Roadrunner—Science at the Petascale

First to Break the petaFLOPS Barrier

On May 26, 2008, the Roadrunner supercomputer achieved more than a thousand trillion operations per second, or 1 sustained petaFLOPS, becoming number one on the TOP500 list of supercomputers. Built by IBM with funding from the NNSA for Los Alamos National Laboratory, Roadrunner is a "hybrid supercomputer," integrating a new Cell-based processor designed and built by IBM with a traditional microprocessor supplied by AMD. Coupled with programs designed to utilize its unprecedented performance, Roadrunner will foster scientific discovery in many fields, ranging from physical sciences to biology and medicine, and it will provide a petaFLOPS-scale scientific computing capability for the nation's weapons program.

Advanced Architecture for Algorithms and Applications

Our vision for high-performance computing embraces both multi- and unit-physics codes for weapons and open science. We target select physics implementations and convert the code to provide faster solutions or improved accuracy in key areas. The focus is more predictive-science oriented to validate model assumptions and better understand physics. Multi-scale problems also cross-validate physics models at overlapping resolutions. Roadrunner will provide resources necessary for predictive science@scale simulations.

Gordon Bell Prize Runs

Within a week of reaching a petaFLOPS of sustained performance, IBM gave LANL early access to Roadrunner to begin running three scientific codes on the full machine (17 Connected Units) in the Poughkeepsie, New York, plant. All three applications—VPIC, SPaSM, and PetaVision—achieved record-breaking levels of performance. SPaSM (molecular dynamics) and VPIC (plasma physics) code teams are finalists for the 2008 Gordon Bell Prizes.

Both photographs taken at Poughkeepsie, NY. Left: IBM and LANL team celebrating Linpack runs in May 2008. Right: Los Alamos National Laboratory Gordon Bell Peak Performance Prize finalists (L–R) Sriram Swaminarayan, Tim Germann, Ben Bergen, Brian Albright.

Green500

In addition to breaking the petaFLOPS barrier, the Roadrunner supercomputer located at Los Alamos is number 3 on the June 2008 Green500 list. The Roadrunner system delivers record-breaking 1.026 petaFLOPS while using only 2.345 megaWatts of power, an important advantage since construction of larger facilities would have been costly and time consuming. Roadrunner enables significant savings in operating costs with its power efficiency of 437 megaFLOPS/Watt, more than double that of the number 2 machine on the TOP500 list. Visit the Green500 website at www.green500.org/lists/2008/06/green500.php.

Roadrunner machine installed in the Metropolis Center for Modeling and Simulation at LANL.

ROADRUNNER AT A GLANCE

Cluster of 17 Connected Units

- 180 Triblades/Connected Unit (CU)
- 6,120 AMD dual-core Opterons
- 12,240 IBM PowerXCell 8i processors
- 44.1 teraFLOPS peak (Opteron)
- 1.33 petaFLOPS peak (Cell eDP)
- 1.026 petaFLOPS sustained Linpack

InfiniBand 4x DDR fabric

- 2-stage fat-tree; all optical cables
- Full bisection BW within each CU
  - 384 GB/s (bidirectional)
- Half bisection BW among CUs
  - 3.3 TB/s (bidirectional)
- Nondisruptive expansion to 24 Cus

98 TB aggregate memory

- 49 TB Opteron
- 49 TB Cell

204 GB/s sustained File System I/O

- 204 x 2 10G Ethernets to Panasas

Fedora Linux (RHEL possible)

SDK for Multicore Acceleration

- Cell compilers, libraries and tools

xCAT Cluster Management

- System-wide GigE management network

2.35 MW Power

- 437 Mflop/Watt, #3 on Green500

Size

- 278 racks
- 5200 ft^2
- 55 miles of IB cable
- 250 tons

For more information, visit http://www.lanl.gov/roadrunner