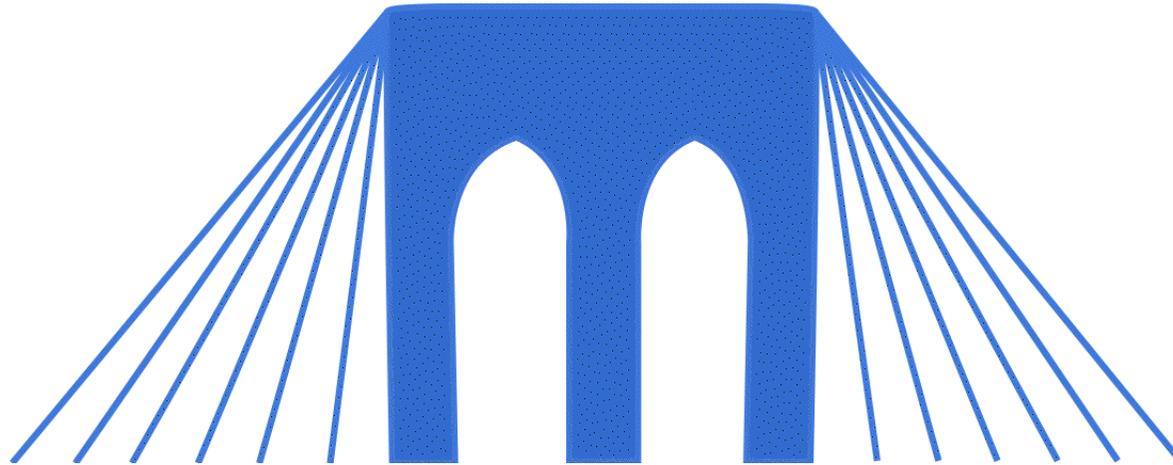# BRIDGES TO COMPUTING

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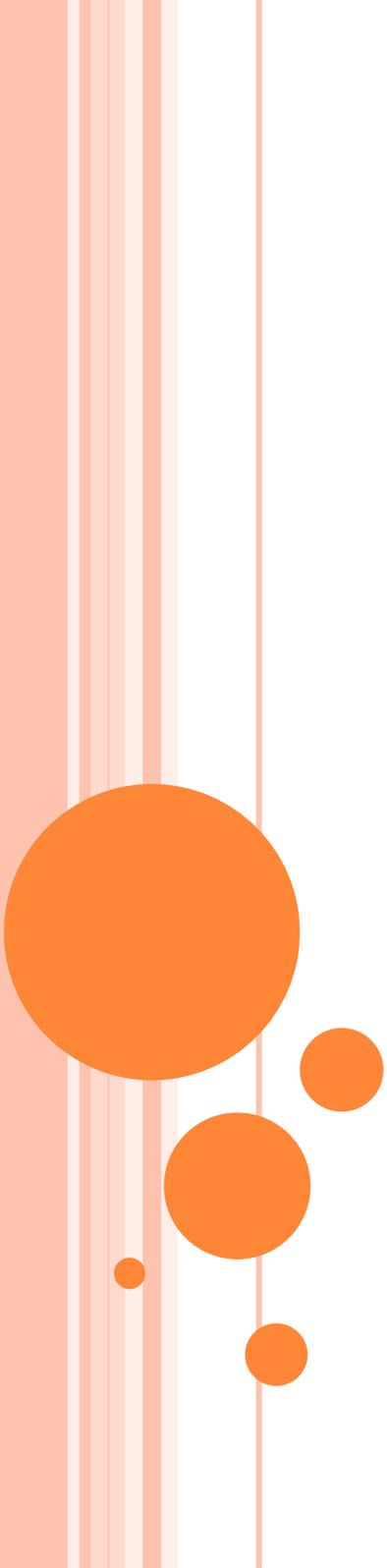
Clarke's 3rd Law:

"Any sufficiently advanced technology is indistinguishable from magic."

Corollary:

Any technology, no matter how primitive, is magic to those who don't understand it.

INTRODUCTION TO COMPUTER HARDWARE

It's not magic

M. Meyer

Bridges To Computing

2010

CONTENT

- Bare Bones System
  - CPU -> ALU, Controller, Registers
  - Memory -> Registers, Cache, RAM, Solid State Storage
  - Motherboard -> Clock, BUS, BIOS
  - Case & Power Supply
- Simple Machine Demonstration
- A+ Certification

(1) Bare Bones Computer Systems

- A "bare bones" computer system is a computer that has no "frills". It contains the minimum number of essential components required to be a self-contained system that can run basic programs/applications and nothing more.

- Essential components are:
  - CPU (Central Processing Unit)
  - Memory (includes RAM as well as Cache memory)
  - Motherboard (facilitates communication among the different parts of the computer).
  - Power Supply (lowers voltage, and converts AC to DC)
 - Case (protects components from physical damage and ESD)

(1.1) CPU (Central Processing Unit)

- Central Processing Unit: The part of a computer (a microprocessor chip) that does most of the data processing.

- Modern CPU's have billions of transistors arranged over several layers of silicon wafers.
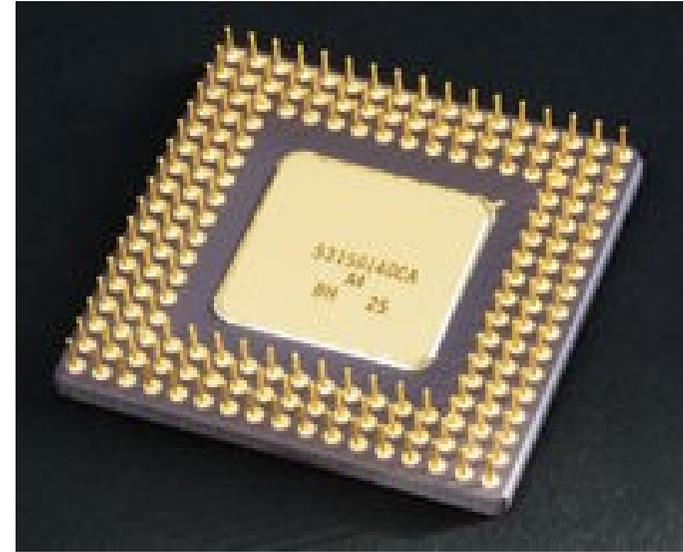
(1.1) CPU – 3 Parts

- Control Unit: Fetches and decodes instructions and tells the rest of the system what to do.
- Memory Unit: Registers and Cache memory (capacitor memory) holds data and instructions which are currently being used. Data and instructions not currently in use stay in main memory (RAM) or on hard-drive.
- ALU: Performs arithmetic calculations and data manipulation. (The calculator part of the CPU).

Control Unit
(fetches & decodes)

Memory
(instructions / data)

Registers / L1 Cache
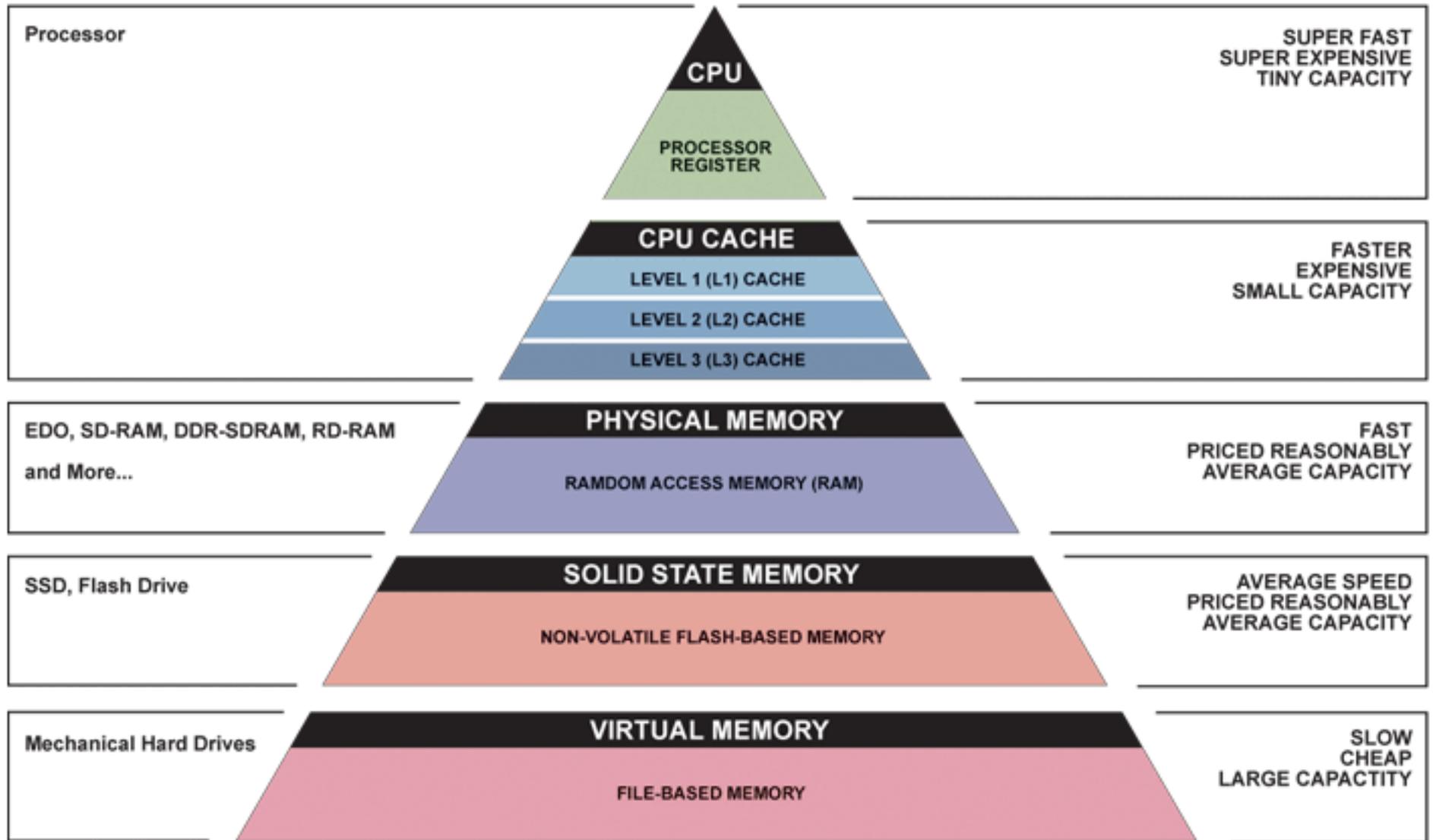
ALU
(Arithmetic Logic Unit)
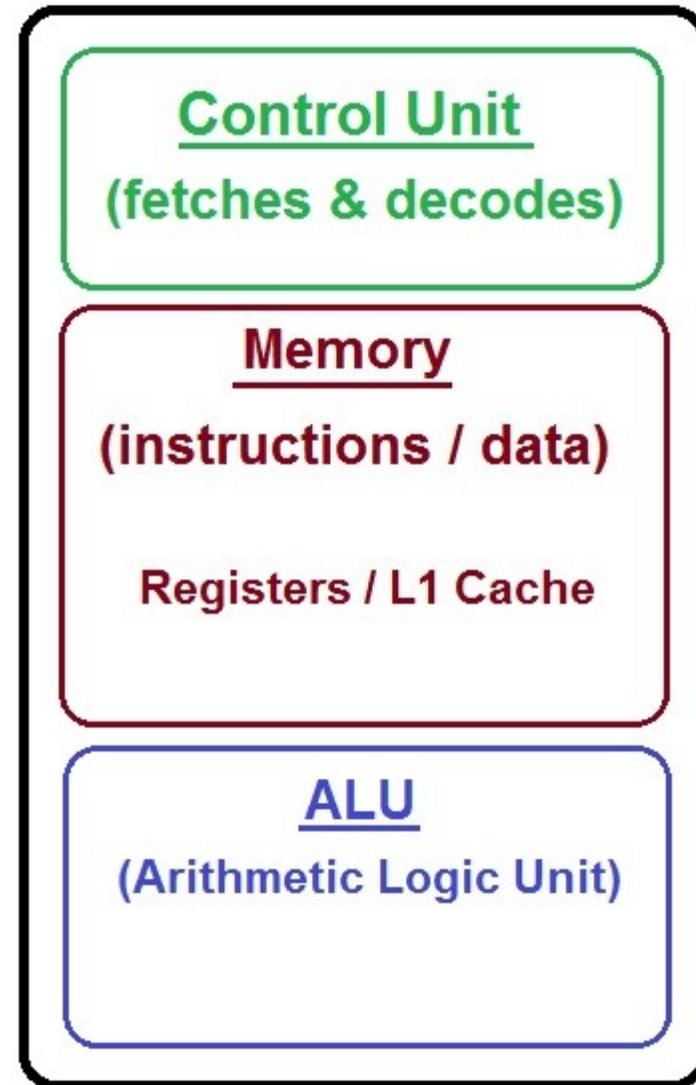
(1.2) MEMORY

- What's the largest two numbers you can multiply in your head? Go beyond that size, and you will need scratch paper to write things down. You might even need to look up in a book how to do long division if you have forgotten.

- A computer is similar to you in that it has levels of memory storage. Some things it can store (remember) right inside the CPU other things it needs to store in other places. All of this storage is referred to as "memory".

- Some memory is very fast and very close to the CPU (registers, L1 cache) but we don't get a lot of it, and it's very expensive.

- Other memory we can get a great deal of, cheaply, but it is slower and not 'close' to the CPU (hard-drives, network, Internet).

- We can conceptualize this hierarchy as a tree.

(1.2) Memory Tree

Processor

CPU

SUPER FAST
SUPER EXPENSIVE
TINY CAPACITY

PROCESSOR REGISTER

CPU CACHE

FASTER
EXPENSIVE
SMALL CAPACITY

LEVEL 1 (L1) CACHE

LEVEL 2 (L2) CACHE

LEVEL 3 (L3) CACHE

EDO, SD-RAM, DDR-SDRAM, RD-RAM
and More...

PHYSICAL MEMORY

FAST
PRICED REASONABLY
AVERAGE CAPACITY

RAMDOM ACCESS MEMORY (RAM)

SSD, Flash Drive

SOLID STATE MEMORY

AVERAGE SPEED
PRICED REASONABLY
AVERAGE CAPACITY

NON-VOLATILE FLASH-BASED MEMORY

Mechanical Hard Drives

VIRTUAL MEMORY

SLOW
CHEAP
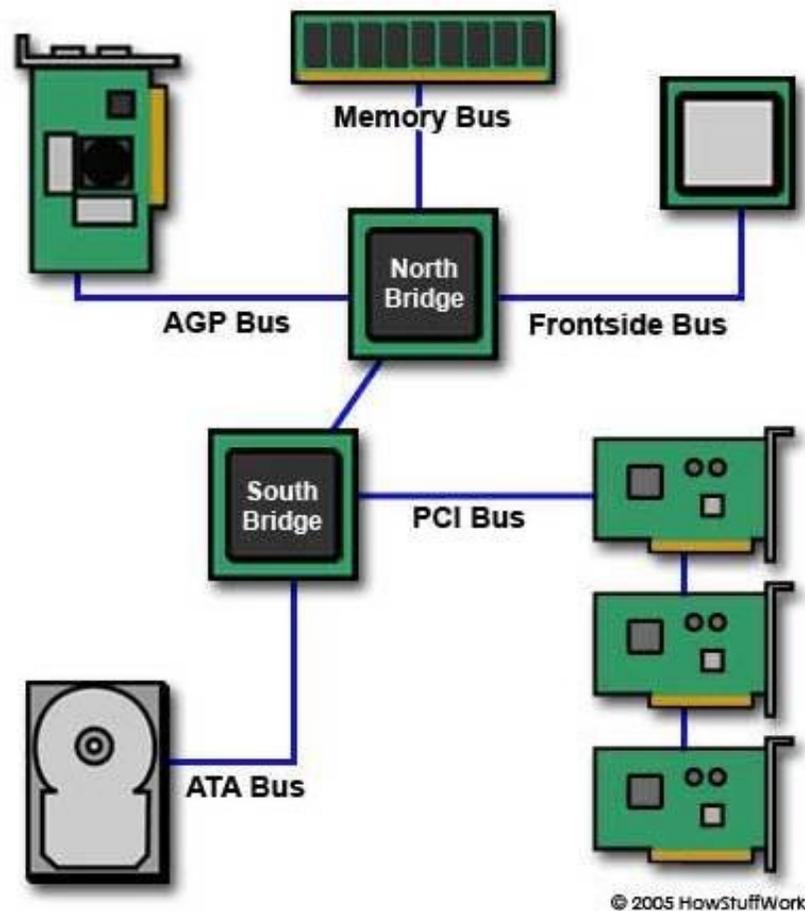LARGE CAPACTITY

FILE-BASED MEMORY

(1.2) Main Memory - RAM

- RAM (or R.A.M) is an acronym for Random Access Memory.
- This is where you computer stores any program that is currently running.
- RAM comes in many different sizes and types.
- RAM chips, plug into slots on the motherboard.
- Adding more RAM to your computer is one easy way to improve performance.

(1.3) Buses

- The CPU and RAM and other parts of the computer all need to communicate. They do this through special connections called Buses.

- Information that wants to move from one component to another, must "get on the Bus"!

Memory Bus

North Bridge

AGP Bus

Frontside Bus

South Bridge

PCI Bus

ATA Bus

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(1.3) MOTHERBOARD

- The Motherboard holds all the computer components together (including the buses)
- The BIOS chip (a special embedded program) runs the motherboard.
- AGP & PCI (expansion slots) allow users to plug-in "expansion cards" (graphics, network, sound cards).
- IDE and SATA ports allow users to attach cables to hard drives.

North Bridge   Processor Socket

PCI   AGP

SATA

Memory

BIOS   South Bridge   IDE
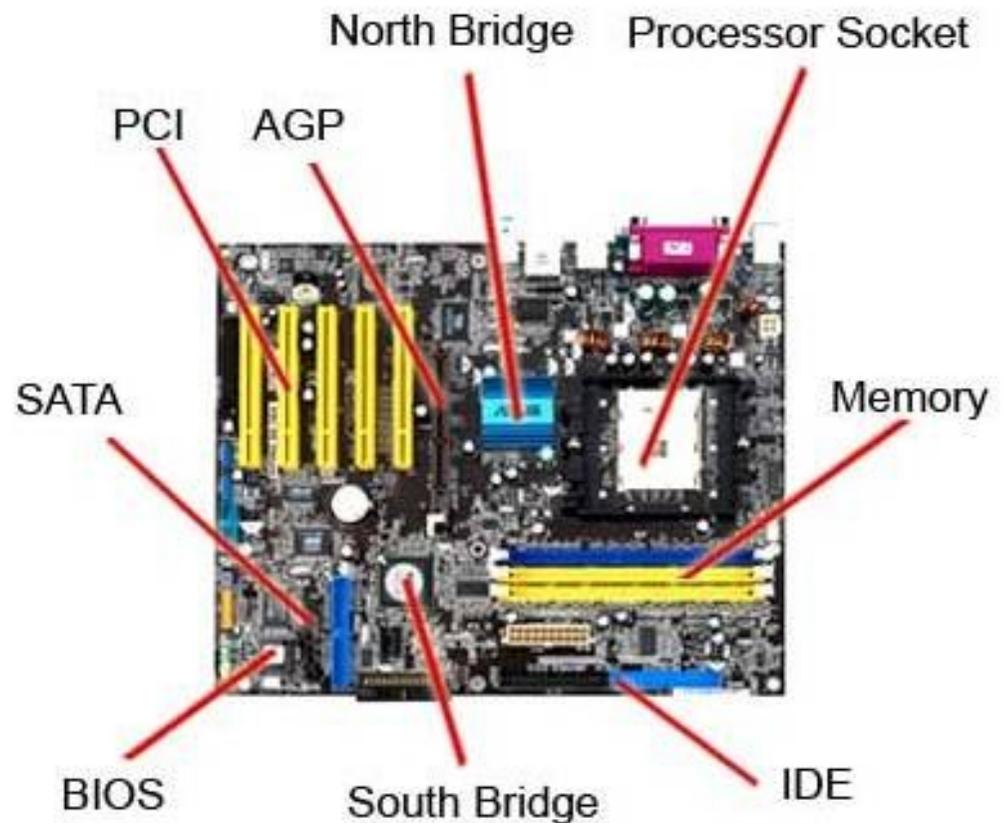
(1.4) POWER SUPPLY

- Household current (U.S.) is 110-120Volts AC (Alternating Current).

- A computer needs (at most) 12Volts of DC (Direct Current).

- The power supply transforms household electricity into electricity for the computer.

ATX 24 Pin Connector

ATX 12V Connector

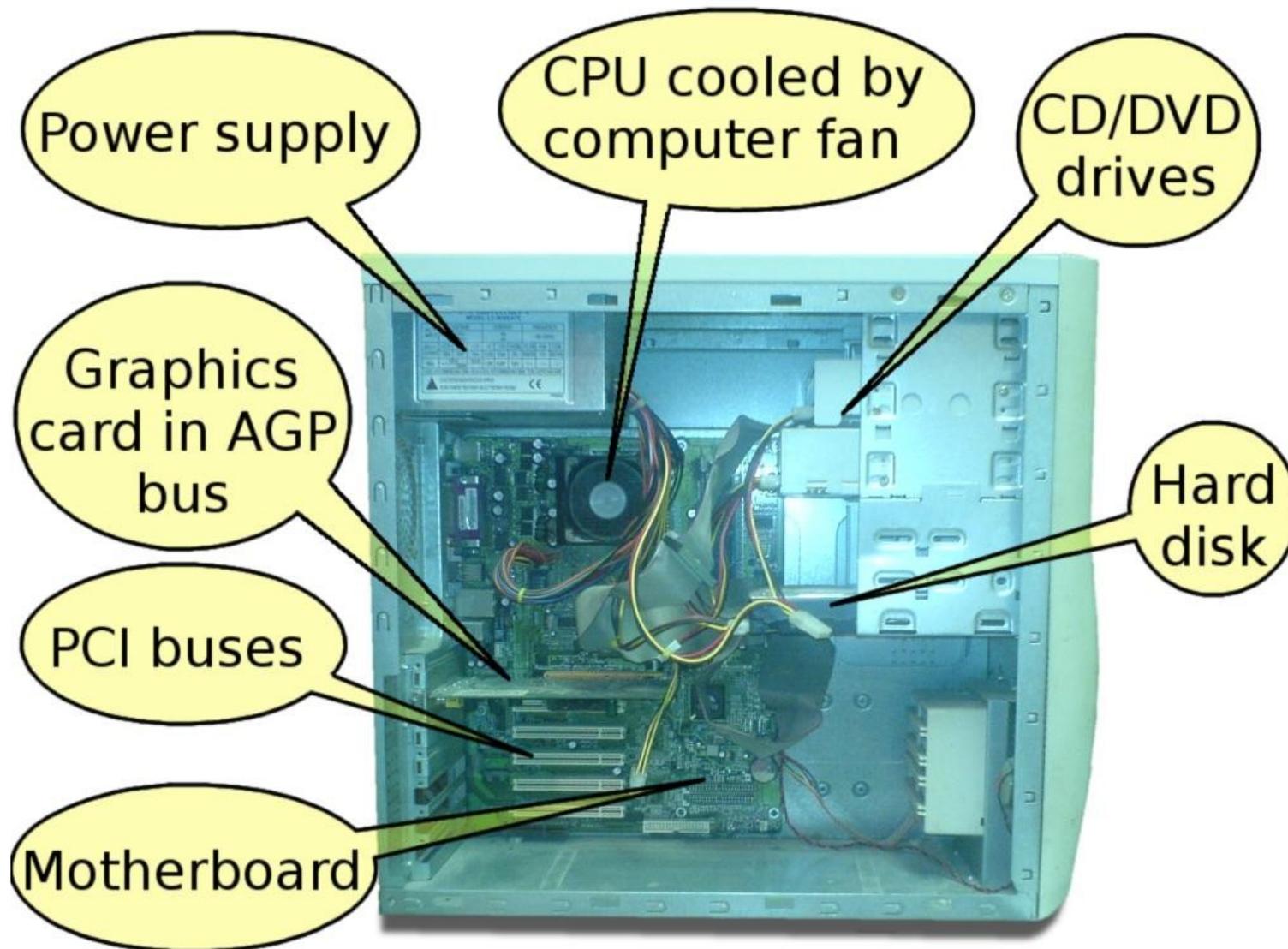SATA Power Connection

Standard 4-Pin
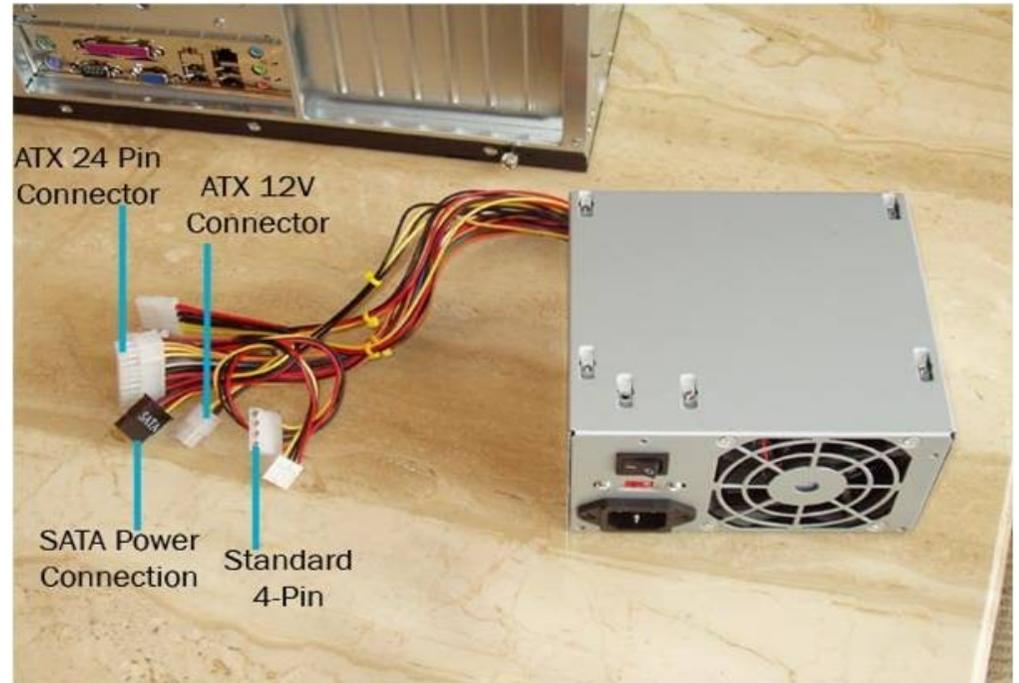
(1.5) CASE

- The computer case, protects the computer from mechanical and water damage, as well as ESD (Electro Static Discharge).

- On a cold dry day, you can build up a static charge capable of damaging sensitive computer parts like the CPU.

(1.6) PUTTING IT ALL TOGETHER

(2) Simple Program Execution

- On a bare bones system, executing a program involves:
  - Memory: The instructions for a (running) program and any variables that the program is using are stored in RAM.
  - CPU: The CU fetches/decodes instructions, (from RAM) the ALU executes mathematical and logical operations, registers and cache are used to hold data in use.
  - MotherBoard: The system clock is on the motherboard, information moves from CPU to RAM on the BUS(es), and the BIOS manages the operation of the Motherboard.
- To see a simple example of this process click on this link.

(3) A+ Certification

- Did you find this information interesting?
- CompTIA A+ certification is a vendor neutral certification that anyone can earn by passing a series of tests (currently 2).
- A+ certification demonstrates competency as a computer support technician.
- An A+ certified individual can take apart a computer and reassemble it, as well as install and troubleshoot common operating systems.
- Certified computer support technician salaries average in the low 40K range.

THE END