U.S. DEPARTMENT OF ENERGY

Department of Energy
Planning for Exascale

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Department of Energy

United States Government
Organization Chart

THE GOVERNMENT OF THE UNITED STATES

THE CONSTITUTION

LEGISLATIVE BRANCH

THE CONGRESS

SENATE HOUSE

ARCHITECT OF THE CAPITOL
UNITED STATES BOTANIC GARDEN
GOVERNMENT ACCOUNTABILITY OFFICE
GOVERNMENT PRINTING OFFICE
LIBRARY OF CONGRESS
CONGRESSIONAL BUDGET OFFICE

EXECUTIVE BRANCH

THE PRESIDENT
THE VICE PRESIDENT
EXECUTIVE OFFICE OF THE PRESIDENT

WHITE HOUSE OFFICE
OFFICE OF THE VICE PRESIDENT
COUNCIL OF ECONOMIC ADVISERS
COUNCIL ON ENVIRONMENTAL QUALITY
NATIONAL SECURITY COUNCIL
OFFICE OF ADMINISTRATION
OFFICE OF MANAGEMENT AND BUDGET
OFFICE OF NATIONAL DRUG CONTROL POLICY
OFFICE OF POLICY DEVELOPMENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
OFFICE OF THE UNITED STATES TRADE REPRESENTATIVE

JUDICIAL BRANCH

THE SUPREME COURT OF THE UNITED STATES

UNITED STATES COURTS OF APPEALS
UNITED STATES DISTRICT COURTS
TERRITORIAL COURTS
UNITED STATES COURT OF INTERNATIONAL TRADE
UNITED STATES COURT OF FEDERAL CLAIMS
UNITED STATES COURT OF APPEALS FOR THE ARMED FORCES
UNITED STATES TAX COURT
UNITED STATES COURT OF APPEALS FOR VETERANS CLAIMS
ADMINISTRATIVE OFFICE OF THE UNITED STATES COURTS
FEDERAL JUDICIAL CENTER
UNITED STATES SENTENCING COMMISSION

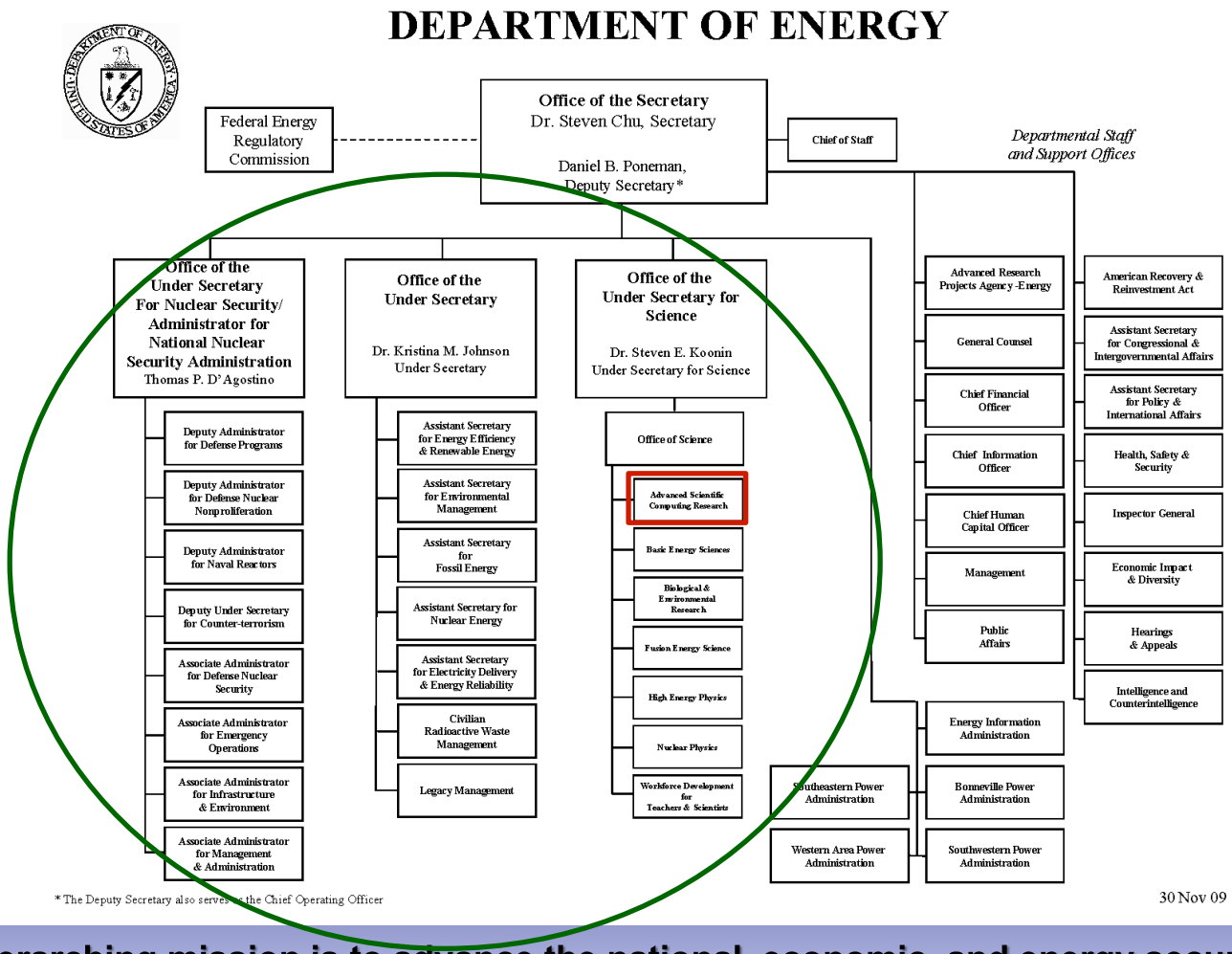
DEPARTMENT OF AGRICULTURE | **DEPARTMENT OF COMMERCE** | **DEPARTMENT OF DEFENSE** | **DEPARTMENT OF EDUCATION** | **DEPARTMENT OF ENERGY** | **DEPARTMENT OF HEALTH AND HUMAN SERVICES** | **DEPARTMENT OF HOMELAND SECURITY** | **DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT**

DEPARTMENT OF THE INTERIOR | **DEPARTMENT OF JUSTICE** | **DEPARTMENT OF LABOR** | **DEPARTMENT OF STATE** | **DEPARTMENT OF TRANSPORTATION** | **DEPARTMENT OF THE TREASURY** | **DEPARTMENT OF VETERANS AFFAIRS**

INDEPENDENT ESTABLISHMENTS AND GOVERNMENT CORPORATIONS

AFRICAN DEVELOPMENT FOUNDATION
BROADCASTING BOARD OF GOVERNORS
CENTRAL INTELLIGENCE AGENCY
COMMODITY FUTURES TRADING COMMISSION
CONSUMER PRODUCT SAFETY COMMISSION
CORPORATION FOR NATIONAL AND COMMUNITY SERVICE
DEFENSE NUCLEAR FACILITIES SAFETY BOARD
ENVIRONMENTAL PROTECTION AGENCY
EQUAL EMPLOYMENT OPPORTUNITY COMMISSION
EXPORT-IMPORT BANK OF THE UNITED STATES
FARM CREDIT ADMINISTRATION
FEDERAL COMMUNICATIONS COMMISSION
FEDERAL DEPOSIT INSURANCE CORPORATION
FEDERAL ELECTION COMMISSION
FEDERAL HOUSING FINANCE BOARD
FEDERAL LABOR RELATIONS AUTHORITY
FEDERAL MARITIME COMMISSION
FEDERAL MEDIATION AND CONCILIATION SERVICE
FEDERAL MINE SAFETY AND HEALTH REVIEW COMMISSION
FEDERAL RESERVE SYSTEM
FEDERAL RETIREMENT THRIFT INVESTMENT BOARD
FEDERAL TRADE COMMISSION
GENERAL SERVICES ADMINISTRATION
INTER-AMERICAN FOUNDATION
MERIT SYSTEMS PROTECTION BOARD
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NATIONAL ARCHIVES AND RECORDS ADMINISTRATION
NATIONAL CAPITAL PLANNING COMMISSION
NATIONAL CREDIT UNION ADMINISTRATION
NATIONAL FOUNDATION ON THE ARTS AND THE HUMANITIES
NATIONAL LABOR RELATIONS BOARD
NATIONAL MEDIATION BOARD
NATIONAL RAILROAD PASSENGER CORPORATION (AMTRAK)
NATIONAL SCIENCE FOUNDATION
NATIONAL TRANSPORTATION SAFETY BOARD
NUCLEAR REGULATORY COMMISSION
OCCUPATIONAL SAFETY AND HEALTH REVIEW COMMISSION
OFFICE OF THE DIRECTOR OF NATIONAL INTELLIGENCE
OFFICE OF GOVERNMENT ETHICS
OFFICE OF PERSONNEL MANAGEMENT
OFFICE OF SPECIAL COUNSEL
OVERSEAS PRIVATE INVESTMENT CORPORATION
PEACE CORPS
PENSION BENEFIT GUARANTY CORPORATION
POSTAL REGULATORY COMMISSION
NATIONAL RAILROAD RETIREMENT BOARD
SECURITIES AND EXCHANGE COMMISSION
SELECTIVE SERVICE SYSTEM
SMALL BUSINESS ADMINISTRATION
SOCIAL SECURITY ADMINISTRATION
TENNESSEE VALLEY AUTHORITY
TRADE AND DEVELOPMENT AGENCY
UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
UNITED STATES COMMISSION ON CIVIL RIGHTS
UNITED STATES INTERNATIONAL TRADE COMMISSION
UNITED STATES POSTAL SERVICE

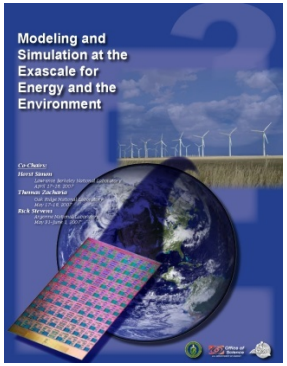
Department of Energy

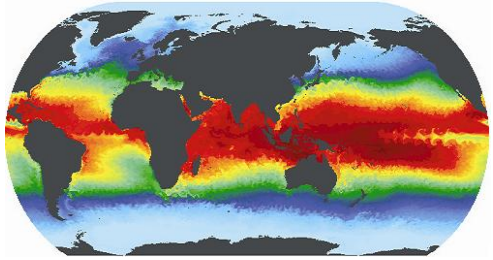


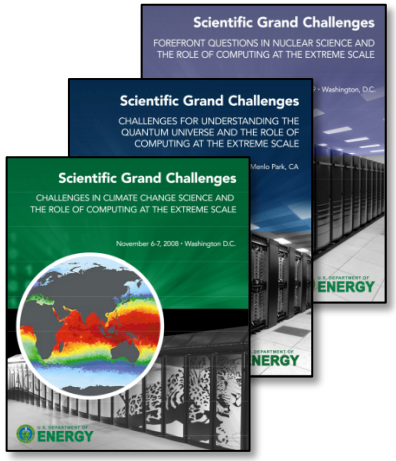
DOE's overarching mission is to advance the national, economic, and energy security of the United States; to promote scientific and technological innovation in support of that mission; and to ensure the environmental cleanup of the national nuclear weapons complex.

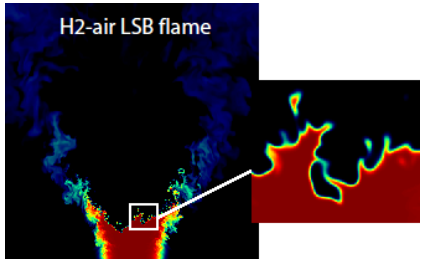
Mission Need for Exascale

- **Town Hall Meetings April-June 2007**
- **Scientific Grand Challenges Workshops Nov, 2008 – Oct, 2009**
  - **Climate Science (11/08),**
  - **High Energy Physics (12/08),**
  - **Nuclear Physics (1/09),**
  - **Fusion Energy (3/09),**
  - **Nuclear Energy (5/09),**
  - **Biology (8/09),**
  - **Material Science and Chemistry (8/09),**
  - **National Security (10/09)**
- **Cross-cutting Workshops**
  - **Architecture and Technology (12/09)**
  - **Architecture, Applied Mathematics and Computer Science (2/10)**
- **International Exascale Software Project**
  - **Santa Fe, NM 4/09; Paris, France 6/09; Tsukuba, Japan 10/09**

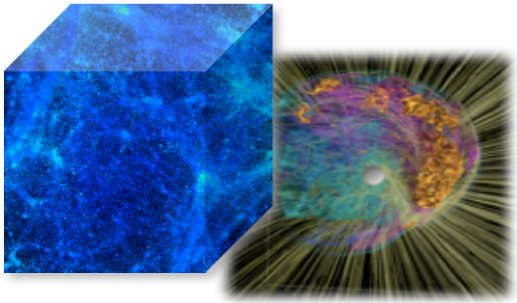








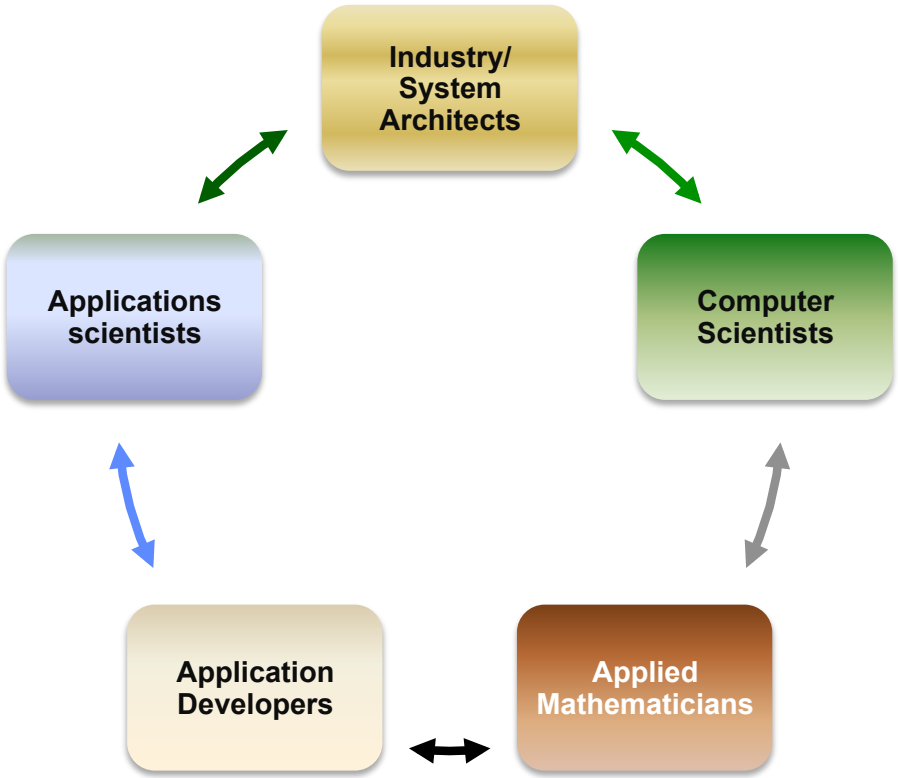
MISSION IMPERATIVES



FUNDAMENTAL SCIENCE

Co-design will be key for Exascale scientific discovery by 2018

- Tightly-coupled multi-disciplinary partnerships will ensure delivery of science applications on exascale platforms
- Transition to exascale will be as disruptive as transition from vector computing
  - New programming paradigms required
  - Emphasis on physics fidelity and UQ
- Appropriate investments will be required
  - Significant investment in computer science and math research
  - Significant investment in re-design and re-write of applications codes



Co-design partnerships for exascale computing

Exascale
Where are we Today

- **Applied Math**
  - **Advancing Uncertainty Quantification (UQ) in Modeling, Simulation and Analysis of Complex Systems -- $3M / year for 3 years to fund 2-6 awards, closes April 26, 2010**
    - Development of highly scalable approaches for uncertainty analysis in the modeling and simulation of complex natural and engineered systems.
- **Computer Science**
  - **X-Stack Software Research -- $10M / year for 3 years to fund 4-5 awards, closed April 2, 2010**
    - Development of a scientific software stack that supports extreme scale scientific computing, from operating systems to development environments. -- **BASED on IESP Roadmap**
  - **Advanced Architectures and Critical Technologies for Exascale Computing -- $5M / year for 3 years to fund 4-5 awards, Closed March 26, 2010**
    - Design of energy-efficient, resilient hardware and software architectures and technology for high performance computing systems at exascale.
  - **Scientific Data Management and Analysis at the Extreme Scale -- $5M / year for 3 years for 10-15 awards, Closed March 18, 2010**
    - Management and analysis of extreme-scale scientific data in the context of petascale computers and/or exascale computers with heterogeneous multi-core architectures.

A Taxonomy for a DOE Exascale Initiative