

Computer Abstractions

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Everything is bits

- Bottom-Up description of a computer:
 - “an organized collection of bits”
- Bit: anything that can take on either one of values 1 or 0.
 - an element of the set $\{0,1\}$

An abstraction!

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Why Bits?

- Humans usually deal with more complex abstractions, for example:
 - using *digits* to communicate mathematical quantities.
 - using *letters* from some alphabet to communicate in written language.
 - using *words* and *expressions* to communication in spoken language.

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Machines

- Many mechanical addition machines were based on decimal.
- It is feasible to build an electronic machine that could work in decimal:
 - 10 different voltage levels, one for each digit.
 - 10 different current levels, ...

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Simple \approx Best ?

- It is much simpler to build an electronic machine based on only 2 distinct *quantities*.
- Question: if we use 10 possible values, is that more powerful than using 2 ?

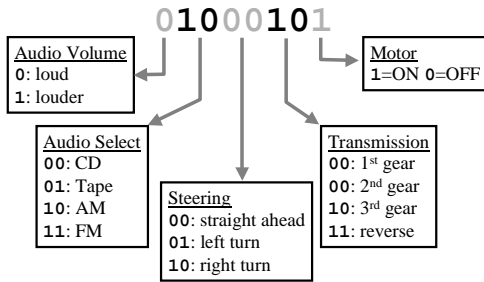
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Consider This

- Make up any set of symbols (of any cardinality).
- I can show you how to *encode* each of your symbols using only 1s and 0s.
- Any machine that can perform all possible operations on 1s and 0s can simulate a machine that can perform operations on the elements of your set.

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Bits as controls



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Top-Down Description of Computers

- Break the computer in to components.
- Describe each component by breaking it down in to smaller components.
- ...
- eventually get to “bits”

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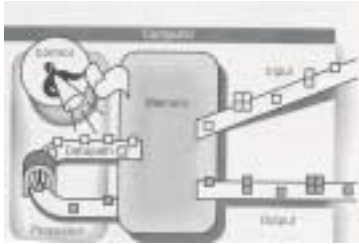
Five Classic Components

- Control
- Datapath
- Memory
- Input
- Output

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Components

(Fig 1.10)



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Control and Datapath

- *Processor or Central Processing Unit*
- The Control *tells* the datapath, memory, I/O what to do and when (via on/off signals).
- The datapath includes movement of bits from one place to another, and arithmetic and logic operations.

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Memory

- Place to store sequence of bits.
- Organized in to groups of bits (typically bytes).
- Each byte (word) has a unique *address*.

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Types of Memory

- Primary Memory
 - RAM: Random Access Memory
 - Constant time lookup
 - Volatile
- Secondary Memory
 - Disk, Tape, CD, ...
 - nonvolatile (does not require power to maintain state)

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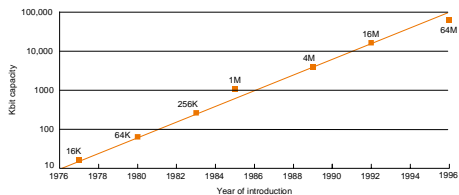
RAM and Performance

For many years the size, speed (and cost) of primary memory was a limiting factor in computer performance.

Still a very important factor, but memory has caught up to other components (now the CPU and I/O can be limiting factors).

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DRAM Capacity over time



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I/O

- Keyboard
- Mouse
- Screen
- Audio (in and out)
- Network
- Disks
- Printers
- ...

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Fallacies & Pitfalls

Computer organization has not changed much over the years, so something completely different is needed to increase performance.

stuck in a rut?

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Maybe not yet?

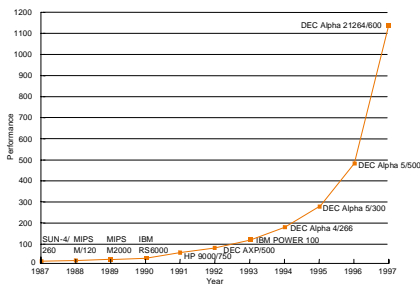


Figure 1.20 from the book: Workstation Performance based on specint_92

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