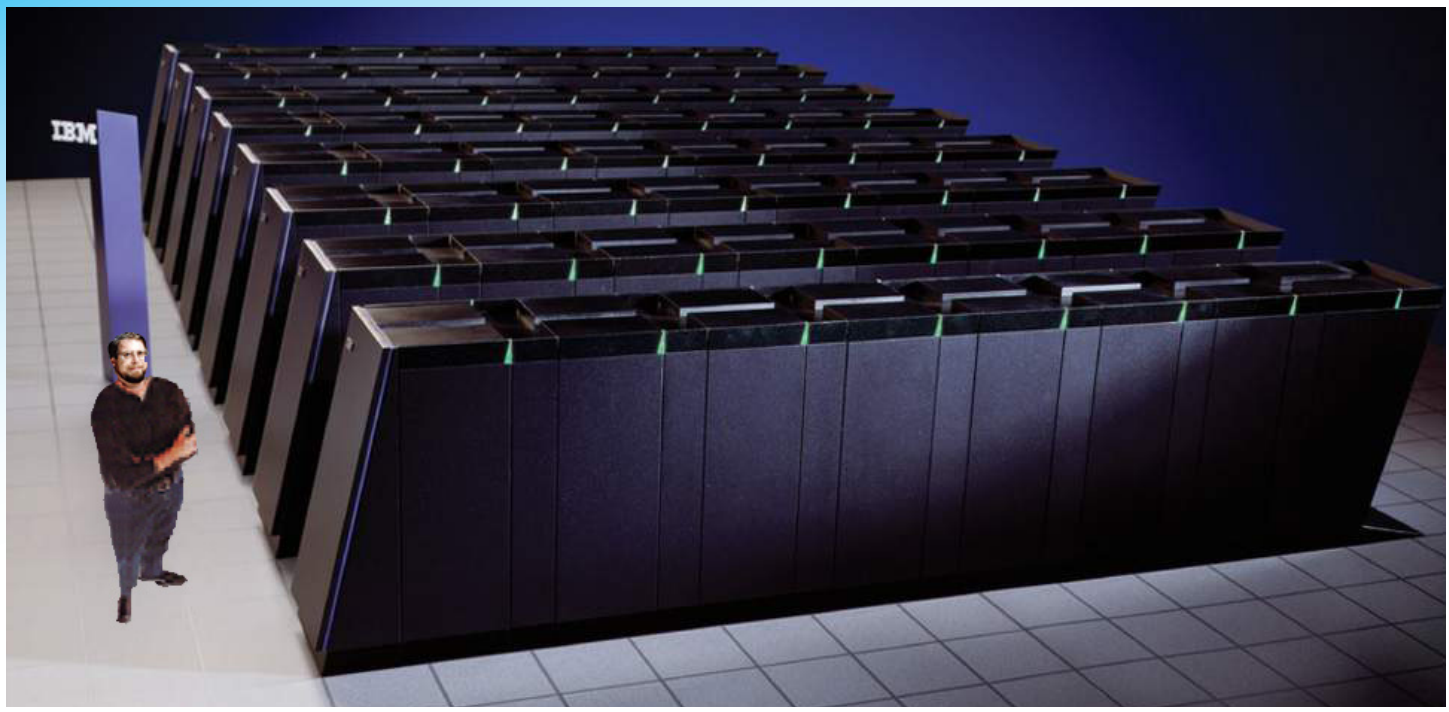
BlueGene/L

A revolutionary, low-cost machine to deliver extraordinary computing power for scientific simulations and programmatic work.



Creating a pathway for cost-effective scaling to petaop computing while delivering low platform and facility costs, BlueGene/L—a computational sciences research and evaluation platform designed by IBM Research for the DOE/NNSA Advanced Simulation and Computing (ASC) Program—is slated for delivery to Lawrence Livermore National Laboratory in early 2005.

To achieve ultra-performance computing, BlueGene/L takes a radically different approach from supercomputers such as ASC Purple and the Earth Simulator. Using a cell-based design, BlueGene/L is a scalable architecture in which the computational power of the machine can be expanded by adding more building blocks without introduction of bottlenecks as the machine scales up. By utilizing system-on-a-chip design technology and low-cost, low-power embedded microprocessors, BlueGene/L offers a theoretical peak computational rate of 360 teraops per second through extreme scalability.[1]

In June 2004, a 4096-node BlueGene/L prototype running at 500 megahertz (eventual target rate is 700 megahertz) delivered 11.68 teraops per second on the LINPACK benchmark, placing the prototype fourth on the twenty-fourth semi-annual "Top500 List of the World's Fastest Supercomputers." Another 2024-node BlueGene/L prototype with 700-megahertz processors delivered 8.655 teraops per second, placing it eighth on the list. With more than 65,536 dual processor nodes and 32 tebibytes of total memory (16×2^{40} bytes or 512 mebibytes memory per node), BlueGene/L is expected to be the fastest supercomputer in the world when it becomes operational in 2005.

To achieve this dramatic scale, BlueGene/L has three main communications networks: a 3D torus for nearest-neighbor calculations on grids; a global tree network for broadcasts and reduction operations; and a barrier network for synchronizing the complex algorithms in scientific calculations envisioned for the machine. The ASC strategy for using this cutting edge research platform is to significantly enhance ASC scientific simulations with BlueGene/L in targeted areas for maximum benefit. These areas include *ab initio* molecular dynamics for materials science, 3D disloca-

[1] A teraop per second is one trillion (10^{12}) floating-point operations per second.

From left: Lawrence Livermore National Laboratory Director Michael Anastasio and Computation Associate Director Dona Crawford watch as Secretary of Energy Spencer Abraham signs the first BlueGene/L rack on July 8, 2004.

The Terascale Simulation Facility at Lawrence Livermore National Laboratory will house both BlueGene/L and ASC Purple.

tion dynamics for materials modeling, kinetic Monte Carlo, turbulence, shock, and instability phenomena in hydrodynamics. The more complicated multiphysics mainline ASC and stockpile stewardship applications are targeted at ASC Purple. The demanding science applications targeted at BlueGene/L will relieve some of the intense pressure for access to ASC Purple. With this unique resource, BlueGene/L will provide ASC science researchers with a tool for computational sciences that is much more advanced than anything else available.

BlueGene/L will reside in the new Terascale Simulation Facility currently under construction at Lawrence Livermore National Laboratory. The Laboratory plans to use BlueGene/L as the vehicle for deploying revolutionary file system technology for large-scale storage, providing ultra-high bandwidth sharing of data between multiple systems and visualization platforms on the same system area network.

BlueGene/L will deliver nearly 10 times the peak compute speed, in one-fifth the area, using a fraction of the electrical power of the largest supercomputers. BlueGene/L is an essential step on the path to cost-effective scaling for petaop-level computing.

BLUEGENE/L

National Nuclear Security Administration

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