Argonne NATIONAL LABORATORY

MATHEMATICS AND COMPUTER SCIENCE DIVISION

Argonne and the MCS Division are integral partners in the Array of Things project, which will use publicly available data collected from hundreds of sensors throughout the City of Chicago, such as the one illustrated in the top left, to provide real-time and highly local information on safety, traffic, and environmental conditions.

To help solve some of the nation's most critical scientific problems, the Mathematics and Computer Science (MCS) Division at Argonne National Laboratory produces next-generation technologies and software that exploit high-performance computing (HPC) and tackle the challenges of big data generated by HPC and large, experimental facilities.

AREAS OF EXPERTISE

EXTREME COMPUTING

By exploring innovative approaches to system software, fault tolerance, and programming models, MCS scientists, mathematicians, and software developers are addressing the greater complexities of extreme-scale computers—including tomorrow's exascale systems, which will perform more than one billion-billion operations per second.

DATA-INTENSIVE SCIENCE

With extreme computing comes extreme amounts of data. MCS scientists are creating technologies and tools for storing, transferring, accessing, analyzing, and visualizing datasets of unprecedented sizes and complexities.

APPLIED MATHEMATICS

To overcome current roadblocks to scientific discoveries, applied mathematicians are devising mathematical models and numerical algorithms to study multiscale phenomena with many physical components. Working with computational scientists, they incorporate these models and algorithms into portable HPC software products and test them in large-scale simulations.

SCIENCE AND ENGINEERING APPLICATIONS

MCS scientists work with researchers to apply advanced algorithms and software tools in challenging problems across a broad range of disciplines, including physics, materials science, chemistry, and biology.

CENTERS AND INITIATIVES

URBAN CENTER FOR COMPUTATION AND DATA

Rapidly expanding city populations of the twenty-first century are expected to strain energy resources, public health, and the surrounding environment. In this joint initiative, Argonne and the University of Chicago are creating computational methods to design smarter, more efficient cities that can handle growth while enhancing quality of life. In particular, MCS is developing tools that collect and integrate data from many sources, such as sensors, databases, and simulations.

ARRAY OF THINGS

Within the Urban Center for Computation and Data, Array of Things is a new, joint project with the University of Chicago—conducted in partnership with the City of Chicago and researchers at several other institutions—to deploy 500 sensors throughout Chicago by the end of 2017. The sensors are like "fitness trackers" that collect data on temperature, light, vibration, carbon monoxide, traffic, ambient sound intensity, and other environmental indicators. They will provide real-time, nearly block-by-block information on air quality, traffic, and safety conditions. The data collected by the sensors—as well as the software, hardware, and specifications for the sensors—will be available to the public. The sensors do not collect any private or personal information. Array of Things is funded by Argonne, the National Science Foundation, and the Chicago Innovation Fund.

JOINT LABORATORY FOR SYSTEM EVALUATION (JLSE)

JLSE is a collaboration between MCS and the Argonne Leadership Computing Facility (ALCF) to evaluate future HPC platforms. MCS and ALCF experts will develop and test prototype technologies for petascale and exascale systems that will be used for future ALCF deployments and MCS research. Current MCS projects include integrating and validating the components of Argo (a new exascale operating system and runtime system); exploring the effects of various hardware features and settings on the performance, power, and thermal behaviors of a node; and testing tools for storage-aware, large-scale data transfers.

JOINT LABORATORY FOR EXTREME-SCALE COMPUTING (JLESC)

Based at Argonne, JLESC brings together the expertise and resources of several supercomputer centers, including the University of Illinois at Urbana-Champaign's National Center for Supercomputing Applications, INRIA (the national French computer science institute), Barcelona Supercomputing Center, Jülich Supercomputing Centre in Germany, and RIKEN Advanced Institute for Computational Science in Japan.

This international team is working to solve software challenges associated with extreme-scale computing by investigating new approaches to programming models, resilience and fault tolerance, input/output, visualization, numerical libraries, and scientific applications for big computing and data.

MULTIFACETED MATHEMATICS CENTER FOR COMPLEX ENERGY SYSTEMS (M^2ACS)

Changes in the ways that energy is produced, distributed, stored, and used are introducing numerous technical challenges. To address these challenges, M^2ACS researchers are developing, analyzing, and integrating predictive models of system behavior, new optimization-based sampling approaches, and new analysis methods and scalable algorithms made possible by the rich mathematical structure of increasingly complex and dynamic electrical energy systems.

R&D 100 Award-Winning Software

2012
GLOBUS ONLINE
moves large quantities of information reliably, efficiently, and securely worldwide.

2009
PETSc
provides a suite of codes for solving large-scale problems modeled using partial differential equations.

2005
MPICH
is a high-performance, widely portable implementation of the Message Passing Interface and is considered the de facto standard for parallel computing.

2002
GLOBUS TOOLKIT
enables the secure, scalable, and coordinated use of resources in dynamic, multi-institutional "virtual organizations."

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