CS61C
Machine Structures
Lecture 1
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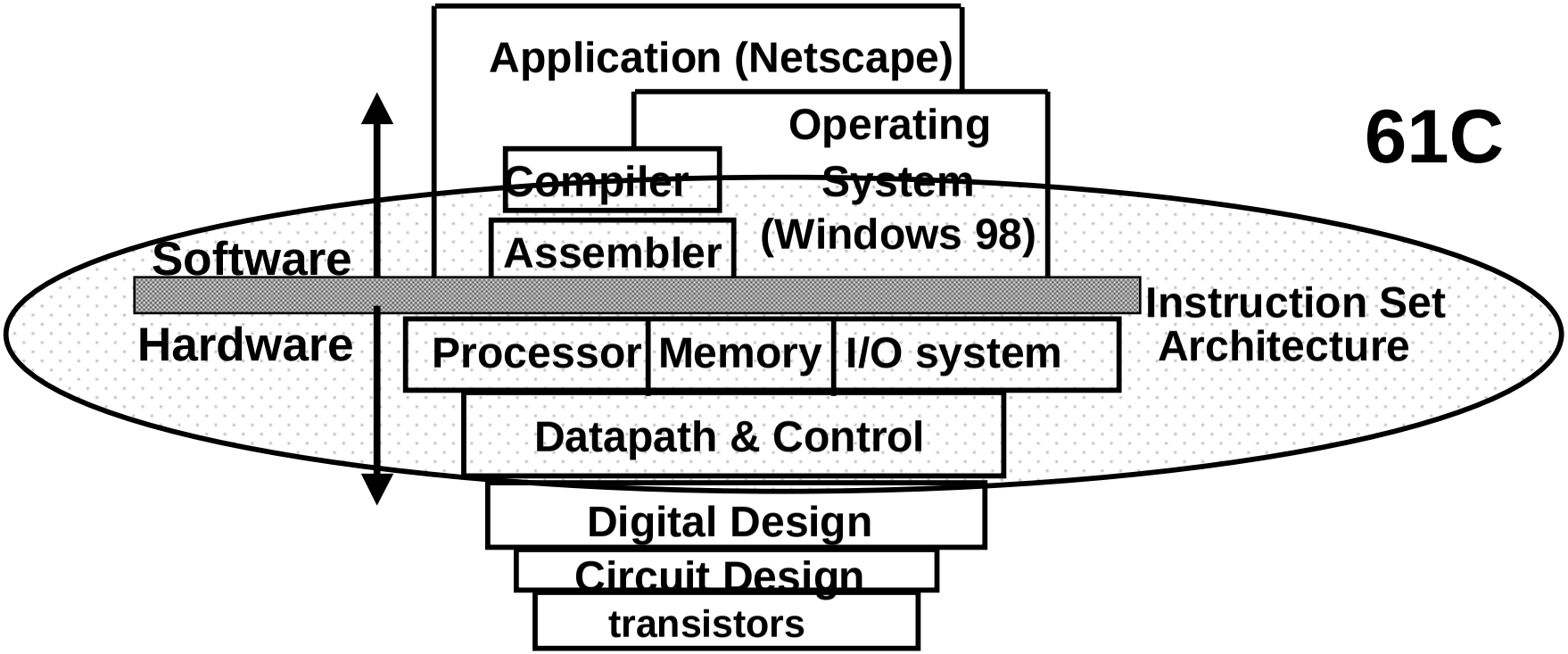
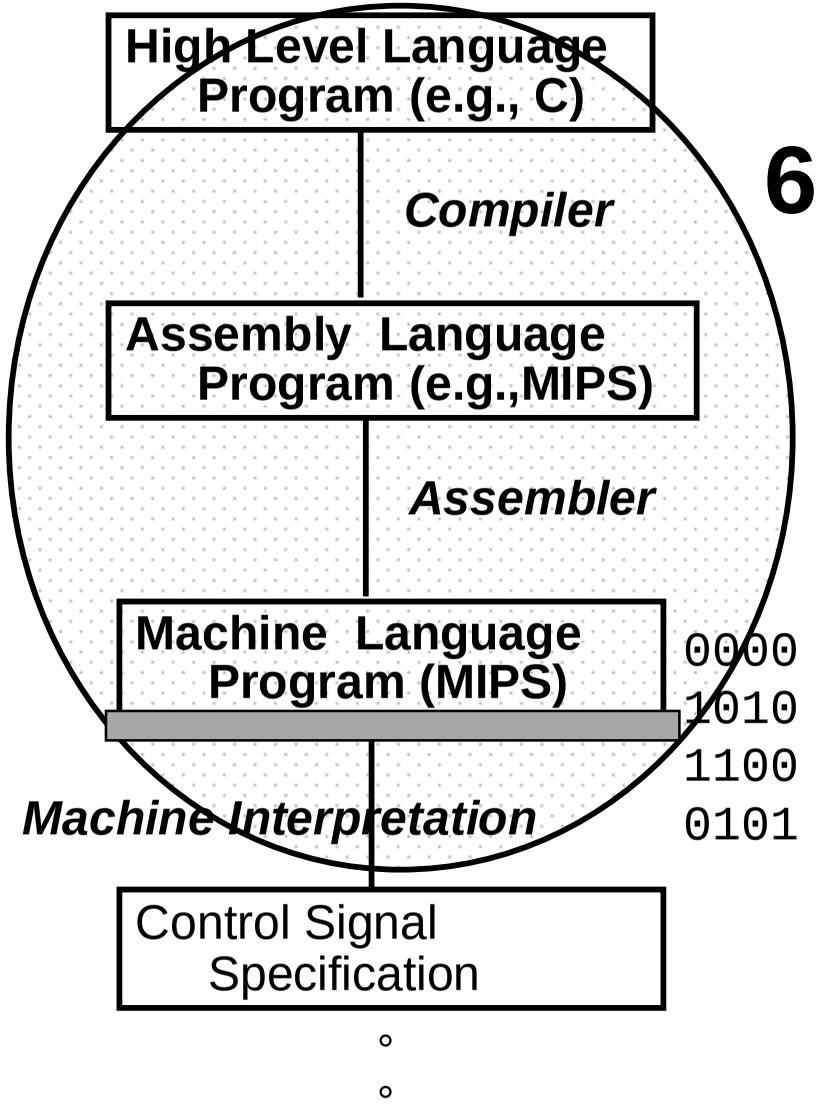
What are "Machine Structures"?



- Coordination of many *levels of abstraction*

Levels of Representation



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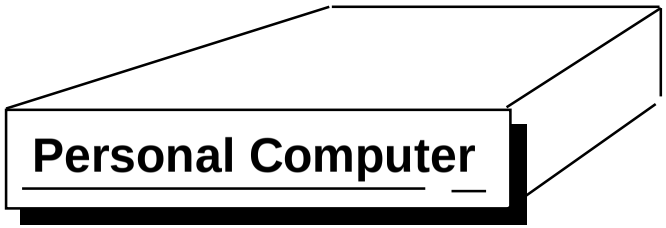
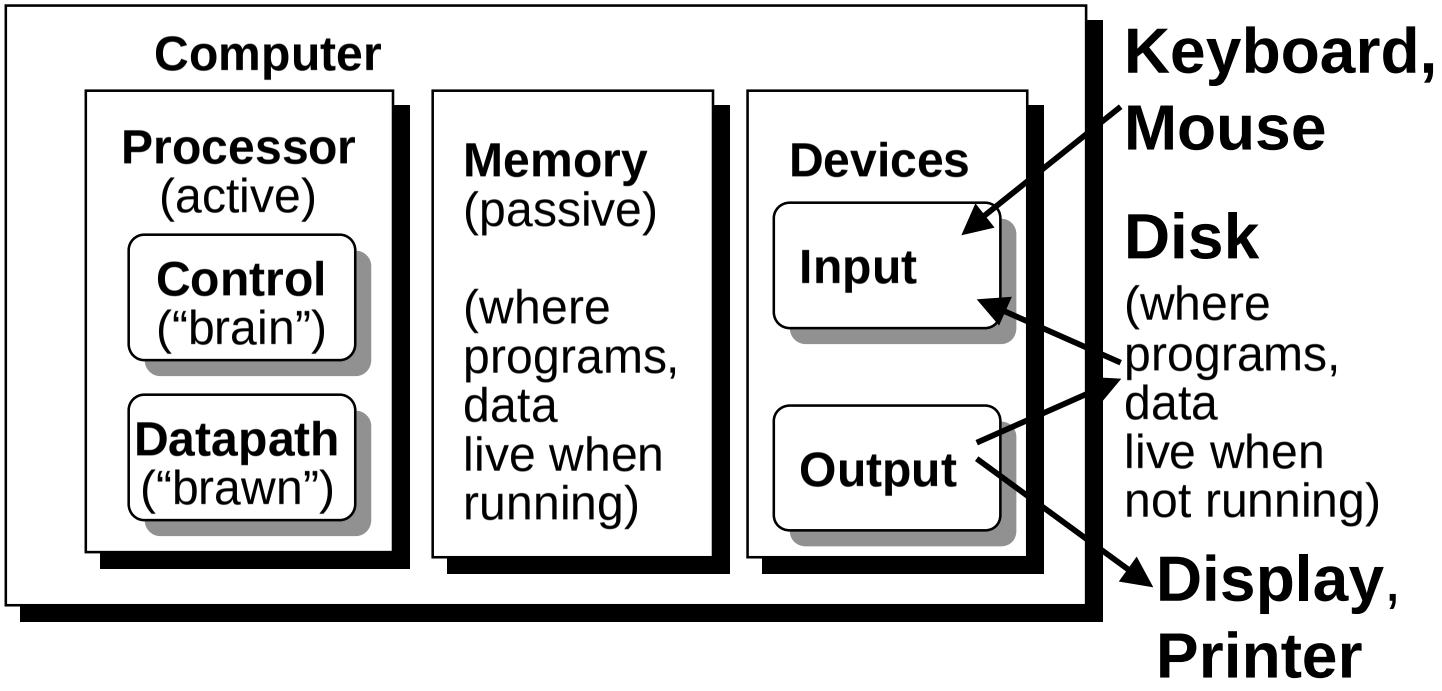
```
temp = v[k];
v[k] = v[k+1];
v[k+1] = temp;
lw      $to, 0($2)
lw      $t1, 4($2)
sw      $t1, 0($2)
sw      $t0, 4($2)
```

```
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
```

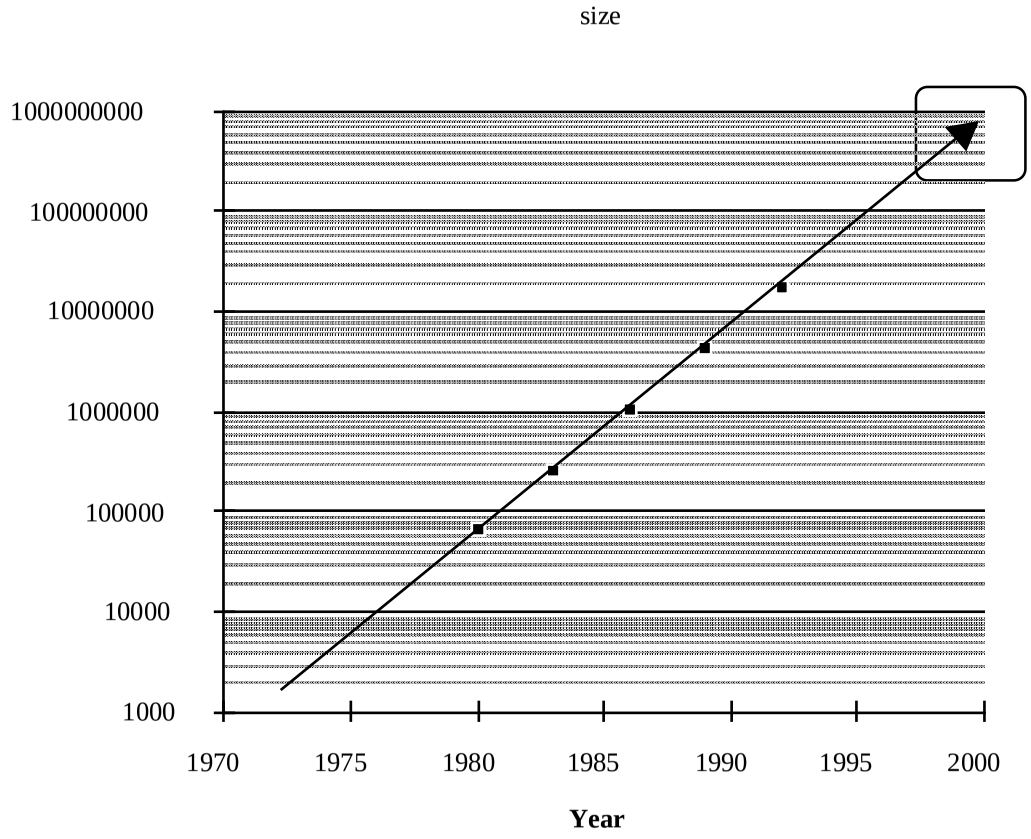
Anatomy: 5 components of any Computer





Technology Trends: Memory Capacity (1 Chip DRAM)

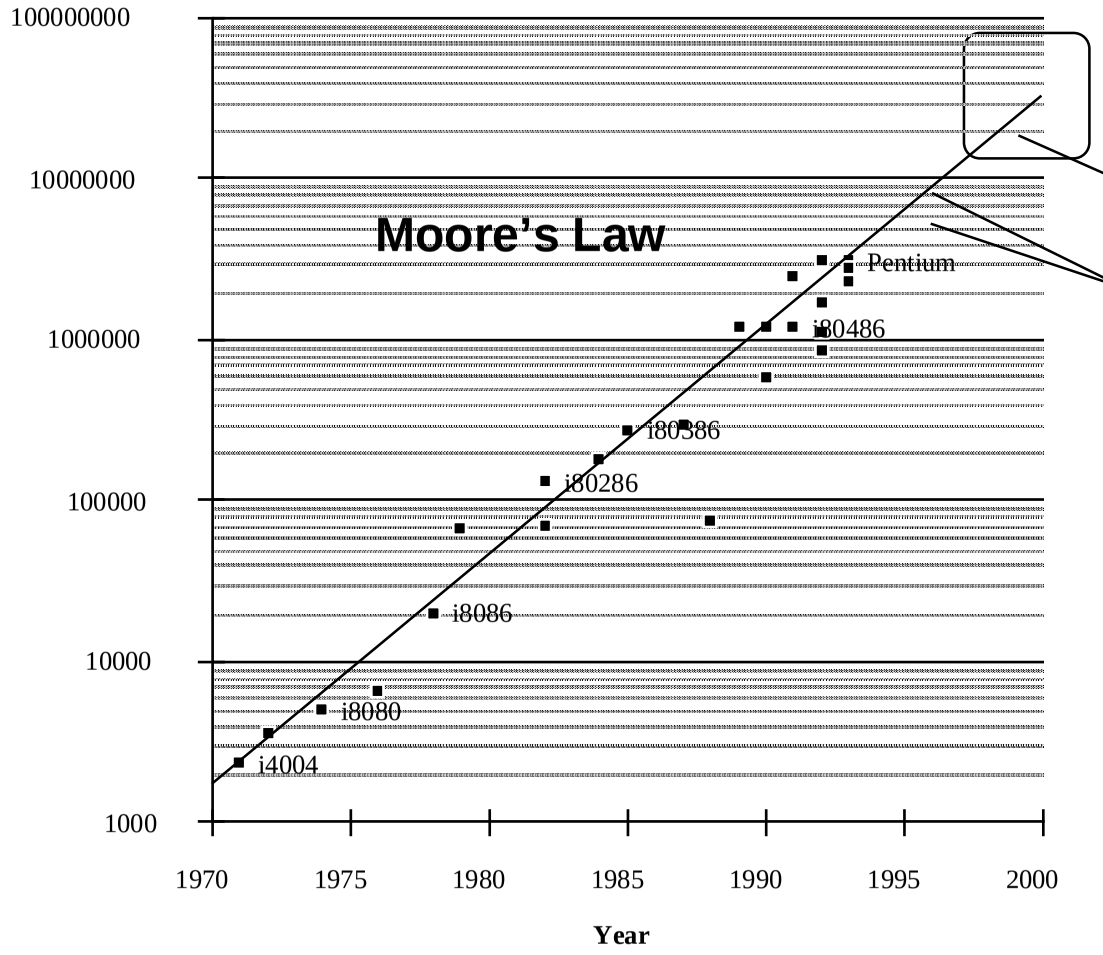
year	size(Megabit)
1980	0.0625
1983	0.25
1986	1
1989	4
1992	16
1996	64
2000	256



Now 1.4X/yr, or doubling every 2 years

4000X since 1980

Technology Trends: Microprocessor Capacity

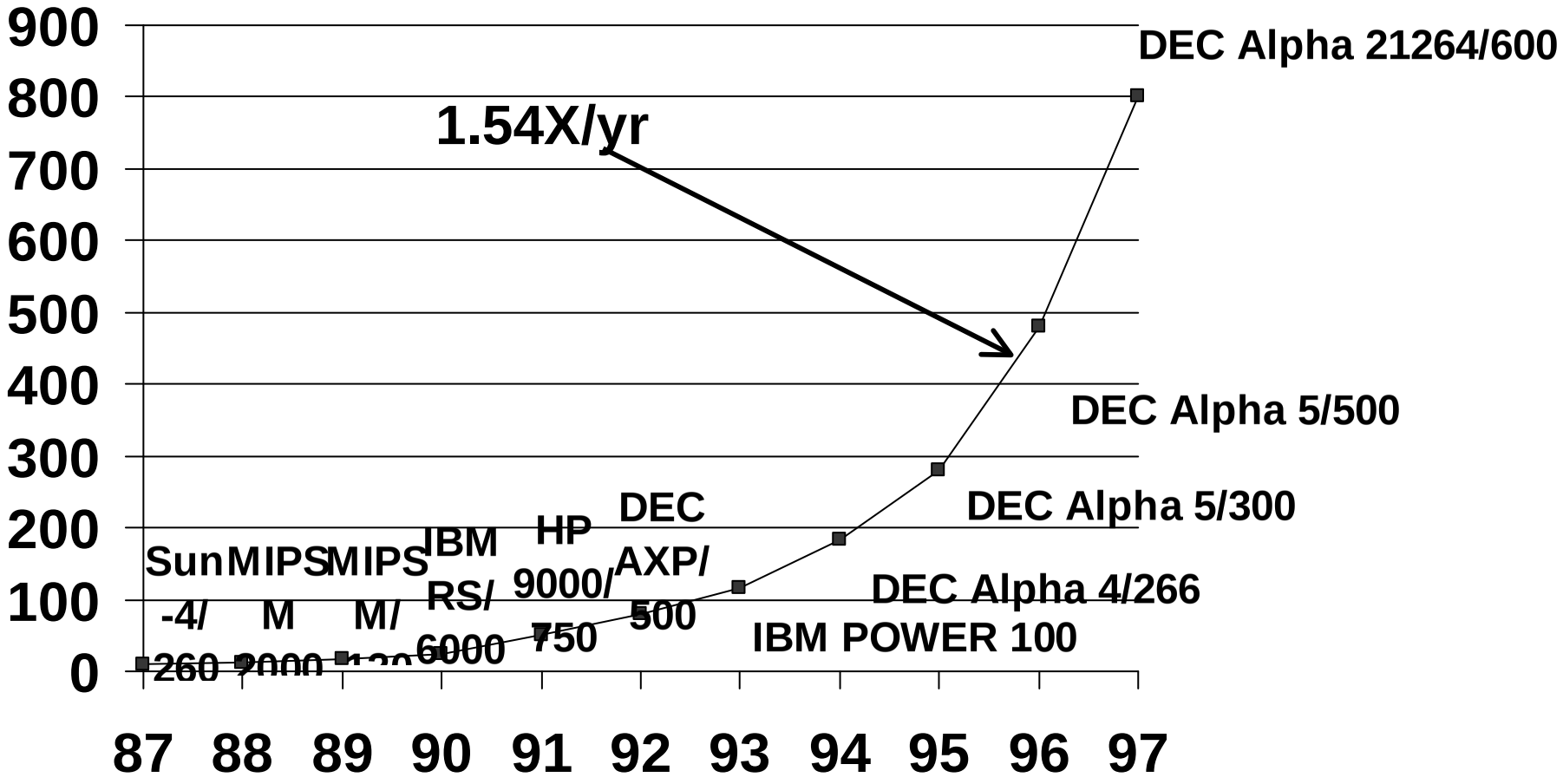


Alpha 21264: 15 million
Pentium Pro: 5.5 million
PowerPC 620: 6.9 million
Alpha 21164: 9.3 million
Sparc Ultra: 5.2 million

2X transistors/Chip Every 1.5 years

Called "Moore's Law"

Technology Trends: Processor Performance



Processor performance increase/year, mistakenly referred to as Moore's Law (transistors/chip)

Computer Technology => Dramatic Change

- **Processor**
  - **2X in speed every 1.5 years; 100X performance in last decade**
- **Memory**
  - **DRAM capacity: 2x / 2 years; 64X size in last decade**
  - **Cost per bit: improves about 25% per year**
- **Disk**
  - **capacity: > 2X in size every 1.0 years**
  - **Cost per bit: improves about 100% per year**
  - **120X size in last decade**

Computer Technology => Dramatic Change

- State-of-the-art PC when you graduate:
  - Processor clock speed: 4000 MegaHertz (4.0 GigaHertz)
  - Memory capacity: 1000 MegaByte (1.0 GigaBytes)
  - Disk capacity: 1000 GigaBytes (1.0 TeraBytes)
- New units! Mega => Giga, Giga => Tera

CS61C: 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
  - Compilation v. interpretation thru system layers
  - Principles/Pitfalls of Performance Measurement

And in Conclusion...

- **Continued rapid improvement in Computing**
  - **2X every 1.5 years in processor speed; every 2.0 years in memory size; every 1.0 year in disk capacity; Moore's Law enables processor, memory (2X transistors/chip/ ~1.5 yrs)**
- **5 classic components of all computers**