Ohio Supercomputer Center

An **OH·TECH** Consortium Member

ANNUAL
REPORT

OWENS

JESSE OWENS

payments

2016
2017

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"**OSC offers powerful computing and storage services to Ohio students, scientists, engineers and clinicians in an effort to drive education, discovery and innovation.**"

— *John Carey, Chancellor, Ohio Department of Higher Education*

Ohio Supercomputer Center: OSC addresses the rising computational demands of academic and industrial research communities by providing a robust shared infrastructure and proven expertise in advanced modeling, simulation and analysis. OSC empowers scientists with the services essential to making extraordinary discoveries and innovations, partners with businesses and industry to leverage computational science as a competitive force in the global knowledge economy and leads efforts to equip the workforce with the key technology skills required for 21st century jobs.

Ohio Technology Consortium: Governed by the Chancellor of the Department of Higher Education, OH-TECH serves as the technology and information division of the Ohio Department of Higher Education. The consortium comprises a suite of widely respected member organizations unsurpassed in any other state: OSC, OARnet, OhioLINK and eStudent Services.

osc.edu

FROM THE DIRECTOR

A single computer job run earlier this year demonstrates how much the Ohio Supercomputer Center has evolved since its creation in 1987. An industry client throttled up 16,800 cores of our Owens Cluster to generate multiple terabytes of synthetic weather data. The client was testing a proprietary database software package optimized to run on supercomputer systems, a "Big Data" job that marks the single-largest scale calculation in the center's history.

The new Owens Cluster and high-performance storage solutions we recently deployed keep Ohio competitive with other regional and campus supercomputing centers. The vision and support of policymakers for advanced technologies are vital to keeping Ohio productive and prosperous as we continue to empower our educational and commercial clients into the remarkable realm of the Information Age.

But, in 2017 this feat represents not only how far we've come, but also how much remains intact. These advantages are not delivered solely through installations of cutting-edge hardware; it is the people behind the equipment who represent the most integral fixture. Our experts in computing, storage, education, visualization and software development were key to the computational research of more than 1,300 students, scientists, engineers and clinicians in 2016–17.

For three decades, blending human expertise and curiosity with sophisticated instrumentation has generated important scientific discoveries and industrial innovations. This same potent combination, I believe, should serve all of us well for many years into the future.

David Hudak, Ph.D.
Interim Executive Director

2016–17 HIGHLIGHTS

Owens Cluster deployment & dedication

OSC's most powerful system ever officially deployed this year, offering not only greater performance and shorter queue times for clients, but also greatly increased system storage and memory. All spinning storage has been upgraded and a DDN Infinite Memory Engine installed. OSC has over five petabytes (PB) of disk storage capacity distributed over three file systems, plus more than 5.5 PB of backup tape storage.

Facilities transformation

OSC facilities and resources saw huge upgrades in 2016–17. These included new cooling for the Owens Cluster, plexiglass containment around cabinets and an informational vestibule for visitors to the State of Ohio Computer Center. These upgrades reduce energy consumption and noise.

New versions of OnDemand

OSC launched OnDemand 3.0, a vastly upgraded version of its "one-stop shop" for access to High Performance Computing services. The new version provides a better experience for clients, including many more programs supported and greater compatibility with internet browsers. Additionally, users can upload and share their own web apps with other users.

Active Projects

U. of Toledo ☐
○ Bowling Green State U.
Oberlin Coll. ○
△ ☐ Case Western Reserve U.
Cleveland State U.
☐ Kent State U.
U. of Akron ☐
△ Youngstown State U.
○ Ohio Northern U.
Coll. of Wooster ○
○ Kenyon Coll.
Nationwide Children's
○ Denison U.
○ Wittenberg U.
⬠ Ohio State U.
U. of Dayton △
Wright State U. △
○ Cedarville U.
Central State U.
△ Miami U.
U. of Cincinnati
⬠ Xavier U.
○ Good Samaritan Coll.
☐ Ohio U.

Key
- ○ 1–5
- △ 6–10
- ☐ 11–20
- ⬠ 21+

Client Impact

26 Ohio-based universities

41 companies

1,358 clients

218 trainees

8 training opportunities

218 awards made

533 projects served

31 academic courses used OSC's supercomputers

Academic Usage

Kent State **2%**

Ohio University **2%**

Other Universities **3%**

Case Western Reserve University **3%**

Bowling Green State University **5%**

University of Akron **5%**

University of Cincinnati **6%**

Ohio State University **74%**
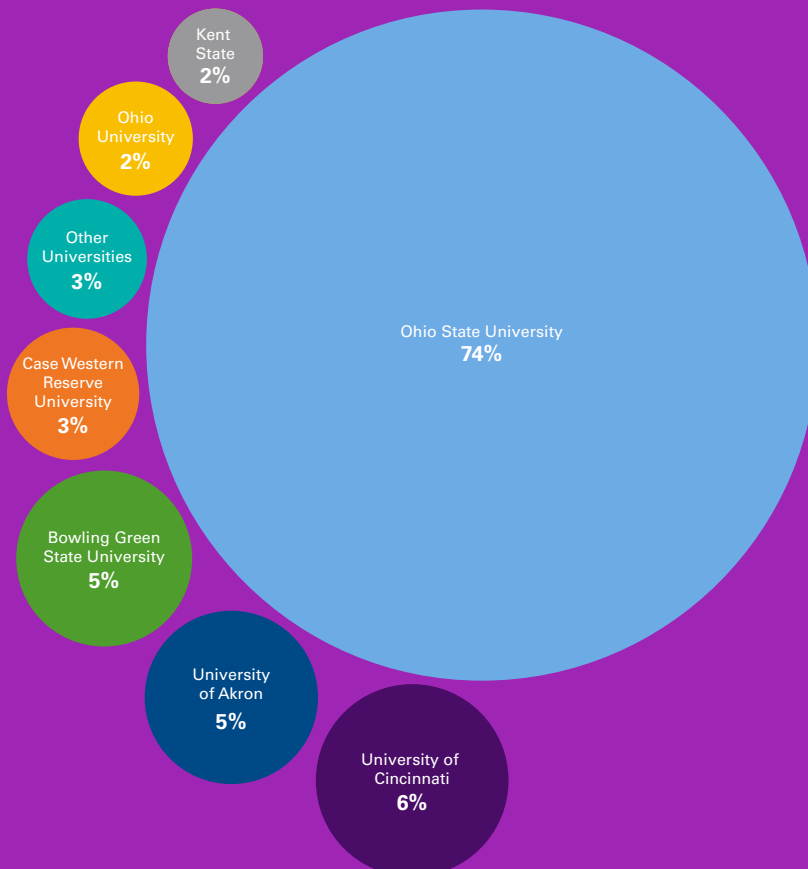
Services Delivered

115 M+ core hours consumed
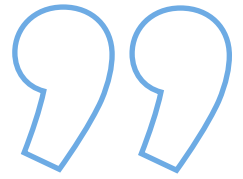
3.4 M+ computational jobs

1,101 TB data stored

97.9% up-time (target: 96%)

CLIENTS

As a unique resource for the state, Ohio's academic, healthcare and industrial researchers continue to turn to OSC as a key resource for scientific discovery. OSC provides statewide resources to help researchers making discoveries in a vast array of scientific disciplines. Beyond providing shared statewide resources, OSC works to create a user-focused, user-friendly environment for our clients. The center continues to empower its clients as they break ground in the biosciences, advanced materials, manufacturing, energy and the environment along with a multitude of emerging disciplines.

"There's no way we could compete with bigger companies if it weren't for OSC.

— *Sandeep Vijayakar, Ph.D., President, Advanced Numerical Solutions LLC*

ACADEMIC

This year, OSC served 1,358 distinct students, faculty and staff members across 26 Ohio universities. As part of our expanding training programs, we had 218 people attend eight individual training opportunities throughout the year. We also saw a huge increase in classroom use of our resources. As a whole, OSC clients accomplished:

- 3.4 million computational jobs run
- 115 million computing hours consumed
- 533 projects served
- 31 academic courses delivered using OSC's supercomputers

"A supercomputer is the ultimate machine for us to solve the hardest and most difficult problems.

— *Ahmet Selamet, Ph.D., The Ohio State University, Professor, Mechanical & Aerospace Engineering*
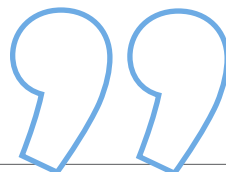
INDUSTRIAL

OSC has a long history of supporting industrial research, reaching back as far as the Center's founding in 1987. Manufacturers have leveraged OSC's computational and storage resources to design and test many products.

Under the AweSim program, small- to mid-sized manufacturers can enhance innovation and strengthen economic competitiveness with simulation-driven design. A number of prominent studies indicate that modeling and simulation based on high-performance computing is critical to the competitiveness of industry. AweSim provides affordable, accessible and scalable modeling and simulation on high performance computers via:

- online modeling and simulation apps
- educational resources
- industry-specific expertise and consultants

With over 41 companies growing from the use of high performance computing through OSC, Ohio benefits from improved manufacturing competitiveness.

AWE**SIM**
Virtual Designs. Real Benefits.

SERVICES & TRAINING

OSC employs experts to assist with individual client requests. For any issues that arise, OSC's 24/7 support desk is available to provide clients with technical expertise and consulting services.

Cluster computing

OSC's cluster computing capabilities make it a fully scalable center with mid-range machines to match those found at National Science Foundation centers and other national labs.

The new Owens cluster, with its 23,000-plus CPU cores, allows clients to solve large problems or large numbers of small independent calculations, in the same environment.

Client engagement

Want to know what OSC can do for you? Ask one of the more than 200 clients who attended our training sessions this past year. OSC training and education leads visit campuses all around the state to provide personalized instruction, facilitate classroom projects, train students on the basics of supercomputing and demonstrate OSC's broad service offerings. This takes an instructional load off faculty members so their time is maximized to focus on content and solving problems.

OSC's bi-annual Statewide Users Group meetings saw record attendance this past year. These meetings, held at OSC, are an opportunity for our users to meet facem to face and share ideas and research with each other. At these meetings, the OSC team shares updates and opens the floor for deeper engagement with clients. These meetings are also a great chance for students to present in front of a crowd, some using them as a dry run for masters and doctoral defenses.

Summer student programs

OSC prepares Ohio's future STEM field leaders through its Summer Institute for high school freshmen, sophomores and juniors, and Young Women's Summer Institute for middle school girls. Students experience the dynamic world of high performance computing as they work with peers and experts in the field through hands-on, collaborative projects.

Visualization & virtual environments

OSC's award-winning Interface Lab translates technology into effective training and assessment tools for use by various sectors, such as the health care, automotive and manufacturing industries. With recent upgrades, the lab will soon work toward shared virtual environments where individuals can move around freely without tethered devices.

Software development

Researchers can access a wide variety of software packages as well run software for which they provide the license, open-source packages or in-house developed applications as well.

Through Open OnDemand, an open-source software based on the proven OSC OnDemand platform, HPC centers around the U.S. and world can allow researchers and students to install and deploy advanced web and graphical interfaces.

For industrial clients, OSC's AweSim app developers can share apps through the AweSim dashboard, an app store for supercomputers. This makes modeling and simulation more affordable and accessible to even small businesses, allowing them to compete in a world driven by cutting-edge technology and lightning-fast production.

PHOTO {RIGHT} // OSC STATEWIDE USERS GROUP (SUG) MEETINGS SAW RECORD ATTENDANCE IN 2016–17.

SYSTEMS

Collectively, OSC supercomputers provide a peak computing performance of nearly 1,900 teraflops. The center also offers more than five petabytes of disk storage capacity distributed over several file systems, plus 5.5 petabytes of backup tape storage.

OSC also provides more than 114 different software packages to researchers, with about 15 of them licensed packages. Researchers also can bring their own software or applications, as well. OSC staff members are available for consulting or collaboration with research computing teams that require expertise to increase the problem sizes that they can tackle or reduce the runtime for their analyses. Our team members have experience with several computing languages, programming models, numerical libraries and development tools for parallel/threaded computing and data analysis.

Systems

	Oakley	Ruby	Owens
Date	2012	2014	2016
Cost	$4 million	$1.5 million	$7 million
Theoretical Performance	~154 TF	~144 TF	~1600 TF
Nodes	692	240	824
CPU Cores	8304	4800	23392
RAM	~33.4 TB	~15.3 TB	~120 TB
GPUs	128 NVIDIA Tesla M2070	20 NVIDIA Tesla K40	160 NVIDIA Pascal P100
Total compute: ~1900 TF			

Storage

	Home	Project	Scratch	Tape Library (backup & archive)
Capacity	.8 PB	3.4 PB	1.1 PB	5+ PB
Bandwidth	10 Gbps	40 Gbps	100 Gbps	3.5 Gbps

PHOTO {TOP} // CHANCELLOR JOHN CAREY (LEFT) AND TOM BECK, STATEWIDE USERS GROUP CHAIR, UNVEIL THE OWENS CLUSTER ENDCAP.

WHO:

Hongyu Chen, graduate assistant, under Lucia Dunn, Ph.D., Department of Economics, The Ohio State University

WHAT:

Chen used OSC's Oakley Cluster to run student loan data simulations that reduced his processing time from nearly 10 years on a single computer to six months.

IMPACT:

Chen's results from the simulations could inform future legislation regarding federal student loan repayment plans.

OSC DATA PROCESSING HELPS UNCOVER THE IMPACT OF LOAN FORGIVENESS PROGRAMS

In 2017, 44.2 million Americans held student loan debt, totaling more than $1.4 trillion, according to the U.S. Federal Reserve. With the cost of tuition rising at most higher education institutions and enrollment increasing, these numbers are expected to keep climbing.

To evaluate the wide-reaching effects student loan policy change could have on borrowers' lives, researchers from the Department of Economics at The Ohio State University ran thousands of situational simulations using the Ohio Supercomputer Center.

To reduce the weight of student loan debt on borrowers, Congress passed the College Cost Reduction and Access Act in 2007. This major change in loan repayment plans can relieve debt for many

forgiveness program. Chen wrote a program that ran simulations of over 151 parameters on a population of approximately 2,500 individuals between the ages of 18 and 65 during different periods of their lives.

"The estimation takes around 10 years if I'm running just one single computer," Chen said. "That's why I have to use the cluster of computers, like the supercomputer, that use multiple cores at the same time, so that saves me a lot of time."

Still, the model took Chen around six months to complete on OSC's Oakley Cluster using a program he wrote specifically for this project.

Chen found that the population affected by the change in student loan repayment plans increased the average total years of postsecondary education

"The estimation takes around 10 years if I'm running just one single computer," Chen said. "That's why I have to use the cluster of computers, like the supercomputer, that uses multiple cores at the same time, so that saves me a lot of time.
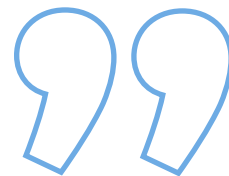
— *Hongyu Chen, graduate assistant, Department of Economics at The Ohio State University*

Americans sooner than expected. This legislation created two programs: one that would forgive student loans after 10 years of service in the public sector, and another that would allow borrowers at a certain income to make reduced payments and, after 20 years, have the outstanding loan balance forgiven.

A graduate assistant working under the guidance of Lucia Dunn, Ph.D., professor of economics at Ohio State, Hongyu Chen used data from the National Longitudinal Survey of Youth to model individuals' education, career, borrowing and spending decisions based on whether or not they were part of a loan

by 9 percent. Individuals were also more likely to take on more debt, holding 12 percent more before age 30 under the new plan, when knowing their loans would be forgiven. Chen said this data could be useful in informing federal government policies.

"(Student loans) are very expensive for the government. So, this directly provides the evidence (for determining) the best policies for the government to improve college enrollment or social welfare," Chen said. "It has very important direct policy implications." ◄

OSC HELPING NAHAR SHARE COMPUTATIONAL KNOWLEDGE IN COLUMBUS, AROUND THE WORLD

"Without OSC, I could not run this program, and they could not learn."

— *Sultana Nahar, Ph.D., senior research professor in Ohio State's Department of Astronomy*

Sultana Nahar, Ph.D., wants more scientific advances and discoveries, and she wants them faster.

Her strategy? Teaching research-based courses.

Through physics and STEM courses and workshops, Nahar has been improving the computational skills of the scientific community one person at a time in the hopes more breakthroughs will be made.

"We can solve more problems in science, we just need manpower," said Nahar, a senior research professor in Ohio State's Department of Astronomy. "Through these workshops, we can achieve our goals faster."

Supercomputing services through OSC help Nahar conduct computational workshops as part of her lecture courses. These workshops train participants to use computer programs for research projects.

As a long-time OSC client since accepting a post-doctoral fellowship position at Ohio State in 1990, Nahar knows the importance of high performance computing for her own research. Nahar has used OSC for large-scale, high-accuracy computations for atomic processes under the international collaborations of the Opacity Project and the IRON Project.

OSC's support is especially vital to Nahar's efforts to educate students and researchers in underdeveloped countries.

Nahar has been teaching courses and conducting workshops for students and faculty members in countries such as Bangladesh,

Egypt, India—drawing students from many universities in each country—to expand and grow international diversity for science engineering students and post-doctoral researchers.

"Without the workshops, it is very difficult for these students to learn codes and understand the programs for their research," she said. "They're very smart, as smart as any students in developed countries. They just need resources."

In the mid-1990s, Nahar started an outreach program to help improve the quality of education and research in underserved areas and to encourage international involvement of scientists in developing countries, such as her home country of Bangladesh. The outreach programs evolved when she began doing physics workshops with programs installed at OSC through emails for researchers in Bangladesh, Egypt, India, Iran, Iraq and Turkey.

In 2013, Nahar traveled to Cairo University in Egypt for her first on-site workshop, thanks to an agreement between Ohio State University and Cairo University. Nahar initiated and coordinated the arrangement years ago as part of her mentoring efforts; it covers the Colleges of Arts and Sciences and Engineering.

That initial atomic astrophysics course, which included the computation workshop, was a tremendous success.

"We had students, researchers, faculty members from seven organizations," Nahar said. "They were very interested in the workshops for two reasons: One, my topics are interesting and are research based; and

two, the supercomputer center is a highly sophisticated facility they can use."

These workshops help the students gain experience as they try to attain their doctorates.

"We need very high accuracy in our results, that can only be achieved through precise computations with high performance computer facilities," Nahar said. "Without OSC, I could not run this program, and they could not learn." ◄

WHO:

Sultana Nahar, Ph.D., senior research professor in Ohio State's Department of Astronomy

WHAT:

Supercomputing services through OSC help Nahar conduct computational workshops to educate students and researchers in underdeveloped countries.

IMPACT:

Through physics and STEM courses and workshops, Nahar has been improving the computational skills of the scientific community in countries, such as Bangladesh, Egypt, India, Iran, Iraq and Turkey.

PHOTOS // SINCE 2013, SULTANA NAHAR, PH.D., HAS TRAVELED TO DIFFERENT UNIVERSITIES IN THE UNDERDEVELOPED WORLD FOR PHYSICS AND STEM COURSES AND WORKSHOPS FEATURING OSC RESOURCES.

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