

Los Alamos Computer Science Symposium (LACSS)

- * LANL is delighted to restart the **Los Alamos Computer Science Symposium** series after a 1 year interruption (following the passing of Prof. Ken Kennedy who chaired the previous Symposia)
- * **Motivation** for the Symposium:
 - serve as a premier international event showcasing research and development in high-performance computing
 - foster collaborations between national labs, academia and industry in the HPC arena
 - promote computer science research that will advance HPC programs at LANL and elsewhere
 - encourage a strong focus on HPC in the academic computer science community
- * Symposium **theme this year**: hybrid and heterogeneous systems, including architecture and programming environments.



FY 2008 LANL Budget: \$2.2 Billion

LANL's future is multi-program, based on integrated capabilities

Be the premier National Security Science Laboratory for a dynamic future.

- *We must succeed in three broad areas of growth and transformation*

Science that Matters

- Information Science & Technology enabling Integrative and Predictive Science
- Experimental Science focused on Materials for the Future
- Fundamental Forensic Science for Nuclear, Biological, Chemical Threats

How We Work

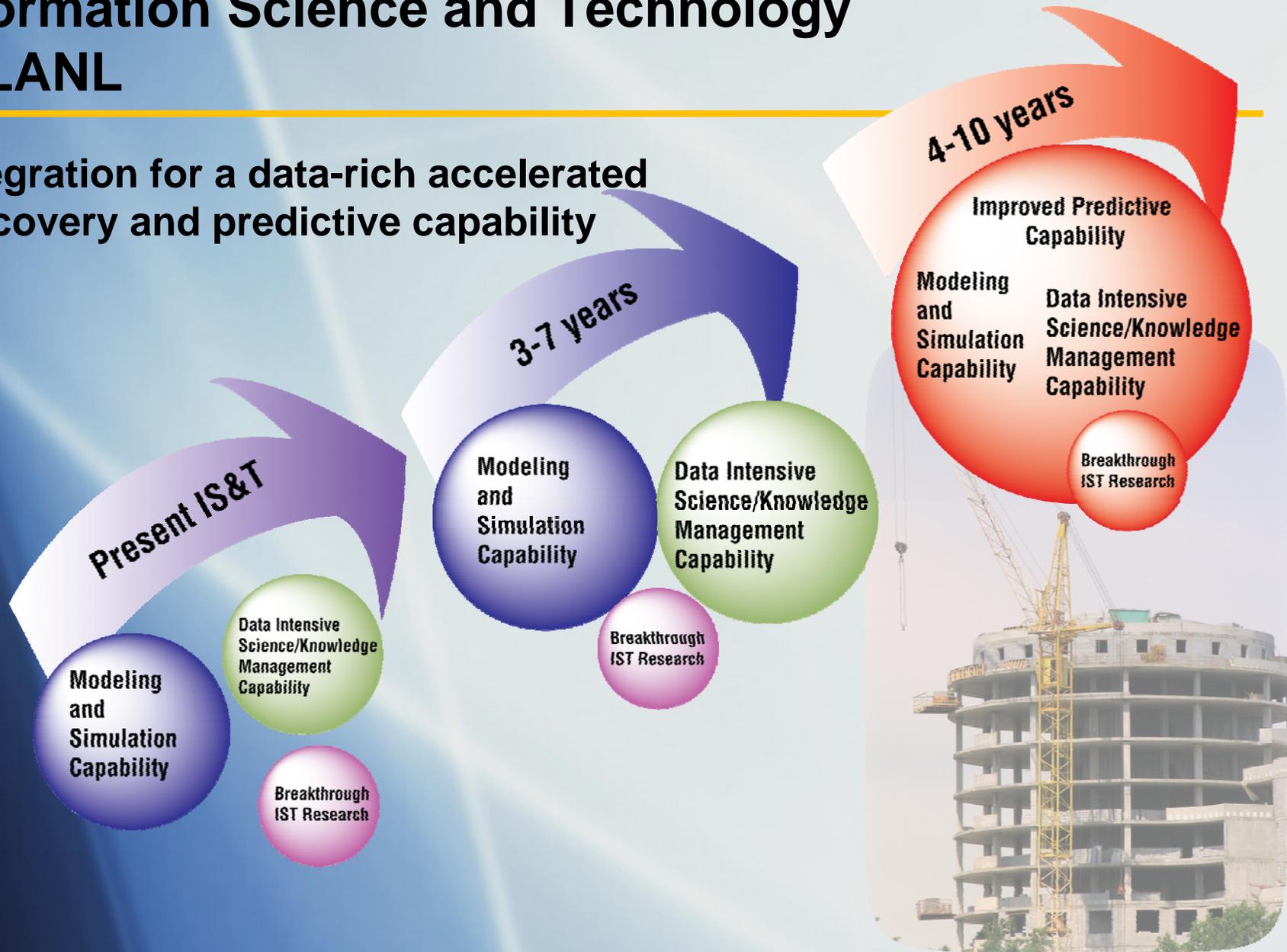
- Collaborate, partner and team to make decisive contributions to our sponsors
- Outstanding operational excellence for safety, security, and efficient pursuit of ST&E for our missions

Transform our Scientific Campus and Facilities

- Campus for 2020
- Consistent with complex transformation
- LANSCE-R, CMRR, Science Complex
- Signature Facilities: MaRIE and Roadrunner

Information Science and Technology at LANL

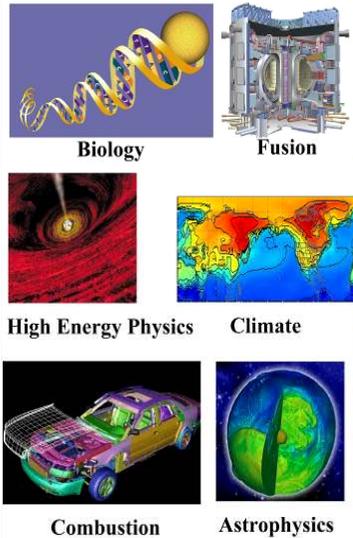
Integration for a data-rich accelerated discovery and predictive capability



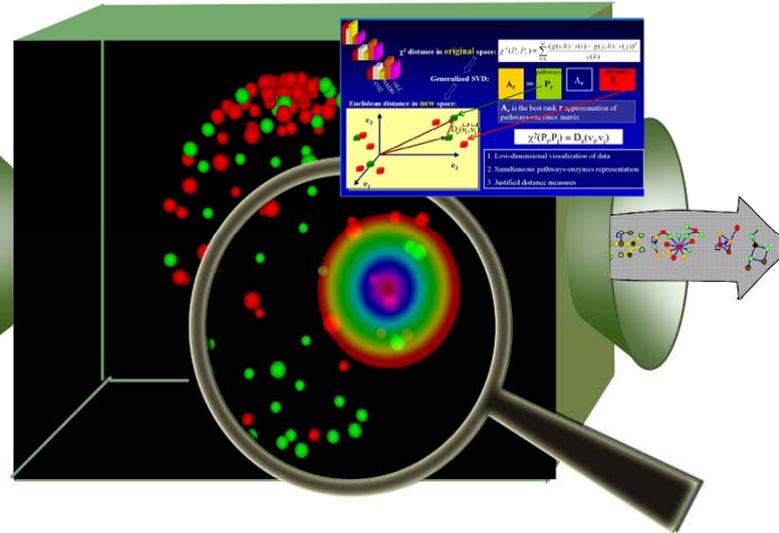
Connecting the Dots in Science

Finding the Dots

Raw Scientific Data



Connecting the Dots



Understanding the Dots

Payoffs for the Nation



Sheer Volume of Data

Climate

Now: 20-40 Terabytes/year
 5 years: 5-10 Petabytes/year

Fusion

Now: 100 Megabytes/15 min
 5 years: 1000 Megabytes/2 min

Advanced Mathematics and Algorithms

- Huge dimensional space
- Combinatorial challenge
- Complicated by noisy data
- **Requires high-performance computers**

Providing Predictive Understanding

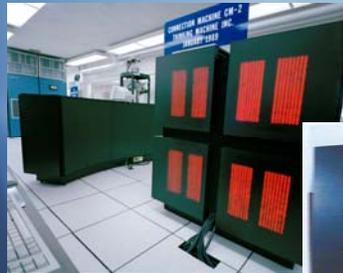
- Produce hydrogen-based energy
- Stabilize carbon dioxide
- Clean and dispose toxic waste



Raymond L. Orbach, DOE Undersecretary for Science
 2006 AAAS Annual Meeting

LANL History in HPC Hardware and Advanced Architectures for HPC-Enabled S&T Frontiers

Thinking Machines - We started the modern Era



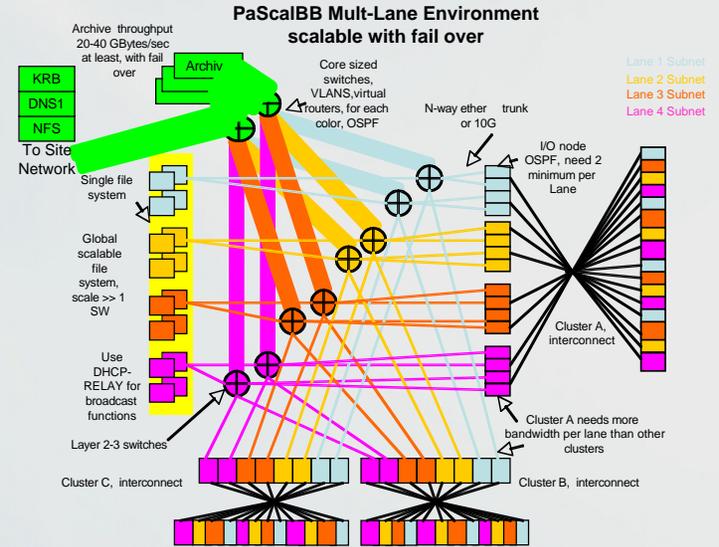
1985



Lightning - Modern Linux Clusters



Robust scalable computing and communications



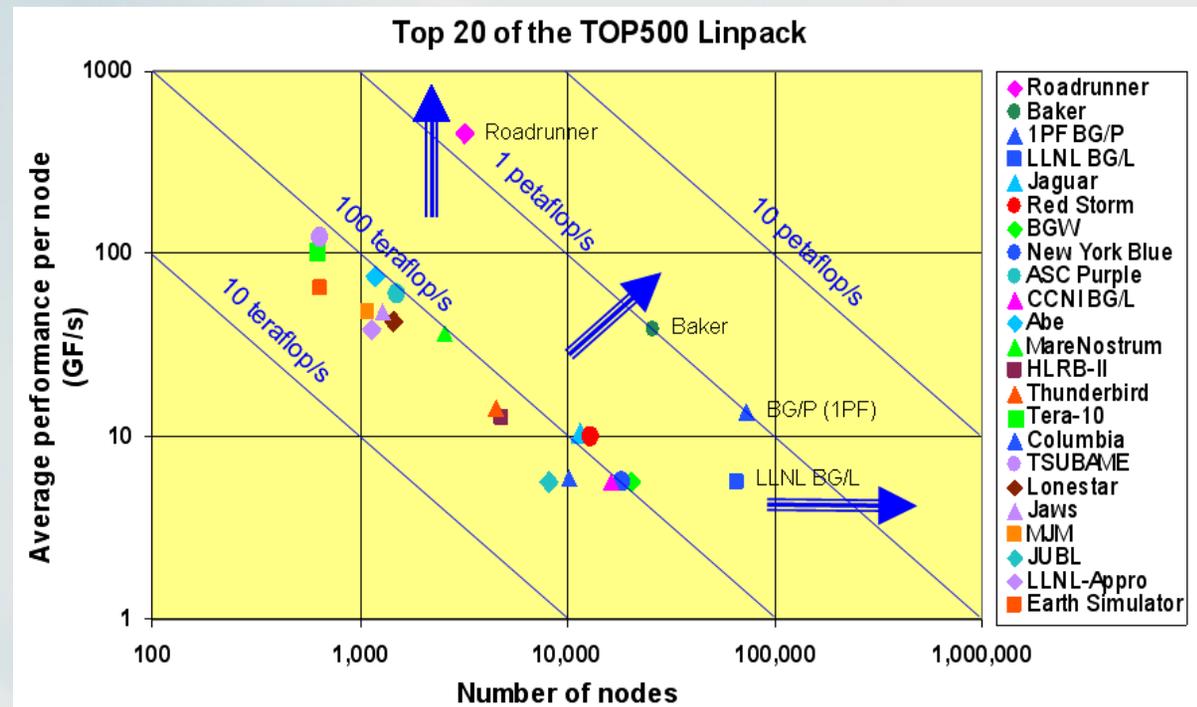
Heterogeneous Computing Roadrunner - to **Petaflops**



2006 →

LANL has been exploring hybrid computing, a transformational technology, for over 5 years

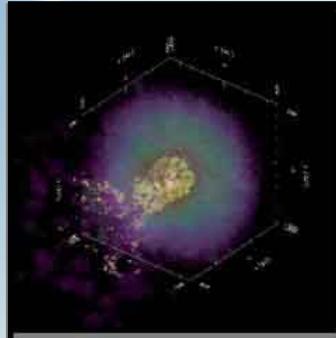
- Roadrunner embodies many key architectural trends
 - Cluster computing
 - Multicore
 - SIMD
 - Hybrid
- Roadrunner provides immediate benefits for solving important problems in weapons science



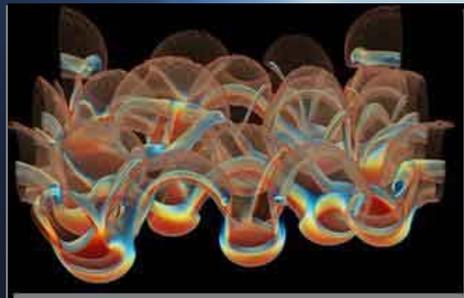
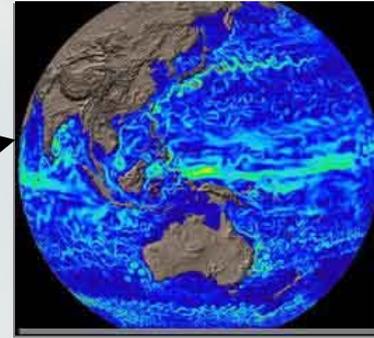
Roadrunner is a different path to a petascale system

Petascale performance provided by Roadrunner will push scientific boundaries in numerous areas.

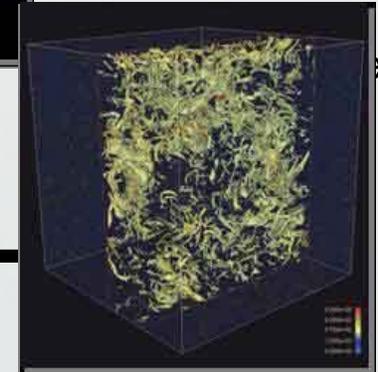
astrophysics



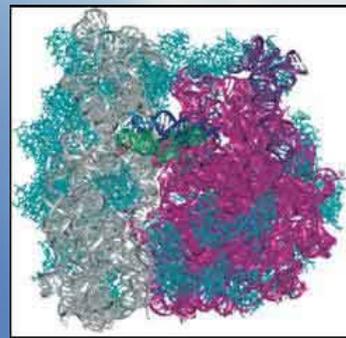
ocean modeling



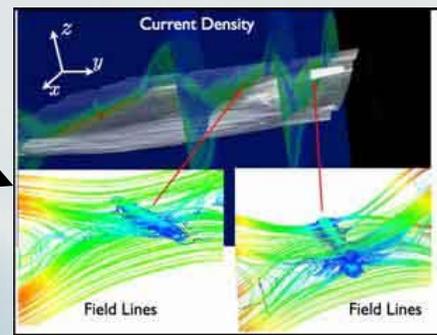
fluid instabilities



protein dynamics



magnetic reconnection



***Roadrunner* embodies many key architectural trends, each in moderation**

- ✦ *Roadrunner* has: multicore, short-vector SIMD, threads, heterogeneous instruction sets, local stores instead of caches, on-chip CPU/memory networks, remote accelerators and cluster computing.
- ✦ Any of these features can be used as needed, without requiring extremes in any one of them.
- ✦ *Roadrunner's* scale and flexibility makes it an ideal base from which to explore the changing landscape of hybrid and heterogeneous architectures.

A LANL Update for LACSS

To emphasize the importance of this area for LANL endeavors, we have established the **Center for Advanced Architectures and Usable Supercomputing (CAAUS)**

✳️ LACSS is organized under the auspices of CAAUS

✳️ Some goals of CAAUS:

- comprehensive focus on the design of new generations of high-productivity supercomputing systems grounded in applications of interest to LANL for the 21st century
- build a world-class computer science capability for HPC at Los Alamos
- attract staff at Los Alamos in computer science, and serve as a portal for staff integration into other technical activities at the laboratory
- build new programs to support LANL goals in HPC R&D