

PROCESSOR

FAMILIES



By
Prabhanshu Tripathi
Ankit Gupta

What is a Processor ?

- ❖ The processor (short form for *microprocessor* and also often called the *CPU* or *central processing unit*) is the central component of the PC. It is the brain that runs the show inside the PC. All work that you do on your computer is performed directly or indirectly by the processor. Obviously, it is one of the most important components of the PC.

Characteristics of Processor

- ❖ General information:- It consists of Manufacturer, Family name, Code name, Version etc.
- ❖ Speed Specification:- It includes Memory bus Speed(MHz), Processor Speed(MHz).
- ❖ Benchmarks:- ICOMP rating, Norton SI, CPUmark 32.
- ❖ Physical Characteristics:- Process technology, Circuit size(microns), Transistors(millions).
- ❖ Voltage Power Management & Cooling requirements.

- ❖ External Architecture:- Data Bus Width(bits), Level 2 cache type, Level 2 cache size, Multiprocessing.
- ❖ Internal Architecture:- Processor modes, MMX support, x86 execution method.
- ❖ Internal Components:- Level 1 cache size, Level 1 cache write policy, instruction decoders, Performance enhancing features.

Functions of Processor

- **Performance:**
- **Software Support:**
- **Reliability and Stability:**
- **Energy Consumption and Cooling:**
- **Motherboard Support:**

Processor Families

- The processors here are grouped by "families", where we consider a family of processors to be a group of processors that vary only in clock speed, not in architecture.
- We will discuss here about all the major processor families used on PC-compatible computers. It covers every major x86 processor on the market, from the first Intel 8088 used in the original IBM PC, to the latest released hot chips

First Generation Processors

- ❖ First generation processors were used on the earliest of machines, the original IBM PC and XT, and the first clones. These machines were primitive in most ways compared to modern PCs, and the processors they used were of limited capabilities. First generation processors run at system bus speed and use the oldest processor technologies.

INTEL 8088- FIRST GENERATION PROCESSOR

- ❖ The first chip used in PCs was Intel's 8088. This was not, at the time it was chosen, the best available CPU, in fact Intel's own 8086 was more powerful and had been released earlier. The 8088 was chosen for reasons of economics: its 8-bit data bus required less costly motherboards than the 16-bit 8086. Also, at the time that the original PC was designed, most of the interface chips available were intended for use in 8-bit designs.

Second Generation Processors

- ❖ The only chip generally considered second generation is the 80286. Intel also made a chip between the 8088 and the 80286, called the 80186. Largely due to a lack of performance enhancements compared to the 286, in addition to compatibility problems with support chips, the 80186 was never really used in PCs. It has however found a strong niche role in the design of embedded microcontrollers, even to this day.

INTEL 80286- A SECOND GENERATION PROCESSOR

- ❖ The 80286 was the chip used in IBM's AT (advanced technology) system. The 286 was the first major step up in PC processors, providing significant performance increases over the 8088 and 8086--double or more performance at the same clock speed. The 286 also widened the address bus to allow access to 16 MB of memory, and introduced protected mode operation. It was originally available in 6 MHz and 8 MHz versions, but was later expanded to faster versions, all the way up to 20 MHz.

Third Generation Processors

- ❖ The third generation processors (the 386 family) represent another step forward from the second generation class. Intel started with this generation of chips to create "subfamilies" of related chips with different capabilities, using the "DX" and "SX" designations.

INTEL 80386DX

- ❖ The Intel 80386DX was the first true 32-bit processor used on the PC platform. Its internal register size was increased to 32 bits, and its data and address buses were as well, doubling data path width to the processor and increasing addressable memory to 4 GB theoretical. The 80386 family of chips offered more performance than the 80286s they replaced, largely through processor speed increases.
- ❖ The 386DX's increased power and improved processor modes.

INTEL 80386SX

- ❖ The 80386SX is a "lite" version of the 80386DX chip. It uses only a 16-bit data bus, the same external bus width as the 80286. It also only can address 16 MB of memory, like the 80286. The SX version of the 386 chip was in fact released after the DX.
- ❖ The narrower data bus width of the 386SX creates a reduction in performance of about 20-25% compared to an equivalent-speed 386DX.
- ❖ The 386SX is still a 32-bit processor internally and will run 32-bit software . It is available in speeds from 16 to 33 MHz.

Fourth Generation Processors

- ❖ The fourth generation of processors saw rapid growth in the CPUs' power and capabilities, and the introduction of several new technologies as well. It was here that AMD and Cyrix had their first real early successes .
- ❖ Also, it was at this time that the new phenomenon of upgradable processors and standardized motherboard sockets began to become prevalent.
- ❖ Some fourth Generation Processors are:-
INTEL80486DX, INTEL 80486SX, INTEL 80486DX2 & INTEL 80486DX2 overdrive, INTEL 80486DX4 & INTEL 80486DX4 overdrive, AMD 5x86, Cyrix 5x86 .

CYRIX 5x86 (“M1sc”)

- ❖ Despite having the same name as AMD's 5x86 processor, the Cyrix 5x86 is a totally different . While AMD designed its 5x86 by further increasing the clock on the 486DX4, Cyrix took the opposite approach by modifying its M1 processor core (used for the 6x86 processor) to make a "lite" version to work on 486 motherboards. As such, the Cyrix 5x86 in some ways resembles a Pentium OverDrive (which is a Pentium core modified to work in a 486 motherboard) internally more than it resembles the AMD 5x86. This chip is probably the hardest to classify as either fourth or fifth generation.

Fifth Generation Processors

- ❖ The fifth generation of processors saw several changes from earlier CPU families, and several trends continue as well. Chips continued to get faster and faster, and architectural changes were made to increase overall system speed as well. AMD and Cyrix developed their own compatible processors instead of just trying to clone Intel's, leading to more variety and choice in the marketplace. The Pentium and the compatibles that followed it opened up the world of computers for millions of users and propelled computing to the next level.
- ❖ Some examples are Intel Pentium("P5"/ "P54C"), Intel Pentium over drive, Intel Pentium with MMX technology, Intel Pentium with MMX technology over drive, Cyrix 6x86, AMD K5.

AMD K5

- ❖ AMD's entry in the fifth generation processor sweepstakes is called the K5
- ❖ The K5 is, internally, a very advanced processor, the most advanced of the fifth-generation chips. Internally it is more comparable to the Pentium Pro. It is an x86 translation/emulation processor, decoding x86 instructions into RISC-like microinstructions and executing them on a 6-pipeline internal core. This allows the K5 to achieve higher performance than a Pentium of the same speed. In many ways, the K5 is sixth-generation, but its performance level is held back to fifth-generation levels due its low clock speeds.

- ❖ Compared to the Pentium (classic), the K5 has the following architectural improvements that contribute to its greater performance to clock speed ratio (it also has all the advantages over the 486 that are mentioned in the section discussing the Pentium):
- ❖ **RISC-Based Internal Architecture:** The K5 is internally a highly-parallel RISC processor using an x86 decoding front-end.
- ❖ **Six Execution Units:** The K5 has five integer units and one floating point unit for processing micro-instructions, while the Pentium has only two integer units.
- ❖ **Out of Order Completion:** Instructions flowing down the two integer pipelines can complete out of order.
- ❖ **Superior Branch Prediction Unit:** The branch target buffer is four times the size of the Pentium's (although K5 claims a lower accuracy with it than Intel does with the

- ❖ **Larger Primary Cache:** The K5 has a 16 KB instruction cache instead of the Pentium's 8 KB. The data cache is unchanged at 8 KB.
- ❖ **Improved Cache Mapping:** The primary cache in the K5 is 4-way set associative instead of the Pentium's 2-way.
- ❖ **Register Renaming:** This feature improves parallel performance of the pipelines.
- ❖ **Speculative Execution:** The K5 uses speculative execution to reduce pipeline stall time in its RISC core.

Sixth Generation Processors

- ❖ New and innovative architectural designs are employed in the CPUs, as the easy performance improvements such as widening buses and increasing clock speeds get harder to continue.
- ❖ The line between fifth and sixth generation is much blurrier here than between previous generations, due to sixth generation chips running in fifth generation motherboards, and the mixing of technologies between different chip families. I consider the AMD K6 and the Cyrix 6x86MX to be sixth generation chips despite the fact that they run in fifth generation motherboards. This is based on assessing them technologically and in terms of their performance, along with when they were released to market.
- ❖ Some of the processors of this generation are Intel Pentium Pro("p6"), Intel Pentium II ("Klamath"), AMD K6, Cyrix 6x86MX("M2")

INTEL PENTIUM PRO("P6")

- ❖ The Pentium Pro was introduced in 1995 as the successor to the Pentium
- ❖ The Pentium Pro was the first mainstream CPU to radically change how it executes instructions, by translating them into RISC-like microinstructions and executing these on a highly advanced internal core.
- ❖ The Pentium Pro achieves performance approximately 50% higher than a Pentium of the same clock speed.

□ In addition to its new way of processing instructions, the Pentium Pro incorporates several other technical advances that contribute to this increased performance:

- ❖ **Super pipelining:** The Pentium Pro dramatically increases the number of execution steps, to 14, from the Pentium's 5.
- ❖ **Integrated Level 2 Cache:** The Pentium Pro features a dramatically higher-performance secondary cache compared to all earlier processors. Instead of using motherboard-based cache running at the speed of the memory bus, it uses an integrated level 2 cache with its own bus, running at full processor speed, typically three times the speed that the cache runs at on the Pentium. The Pentium Pro's cache is also non-blocking, which allows the processor to continue without waiting on a cache miss.
- ❖ **32-Bit Optimization:** The Pentium Pro is optimized for running 32-bit code (which most modern operating systems and applications use) and so gives a greater performance improvement over the Pentium when using the latest software.

- **Wider Address Bus:** The address bus on the Pentium Pro is widened to 36 bits, giving it a maximum addressability of 64 GB of memory.
- **Greater Multiprocessing:** Quad processor configurations are supported with the Pentium Pro compared to only dual with the Pentium.
- **Out of Order Completion:** Instructions flowing down the execution pipelines can complete out of order.
- **Superior Branch Prediction Unit:** The branch target buffer is double the size of the Pentium's and its accuracy is increased.
- **Register Renaming:** This feature improves parallel performance of the pipelines.
- **Speculative Execution:** The Pro uses speculative execution to reduce pipeline stall time in its RISC core.

Multi Core Processors

- ❖ A **multi-core** processor (or **chip-level multiprocessor, CMP**) combines two or more independent cores into a single package composed of a single integrated circuit (IC), called a die, or more dies packaged together. The individual core is normally a CPU. A **dual-core** processor contains two cores, and a **quad-core** processor contains four cores. A multi-core microprocessor implements multiprocessing in a single physical package.
- ❖ Some multicore Processors are:-**POWER4**, the world's first dual-core processor, released in 2001, Celeron dual core, core duo, core 2 duo, core 2 quad, Xeon dual-, quad- and hexa-core processors.

INTEL CORE 2

- ❖ The **Core 2** brand refers to a range of **Intel**'s consumer 64-bit dual-core and 2x2 MCM quad-core CPUs with the x86-64 instruction set, based on the Intel Core micro architecture, derived from the 32-bit dual-core Yonah laptop processor.
- ❖ The *Core 2* brand was introduced on July 27, 2006^[3] comprising the **Solo** (single-core), **Duo** (dual-core), **Quad** (quad-core), and **Extreme** (dual- or quad-core CPUs for enthusiasts) branches, during 2007.^[4] Intel Core 2 processors with vPro technology (designed for businesses) include the dual-core and quad-core branches.^[5]