DOE Initiatives in Scientific Simulation

A Golden Opportunity for Lattice Gauge Theory

The Scientific Simulation Initiative

SSI

- 5 TFlops Computer in 2000 → 40 TFlops in 2004
- Funding for a limited number of fields to use these machines
  - Combustion
  - Global Change
  - A Few Areas of Basic Science

High Energy and Nuclear Physics Participation in SSI

- Data Management for High Energy Physics Experiments (LHC)
- Accelerator Design
- Supernova
- Lattice Gauge Theory

Lattice Gauge Theory Executive Committee

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Whitepaper

- **Scientific Objective: Precision non-perturbative calculations in QCD with direct bearing to experiments.**
  - **Weak interactions of strongly interacting particles**
  - **Hadron mass spectrum**
  - **High temperature QCD**
  - **Internal structure of hadrons**
- **Resource Needs**
  - **Calculation of α_s:**

    1 Gflops-year
  - **Current state of the art calculations:**

    50 Gflops-years
  - **High precision calculations with light quarks:**

    Several Tflops-years

- **Resources Available for Lattice QCD in Various Countries in Sustained Gflops**

Country	Current Resources	Expect Resources (In 2000)
Germany	134	264
Italy	154	554
Japan	380	980
United Kingdom	41	41
United States	320	320

- **Resources Available for Lattice QCD in the US in Sustained Gflops**

Source	Resources
Columbia QCDSP	120
BNL QCDSP	180
Largest LGT Allocation at NERSC for 2000	2
Largest LGT Allocation at NSF Centers for 2000	10

- Conclusions:
  - At present 90% of US lattice gauge theorists do not have the computational resources to carry out state of the art calculations.

  - The US lattice gauge theory community must acquire the capability of performing multi-Tflops-years calculations within the next few years if it is to maintain its leadership role in the field, and serve the needs of the experimental program.

- Cost Comparisons of Computers for QCD

Computer	Cost ($/Mflops)
T3E	480
Origin 2000	190
CP-PACS	70
QCDSP	10
Indiana U. Cluster	10
Fermilab Cluster	25

- **Conclusion: For QCD we should build our own machines, not buy commercial ones.**

Plan for 2000 – 2001

- **Objectives**
  - To enable lattice gauge theorists outside of Columbia and BNL to perform three to five state of the art calculations (50 Gflops-years) simultaneously.
  - To carry out the research and development needed for the next stage of the plan, which aims at multiple Tflops-year projects.
- **Hardware Development and Use**
  - QCDSP
  - Pentium Based Cluster at Fermilab
  - Alpha Based Cluster at Jefferson Lab/MIT
  - Development of the QCDOC
- **Projected Cost: $4,000,000**

Plan for 2002 – 2005

- **Objective: To enable US lattice gauge theorists to carry out precision calculations of quantities with direct bearing on experiments. Such calculations will typically require multi-Tflops-years.**
- **Hardware Options**
  - **QCDOC**
  - **Clusters**
  - **Hardware decisions will be made on the basis of the experience gained in the first two years of the plan, the outcome of development work on the QCDOC and dedicated clusters, and the commodity hardware market.**
  - **The ability of the hardware and software to support the scientific program will be the ultimate deciding factor.**
- **Projected Cost: $8,000,000**
- **It is vital to establish a long term program with stable funding.**

Scientific Discovery through Advanced Computing

SDAC

- Complex Problems of Basic and Strategic Importance
  - Fundamental nature of matter
  - Origin of the universe
  - Behavior of plasmas
  - Design of materials
  - Weather prediction
  - Climate prediction
  - Analysis of impacts of earthquakes
  - Improvement of human health
  - Solution of environmental problems
  - Design of combustion devices
- Scientific Computing Software Infrastructure
- Scientific Computing Hardware Infrastructure
  - Flagship Computing Facilities
  - Topical Computing Facilities
  - Experimental Computing Facilities
- The SDAC Initiative includes $7,000,000 in direct funding for HENP in 2001.

Message from Peter Rosen: **Lattice gauge theorists must have a plan for their field as a whole which is broadly supported by their community, if they are to participate in SDAC, or obtain new funding from the HENP Program.**