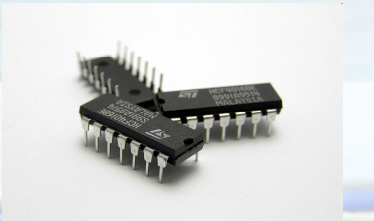
Lesson 5

Identifying Purposes and Characteristics of Processors

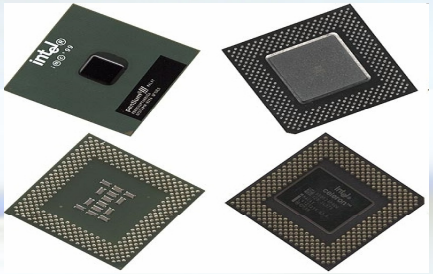
Central Processing Unit

- **The CPU performs the system's calculating and processing.**
- **The terms chip** ,**chip carrier**, *also known as a* **chip container** *or* **chip package**, *are* has grown to <u>describe the entire package that a technician might install in a socket.</u>
- **processor chip** consisting of an array of *millions* of transistors.
- **Intel** and Advanced Micro Devices **(AMD)** are the two largest PC-compatible CPU manufacturers.

Processor form factors



DIP (Dual In-line Package



PGA (Pin Grid Array)

Single Edge Contact Cartridge (SECC

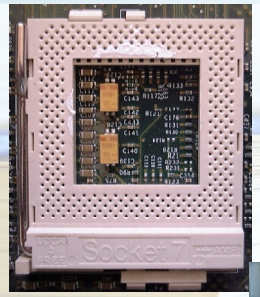
SECC is essentially a PGA-type socket on a special expansion card.

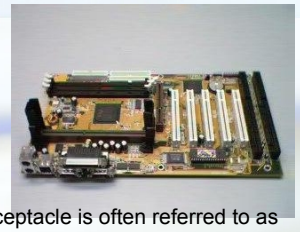
LGA (Land **Grid Array)** Socket T

More information

http://www3.intel.com/support/processors/sb/cs-009863.htm

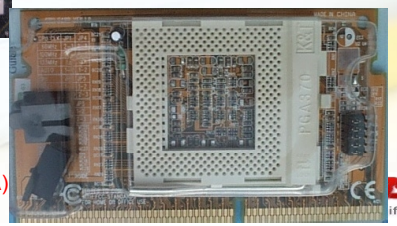
Processor Sockets and Slots





Slot 1 receptacle is often referred to as the Single Edge Contact or SEC

slot-to-socket adapter (SSA)



Determine which CPU your computer is using

- open the case and view the numbers stamped on the CPU **Or**
- sticker on the case indicating the processor type (go to the manufacturer's website and look up the information on the model of computer you have.) **O**
- System Properties pages **Or**
- System Information utility **Or**
- restart the computer

Processors can be identified by two main parameters:

1. Speed of a processor
2. Front Side Bus (FSB)
   - Speed
   - Data Path width
3. Cash memory

1-Speed of a processor

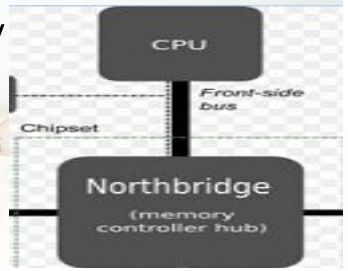
- Speed is counted in megahertz (MHz) and gigahertz (GHz), which means millions and billions, respectively, of cycles per second and faster is better
- be careful in comparing **systems** based on pure MHz alone because many other factors affect system performance.
- Example 1
- A single cycle is the smallest element of time for the processor. Every action requires at least one cycle and usually multiple cycles.
- The time required to execute instructions varies:
- 8086 and 8088. The original 8086 and 8088 processors take an average of 12 cycles to execute a single instruction
- Pentium Pro, Pentium II/III/4 processors can execute as many as
  3 or more instructions **per cycle**.
- The clock rate of a CPU is only useful for providing comparisons between CPUs in the same family.

More information

- http://www.intel.com/products/processor/core2quad/specifications.htm

2. Front Side Bus (FSB)

- is also called the Front side bus (FSB), processor data bus, processor side bus (PSB), or just CPU bus.
- All these terms refer to the bus that is between the CPU and the main chipset component (North Bridge or Memory Controller Hub).



Front Side Bus (FSB) "Speed "

- This defines the rate at which data can be moved into or out of the processor.

http://www.intel.com/products/processor/core2quad/specifications.htm

Front Side Bus (FSB) "Data Path width"

- the bundle of wires (or pins) used to send and receive data.
- The more signals that can be sent at the same time, the more data can be transmitted in a specified interval and, therefore, the faster (and wider) the bus.

How does FSB determine CPU speed?

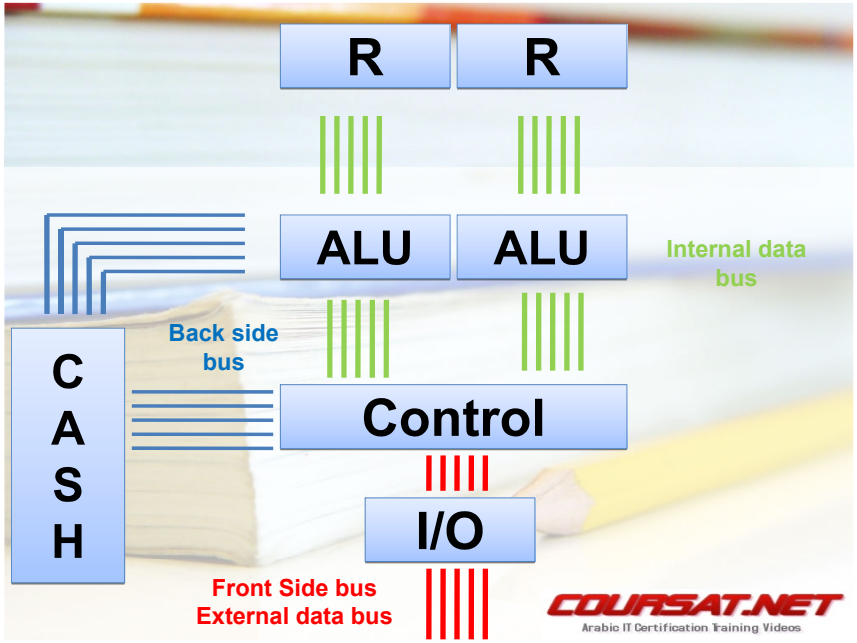
- CPU speed is determined by the following formula:
- FSB x Multiplier = CPU Speed
- For example, if you had a FSB setting of 133MHz and a 10x Multiplier, your CPU speed would be 1330MHz or 1.33GHz.

Clock multiplying

- Clock multiplying is the concept that the processor will run faster than the motherboard that the processor sits in.
- For example, the original Pentium processor ran on 60 or 66 MHz motherboards.
- Say that the computer is marketed as being a Pentium 90.
- Since we know that the motherboard runs at60 or 66 MHz, we can determine that the 90 comes from 60 * 1.5 — meaning that the processor runs 1.5 times the speed of the motherboard.uld be 1330MHz or 1.33GHz.

know what the motherboard speed is, too, not just the advertised speed of the processor.

- From a consumer's point of view, clock multipliers become important when you take a look at computers such as the Pentium 133 and the Pentium 150.
- Which is faster? The obvious answer is the Pentium 150, the system with the higher megahertz speed. But is it really? The Pentium 133 is a clock double of the 66 MHz board, while the Pentium 150 is a clock double and a half of the 60 MHz board.
- My point being that the overall performance of the system is controlled by more than just the speed



32- and 64-bit processors

- The set of data lines between the CPU and the primary memory of the system can be 32 or 64 bits wide, among other widths.
- The wider the bus, the more data that can be processed per unit of time, and hence, the more work that can be performed.
- Internal registers in the CPU might be only 32 bits wide, but with a 64-bit system bus, two separate pipelines can receive information simultaneously.
- For true 64-bit CPUs, which have 64-bit internal registers and can run x64 versions of Microsoft operating systems, the external system data bus should be 64 bits wide or some larger multiple thereof.

The Pentium is an example of this type of design. All Pentiums have a 64-bit data bus and 32-bit registers—a structure that might seem to be a problem until you understand that the Pentium has two internal 32-bit pipelines for processing information. In many ways, the Pentium is like two 32-bit chips in one. The 64-bit data bus provides for very efficient filling of these multiple registers. Multiple pipelines are called *superscalar* architecture, which was introduced with the Pentium processor.

3- Processor Cache
" Cache memory"

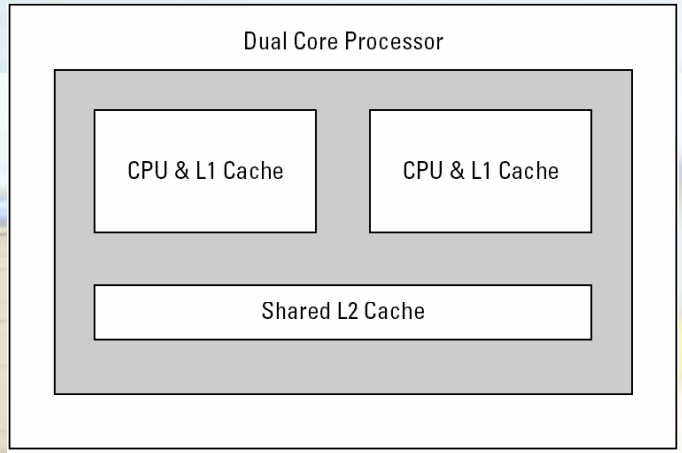
- is a very fast chip memory that is used to hold data and instructions that are most likely to be requested next by the CPU.
- An area of high-speed memory linked directly to the CPU.
- The CPU can access information in the processor cache much more quickly than information stored in main memory.
- Frequently-used data is stored here.
- The more caching the processor has, the more it can hold before needing to go elsewhere to get it.

there are three kinds

- level 1 (L1) or internal cache
- level 2 (L2) or external cache
- level 3 (L3) cache.

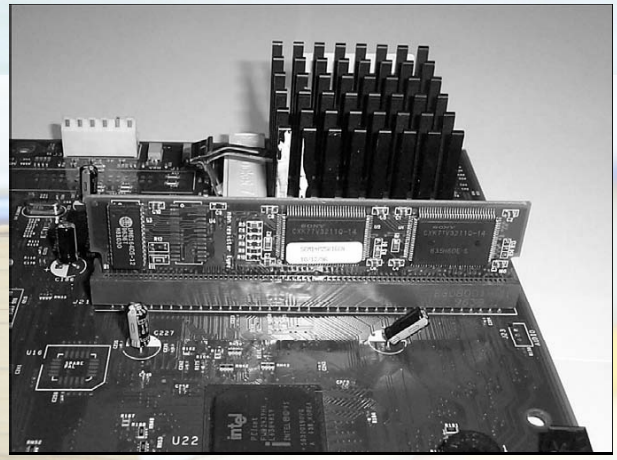
level 1 (L1) or internal cache

- L1 is the fastest
- its integrated directly into the processors
- Fast (it runs at the same speed as the core. This, combined with the hit ratio of 90% or greater,)
- cache size is also small (because it has to fit on the chip).
- L1 cache is typically 16 KB to 32 KB in size
- each of the processors in the dual core each have a block of L1 cache available.



level 2 (L2) or external cache

- L2 cache has been integrated into the processor packaging.
- Previously, it had been built into the motherboard.
- The dual core processor also has a block of shared L2 cache between the two processors in the dual core chip.
- Today's L2 caches are 512 KB and up to 12 MB



Remember

- that L1 cache is SRAM integrated into the processor's chip, whereas L2 cache is SRAM located outside the CPU, usually on the system board or in the casing of the processor.

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level 3 (L3) cache.

- Level 3 cache is now the name for the extra cache built into motherboards between the microprocessor and the main memory.

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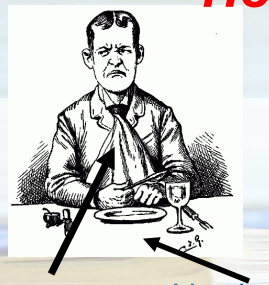
How cash works



processor

L1 cache

cache controller

system memory

one bite (byte? <g>) every four seconds (233MHz = about 4ns cycling).

The waiter guessed wrong

takes 60 seconds for the kitchen to produce any given item that you order (60ns main memory).

cache miss, in which the cache controller did not correctly fill the cache with the data the processor actually needed next

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According to Intel, the L1 cache in most of its processors has approximately a 90% hit ratio (some processors, such as the Pentium 4, are slightly higher).
This means that the cache has the correct data 90% of the time, and consequently the processor runs at full speed233MHz in this example90% of the time.
However, 10% of the time the cache controller guesses wrong and the data has to be retrieved out of the significantly slower main memory, meaning the processor has to wait.
This essentially throttles the system back to RAM speed, which in this example was 60ns or 16MHz.

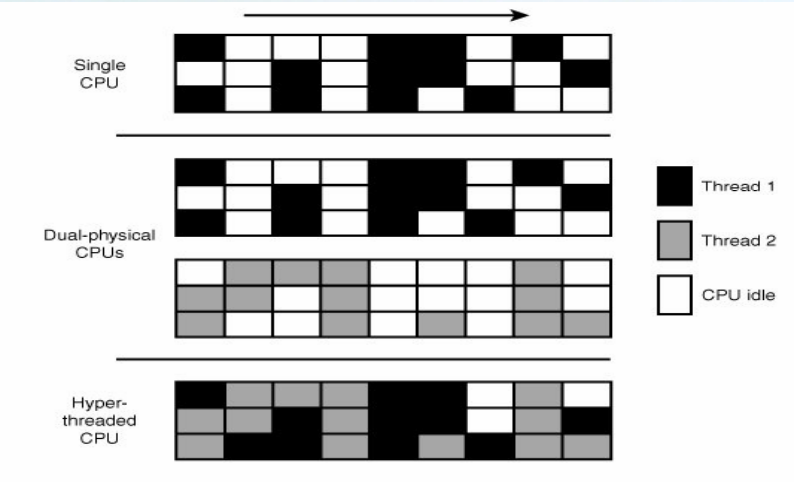
Modern processors can feature the following:

- **Hyperthreading**
- **Multicore**
- **Throttling**
- **Microcode and multimedia extensions**

Hyperthreading

- Intel's Hyper-Threading (HT) Technology allows a single processor to handle two independent sets of instructions at the same time.
- HT Technology converts a single physical processor into two virtual processors
- operating system must support SMP (symmetric multiprocessing) in order to take advantage of HTT.
- many applications do not support HT Technology and slow down when HT Technology is enabled
- It can be disabled form the BOIS

How Hyper-Threading Works



Multicore

- A multi-core processor implements multiprocessing in a single physical package.
- A **dual-core** processor contains two cores, and a **quad-core** processor contains four cores.
- A dual-core processor provides virtually all the advantages of a multiple-processor computer at a cost lower than two matched processors.
- A dual-core processor is designed for users who frequently multitask (run multiple programs at the same time) or who use multithreaded applications.
- It's important to realize that a dual-core processor does not improve single-task performance

Throttling

- CPU throttling allows reducing the operating frequency of the CPU during times of less demand or during battery operation.
- CPU throttling is very common in processors for mobile devices, where heat generation and system-battery drain are key issues of full power usage.
- You might discover throttling in action when you use a utility that reports a lower CPU clock frequency than expected.
- If the load on the system does not require full-throttle operation, there is no need to push such a limit.

Microcode and multimedia extensions MMX

- *Microcode* is the set of instructions (known as an *instruction set*) that make up the various microprograms that the processor executes while carrying out its various duties.
- The Multimedia Extensions (MMX) microcode is a specialized example of a separate microprogram that carries out a particular set of functions.
- Microcode is at a much lower level than the code that makes up application programs.
- Each instruction in an application will end up being represented by many microinstructions, on average.
- The MMX instruction set is incorporated into most modern CPUs from Intel and others.MMX came about as a way to take much of the multimedia processing off the CPU's hands, leaving the processor to other tasks.
- Think of it as sort of a coprocessor for multimedia, much like the floating-point unit (FPU) is a math coprocessor