Central Processing Unit **- (Processor).**

Processor. (An Introduction)

Components of the computer function together as a team, executing each instruction and working toward the same goal.

If any PC component were to be considered the team leader, it would probably be the CPU, or central processing unit. The key word here is **“central”** which implies **“center”** or **“focus.”**

The CPU can be considered the focus of the computer because it controls a large number of the computer system’s capabilities, such as the type of software that can run, the amount of total memory that the computer can physically see, and the speed at which the system will run.

Processor Speed.

Processor speed is the speed at which the processor executes its instructions or commands. This speed is measured in millions of cycles per second, or megahertz (MHz).

Original CPUs had a speed of ***4.77 MHz***, although processor speed is not the only factor affecting performance, in general, the larger the MHz the faster the system.

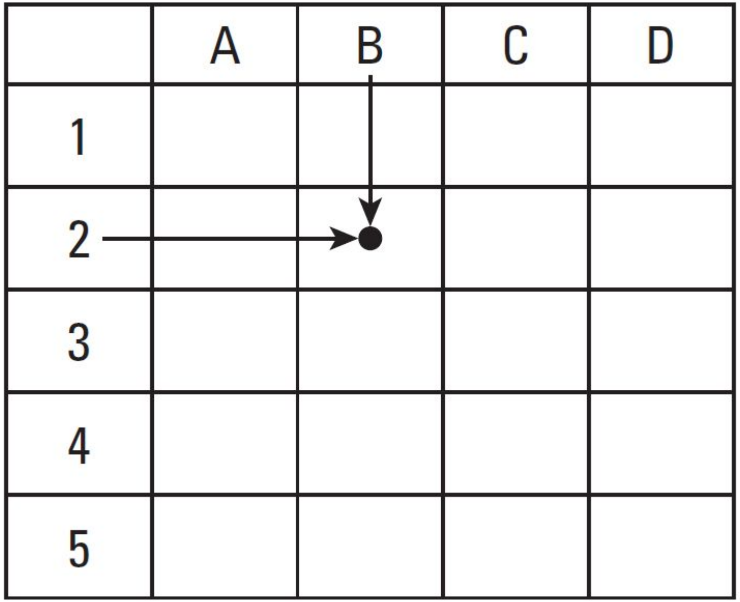
Data Bus

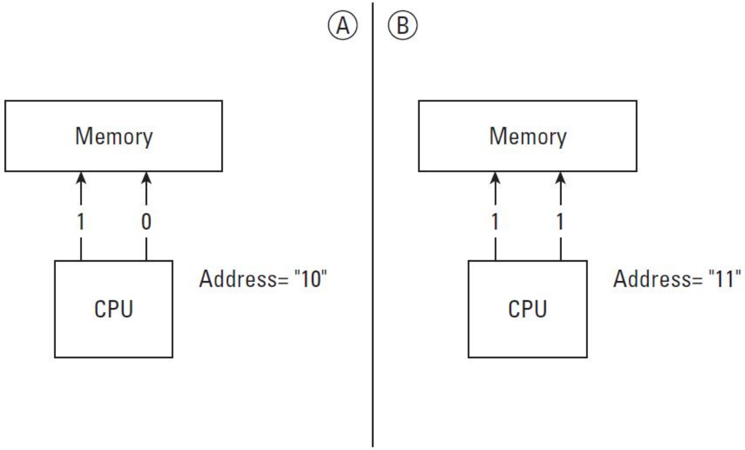
A city bus is responsible for transferring people from one location to another. In the world of computers, a **data bus** is responsible for delivering data from one location on the PC to another (for example, from the processor to memory).

Data bus in terms of processors means the pathway to memory. The processor uses the data bus solely for delivering data back and forth from system memory and the processor. Because the processor accesses information from memory so often, an entire bus—the data bus—is dedicated to this action.

If a processor has a 16-bit data bus, it means that it can deliver 16 bits of data at any given time, same goes for 32bit and 64bit processors.

Diagram Illustrating Address Bus





2bit adress bus.

Address Bus

The processor accesses memory locations through the address bus. If, for example, the address bus is 2-bit, the processor has two address lines from the processor to system memory as shown in the previous slide.

A two-bit address bus can make a reference to four possible memory addresses (2 × 2), while a three-bit address bus can make a reference to eight possible memory addresses (2 × 2 ×2).

Therefore, the address bus dictates how much physical memory the processor can access. For example, an 80286 processor has a 24-bit address bus, which means that it can access 16,777,216 memory addresses, or 16MB of system memory.

Register

Registers are storage areas within the processor. They are used to store and process data, and perhaps write back the result of the processed data.

Registers give a processor quicker access to data, and the more registers a processor has, the more data it can get to.

Registers are measured in bits. A processor with ***16-bit*** registers would have 16 containers to store information used by the system. A processor with ***32-bit*** registers would have double the amount of containers that it would use to store information.

Cache Memory

The processor accesses information that resides in system memory, which is a slower process than if the information was stored in the processor’s own “memory.”

When the information is sitting in system memory and the processor sends a request for that information, the request goes to the ***memory controller*** (which manages data in memory).

The memory controller finds the data in memory, retrieves it, and delivers it to the processor. Throughout this entire process, the processor is simply “waiting around” for the information. ***Thus, many of the newer processors include their own memory within the processor’s chip (called cache).***

Cache Memory Cont.

Cache can be thought of as a “bucket” that holds information accessed by the processor on a regular basis. This cache bucket is integrated right into the processor’s chip and is made up of ***SRAM***.

(SRAM is an acronym for ***static RAM***; it is very expensive, because it is much quicker than regular system memory.) As a result of this extra memory being integrated into the chip, the processor becomes more costly.

Cache Memory Cont.

The two types of cache memory are: **Level 1 (L1)** cache and **Level 2 (L2)** cache.

L1 cache is cache that is built into the processor, whereas L2 cache usually resides on the main system board and is considered external cache memory because it is outside of the CPU.

When you upgrade the cache memory on your computer, you are adding L2 cache. Because L1 cache is built into the chip, it will never be upgraded without upgrading to a processor that has more L1 cache.

Math Co-processor

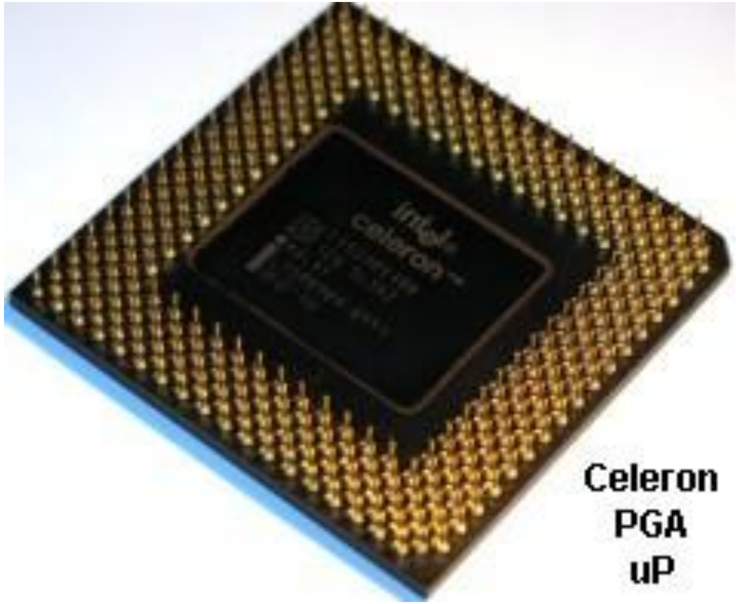
The math co-processor (also known as the ***NPU, or Numeric Processing Unit***) is the processor's sidekick. Systems that have math co-processors can well outperform systems that do not have math co-processors, because the math co-processor takes some of the workload off the CPU.

For example, it performs many of the large calculations that applications may require, such as floating point arithmetic. Overall system performance increases, because the CPU can focus on logic functions while the math co-processor executes complicated mathematical functions.

Chip Types

There are two major chip types that processors have used:
The first is the **Dual Inline Package (DIP)** chip, a rectangular chip with two rows of 20 pins. Pin 1 is located at the end of the chip that has a square notch carved into it. It is important to identify Pin 1, because when adding the chip to the system board, you will have to match Pin 1 on the chip with Pin 1 in the chip socket.

The second major chip type is the ***Pin Grid Array (PGA)***, one of the most popular processor chip types in use today. The PGA chip is a square chip that has an array of pins filling up its shape.



Pin Grid Array

Dual In-line Package

CPU Voltage and Transistor Integration

The voltage is the power the processor draws from the main system board, which it receives originally from the power supply.

A processor is designed to run at a certain voltage. You need to ensure that the system board you are placing the processor into is providing that voltage. If a system board supports more than one voltage, you can change a jumper on the system board—which will then control the voltage used by the processor.

Processors are made up of thousands, even millions, of transistors. A transistor acts as a switch, either permitting or prohibiting the flow of current.

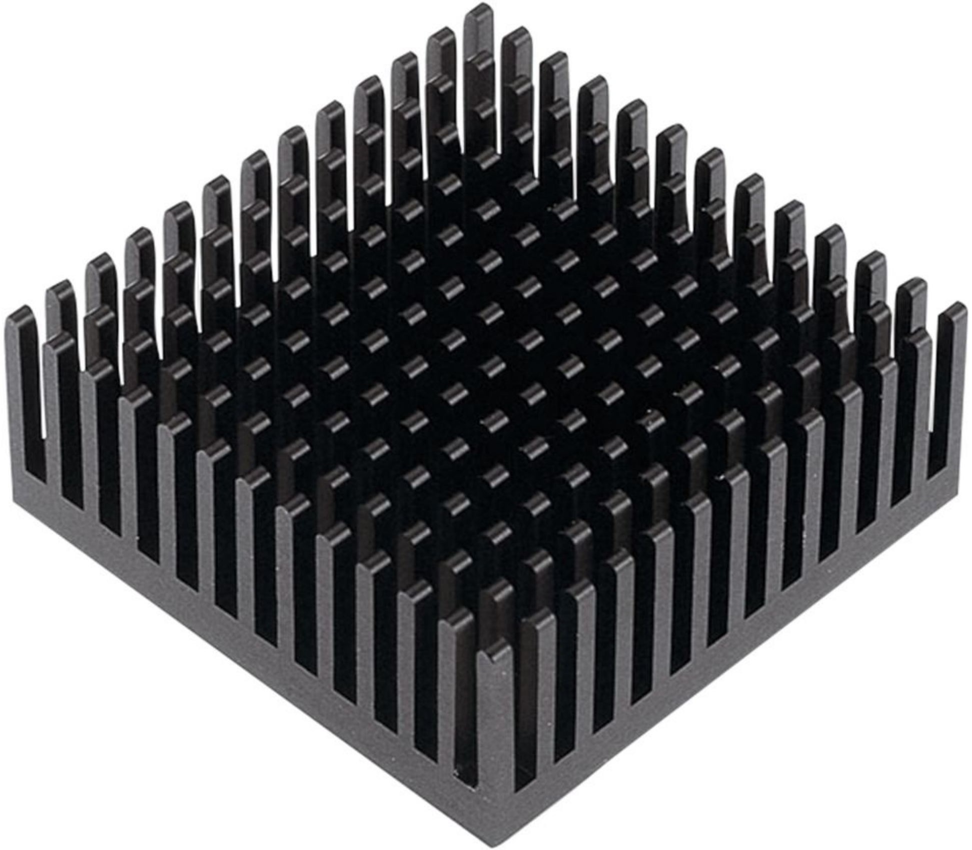
Table 2-1
CPU Voltages/Transistors

Processor	*Voltage*	*Transistors*
8088	5	29,000
80286	5	134,000
80386DX	5	275,000
80386SX	5	275,000
80486DX	5	1.2 million
80486SX	5	1.2 million
80486DX-2	3.3 or 5	2 million
80486DX-4	3.3 or 5	2.5 million
Pentium	3.3 or 5	3.3 million
Pentium Pro	3.1	5.5 million
Pentium II	2.8	7.5 million

Heat Sinks and CPU Fans

Due to the size of processors and the number of transistors passing current, the chip reached undesirable levels of heat, which causes it to become unstable.
Thus, processors came with either a cooling fan or heat sinks.

Heat sinks are a group of metal-like pins that are placed on the chip to draw heat away from it. A cooling fan is a small fan placed on top of the processor. The function of the cooling fan is to pull the hot air away from the processor, helping to keep the processor cool. Some processors may get so hot that a heat sink may not be enough of a cooling device; in this case, the manufacturer may place a fan on top of the heat sink.



Superscalar Design

Before the Pentium came along, processors used one instruction pipeline. This meant that when an application executed, it would run each stage of the application job one step after the other. For example, if an application has three lines of code, as seen in the next slide, each line of code can only be processed after the previous line of code is fully completed. This creates a delay, or wait time, that slows performance.

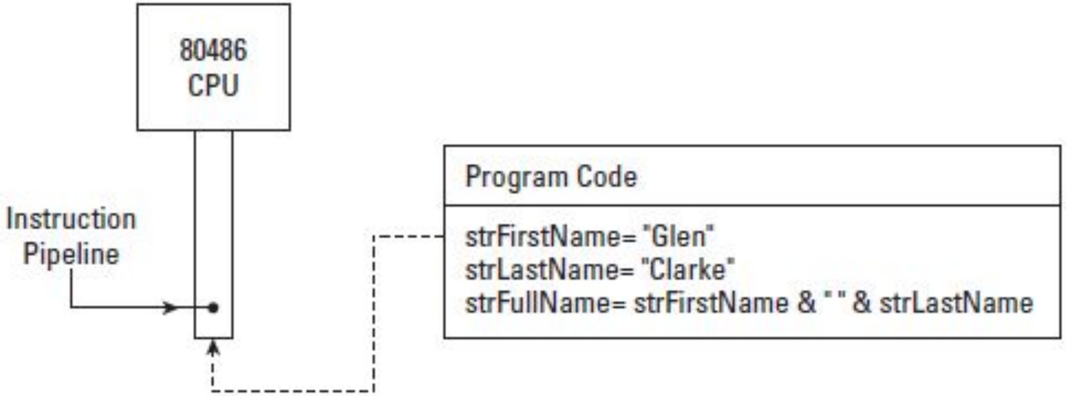


Figure 2-7: Single instruction pipelined processor executing application code

The Pentium processor has two instruction pipelines, named U and V. Having two instruction pipelines enables the processor to execute two instructions at the same time. Thus, the three lines of program code, shown in Figure 2-8, can be quickly executed on a Pentium processor because Lines 1 and 2 are processed at the same time, causing Line 3 to be processed that much faster. Notice that Lines 1 and 2 execute parallel to one another; therefore, “parallel processing” is taking place.

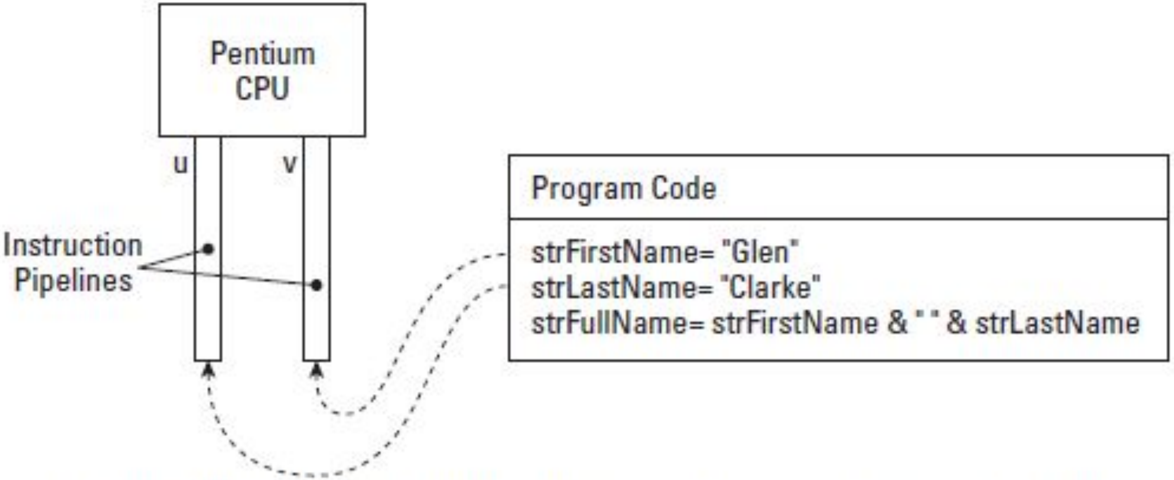


Figure 2-8: Dual instruction pipelined processor processing application code

Increasing Performance.

When it comes to processors, there are a number of different ways to increase the performance of your system.

A first and obvious way is to buy the faster processor when upgrading; for example, upgrade a PII 300 MHz to a P II 450 MHz.

Also, get a processor that is designed to run on the faster motherboard. For example, the Pentium III chip runs on a 133 MHz system board, compared to a Pentium chip, which still runs on 60/66 MHz system boards.

Increasing Performance.

You will have to look at other features of the processor, such as the L1 cache and L2 cache that resides either on or around the processor. Acquiring a processor with more cache memory can dramatically increase system performance.