



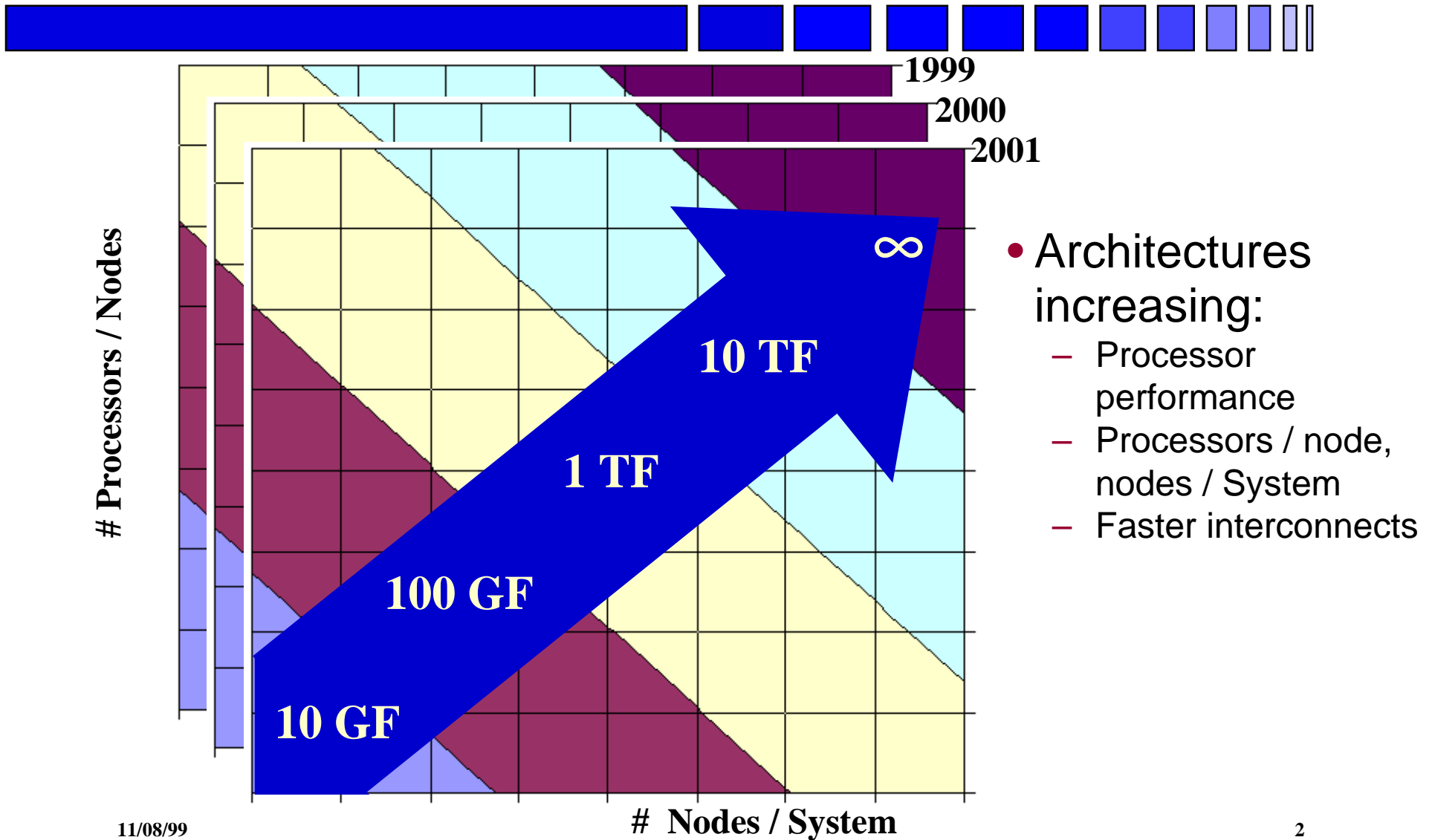
Department of Energy High Performance Computing

Optical Interconnect Workshop
November 8, 1999

George Seweryniak
ESnet Program Manager
DOE HQ (GTN)



System Architecture Trends

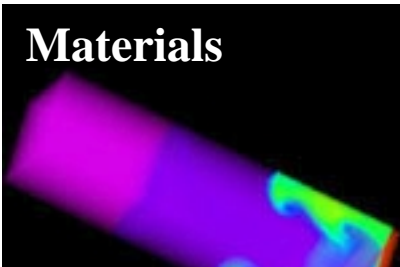




DOE Challenges

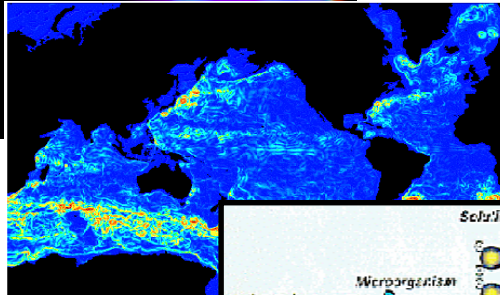
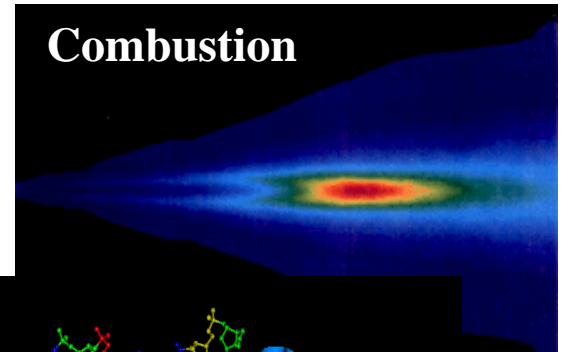


Materials

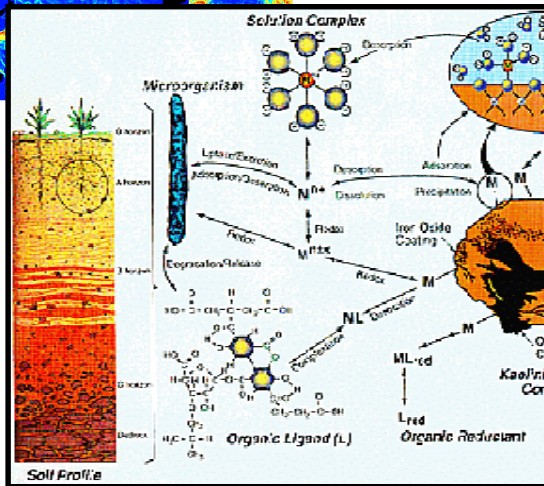


Many DOE Programs Need Dramatic Advances in Computing Capabilities To Meet Their Mission Goals

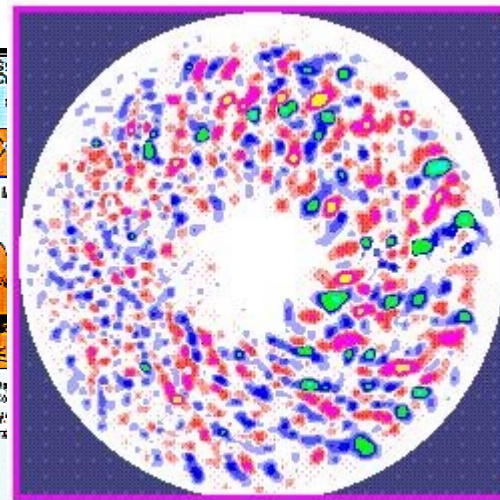
Combustion



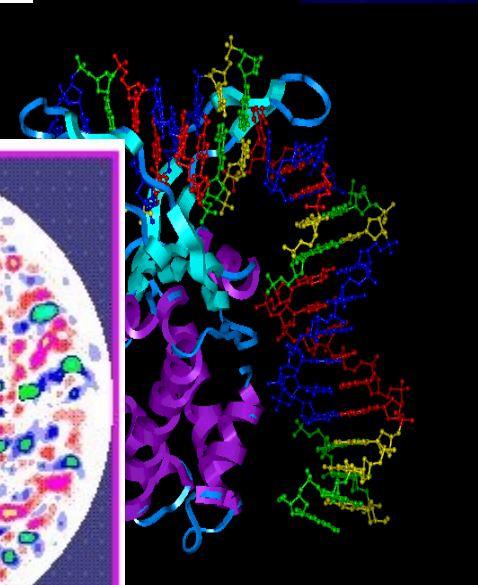
Global
Systems



Subsurface Transport



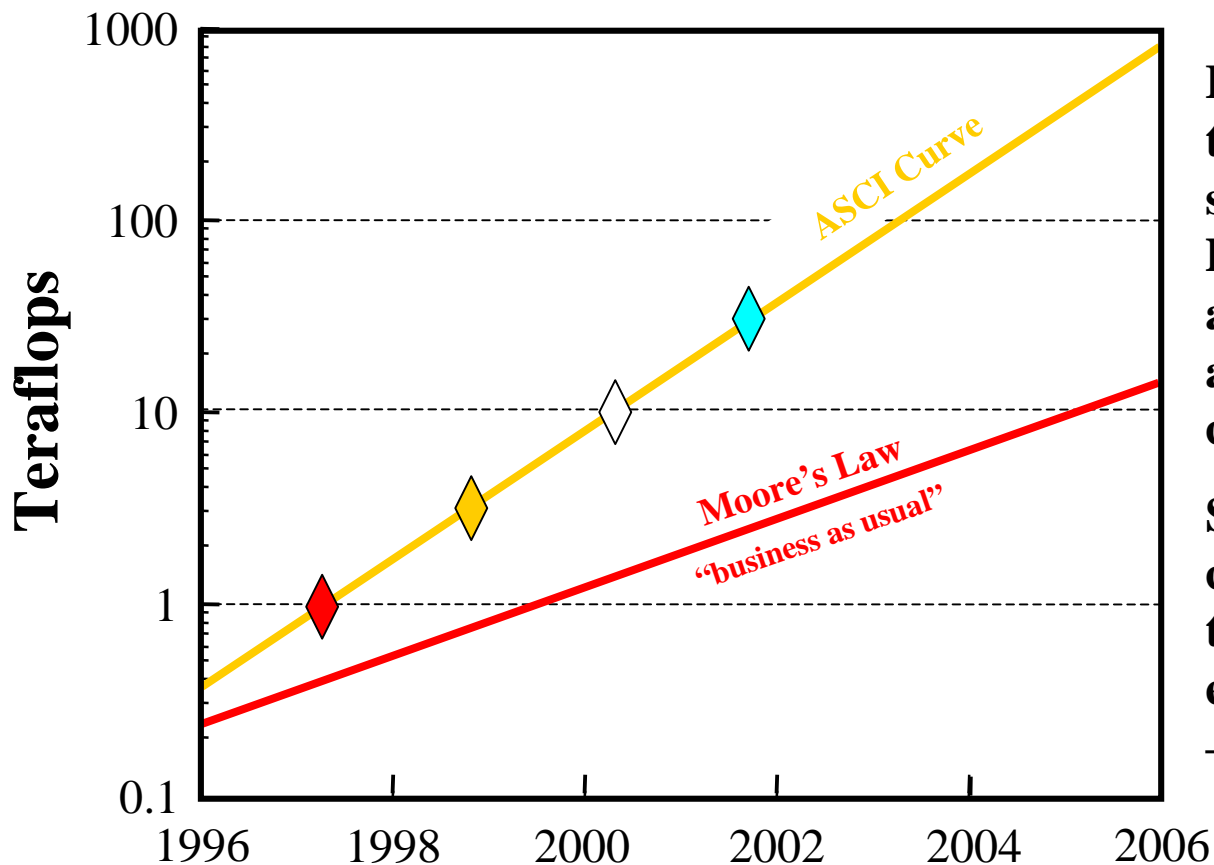
SCIENCE 9/18/98
Simulation of Plasma Turbulence
Fusion Energy



Health Effects,
Bioremediation



DOE Computing Challenges



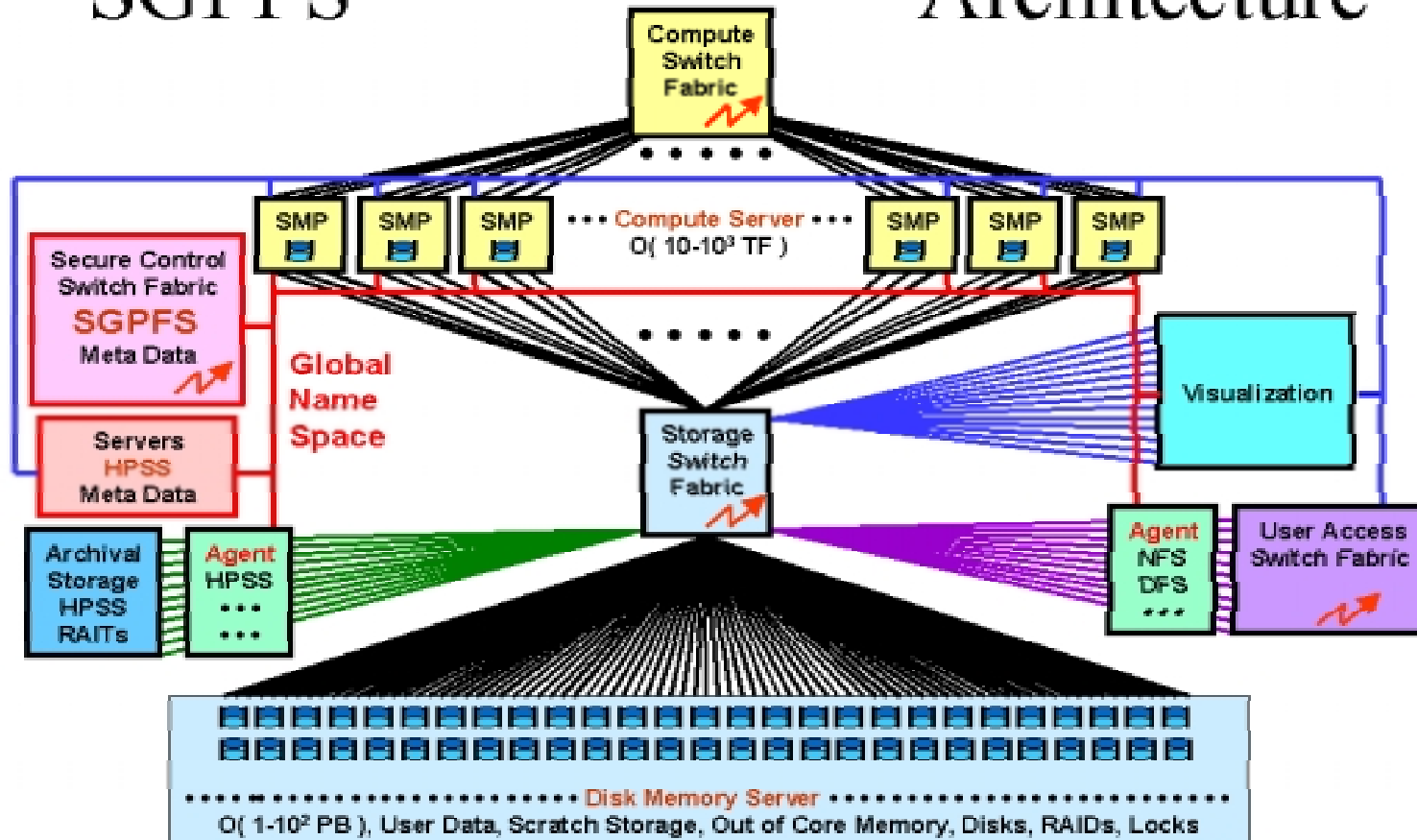
Building on a long tradition of driving the supercomputer industry, DOE, *via* ASCI, is once again fostering dramatic advancements in scientific computing.

SSI will make these capabilities available to the broader scientific and engineering communities —at much reduced cost.



DOE ASCI Challenge

Scalable Global Parallel File System Architecture SGPFS





Scientific Simulation Initiative

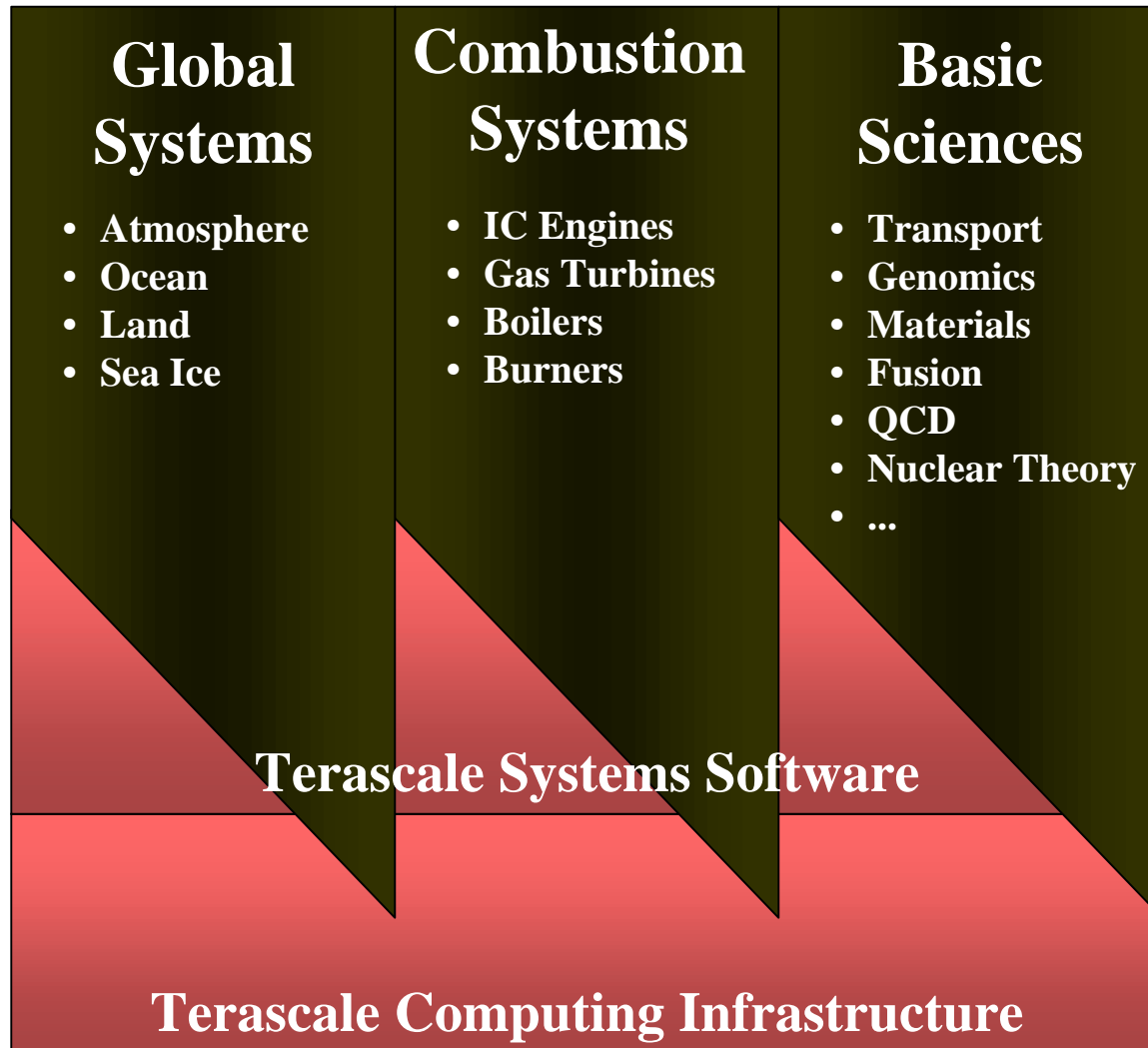
In FY2000 the U.S. Department of Energy requested funding to initiate the **Scientific Simulation Initiative**. The SSI seeks to:

“... revolutionize the way that the Department of Energy solves its most demanding, mission-critical problems by fully utilizing the power of advanced computational simulation.”

*Ernest J. Moniz
Undersecretary of Energy
December 1997*



Initial SSI Program

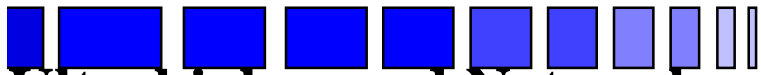
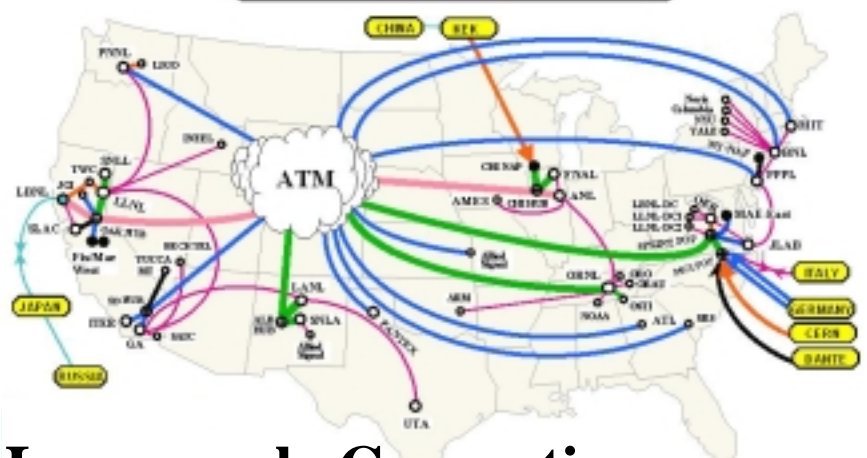




Terascale Computing Infrastructure



ESnet BACKBONE
Mid 1999



Ultrahigh-speed Networks

- 10-... Gbits/sec backbone network
- 1-... Gbits/sec network to support major sites
- Team with IT² agencies to extend networking capabilities to other sites

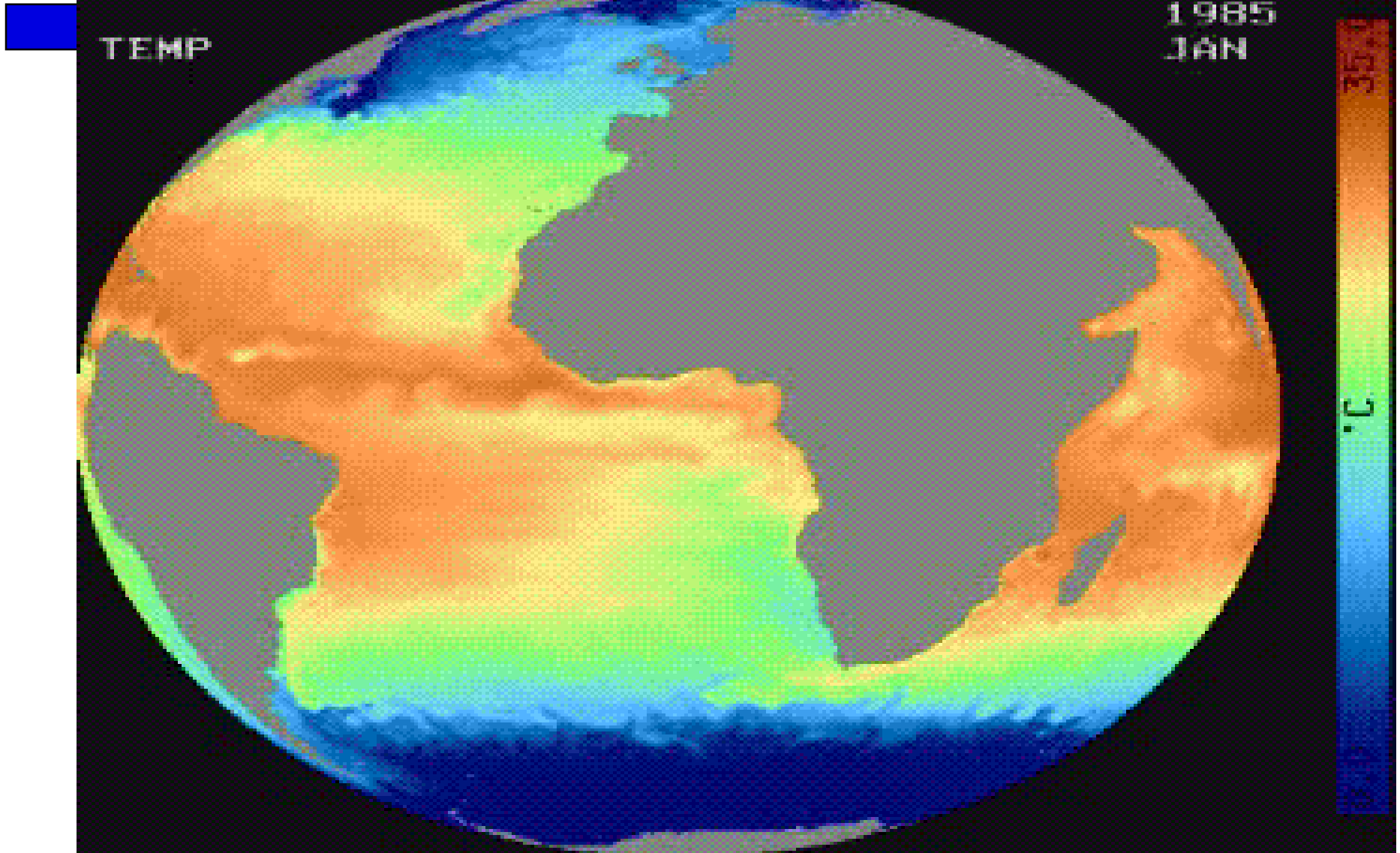
Large-scale Computing Systems

- A site to operate a leading-edge tera-scale (5-40-... tf) computer system
- A terascale computing infrastructure to enable full utilization of the leading-edge capability
- Team with other agencies to extend computing capabilities to other sites.





Global Climate Computing

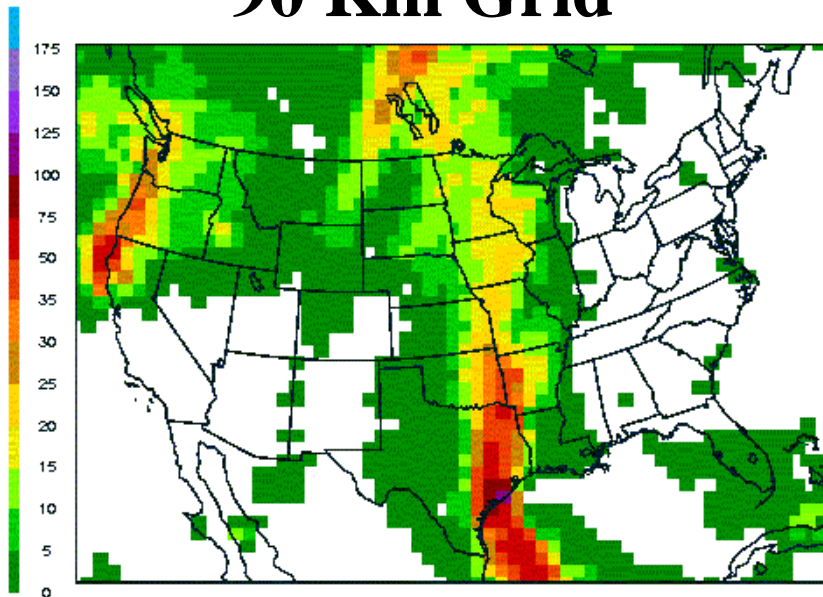




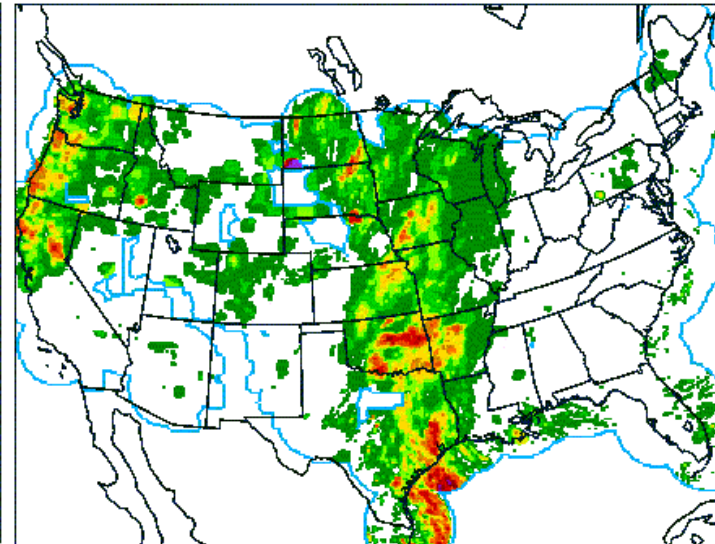
Meteorological Models



90 Km Grid



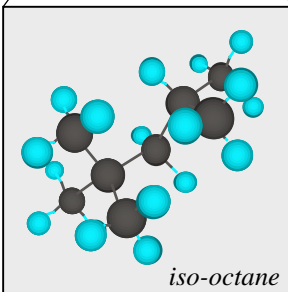
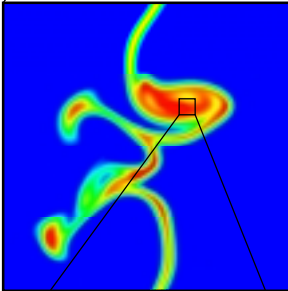
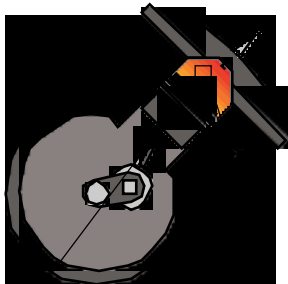
14 Km Grid



- **Finer grid resolution provides more detail**
 - Increase vertical and horizontal resolution
 - Data collection can be a major problem
 - Requires more computational power and storage
- **Can add more physics to the model**
 - Need high speed interconnects for computation/storage



Combustion Systems



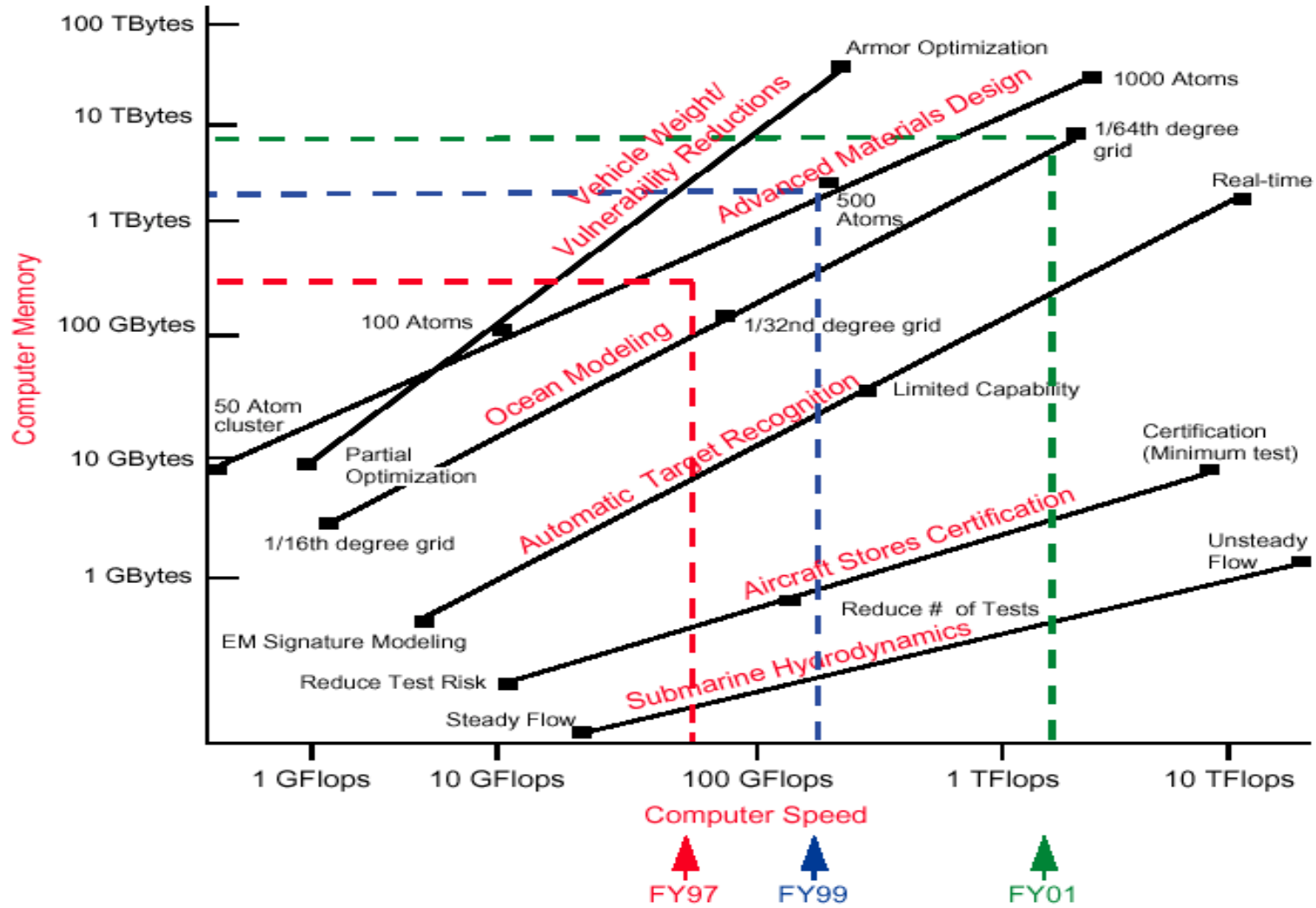
Advances in combustion systems simulation requires **fundamental advances** in a number of areas, including:

- ▲ Development and utilization of high-resolution models of combustion devices (engines, burners, *etc.*);
- ▲ Development of reduced chemical mechanisms for fuel oxidation and pollutant formation;
- ▲ Development of rigorous science-based descriptions of processes, such as turbulence-chemistry interactions, droplet evaporation, *etc.*; and
- ▲ Integration of these submodels into a high-fidelity model of the complete system;

as well as in using terascale computer systems for the wide range of scientific applications (mechanical engineering, fluid dynamics, chemistry, materials science) involved in combustion.



Problem Ensembles





Technical Challenges

- **Computers**

- Terascale computers are based on a **new architecture**
—massively parallel arrays of multiprocessors
- require very fast / reliable interconnects

- **Systems Software**

- **Operating system software** does **not** provide all of the needed functionality—lack of vendor financial interest
- **Applications systems software** is non-existent for the scale of problems of interest

- **Simulation Software**

- **Existing software** does **not exploit the power** of the new architecture

- **Industry**

- Government / industry partnerships required to meet the challenges



Can DOE Meet the Challenge?

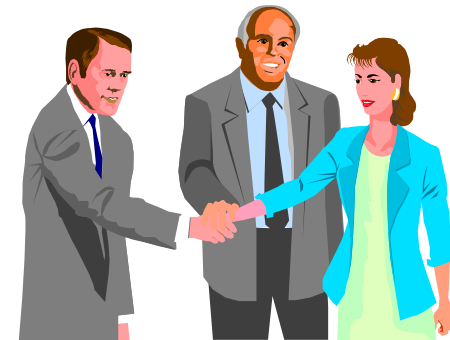
- Because of its mission, DOE has long been a **lead agency in high performance computing, scientific simulation, computer science, and applied mathematics**
- DOE has a long and successful history of establishing and operating **world-class computing facilities** and **first-of-a-kind computer systems**—from the IBM Stretch in the 1960's to the massively parallel computers of the 1990's
- DOE has a long and successful history of **managing large, complex research projects**



DOE Commitment



- **DOE cannot meet its mission without Terascale computing and Terascale infrastructure**
 - cannot solve it alone
 - need to work with industry
 - system level approach

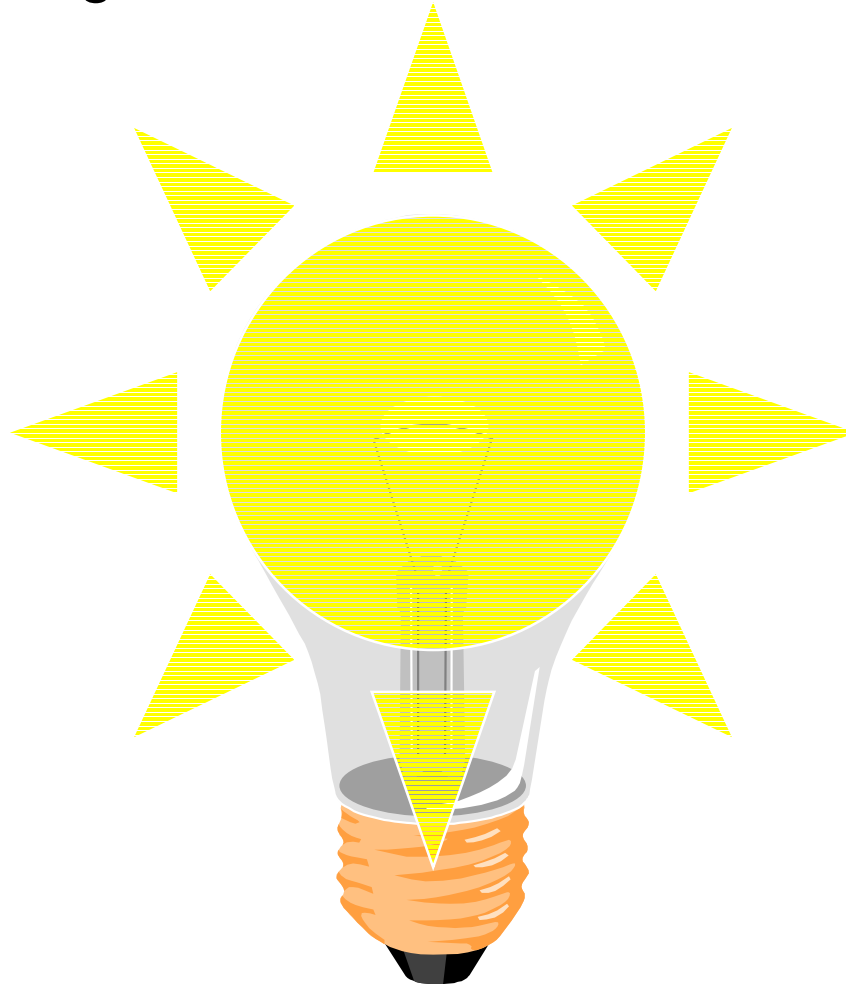




Optical Interconnects



- A light at the end of the tunnel???



THE END