The Next Generation of Computing

During the first session of the SciDAC 2007 conference in Boston, SciDAC Program Director Dr. Michael Strayer spoke about the future of scientific supercomputing and the SciDAC program.

As we travel the road toward the extreme scale (X-scale) generation of supercomputers, we look to petascale computing and beyond to open up a world of discovery, one that will cut across scientific fields and lead us to a greater understanding not only of our world, but of our Universe.

As part of the President's American Competitiveness Initiative, the Office of Advanced Scientific Computing Research (ASCR) has prepared a ten-year vision for computing. It recognizes that as a society we need to revolutionize our approaches to the challenges posed by energy, environmental sustainability, and global security. Planned petascale and future X-scale computer systems will play a critical role, along with theory and experiment, in understanding the behavior of the basic components of nature, as well as in fundamental discovery and exploration of the behavior of complex systems involving billions of components.

To aid in the development of this ten-year vision, LBNL, ORNL, and ANL hosted three town hall meetings on Simulation and Modeling at the Exascale for Energy, Ecological Sustainability and Global Security (E3). The resulting E3 initiative is organized around four programmatic themes: engaging top scientists, engineers, computer scientists, and applied mathematicians; investing in pioneering large-scale science; developing scalable analysis algorithms and storage architectures to accelerate discovery; and accelerating the build-out and future development of DOE's open computing facilities.

SciDAC will serve as the foundation for these efforts. Building on the knowledge and experience gained by SciDAC research teams over the past five years, we must now focus on the opportunities introduced by X-scale computing. ASCR facilities are keeping pace with our strategic goals. By the end of the 2007 fiscal year, a number of high-performance resources will be in place. Next year a petascale Cray Baker system is scheduled for delivery.

The multidisciplinary teams in the SciDAC Centers for Enabling Technologies and SciDAC Institutes will continue to work with the Scientific Application teams to overcome the barriers preventing the effective use of these new systems. They will face three major challenges. First is the development of new algorithms, operating system and runtime software, and tools which scale to parallel systems composed of hundreds of thousands of processors. Second is the need for new program development environments and tools which scale effectively and provide ease-of-use for developers and scientific end users. Third is developing new visualization and data management systems to support moving, storing, analyzing, manipulating, and visualizing multi-petabytes of scientific data and objects.

The SciDAC Centers will take the lead in ensuring that vital computer science and applied mathematics issues, as well as issues associated with research software lifecycles, are addressed in a timely and comprehensive fashion.

The university-led SciDAC Institutes will have more flexibility to pursue new research topics through a wide range of research collaborations. The Institutes will also work to broaden the intellectual and researcher base by conducting short courses and summer schools which take advantage of new high-performance computing capabilities.

The SciDAC Outreach Center at LBNL, as the clearing house for SciDAC activities and resources, will complement the outreach efforts of the SciDAC Institutes. By communicating with the high-performance computing community, the Outreach Center will gain an understanding of the community's needs for workshops, summer schools, and institutes.

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SciDAC is not ASCR's only effort to broaden the computational science community. In 1991, ASCR developed the Computational Science Graduate Fellowship (CSGF) to meet the nation's growing need for scientists and technology professionals with advanced computer skills. Now jointly funded between ASCR and the NNSA, CSGF has provided more than 200 of the best and brightest graduate students with guidance, support, and community. Today, CSGF alumni bring their diverse top-level skills and knowledge to DOE laboratories, to industries such as Proctor & Gamble, Lockheed Martin, and Intel, and to universities, where they are training the next generation of computer scientists.

A new Early Career Principal Investigator's program (ECPI) is now also in development. Its aim will be to stimulate academic research by faculty in the early stages of their careers working in areas within ASCR's purview. In memory of Ken Kennedy, one of the leading lights of our community, whose vision and insight will greatly be missed, the ECPI grant to beginning faculty in Computer Science will be known as the Ken Kennedy Fellowship.

As scientists, researchers, and visionaries prepare to use X-scale computing to carve away the unknown and to reveal exciting scientific secrets, SciDAC will ensure that this tool is the sharpest, most precise, and most efficient available. Thanks to the partnership between research and computing, as we continue along the road to our exascale future, we can look forward to the most stimulating scientific discoveries of our time. ●

Dr. Michael Strayer, June 25, 2007, SciDAC 2007, Boston, MA