A Roadmap for Advanced Scientific Computing: Objectives and Performance Targets

2006 2008 2010 2012 2014 2016

Scientific Discovery

- Deliver operating systems for scientific computers that incorporate fault tolerance **(2007)**
- Deliver algorithms that scale to tens of thousands of processors for key mathematical libraries **(2007)**
- Complete programming model that enables scientists to use 100,000 processors **(2009)**
- Deliver mathematics of complex systems that enables accurate linkage of multiple time and length scales **(2011)**
- Deliver mathematics of complex systems that enables simulations of microbes **(2013)**
- ⬡ Demonstrate progress toward developing the mathematics, algorithms, and software that enable effective, scientifically-critical models of complex systems, including highly nonlinear or uncertain phenomena, or processes that interact on vastly different scales or contain both discrete and continuous elements. **(2015)**
- Revolutionize computing in U.S. industry through research results from applied mathematics and computer science **(2015)**

Scientific Simulation

- Complete computational model of gene regulation **(2005)** **BER**
- Calculate enhanced optical properties at the nanoscale **(2007)** **BES**
- Simulate the catalyst action in automobile exhaust **(2007)** **BES**
- Perform full three-dimensional supernova simulation **(2008)** **HEP NP**
- Simulate soot formation in diesel engines **(2008)** **BES**
- Enable real-time collaborative remote teams at the Spallation Neutron Source **(2008)** **BES**
- Perform climate simulations that incorporate biological carbon sequestration **(2011)** **BER**
- Complete simulation of tokamak disruptions that enable design of active control system to avoid disruptions **(2013)** **FES**
- Deliver virtual catalogue that enables access to all climate data worldwide **(2012)** **BER**
- Enable computational design of microbe for energy production **(2014)** **BER**
- ⬡ Demonstrate progress toward developing, through the Genomes to Life partnership with the Biological and Environmental Research program, the computational science capability to model a complete microbe and a simple microbial community. **(2015)** **BER**
- ⬢ Develop suite of specialized software tools for scientific simulations to effectively utilize terascale computers while handling trillions of bytes of data and high-speed networks. **(2006)**
- Achieve seamless integration of astrophysics simulation and data **(2009)** **NP**
- Compete first integrated burning plasma simulation **(2014)** **FES**
- Deliver hundreds of petabytes per year of data to scientists, routinely **(2015)**

Computing at the Petascale (Future Facilities)

Energy Sciences Network (ESnet) Upgrade:

- Complete expansion of ESnet to deliver core bandwidth of 10 gigabytes per second **(2006)**
- Increase ESnet core capability by 400% **(2008)**
- Expand ESnet core capability to exceed 100 gigabytes per second **(2013)**

National Energy Research Scientific Computing Center (NERSC) Upgrade: construction begins on new facility to deliver high-performance computing resources for science **(2009)**

- NERSC move to new facility complete **(2011)**

UltraScale Scientific Computing Capability:

- Complete evaluation of first computer with more than 50,000 processors **(2005)** **SCICOM**
- Deliver computing facilities for open science with100-fold increase in capability relative to 2004 **(2007)** **SCICOM**
- Achieve computational capability for open science that reaches one petaflop **(2012)** **SCICOM**
- Initiate evaluation of systems from DARPA High Productivity Computing Systems program **(2007)** **DARPA**
- Complete tests of computer systems that lead to the first system with sustained application performance over 10 petaflops **(2011)**
- ⬢ Complete studies on several next generation computer architectures that could be developed into high end supercomputers with 1000 times the performance available in 2003. **(2009)**

Interdependencies: (Descriptions)

*ASCR broadly supports all of SC basic research, and individual elements of Scientific Simulation directly support **BES, BER, FES, HEP, and NP** as noted.*

Among ASCR program elements, with software and hardware developed to enable specific simulations for science

DARPA *=with DARPA.*

SCICOM *=with scientific community for open access*

⬢ =Key Intermediate Objective from DOE Strategic Plan
⬡ =Long Term Success Measure from PART

This timeline is for planning purposes only and does not constitute financial or contractual commitments by the Federal Government.