U.S. DEPARTMENT OF ENERGY

Office of Science

Strengthening America's Infrastructure Security

Making the Case for a Science-based Approach

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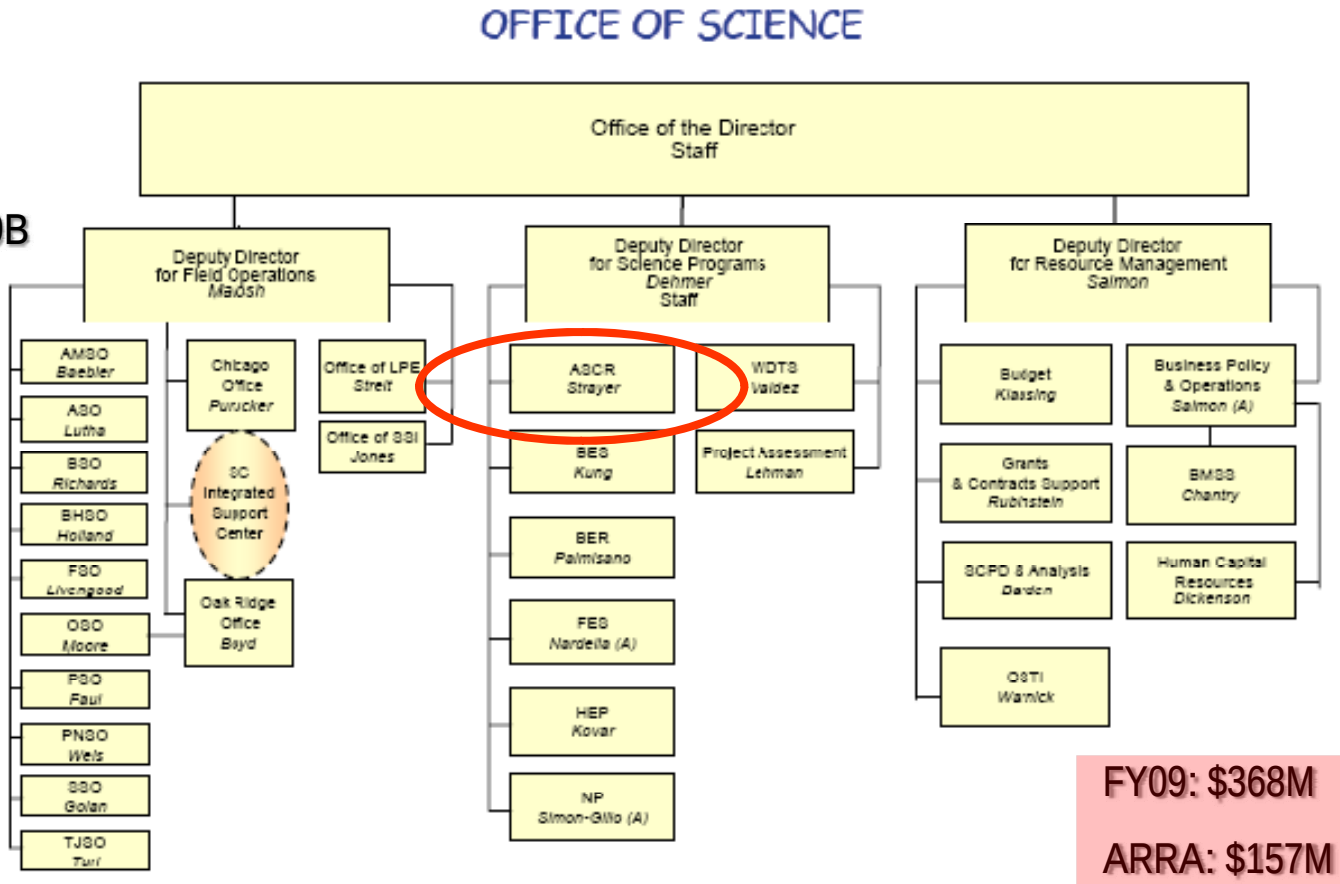
Organization

FY09: $4.8B

ARRA: $1.6B

FY10 (Req): $4.9B



FY09: $368M

ARRA: $157M

FY10 (Req): $409M

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Vision

-- Advanced Scientific Computing Research --

- **Deliver Petascale Science Today**
  - Continue to make the Leadership Computing Facilities available to the very best science through Innovative and Novel Computational Impact on Theory and Experiment (INCITE).
  - Continue to work with Pioneer Applications to deliver scientific results from day one.
- **Build the Intellectual Foundation for the Future**
  - Continue to nurture –
    - World class mathematics and computer science research efforts
    - Applications critical to DOE missions through Scientific Discovery through Advanced Computing (SciDAC).
  - Provide direct support for “bleeding-edge” research groups willing to take on the risk of working with emerging languages and operating systems.
  - Foster innovative research at the ever blurring boundary between Applied Mathematics and Computer Science.
- **Realize the Promise of Extreme Scale**
  - Work with key science applications to identify opportunities for new research areas only possible through extreme scale computing.
  - Support innovative research on advanced architectures and algorithms that accelerates the development of hardware and software that is well suited to extreme scale computational science.

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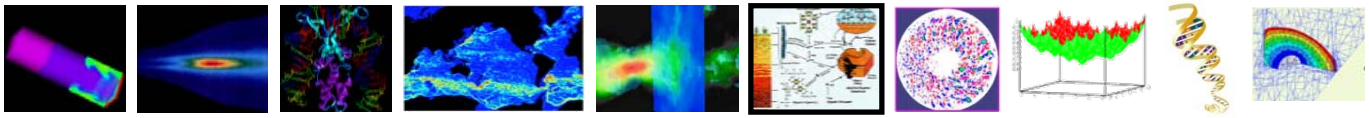
SciDAC 2
Path to Petascale

Scientific Discovery



Applications

Computing/ Networking

SciDAC 2

- Accelerator science and simulation
- Climate modeling and simulation
- Fusion science
- Petabyte high-energy/nuclear physics
- Nuclear physics
- Radiation transport
- Astrophysics
- Computational Biology
- High-energy physics
- Materials science and chemistry
- QCD
- Turbulence
- Groundwater reactive transport modeling and simulation

- Centers for Enabling Technology

- Scientific Applications Partnerships
- Institutes (University-lead)

INCITE NERSC Allocation

Leadership Computing-ANL	556 TF IBM BG/P
Leadership Computing-ORNL	263 TF Cray XT4 → 1 PF Cray XT5
Production Computing-NERSC	104 TF Cray XT4 → ~360 TF Cray XT4
ESnet	On path toward Dual rings 40Gbps/ 10 Gbps fault tolerant

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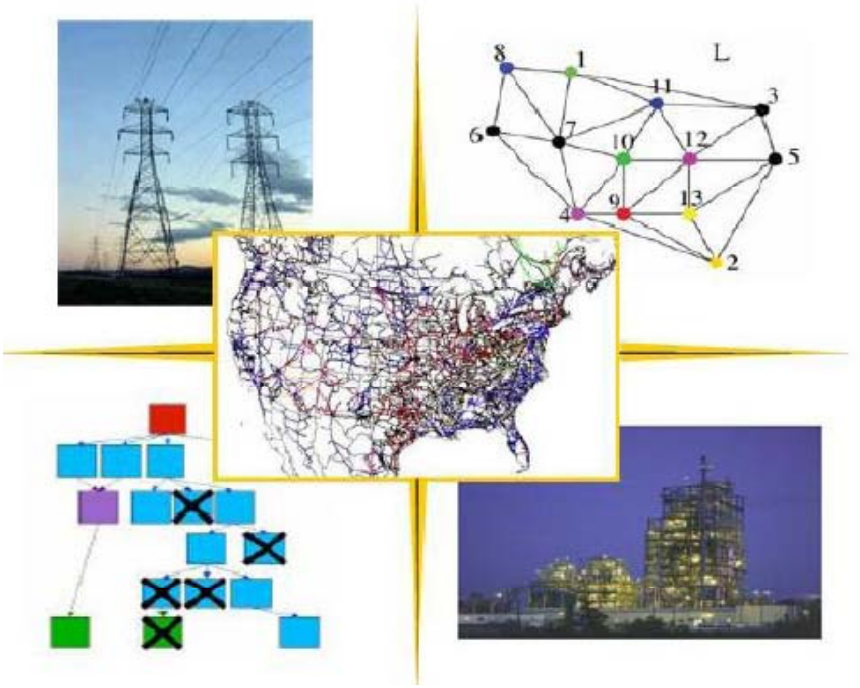
Infrastructure

Electric power grid:

- **coal, hydro, nuclear, wind/solar power generation**
- **Substations and transmission lines**
- **Supervisory control and data acquisition (SCADA) systems**

- **Open-science research information networks:**
  - **remote access to high-performance computing facilities;**
  - **massive data movement;**
  - **international scientific collaborations;**
  - **collaboratories;**
  - **cloud computing**
- **National security assets**



Enormous, distributed, complex, and heterogenous !

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What about Cyber-Security ?

- Solutions are proprietary, provided in response only to known vulnerabilities or exploits.
- Every network component- assumed to be understood and initially trusted
- Users drive network growth and evolution (e.g. home wireless routers; “renewable” energy generation),
- Not understanding complex networks means we cannot:
  - Define the ‘normal’ operation envelope;
  - Rationally optimize performance;
  - Safeguard against abnormal operations.

Science-based understanding and predictive capabilities could lead to a Sustainable Solution

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So you Want to Transmit a Petabyte ?

referemce: see http://fasterdata.es.net/BandwidthRequirements.html

Assuming ideal transmission:

Speed	1 Mbps	50 Mbps	1 Gbps	10 Gbps	100 Gbps
Time	272 years	5.5 years	3 months	9.7 days	1 day

More likely for scientific data movement

- The data may be in transit for a long time
- The "peering arrangements" are numerous and heterogeneous
- Hops are not predetermined

How can delivery be assured and guaranteed ?

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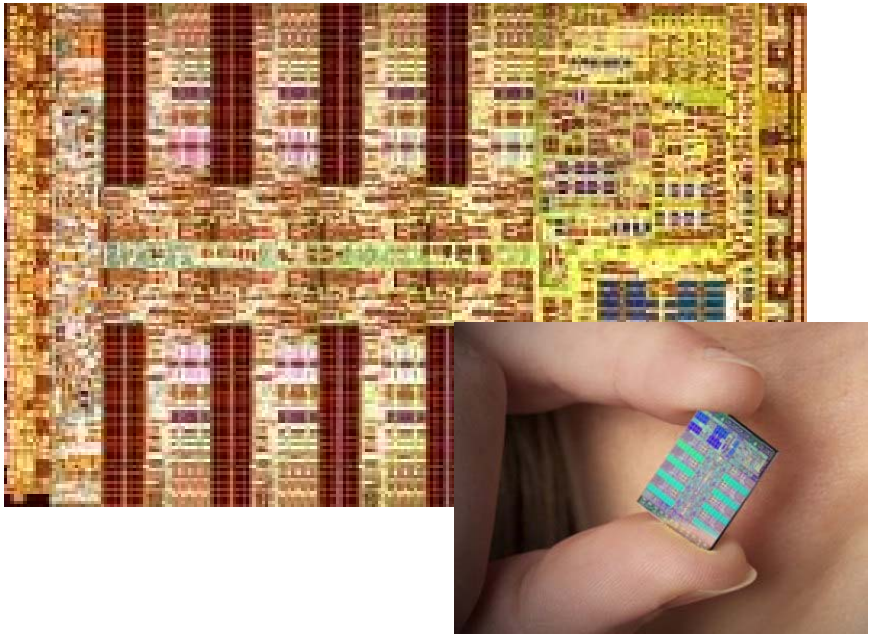
Hardware Landscape

- **Commercial, off the shelf**
- **Unknown supply chain**
- **Proprietary manufacturing processes**
- **Integrity of Firmware (e.g. BIOS) accepted by default**



Grand Challenge

Σ (untrusted components) = Trusted System

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Solving the Puzzle
-- New Research Activity --

- Emphasis on interconnected systems operating *within purview of DOE*: computer networks, electric power grid, critical infrastructures
- Areas of interest include
  - Real-world, real-time data generated by complex, distributed, interconnected systems and associated novel data analysis techniques and methods for advanced situational awareness
  - Modeling and simulation of the key properties and emergent behavior on large-scale complex distributed interconnected systems
  - Mathematical methods for modeling and analysis of the dynamics and evolution of large-scale, complex, distributed interconnected systems
- $3.5M/year
- Lab-based projects:
  - foundation for engaging broad research community in the future
- Anticipate 5-7 awards