Innovative new supercomputers increase nation's computational capacity and capability

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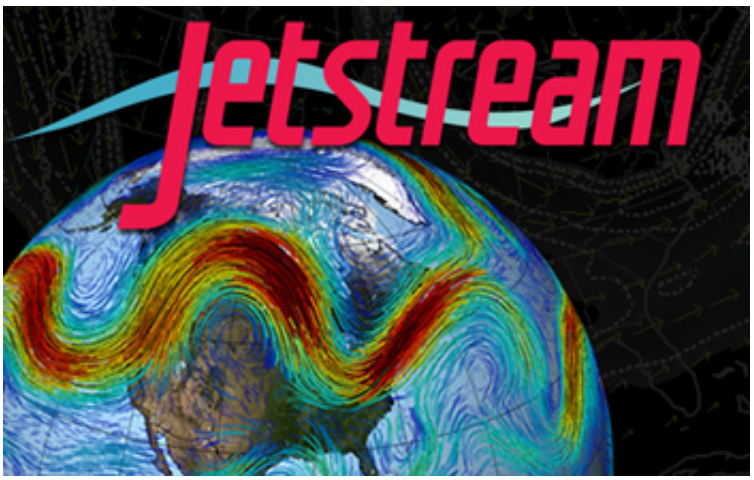


NSF has awarded Indiana University $6.5M to build Jetstream, a research cloud for science and engineering. Jetstream will be a user-friendly cloud environment designed to give researchers and students access to computing and data analysis resources on demand -- from their tablets, laptops or desktop PCs. Credit: Indiana University

Tens of thousands of researchers nationwide currently harness the power of massive supercomputers to solve research problems that cannot be answered in the lab. However, studies show this represents only a fraction of the potential users of such resources.

As supercomputing—also known as high performance computing or

HPC—becomes central to the work and progress of researchers in all fields, from genomics and ecology to medicine and education, new kinds of computing resources and more inclusive modes of interaction are required.

Today, the National Science Foundation (NSF) announced support for two new supercomputing acquisitions for the open science community that will complement existing resources with capabilities that allow advanced computing to be available to a broader portfolio of emerging scientific frontiers and communities. The new resources are anticipated to come online in early 2016.

The systems—"Bridges" at the Pittsburgh Supercomputing Center (PSC) and "Jetstream," co-located at the Indiana University Pervasive Technology Institute (PTI) and The University of Texas at Austin's Texas Advanced Computing Center (TACC)—respond to the needs of the scientific computing community for more high-end, large-scale computing resources while helping to create a more inclusive computing environment for science and engineering.

"Bridges and Jetstream will expand the capabilities of the NSF-supported computational infrastructure, pushing the frontiers of science forward in the life sciences, the social sciences and other emerging computational fields by exploiting interactive and cloud-based computing paradigms," said Irene Qualters, division director for Advanced Cyberinfrastructure at NSF.

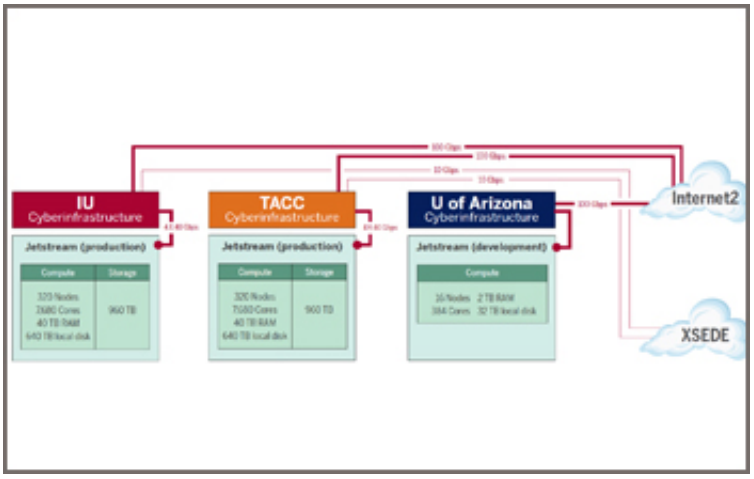
"Bridges and Jetstream offer a mix of new capabilities and usage modalities, from large memory nodes to virtualization technologies that allow a PC-like experience via the cloud. Together, these technologies will let a broader swath of researchers use advancing computing while making new kinds of scientific inquiry possible."

Bridges and Jetstream will both be part of NSF's eXtreme Digital (XD) program, currently the most comprehensive collection of integrated digital resources and services enabling open science research in the world.

The NSF-supported Extreme Science and Engineering Discovery Environment project will supply user services and training for the two new resources, enabling their smooth integration into a familiar and usable ecosystem for computational science. The teams implementing Jetstream and Bridges include some of the leading cyberinfrastructure experts, software providers and application scientists in the nation.

Bridges

Bridges, at PSC, represents a new approach to supercomputing that focuses on research problems that are limited by data movement, not floating-point speed.



A Jetstream architecture diagram. Credit: Indiana University

In addition to serving traditional supercomputing users, Bridges will help researchers tackle new kinds of problems in genetics, the natural sciences and the humanities where scientists are impacted by the volume of data rather than computational speed. Users with different scales of data will also be able to use a mix of memory, data bandwidth and computational power customized to their problem.

"The name Bridges stems from three computational needs the system will fill for the research community," says Nick Nystrom, PSC director of strategic applications and principal investigator in the project. "Foremost, Bridges will bring supercomputing to nontraditional users and research communities. Second, its data-intensive architecture will allow high-performance computing to be applied effectively to big data. Third, it will bridge supercomputing to university campuses to ease access and provide burst capability."

A $9.6-million NSF grant will fund the acquisition of the system, to begin in November 2014, with a target production date of January 2016.

Jetstream

Jetstream—led by Indiana University's Pervasive Technology Institute (PTI)—will add cloud-based computation to the national cyberinfrastructure. Researchers will be able to create virtual machines on the remote resource that look and feel like their lab workstation or home machine, but are able to harness thousands of times the computing power.

"In the atmosphere, a jet stream is the border between two different masses of air. The new Jetstream cloud system will operate at the border between the existing NSF-funded cyberinfrastructure and thousands of researchers and research students who will be new to use of NSF XD program resources," said Craig Stewart, PTI executive director and

associate dean for research technologies at Indiana University. "Jetstream will give researchers access to cloud computing and data analysis resources interactively, when they need them."

Jetstream will be attractive to communities who have not been users of traditional HPC systems, but who would benefit from advanced computational capabilities. Among those groups are researchers in biology, atmospheric science, observational astronomy, and the social sciences.

"We expect Jetstream to be of particular interest to researchers analyzing 'born digital' data with research needs that are more suited to cloud computing than the traditional supercomputers that have been the mainstay of NSF-funded cyberinfrastructure in the past," Stewart said.

IU's partners in implementing and supporting Jetstream include TACC, the University of Chicago, the University of Arizona, University of Texas at San Antonio, Johns Hopkins University, Pennsylvania State University, Cornell University, University of Arkansas at Pine Bluff; University of Hawaii; the National Snow and Ice Data Center, the Odum Institute at the University of North Carolina and the National Center for Genome Analysis Support.

Jetstream is supported by a $6.6-million NSF grant and will go into production in January 2016.

Interactive supercomputing

One important feature that both systems share is increased flexibility and ease of use.

The bulk of existing HPC systems use a batch queuing system, where computations occur whenever processors on the machine become

available. Jetstream and Bridges will both maintain this capability but will also allow scientists and engineers to conduct their research on demand, as needed, in a desktop-like environment, or to compute interactively in order to debug or test a new code.

Atmosphere, a cyber-platform for managing multiple computational clouds developed by the iPlant Collaborative, will provide a usable interface for researchers in all scientific disciplines to leverage cloud capabilities. Credit: Eric Lyons/University of Arizona

This change in the way scientists access and interact with supercomputing resources will empower thousands of currently

underserved researchers whose software and workflows do not conform to the existing resources available. It will also allow researchers to ask "what-if" questions and explore problems in new ways.

Bridges and Jetstream will join an existing ecosystem of hardware, software, networking and people that together constitute the nation's research cyberinfrastructure.

In recent years, NSF has brought online large HPC systems like Stampede, Yellowstone and Blue Waters. Several new production systems with diverse architectures, such as Comet and Wrangler will be deployed in the next year, as will experimental systems such as Data Exacell, Chameleon and CloudLab that are exploring additional modes of HPC. Since 2009, NSF has invested nearly $1 billion for cyberinfrastructure in support of the nation's researchers.

"As high performance computing has evolved over the years, its importance to science and engineering has grown," Qualters said. "Bridges and Jetstream will help researchers today, but also point to the rich future of computational science. With these systems, we continue to push the boundaries of computing so that researchers in all fields can solve critical, and previously intractable, problems."

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