appeared on 15th Jun 2005

64-bit processor steps out

The next hot development in computers is the 64-bit processor, says S.Ananthanayanan.

Computers first started with the 8-bit processor, moved on to 16-bits and are currently at the 32-bit stage. Nobody had expected that increasing the 'bit-rating' of processors would be necessary. But there is Moore's Law!

What does 'bits' mean?

Processors do things in parallel. It is like a pianist's fingers playing several keys at the same time. Computer processors feed data to their internal 'registers' or send data from the registers to locations in memory, several 'bits' at a time. The 'bits' are the numbers '0' or '1', because '0' and '1' are the 2 states that are possible for cells of the 'registers' or the components of locations in the memory. And computer processors transact data, which is in bits, several bits at a time.

Let us see how it works with an '8-bit' processor. Suppose the numbers, 101 and 131 are stored in memory locations 55 and 65 and the computer needs to add them. The program will tell the processor the location of the 2 numbers and that the operation to do is 'add'. In binary arithmetic, the representations for 101,131,55 and 65 are: 01100101, 10000011, 00110111, 01000001. Notice that the way an integer is represented (in the case of this processor) and the range of memory addresses are 8 'bits' long.

This '8-bit' arrangement allows the processor to address a maximum of 2^8, that is 256 memory locations. The program can then store numbers, addresses or even instructions at 256 memory locations and that is the leeway that the computer has to go about its business. The connections in the motherboard also allow communications along 8 independent pathways, or a 'bus', for this parallel transfer to happen.

Growing up

The '8-bit' era soon ended and the 16-bit memory addressing became necessary. With 16 bits the locations possible are 2^{16}, or 64 x 1024, also known as '64K'. The current 32-bit processors address 2^{32} or 4x1024x1024x1024 = 4 Gigabits of memory.

Memory and speed

When a computer opens, say a 'word' document, what it has done is to read from the disk and store it in memory. Any changes or additions we make are only in the copy that is in the memory. If we just closed the document, without 'saving', it is the memory copy that disappears and the version on the disk stays unchanged.

Now, if a large number of programs are running, especially of the kind, like graphics, which use huge memory, then memory space can get short. When this happens, the modern operating systems, like Windows or UNIX, make space by temporarily moving things out to a special part of the disk, and a little ‘directory’ of what has been stored on the disk is created. As soon as any of this ‘transferred’ stuff is required, something else is moved to the disk and the stuff needed is fetched back. In this way, using ‘virtual memory’, as it is called, the computer can manage when memory is short.

But retrieving data from memory is thousands of times faster than moving things to and from the disk and the when the computer resorts to this ‘swapping’, performance soon begins to limp.

Crossing 32 bit

So far, it was effective just to add more memory. The memory needs were usually less than 4 Gigabits and that much memory was also pretty expensive. But now, applications that can use more memory are showing up and the cost of memory has become low.

This is when the addressing limit of a 32 bit processor becomes a disadvantage. With a 32 bit processor, as we saw, it is only 4 Gigabits that can be addressed. To reach more memory, the ‘word’ that a processor can handle at a time needs to be more than 32 bits long. And, there, it’s the turn of the 64 bit processor.

The 64 bit processor can then use over 16 billion gigabits of memory and may never need to use ‘swapping’! Applications that need huge databases to be kept in memory and also entertainment applications that need to store huge graphics to be switched instantaneously are the first beneficiaries.

Another benefit is that the processor would ‘talk’ faster to other devices, because data would flow ’64 bits at a time’ in place of 32 bits, provided the device was appropriately equipped. A case of the ‘pianist growing fingers’. But the chief gain is in greater memory.