

## **SPEED #3: The Motherboard and Processor**

So far, we've considered two things that have major impact on computer speed -- the data bus and the address bus. Now it is time to consider how the motherboard and CPU work together toward speed and efficiency.

The CPU (central processing unit) is the physical chip marked 286 or 386 or 486. It is definitely the most important chip in the computer; indeed, the motherboard is designed for it and built around it. Simple proof: one cannot successfully put a 386 chip in a 286 motherboard, or vice versa. It won't work because the motherboard was designed for a specific class of CPU. (An exception to this rule is the case of a few motherboards that are specifically designed to take more than one processor type, though only one at a time. For example, I have a motherboard that will accommodate either a 386 or 486 CPU).

Every motherboard has on it a crystal, which governs the clock speed of that board, in just the same way a crystal can govern the frequency of an amateur transmitter. Clock speed in a computer is also measured in megahertz. Now, lots of computer users try to compare the speed of different computers by just comparing the frequency ratings of the CPU. "Gee," they say, "this 33 MHz 386 must be about half the speed of that 66 MHz Pentium." Not so. While the clock speed is definitely important as an indication of how fast the computer will do work, clock speed is not the only important factor. Another important factor is the efficiency of the CPU.

In a computer, a single cycle (one Hertz) is the smallest unit of time, and everything done by the CPU takes at least one, and often more than one, clock cycle. It takes 4 cycles for an XT chip (8086) to transmit data to and from memory. Added to these 4 cycles is a little more time, a couple of extra clock ticks, to make sure the CPU is not getting ahead of the other things going on in the computer. These extra clock ticks are called "wait states." A 286 CPU needs only 2 cycles plus wait states to transfer data to and from memory.

An even better way to evaluate the efficiency of a CPU is to consider how fast it can execute an instruction. Instructions are very fundamental pieces of computer work. An example is "take the number in memory register X and put it in memory register Y." Different CPUs are better at this than others; they can be said to be more efficient. The table below shows the average number of cycles it takes each class of CPU to complete an instruction.

CPU	Average Cycles Per Instruction
XT(8086/8088)	12
286/386	4.5
486	2
Pentium	1

Just based on clock speed, then, a 100 MHz Pentium is about equivalent to a 200 MHz 486 or a 450 MHz 386 or 286 or a 1200 MHz XT.

So you see, we have too darn many variables to make direct comparisons based on any single factor. Look at the list of stuff we have to deal with in trying to get a handle on factors that affect the speed of a computer:

**FACTORS THAT INFLUENCE  
THE SPEED OF A COMPUTER**  
(in alphabetical order)

1. Address bus width
2. Clock speed of CPU
3. Clock speed of motherboard
4. Data bus width
5. Instruction execution speed
6. Wait states

I've listed six factors and we haven't even considered factors extraneous to the CPU and motherboard, such as hard and floppy disk access time and video board speed.

So then, is it impossible to assess how fast a computer is? No, it may be difficult, but not impossible. The way it is done is to run a specific program that is designed to measure each of the above factors, or at least how they interact. The results of running the program (called a **benchmark**), is an arbitrary number that is compared with the number generated by running the same program on another computer. One such benchmark program is included in the Norton Utilities, a package of utility programs that has been a longtime favorite of mine. I just ran the Norton benchmark program on the computer I am using to write this article -- a 486DX-66 MHz with a Cyrix (non-Intel) CPU. Here are the results:

CPU	CPU INDEX
Pentium 66	211
WB9RQR's 486DX-66MHz	113
486DX-33MHz	71
386DX-33MHz	36

That is a fairly good indicator of how my machine stacks up -- a little better than half the speed of a Pentium and about triple the speed of a 386. But, that is just the CPU speed. What effect does the hard drive have? Here is the answer:

CPU and Hard Drive	Computer INDEX
Pentium 66+Western Digital	146
WB9RQR's 486DX-66MHz+ Quantum	75
486DX-33MHz+ Maxtor	51
386DX-33MHz+ Seagate	25

The numbers are quite different when combined with a hard drive typically used with each machine. A complicating factor is that this is just one benchmark, and there are many, AND you cannot compare results from one benchmark with the results from another. Oh well, no one ever claimed computers were simple!

Well, I hope that gives you some general ideas about computer speed. The underlying message is that while you cannot compare apples and oranges, at least you can be assured that a Pentium is faster than a 486, which is faster than a 386, which is faster than a 286, which is faster than an XT. Most of the time.

I mentioned previously that my friend Tom (WB9LNL) had requested that I write about computer speed. Well, Tom, you got a series of three articles. I hope you found them informative. How about the rest of you gals and guys out there. Any requests? By the way, next month will bring an article on Windows 95! Happy computing. Stan