CPUs Used in Personal Computers

Intel Processors

Intel Corporation is the largest manufacturer of microchips in the world and is historically the leading provider of PC chips.

Intel invented the microprocessor in 1971 with the 4004 model. This led to the first microcomputers in 1975. Intel's success in this market was not guaranteed until 1981 when IBM released the first IBM PC based on the Intel 8088 processor.

Since 1981 all IBM PCs and compatibles based on the IBM design have been created around Intel chips. The 8088 was the first chip used in an IBM PC but they then went back to the 8086 and this design standard was used in all further chips – 80286, 80386, 84086, Pentium, Pentium Pro, Pentium II, Pentium III, Celeron and Xeon – often referred to as the 80x86 line.

The basic structural design (***architecture***) of each chip has become more sophisticated and complex. The 8086 contained only a few thousand transistors whereas the Xeon processors contain 9.5 million. This increasingly complex architecture is primarily responsible for the increasing power and speed of the Intel processor line.

Pre-Pentium Processors

Intel's first processors were simple by today's standards but provided a level of computing never seen before in a single processing chip. As the 8086 → 80286 Intel developed methods for fitting more transistors onto the surface of its chips so processors could handle more instructions per second and access greater amounts of memory.

A major improvement that came with the 80386 is called virtual 8086 mode. In this mode a single 80386 chip could achieve the processing power of 16 separate 8086 chips each running a separate copy of the operating system. This capability enabled the chip to run different programs at the same time – a technique known as ***multitasking***. All the chips following the 386 had this capability.

In 1989 the 80486 released didn't feature any radically new processor techniques. Instead it combined a 386 processor with a math coprocessor and a cache memory controller all on the one chip. These chips now no longer needed to communicate via the bus so increasing the speed of the system dramatically.

The Pentium

Introduced in 1993. Intel broke with its tradition of numeric names – partly to prevent other manufactures using similar numeric names. It is still considered part of the 80x86 family.

The Pentium itself represented another leap forward for the microprocessor, it's speed and power dwarfed its predecessors' performance. It runs applications approx 5 times faster than the 486 at the same clock speed.

Part of the speed of the Pentium comes from a ***superscalar*** architecture – allows the chip to process more than one instruction in a single clock cycle.

The Pentium Pro

Introduced in 1995, it reflected more design breakthroughs. It can process 3 instructions in a single clock cycle and can achieve faster clock speeds than the Pentium.

The phrase *dynamic execution* was used by Intel to describe the capability of executing the programs instructions most efficiently but not necessarily in the order in which they were written.

The out of order execution of instructions means that he instructions not being processed immediately are put aside while the chip begins processing the other instructions.

Pentium with MMX technology

MMX includes 3 primary architectural design enhancements,

1. new instructions
2. SIMD process
3. additional cache

MMX includes a set of 57 instructions that increase the multimedia capabilities of a chip. These instructions process audio, video and graphical data more efficiently than non MMX processors.

MMX ***single instruction multiple data (SIMD)*** process enables one instruction to perform the same task on multiple pieces of data so reducing the number of loops required to handle audio, video, animation and graphical data.

The Pentium II

Released in Summer 1997. It has 7.5 million transistors and execution ranges of up to 450MHz. It supports MMX technology and dynamic execution.

Differs from other Pentium models due to the fact that it is encased in a plastic and metal cartridge rather than the wafer format used for other chips. It needs this casing because of the ***single edge connector*** connection scheme. Instead of plugging into the regular slot on the motherboard the Pentium II plugs into a special slot called Slot One which requires a different motherboard. Enclosed within the cartridge is the core processor and the L2 cache chip.

In 1998 the Pentium II family was expanded with the release of the ***Celeron*** and ***Xeon*** which adapted the Pentium II technology for new markets.

The Celeron has many of the features of the Pentium II but runs at slower speeds and is designed for entry level PC's in the $1000 range.

The Xeon incorporates a larger L2 cache and features enhanced multiprocessing capabilities. It is designed foe use in network server computers and workstations.

Another advantage of the P II is the ability to work with a 100MHz data bus. Prior to the P II data buses typically ran at 66MHz or less. Improved data bus speeds means faster overall performance.

The Pentium III

Released in 1999 the P III features several enhancements. With speeds that reached 1 GHz in March 2000 the P III includes 70 new built in instructions and improved multimedia handeling features.

Its single most biggest enhancement is ***streaming SIMD extension (SSE)*** – an improved version of the MMX technology resulting in faster video and graphics handling.

Uses a cartridge and slot configuration like the P II and early releases took advantage of the 100MHz bus. Shortly after its release Intel announced a 133MHz bus improving the performance further.

The Xeon version of the P III was released in late 1999 and provided faster performance like its P II version by offering larger L2 cache.

Advanced Micro Devices (AMD) Processors

In 1988 AMD emerged as a primary competitor to Intel. Until then AMD were usually found in low end, low priced home and small business computers.

K6 Processors

Was not entirely compatible with Intel processors and initially performed at slower speeds. AMD continued to improve and began to overtake Intel in some markets.

K6-2 processor released in 1988. Speed range, 300 → 475 MHz and 100MHz data bus, L2 cache sizes up to 2 MB (compared with P II 512KB). Also features 64-bit registers and can address 4GB of memory.

K6-III released in 1999. Speeds of 400 → 450 MHz, smaller L2 cache but features a new L3 cache (up to 2MB) not found in the P III.

K6 feature MMX technology, they do not offer SSE but use AMD's 3DNow! Providing enhanced multimedia performance.

Athlon Processor

Released in 1999, the Athlon was the fastest processor available operating at speeds up to 650 MHz. In March 2000 it was the first PC class processor to achieve speeds of 1GHz. Designed to work with buses

of 200 MHz. Includes 64KB of L1 cache, 512 L2 cache. Capable of addressing 64GB of memory and features 64-bit registers.

Cyrix Processors

The company began as a maker of specialised chips but in mid 1990's began to produce processors to rival Intel. Focuses on PC's that sell for < $1000.

1997 – Introduced the **MediaGX** processor, Pentium compatible microprocessor that integrated audio and graphics functions, operating at speeds of 233 MHZ and higher.

1999 – Cyrix was sold to VIA technologies Inc. which continued the **MII** line. This PII class operates at speeds of 433 MHZ and can be found in PC's from various manufacturers.

Motorola Processors

Apple Macintosh computers use Motorola processors. Other manufacturers, including workstation manufacturers such as SUN Microsystems rely heavily on Motorola chips. They were an early favourite among companies building large UNIX-based computers.

Offers 2 families of processor chips.

1. 680x0 family
2. MPC, has different architecture and is known as the PowerPC family.

680x0 series

Best known as the foundation of the original Macintosh. Actually predates the Mac. IBM considered using the 68000 in its first PC. The 68000 (released in 1979) was more powerful than Intel's 8088 but the improvements were slower. By the time Motorola released the 68060 chip in 1993, Intel were already promoting the Pentium.

PowerPC series

1991 – IBM and Apple joined forces with Motorola to dethrone Intel from pre-eminence in PC chip market. Hardware portion focused on the PowerPC chip, first of which was the 601. Followed soon by the 603, a low power processor suitable for notebooks. 604 and 604e, high power chips designed for high-end desktops. 620 introduced in 1995 established a new performance record for microprocessors. 750 chip (266 MHz) was released for desktop and mobile computers needing high performance but low voltage.

The **G3** released in 1998 provides even more power. Apple's IMac and Power Mac built around the G3 offer better performance and speed than the PII system at a lower cost.

1999 Apple released the **G4**, operating speeds of 500MHz and higher, the 128-bit processor is capable of performing 1 billion floating point operations (1 gigaflop) per second. Also features 1MB of L2 cache, bus speed of 100MHz.

RISC Processors

Both Motorola 680x0 and Intel 80x86 families are **complex instruction set computing (CISC)** processors. Instruction sets are large, typically containing 200 → 300 instructions.

Newer theory – if the instruction set is small and simple, each instruction will execute quicker, thus allowing processor to complete more instructions during a given period. These type of CPU's are called **reduced instruction set computing (RISC)** processors. RISC design – used in the PowerPC but first implemented in mid 80's – results in faster cheaper processor.

This technology has been the engine of midsize computers such as IBM RS/6000 and high-end UNIX workstations. RISC CPU's are also found in printers and other devices that contain their own internal CPU's. PowerPC and G3/G4 processors reflected a major move on the part of industry giants towards using RISC technology in desktop and notebook computers.

1989 – Intel introduced the i860 RISC chip that earned the distinction of being the first chip to contain 1 million transistors. Other RISC processors include Intel i960, Motorola 88100, NEC Electronics VR4000,

Compaq Alpha. SUN Microsystems produces a RISC processor known as SPARC, which it uses in it's UNIX workstations.

Parallel Processing

Emerging school of thought on producing faster computers – build them with more than one processor. This type of system uses parallel-processing techniques. The system harnesses multiple processors that share the processing workload. Result → system can handle greater flow of data, complete more tasks in a shorter time, and deal with the demands of many input and output devices. Parallel processing is also called **multiprocessing (MP)** or **symmetric multiprocessing (SMP)**.

Not a new idea in the minicomputer, mainframe or supercomputer arenas. Some companies are developing computers with 256, 512 and even thousands of microprocessors known as **massively parallel processors (MPP)**.

At the other end of the spectrum, dual processor and quad processor versions of PCs are available today and are commonly used as network servers, Internet hosts computers and stand-alone workstations. Recent generations of standard PC microprocessors incorporate a measure of parallel processing by using pipelining techniques to execute more than one instruction at a time.