IBM's Blue Gene supercomputer to create digital 3D model of the brain

6 June 2005

IBM and The Ecole Polytechnique FÃ©dÃ©rale de Lausanne (EPFL) are today announcing a major joint research initiative â€“ nicknamed the Blue Brain Project â€“ to take brain research to a new level.

Over the next two years scientists from both organizations will work together using the huge computational capacity of IBM's Blue Gene supercomputer to create a detailed model of the circuitry in the neocortex â€“ the largest and most complex part of the human brain. By expanding the project to model other areas of the brain, scientists hope to eventually build an accurate, computer-based model of the entire brain.

Relatively little is actually known about how the brain works. Using the digital model scientists will run computer-based simulations of the brain at the molecular level, shedding light on internal processes such as thought, perception and memory. Scientists also hope to understand more about how and why certain microcircuits in the brain malfunction â€“ thought to be the cause of psychiatric disorders such as autism, schizophrenia and depression.

"Modeling the brain at the cellular level is a massive undertaking because of the hundreds of thousands of parameters that need to be taken into account," said Henry Markram, the EPFL professor heading up the project. "IBM has unparalleled experience in biological simulations and the most advanced supercomputing technology in the world. With our combined resources and expertise we are embarking on one of the most ambitious research initiatives ever undertaken in the field of neuroscience."

Markram is the founder of EPFL's Brain and Mind Institute, where more than 10 years of research and wet-lab experiments have been consolidated into the world's most comprehensive set of empirical data on the micro-architecture of the neocortex.

Researchers from IBM will use their experience in simulating complex biological systems to help turn this data into a working 3-dimensional model recreating the high-speed electro-chemical interactions of the brain's interior. Running on a Blue Gene supercomputer, the model will be capable of simulating brain processes in three dimensions with a precision never before achieved.

"Blue Gene is by far the fastest supercomputing system in the world, giving scientists access to unprecedented levels of computing power," said Tilak Agerwala, Vice President of Systems, IBM Research. "What really matters is not the power itself, but how it is applied to accelerate innovation and discovery in science, engineering and business."

By using a Blue Gene supercomputer to run experiments in real time, Markram anticipates a substantial acceleration in the pace of brain research. "With an accurate computer-based model of the brain much of the pre-testing and planning normally required for a major experiment could be done 'in silico' rather than in the laboratory. With certain simulations we anticipate that a full day's worth of wet lab research could be done in a matter of seconds on Blue Gene."

The system that will be installed at EPFL will occupy the floor space of about four refrigerators, and will have a peak processing speed of at least 22.8 trillion floating-point operations per second (22.8 teraflops), making it one of the most powerful supercomputers in the world.

The first phase of the project will be to make a software replica of a column of the neocortex. The neocortex constitutes about 85% of the human brain's total mass and is thought to be responsible for the cognitive functions of language, learning, memory and complex thought. An accurate replica of the neocortical column is the essential first step

to simulating the whole brain and also will provide the link between genetic, molecular and cognitive levels of brain function. The second and subsequent phases will be to expand the simulation to include circuitry from other brain regions and eventually the whole brain.

As part of the agreement with IBM, some of Blue Gene's time will also be allotted to other ambitious research projects. In one of the projects, researchers from IBM's Zurich Research Lab will work together with scientists from EPFL's Institutes of Complex Matter Physics and Nanostructure Physics to research future semiconductor (post-CMOS) technology such as carbon nanotubes; part of the continuing quest to build smaller semiconductors and microchips.

Elsewhere at EPFL, researchers will use Blue Gene to look at the use of plasmas as a possible method of energy production. Another team will use Blue Gene to research the folding of proteins and their role in the development of Creutzfeldt-Jacob (mad cow) and other diseases.