Nowlan submission-Supercomputer at UI-9-3-10

Understanding Illinois

Blue Waters Run Fast

By Jim Nowlan

The speed of supercomputers is moving from the incomprehensible to the spiritual. Witness the development of the Blue Waters supercomputer at the University of Illinois, which will take the number of calculations *per second* from the trillions to the quadrillions (a quadrillion equals 1,000 trillion).

As a part-time senior fellow (read "old") at the U. of I.'s Institute of Government and Public Affairs, I recently took a stroll from the south side of campus (humanities and agriculture, largely) to the north side of the sprawling university where the engineering and computer science programs are located, mostly in severe, new dusty-peach colored brick buildings.

My objective was the National Center for Supercomputing Applications (NCSA), which has been at the U. of I. since about 1986 and is heavily funded by the National Science Foundation (NSF) and grants from other federal agencies.

Public information specialist Trish Barker met me. An engaging, articulate former newspaper reporter at the *Moline Dispatch & Argus*, Trish tried to drill into my Smith-Corona typewriter-era brain some of the dimensions of this new Blue Waters computer, which should be up and running next year.

The U.I.'s NCSA received an award from the NSF for the management of the computer over competition from the best universities in the nation, of which the U.I. is

one. Over several years, Blue Waters will represent about half a billion dollars in revenue for the university!

Blue Waters is a joint effort of IBM (thus the "blue" in Blue Waters), the U.I. and the NSF. The massively parallel computer (lots of small computers lashed together) will have 300,000 cores, with 8 processing cores on a chip.

Trish said Blue Waters will have the computing power of "about one million cutting-edge laptops." It will be able to reach a peak power of about 10 petaflops (10 quadrillion floating operations per second) and a general running speed of about 1 petaflops.

Why is all the speed necessary? Well, to mathematically model or simulate, and ultimately predict, future events like tornadoes or cyclones requires quadrillions of calculations to replicate the dynamic movement of seemingly chaotic molecules as they hurtle through space.

The same magnitude of computing power is needed to see beyond microscopes to the likely motion of proteins as they fold and unfold within a cell. The computer software and almost infinite calculations help us to describe the natural world that we cannot see through microscopes or telescopes.

Computers don't think for themselves. They require inputs from scientists. At present about 1,500 scientists and other investigators from around the country use computer time on the supercomputers already at NCSA.

They use "Abe," for example, in 2007 one of the world's Top 10 fastest computers. Three years later Abe ranks only in the top 100 for number crunching power. Blue Waters will come on line as the fastest, or one of the two fastest, computers in the

world, but will probably soon be overtaken in the hyper-kinetic race to build ever faster computers.

In addition to weather forecasting, the practical applications of supercomputing are many. For example, if Boeing wanted to design a wing for a new aircraft, it might design a number of possibilities. Rather than build and test various designs in wind tunnels, supercomputers can simulate the design properties of the new wings, allowing Boeing to discard several of the possible designs.

At the more humble level, Trish Barker pointed out that a supercomputer (not at U.I.) was called upon to test the aerodynamic properties of Pringles, which had been moving along the manufacturer's conveyor system so fast that they tended to fly off.

Housed at NCSA, Blue Waters provides great recognition for the U.I. as a long-time leader in high performance computing. While scientists and businesses from across the country may submit proposals for use of supercomputing time at NCSA, machines like Blue Waters attract faculty and students from all over the world who want to be trained to work with the fastest in the field.

Since Blue Waters has not yet been constructed in its new building, I went with Trish to visit Abe in one of the nondescript buildings that house computing facilities on the U.I. campus. If Blue Waters looks like Abe, it will simply be row upon row of black refrigerator-shaped boxes, each holding stacks of probably commercially-available computer servers. Abe and most predecessors are air-cooled; Blue Waters will be water-cooled, with tubes "the size of my pinkie finger," says Barker, running throughout the "refrigerator boxes" of servers.

The lesson I came away with is that the rate of change in the world of science and technology is breath-taking. I have been left completely in the dust. I recommend that you admonish your children and grandchildren regularly to take as many math, science and computer courses as possible, or risk being left in the dust as well.