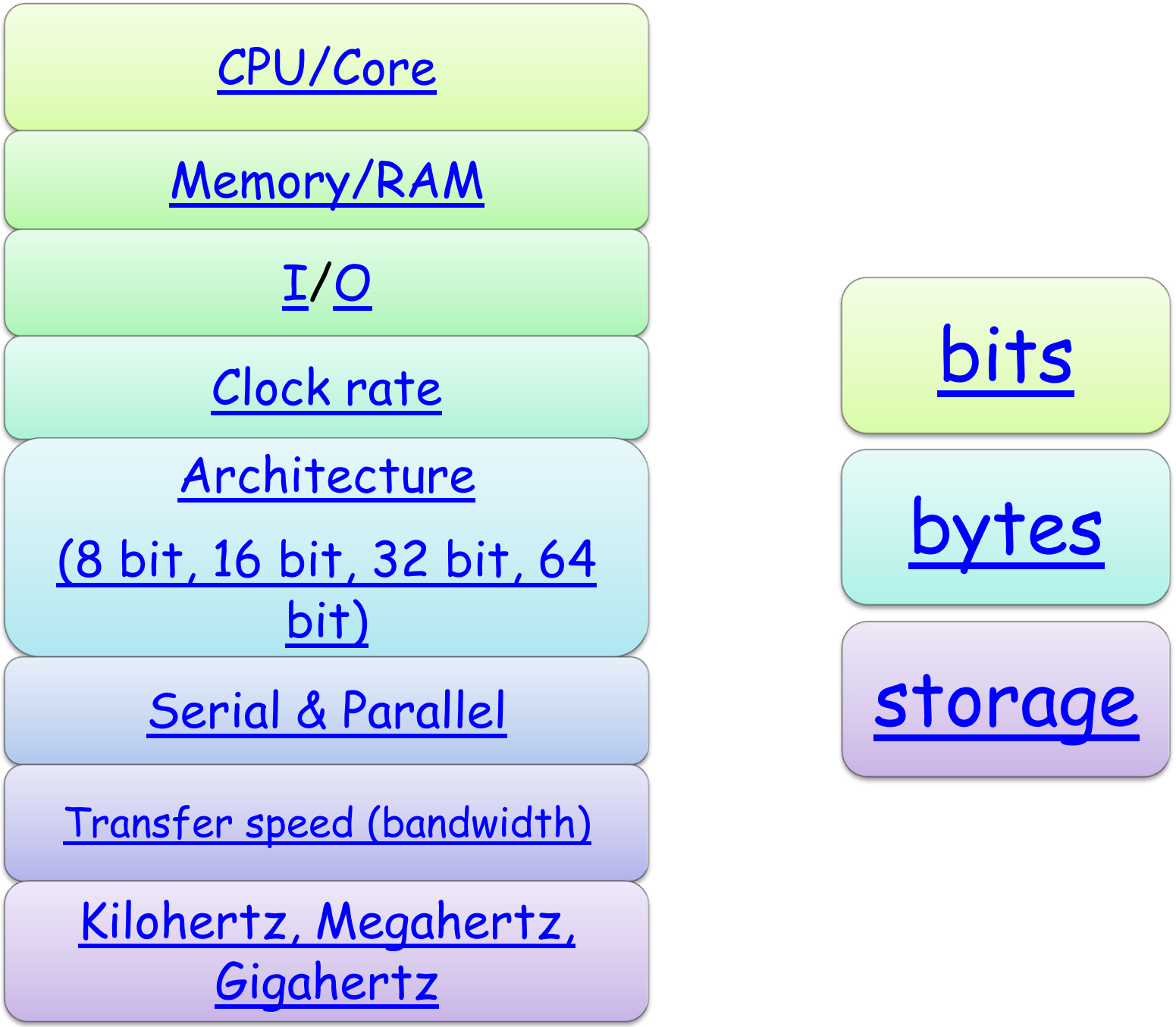
Computer Architecture


CPU/Core
Memory/RAM
I/O
Clock rate
Architecture
(8 bit, 16 bit, 32 bit, 64 bit)
Serial & Parallel
Transfer speed (bandwidth)
Kilohertz, Megahertz, Gigahertz
bits
bytes
storage

CPU

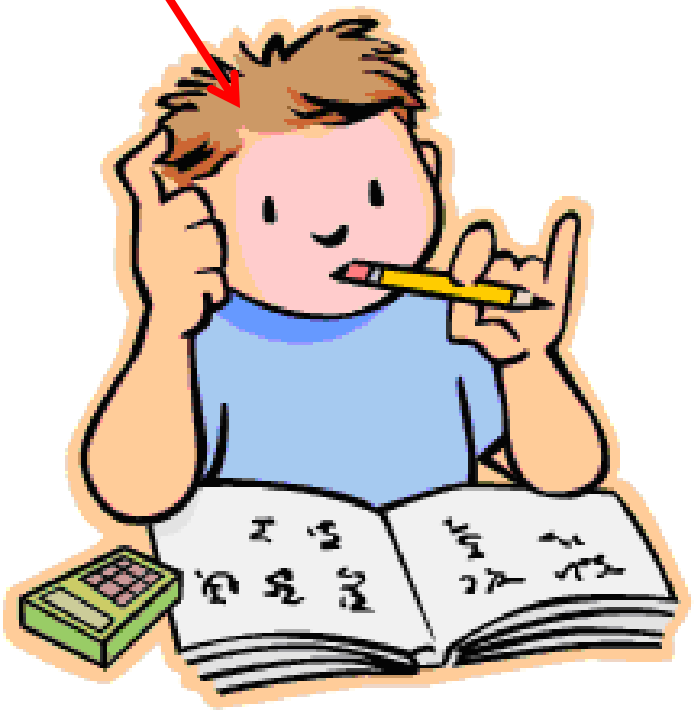
Memory

Input

Output

The Central Processing Unit is like the brain.

It follows a set of rules to fetch, solve and writeback problems



Back to Concepts

Memory stores information

"Memory" usually means short-term (working) memory called Random Access Memory (RAM).

Back to Concepts

RAM is short-term (volatile), because its contents can disappear without a trace.

Long-term memory
is usually called
"**Storage**", (e.g., hard drives).
It is relatively permanent.

Back to Concepts

An **input device** gets data IN to the computer (e.g., microphone, camera, keyboard, mouse etc).

Back to Concepts

An **output device** sends data OUT of the computer (e.g., monitor, speaker, printer).

Back to Concepts

CPU: Brain

Memory:
Working Memory
& Storage

Input:
Hearing, Seeing

Output: Talking, Writing…

A computer's abilities result from

how fast it processes each piece of data,

SLOW

FAST

Input

CPU

Output

Back to Concepts

the size of each piece,

SMALL

LARGE

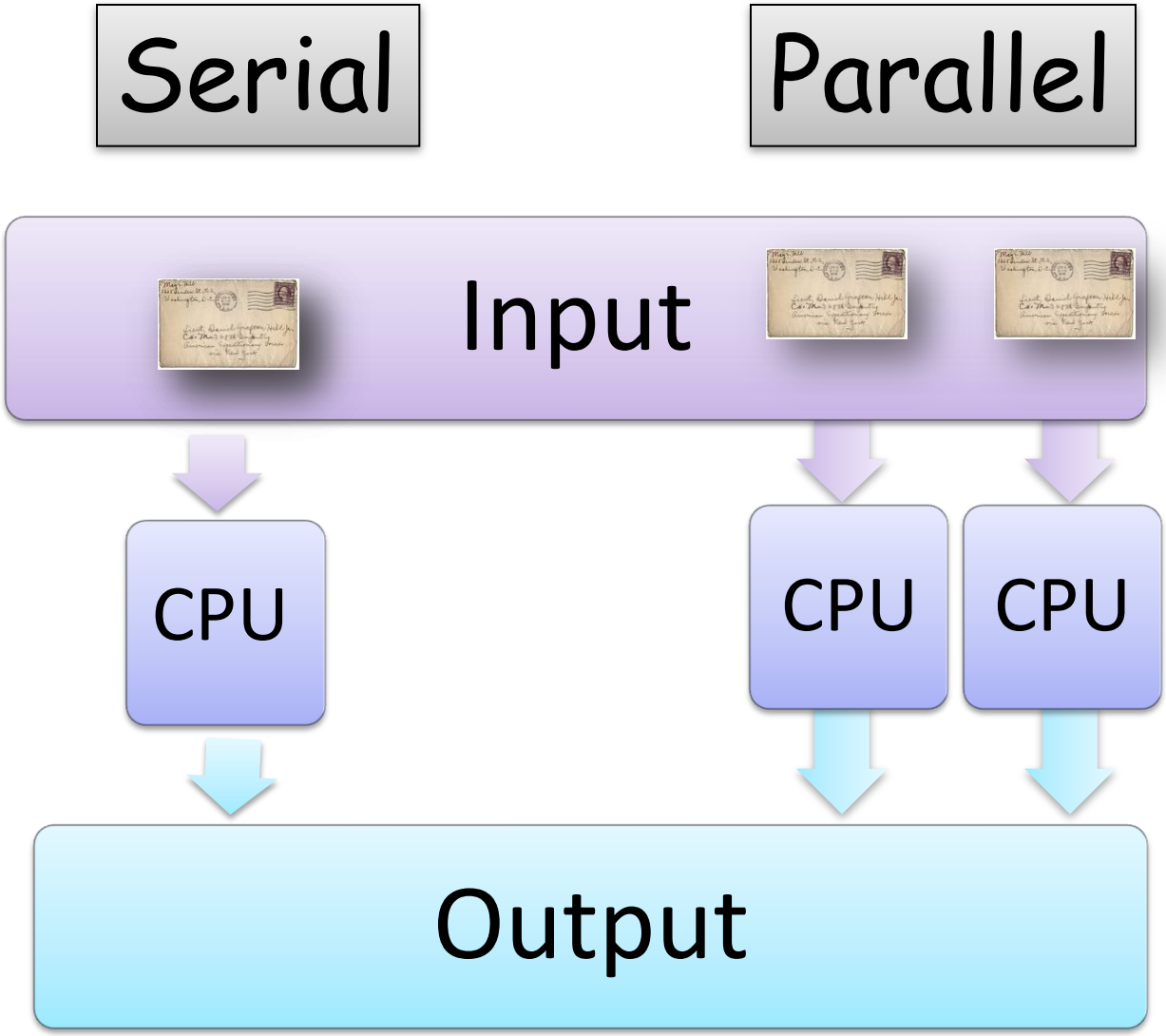
Input

CPU

Output

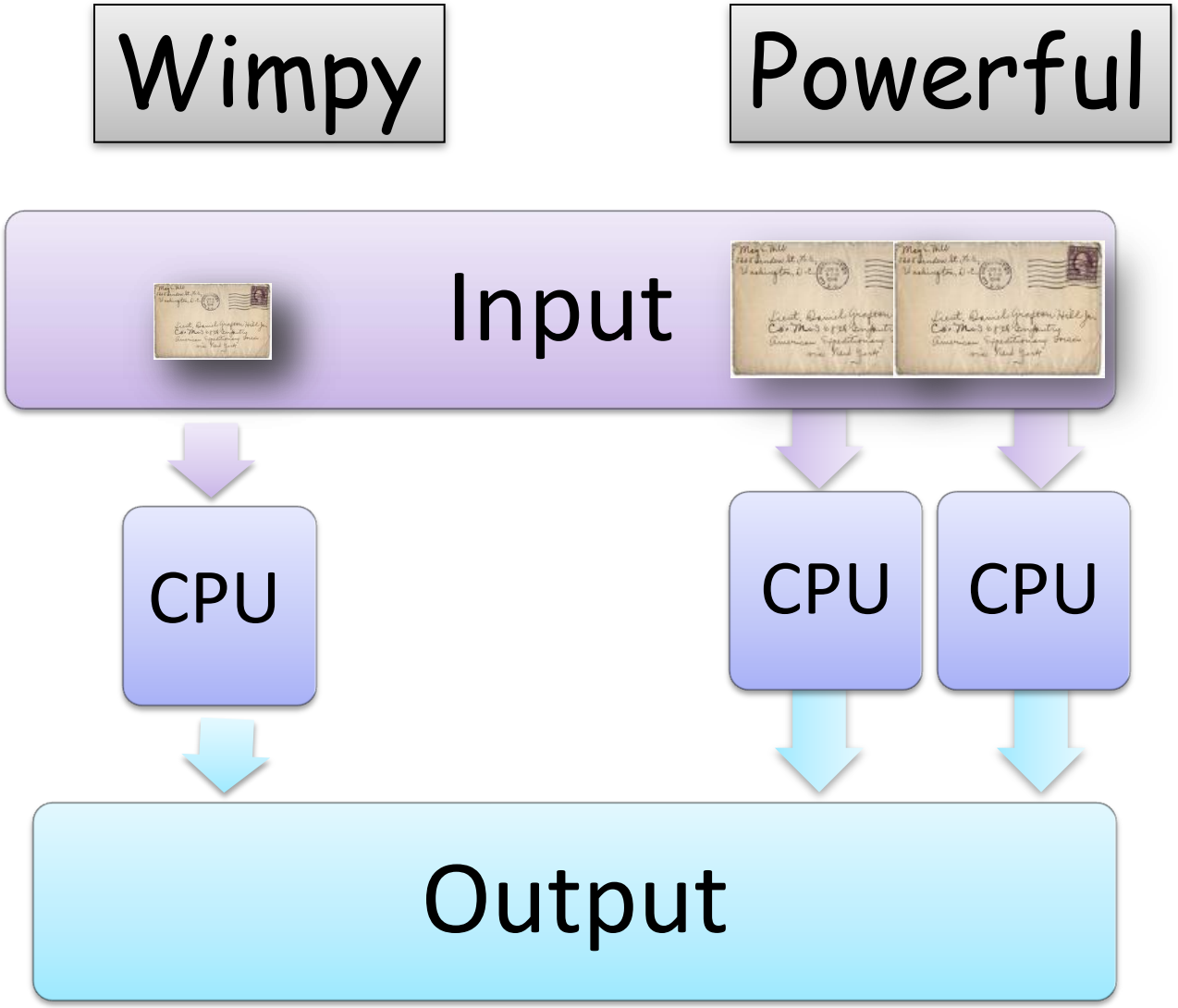
Back to Concepts

and how many pieces it can process at a time:



Back to Concepts

Powerful computers move data fast, in big pieces, and process the data in parallel:



Back to Concepts

To understand size and speed, we need units of measure.

Size:
Bits and Bytes

Computer data is stored as 1's and 0's.

The smallest piece of information is a **bit**, which can be set to 1 or 0 (+ or -)

Back to Concepts

1 bit can store either of 2 states (2^1):

0 or 1

2 bits can store any one of 4 states (2^2)

00 or 01 or 10 or 11

3 bits can store any one of 8 states (2^3):

000, 001, 010, 011,

100, 101, 110, 111

etc.

8 bits= 1 **byte** …which can store any one of 256 states (2^8)

Back to Concepts

1 bit	2 bits	3 bits	4 bits	5 bits	6 bits	7 bits	8 bits
2^1	2^2	2^3	2^4	2^5	2^6	2^7	2^8
2	4	8	16	32	64	128	256

A small piece of data, may be just 8 bits wide:

01010101

Whereas, a large piece of data, may be 64 bits wide:

0101010101010101010101010101010101010101010101010101010101010101

What about speed?

Clock rate is the speed of each simple computation in cycles per second (frequency).

Back to Concepts

Clock rate is a measure applied to the cpu, RAM and motherboard components.

KiloHertz (KHz)	Megahertz (MHz)	GigaHertz (GHz)
thousand cycles per second	1000 KHz (million cycles per second)	1000 MHz (billion cycles per second)

Back to Concepts

Throughput (transfer speed or bandwidth) is how fast data moves from one place to another.

Back to Concepts

Throughput is affected by clock rate,

8 bit

01010101

and the size of the pieces.

16 bit

01010101 01010101

32 bit

01010101 01010101 01010101 01010101

64 bit

01010101 01010101 01010101 01010101 01010101 01010101 01010101 01010101

Because each piece of data is just some number of bits…

we need a wide data path (with lots of lanes), to handle more bits at once (i.e., a big piece of data).

Bandwidth

Back to Concepts

The transfer speed of data traffic is affected by:

the clock rate

and the width of the data path (the number of lanes).

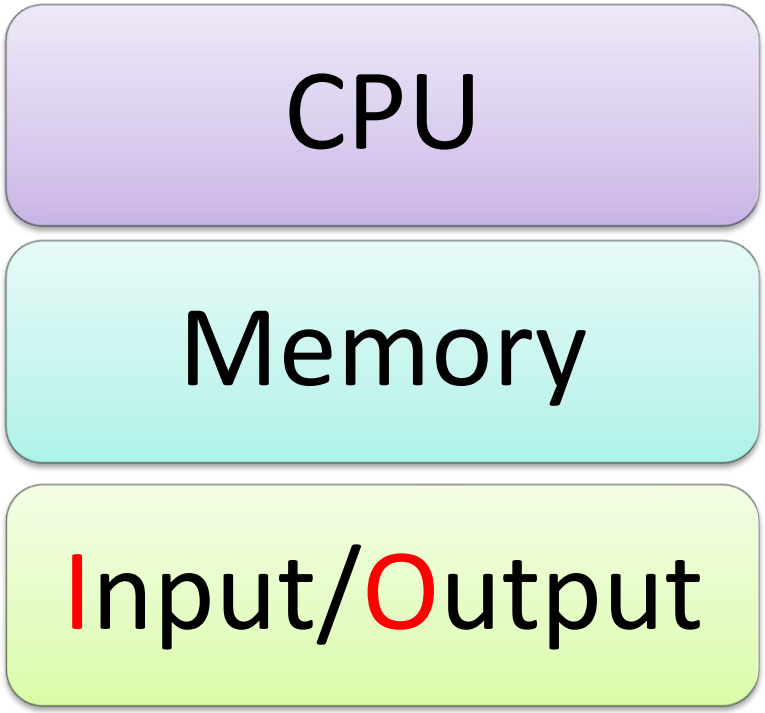
Transfer speed is measured in bits per second

(Or Bytes per second,
or MB per second…)

For example,
USB: 1.5-60 MB/s,
Hard drives: 33-300
MB/s.

Summary

Computers are designed around 3 basic concepts:


CPU
Memory
Input/Output

The most powerful computers move lots of big pieces of data at one time, and do it quickly.

Such computers have fast cpu's (~3 GHz)

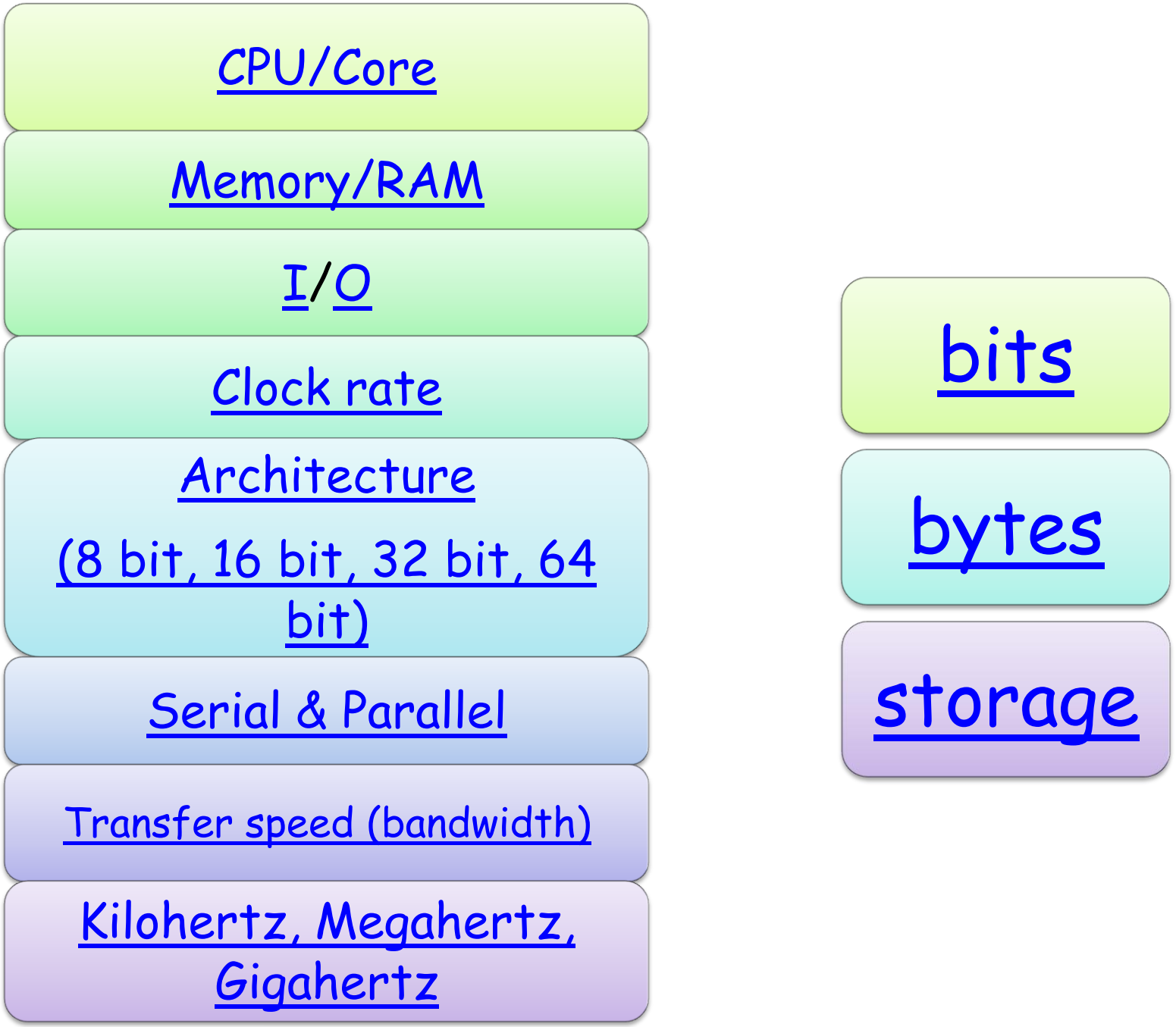
and 64 bit architecture (so they can handle 64 bit pieces of data at a time)

and multiple cpus:
2,4 or 8 cores.

and lots of
fast RAM

Said another way

High clock rate,
wide bandwidth
and
parallel processing
result in a powerful
machine.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Year	Computer	CPU Speed
1975	Altair 8800	2 MHz
1981	IBM PC	4.77 MHz
1995	Pentium	100 MHz
2002	Pentium 4	3 GHz

Sample OS	Architecture	Practical limits
GEOS	8 bit	
DOS	16 bit	640 Kb RAM; 2.1 GB HD; Filenames limited to 8.3
Windows 95	32 bit	4 GB of RAM; Long filenames
Tiger OS X	64 bit	16 exabytes of RAM possible

Storage

Bit	Byte	Kilobyte	Megabyte	Gigabyte	Terabyte	Petabyte	Exabyte
2 states	8 Bits	8,000 Bits	8,000,000 Bits	8 billion Bits	8 trillion Bits	8 quadrillion Bits	8 quintillion Bits
	1 Byte	1,000 Bytes	1,000,000 Bytes	1 billion Bytes	1 trillion Bytes	1 quadrillion Bytes	1 quintillion Bytes
		1 KB	1000 KB	1,000,000 KB	1 billion KB	1 trillion KB	1 quadrillion KB
			1 MB	1000 MB	1,000,000 MB	1 billion MB	1 trillion MB
				1 GB	1000 GB	1,000,000 GB	1 billion GB
					1 TB	1000 TB	1,000,000 TB
						1 Petabyte	1000 PB
							1 Exabyte