Diabologic: Nano-Electronics

by Frank Dolinar

Our current understanding suggests that humans who existed before recorded history knew very little about mathematics and had available even less in terms of computing devices – mostly limited to the fingers on their hands.

Over the centuries, we have come a long way in terms of our technologies, but not necessarily so far in terms of our ability to think more more cogently, to use those technologies effectively, or to understand what they are telling us.

In 2007, we have become accustomed to the idea that our calculating devices, computers, have become much smaller and vastly more powerful in the thirty years since the introduction of the Altair 8800, the first commercially available personal computer.

The trend to miniaturize electronic devices to achieve higher operating speeds and device densities has been relentless. Today, the size of those devices is approaching the nanometer scale. What's coming out of the nanotech labs these days is enough to startle even someone like me who's been watching the process since the mid-1960s.

What's next? News from nanotech research suggests fundamental changes in the concept of a computer, its size, shape, and capabilities:

- 2007 Jan 31: MIT announced a microphotonic device to clean up fiber-optic data signals by setting all the light to the same polarization before the data is processed. (This helps make our networks faster and more reliable.)

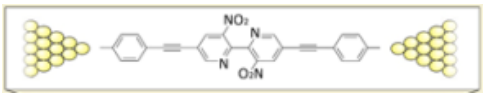
- 2007 Jan 24: The IOP (Institute of Physics) Publishing in the UK announced in its journal Nanotechnology the design and fabrication of an electronic analog to the human brain cell (neuron) with a size of only 500 nanometers. The intent is to use these artificial neurons to mimic brain-like processing such as recognition, perception, and association in nanoscale electronic hardware.

- 2007 Feb 05: Intel announced the first fundamental change in chip fabrication since the 1960s, replacing silicon dioxide insulation with an alloy of hafnium. Improved insulation allows transistors to shrink from 65nm to 45nm. This doubles chip density, improves speed by 20%, and reducing power needs by 30%. The new chips are expected to be available later this year.

- 2007 Jan 16: Hewlett-Packard announced research into hybrid nano-CMOS chips expected to lead to new field programmable gate arrays (FPGA) up to eight times as dense as current devices by using a crossbar structure of nanowires, but which could be built with current fabrication facilities with only minor modifications. Being able to use the current facilities is a major financial saving for HP.

- 2007 Feb 05: CalTech & UCLA have produced a prototype molecular-level memory chip 20 times as dense as today's best silicon. The chip can hold 100 billion bits in a single square centimeter – the equivalent of 100,000 novels. This would make it possible to provide libraries worth of information to anyone.

- 2006 Aug 04: IBM Zurich scientists have demonstrated a single molecule that can be switched between two distinct conductive states, allowing it to store data. The molecule, shown between two microscopic gold electrodes, is a specially designed organic molecule with a length of approximately 1.5 nm. Very tiny indeed.



- 2007 Apr 03: The journal Nature Nanotechnology published an article by scientists Andrei Sokolov and Bernard Doudin documenting the demonstration of a single bit of data storage at the atomic level using 'spin-electronics'. This is a quantum phenomenon that allows the spin on a single electron to be set and measured. This could lead to development of memory 100 to 1000 times as dense as current technology can produce.

Incidentally, this atomic level storage is somewhere between 5 and 50 times the density of the CalTech & UCLA prototype noted above, but we're not going to see either of them in the near future.

As computers get smaller, faster, and more versatile, as it becomes possible to fabricate some real computational horsepower in ever smaller packages, as the onboard intelligence becomes greater, we begin to wonder (as Ray Kurzweil does in his book "The Age of Spiritual Machines") just when computers will become as smart as humans, and once they do, will they still need us?