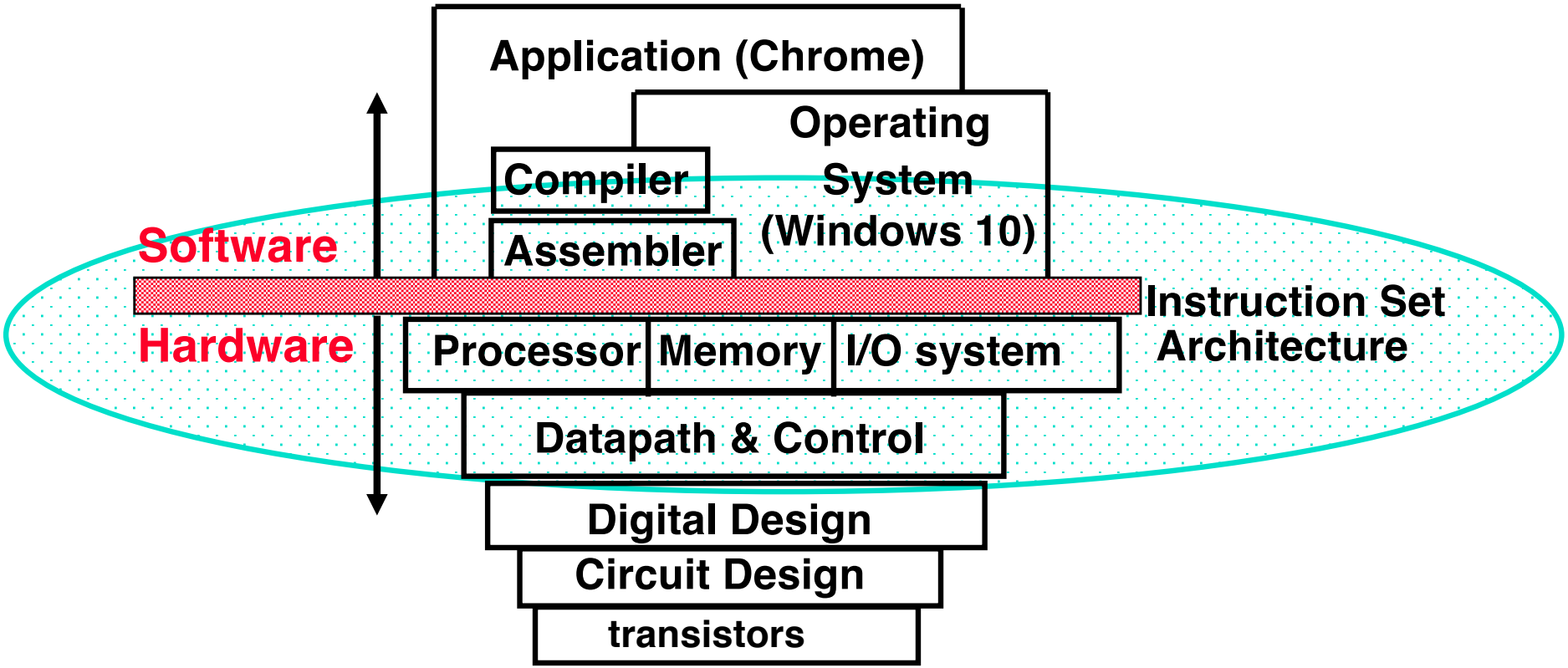
What are “Machine Structures”?

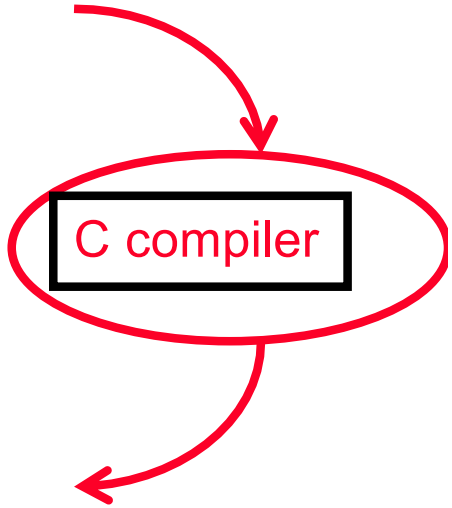


* Coordination of many *levels of abstraction*

Below the Program

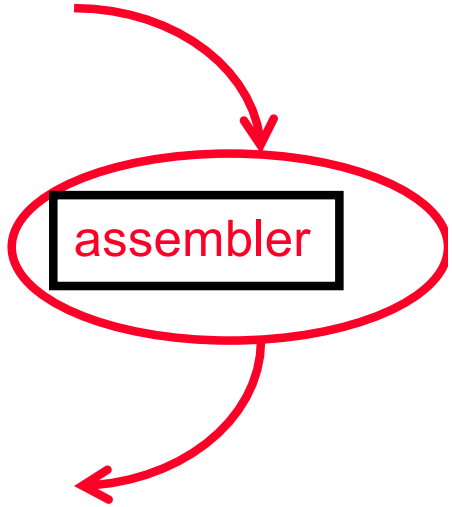
- High-level language program (in C)

```
swap (int v[], int k)
   (int temp;
        temp = v[k];
        v[k] = v[k+1];
        v[k+1] = temp;
   )
```



- Assembly language program (for MIPS)

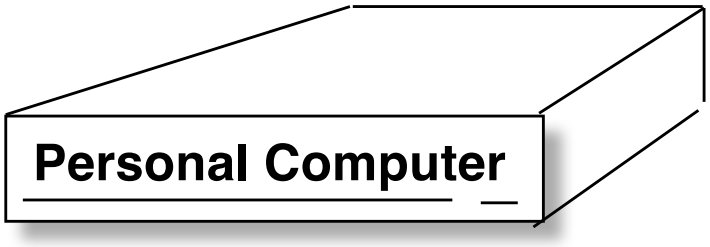
```
   swap:sll  $2, $5, 2
        add  $2, $4,$2
        lw   $15, 0($2)
        lw   $16, 4($2)
        sw   $16, 0($2)
        sw   $15, 4($2)
        jr   $31
```

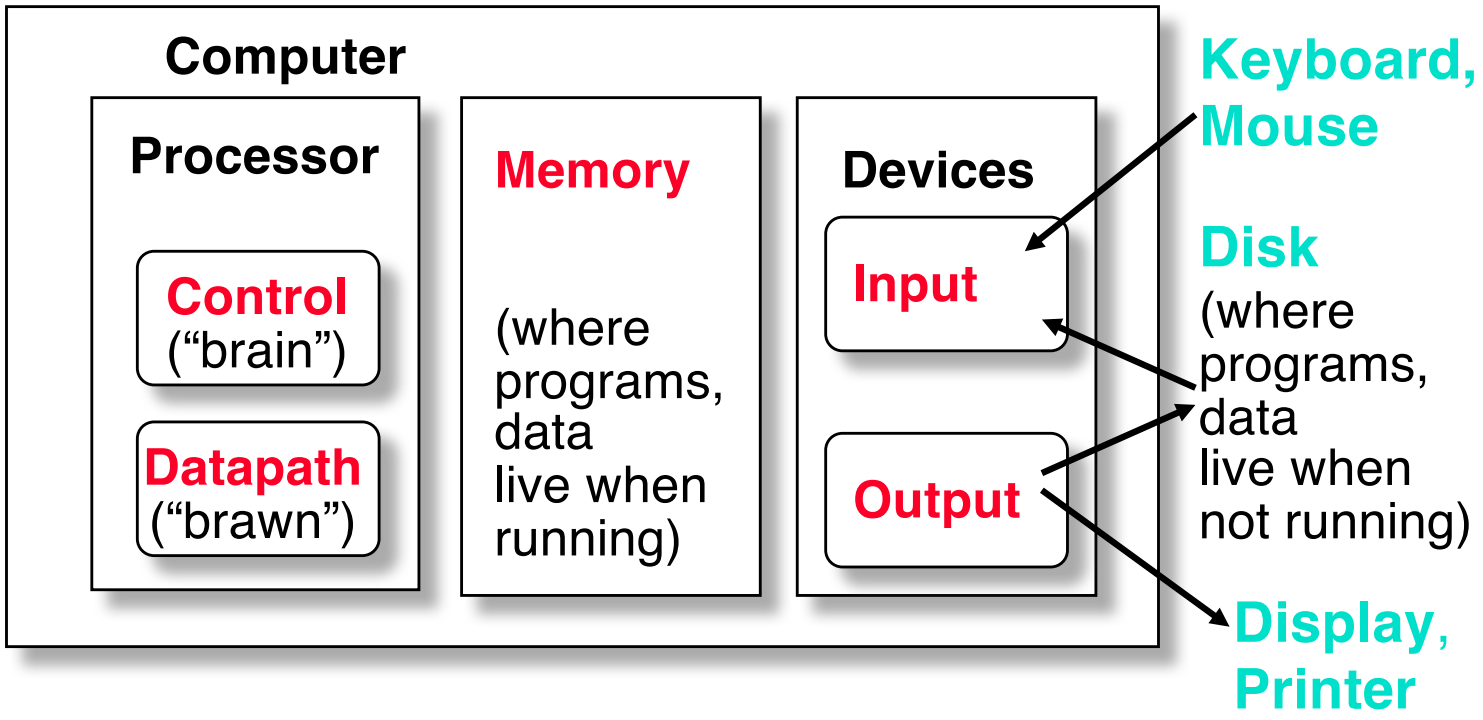


- Machine (object) code (for MIPS)

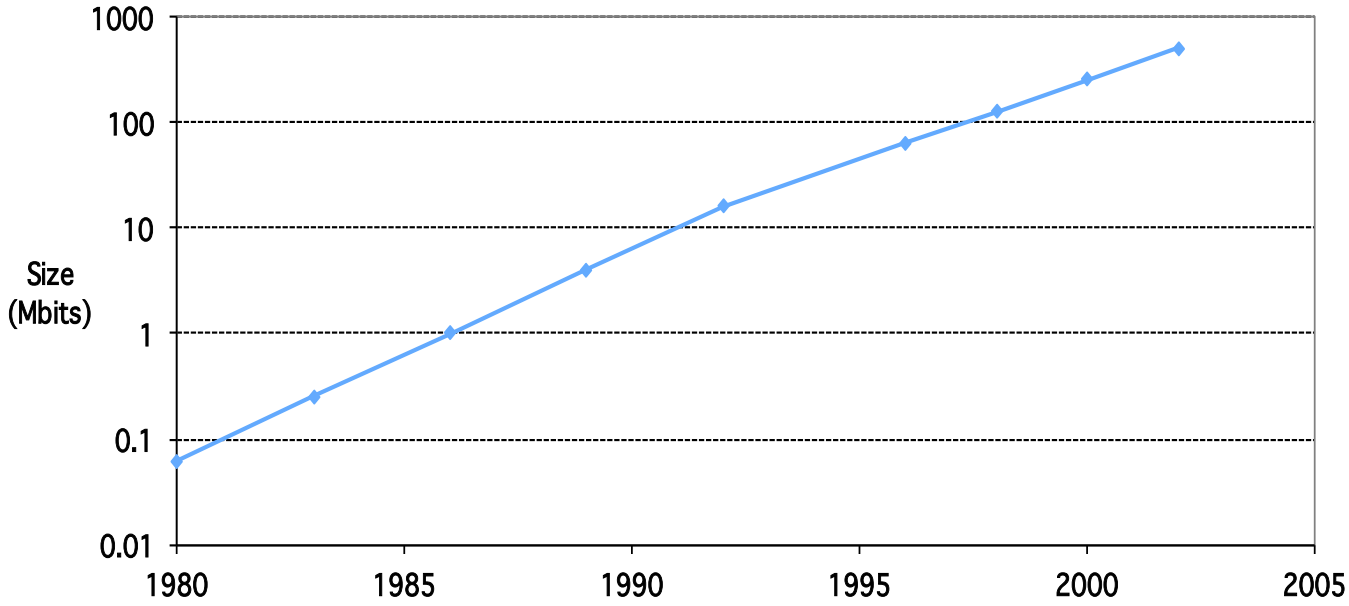
```
   000000 00000 00101 00010000010000000
   000000 00100 00010 00010000000100000
```

Anatomy: 5 components of any Computer





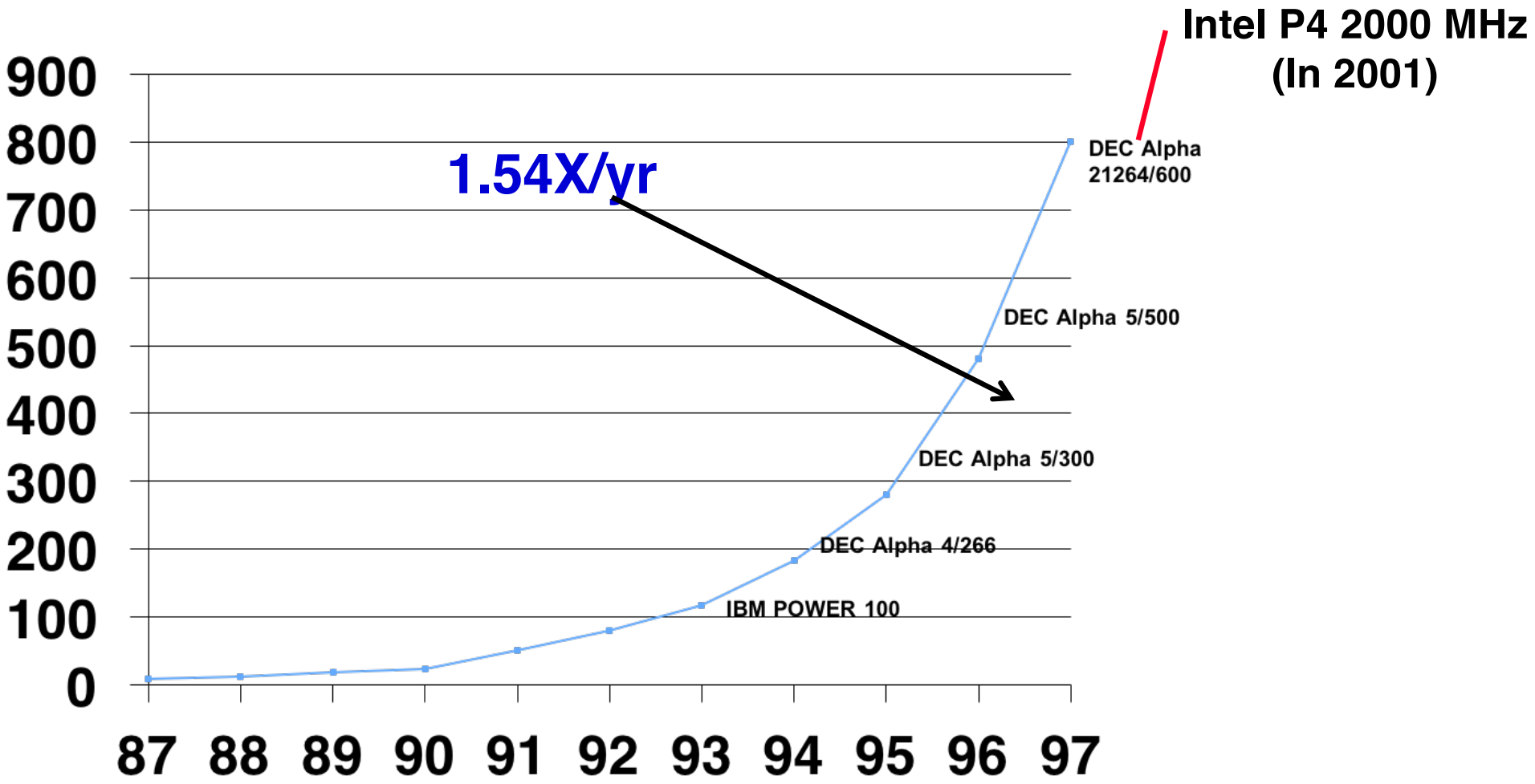
Technology Trends: Memory Capacity (Single-Chip DRAM)



year	size (Mbit)
1986	1
1989	4
1992	16
1996	64
1998	128
2000	256
2002	512 ...

- Now 1.4X/yr, or 2X every 2 years.
- So about 16 Gb by 2012.

Technology Trends: Processor Performance



Processor performance increase/year (really # transistors/chip)

Computer Technology - Dramatic Change!

- Processor
  - 2X in speed every 1.5 years (since ‘86);
- Memory
  - DRAM capacity: 2x / 2 years (since ‘96);
- Disk
  - Capacity: 2X / 1 year (since ‘97)

Computer Technology - Dramatic Change!

- State-of-the-art PC when you graduate:
  - Processor clock speed: 4000 MegaHertz (4.0 GigaHertz)
  - Memory capacity: 8000 MegaBytes (8.0 GigaBytes)
  - Disk capacity: 2000 GigaBytes (2.0 TeraBytes)
  - New units! Mega => Giga, Giga => Tera
  - (Note: we are not even discussing threading, cores, and GPU-based computing, which are all part of the new revolution.)

COMP-273: So what's in it for me?

- Learn big ideas in CS and engineering:
  - 5 Classic components of a Computer
  - Data can be anything (integers, floating point, characters): a program determines what it is
  - Stored program concept: instructions just data
  - Principle of Locality, exploited via a memory hierarchy (cache)
  - Greater performance by exploiting parallelism
  - Principle of abstraction, used to build systems as layers

Course Lecture Outline

Topics

Boolean Algebra/Digital Circuit Design

Number Representation

Assembly Programming (MIPS)

Floating Point

I/0 & Interrupts

Caches

Virtual Memory

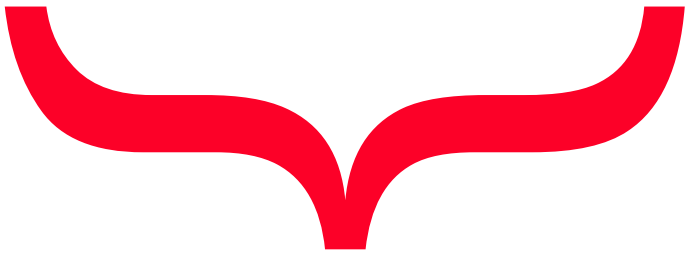
CPU Organization

Finite State Machines

And in Conclusion...

- Continued rapid improvement in Information Technology
  - 2X every 1.5 years in processor speed; every 2.0 years in memory size; every 1.0 year in disk capacity;
  - 5 classic components of all computers

Control Datapath Memory Input Output



Processor