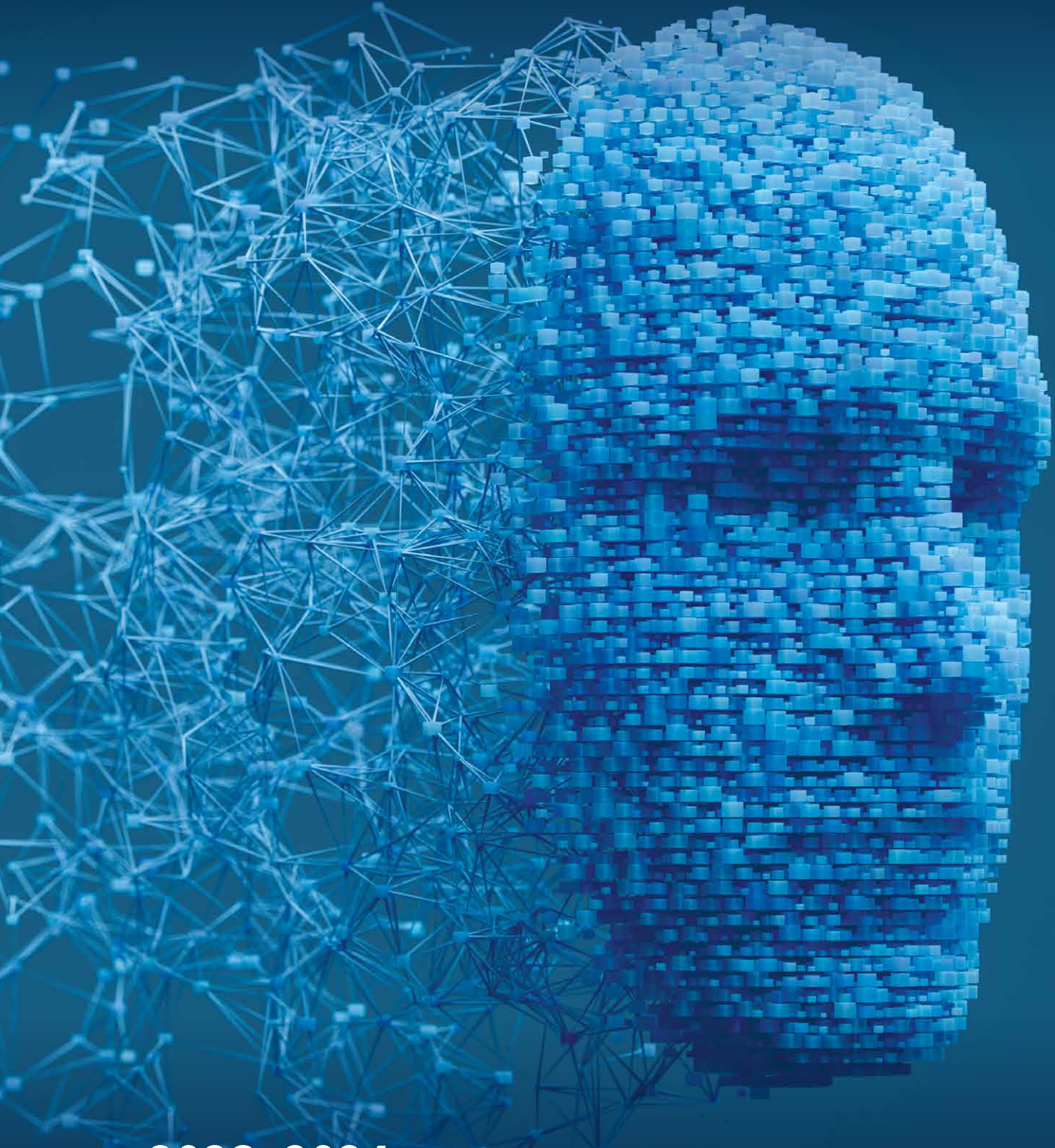




Supercomputer
Center



2023-2024

RESEARCH REPORT



“From artificial intelligence to complex simulations, Ohio’s Supercomputer Center elevates the work of researchers and students.”

— Mike Duffey, Chancellor,
Ohio Department of Higher Education



The Ohio Supercomputer Center (OSC) empowers Ohio higher educational institutions and private industry by providing capable, accessible, reliable and secure computational services enhanced by training, consulting and research partnership. Through OSC’s high performance computational resources, the State of Ohio leverages significant economies of scale resulting in better services and cost savings. OSC can help position Ohio’s higher educational institutions and companies as world leaders with a computationally enabled workforce and research endeavors.

Governed by the Chancellor of the Ohio Department of Higher Education (ODHE), the Ohio Technology Consortium (OH-TECH) serves as the technology and information division of ODHE. The consortium comprises a suite of widely respected member organizations collectively unsurpassed in any other state: OSC, OARnet and OhioLINK. The consortium drives efficiencies through common services provided to member organizations through the Shared Infrastructure and Consortia Services divisions.

LEADERSHIP

David Hudak, Ph.D.

Executive Director
614-247-8670 | dhudak@osc.edu

Doug Johnson

Associate Director
614-292-6286 | djohnson@osc.edu

Karen Tomko, Ph.D.

Director, Research Software Applications
614-292-1091 | ktomko@osc.edu

Alan Chalker, Ph.D.

Director, Strategic Programs
614-247-8672 | alanc@osc.edu

Brian Guilfoos

Manager, HPC Client Services
614-292-2846 | guilfoos@osc.edu

Troy Baer

Manager, HPC Operations
614-292-9701 | troy@osc.edu

Chase Eyster

Manager, Business Development
614-688-0971 | ceyster@osc.edu

Tammi Hysell

Administrative Manager, Grants & Contracts
614-247-8452 | thysell@osc.edu

Heechang Na, Ph.D.

Operations Manager, Scientific Applications
614-688-4803 | hna@osc.edu

Summer Wang, Ph.D.

Sr. Client Engineer
614-688-0993 | xwang@osc.edu

osc.edu

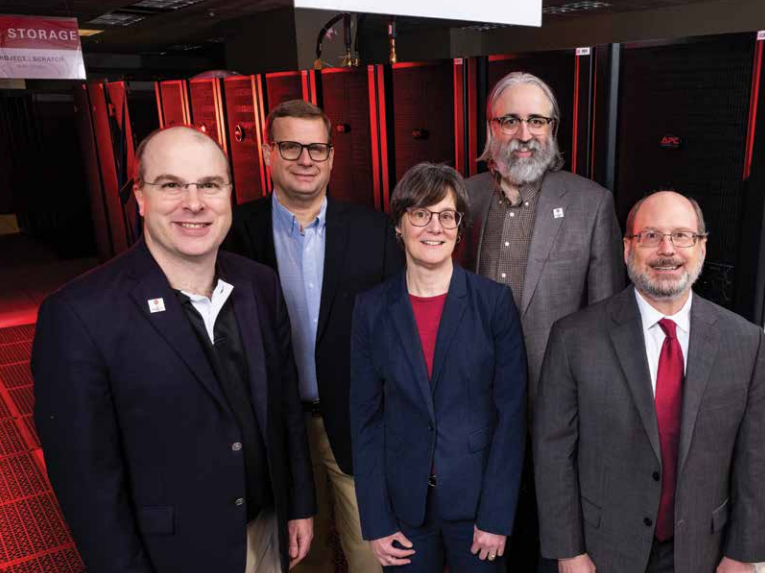


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Members of the Ohio Supercomputer Center leadership team (top image, left to right: Alan Chalker, Doug Johnson, Karen Tomko, Brian Guilfoos and David Hudak) celebrated the launch of the new Ascend cluster (below image) in the data center.



The Ohio Supercomputer Center, in partnership with the Ohio Technology Consortium and Ohio Department of Higher Education, participated in the COSI Big Science Celebration for the second year in 2023, sharing educational information about high performance computing resources and offering several hands-on learning activities.





David Hudak, Ph.D.
Executive Director

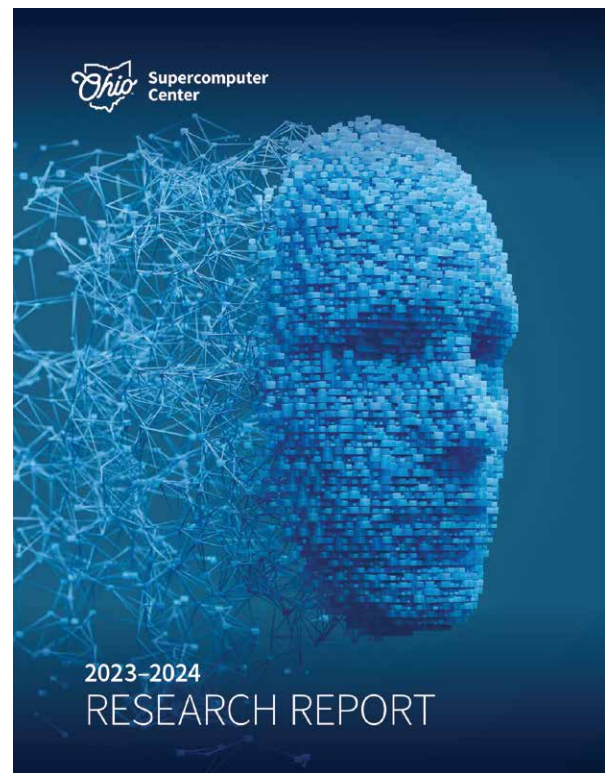
DIRECTOR'S LETTER

In 2023, the rise of new artificial intelligence (AI) tools and applications triggered a global conversation about the power and promise of this technology. In the world of high performance computing (HPC), the Ohio Supercomputer Center (OSC) has witnessed an increasing demand for software and hardware that can handle AI, machine learning and data analytics research over the last several years. Supporting the growth of AI use and inquiry across academic disciplines and industry has become a key focus of OSC's efforts.

Our newest HPC clusters have been strategically designed to advance AI research. Ascend, which became available for client use in late 2022, features dedicated GPUs, storage and applications for AI workloads. Cardinal, which will be deployed in our data center later in 2024 and will eventually replace the Owens cluster, features the latest hardware from Dell Technologies, NVIDIA and Intel, including High Bandwidth Memory (HBM) CPU chips that will offer optimal computing performance.

We also have spearheaded or collaborated on two major programs, both funded by the National Science Foundation (NSF), to train professionals who work at research computing centers around the country to help faculty and students use AI technologies in their work. At OSC, we have bolstered our AI expertise by training staff in AI terminologies, tools and workflow, and also have added a machine learning engineer to our team.

In addition, OSC is a partner on the AI institute for Intelligent Cyberinfrastructure with Computational Learning in the Environment (ICICLE), now in its third year. The project, led by The Ohio State University, is developing software to make it easy to deploy and adopt AI solutions, with initial use cases in digital agriculture, animal ecology and food systems.



ON THE COVER: Supporting research and innovation in artificial intelligence—through hardware, software and training initiatives—has been a key focus for the Ohio Supercomputer Center over the last several years.

Beyond AI, 2023 marked the evolution of the [Open OnDemand portal](#), which is now used by hundreds of organizations around the world. Open OnDemand version 3.0 launched in the spring with advanced features developed by its vast user community. To ensure the portal's ongoing viability, the NSF also provided support for us to create a new Open OnDemand governance structure.

OSC has increased its attendance at national and international conferences, and also has participated in more public outreach in Ohio, to stay engaged with our client community and foster excitement for the research computing field. We hope you will join us at one of our events, such as the new Research Symposium or Community Briefing, or visit us at COSI or the Ohio State Fair to learn about the latest ways we support HPC innovation at OSC.

David Hudak, Ph.D.
Executive Director

IMPACT

OSC serves higher education, nonprofit, government, education and commercial communities in Ohio, with services available to clients across the nation and globe. From hardware and software offerings, computing resources and data storage, to training and educational opportunities, OSC continued to make a measurable impact on clients' discovery, learning and innovation in the last year.



\$9.3+ MILLION
ESTIMATED ANNUAL COST SAVINGS
COMPARED TO COMMERCIAL CLOUD



9,725
CLIENTS



701
TRAINEES



218
COLLEGE COURSES
USED OSC RESOURCES



23
TRAINING
OPPORTUNITIES

HARDWARE

Launch of Ascend, dedicated GPU cluster

In January 2023, OSC officially launched Ascend, its first-ever high performance computing (HPC) cluster with a dedicated graphics processing unit (GPU) platform, featuring advanced NVIDIA GPUs. The Dell Technologies-based cluster was designed to accommodate the growth of client work in the areas of artificial intelligence (AI), data analytics and machine learning. Although Ascend is smaller than the Pitzer and Owens clusters, with just 24 compute nodes, “its peak performance is on par with all of the other systems, and that’s mainly because of the performance that the GPUs add to these nodes,” said Doug Johnson, OSC associate director.

New cluster Cardinal in 2024

OSC will launch a major new HPC cluster, Cardinal, in the second half of 2024. The Dell Technologies-based cluster will support the growing need for HPC resources in Ohio for research, education and industry innovation, especially in the area of AI. Cardinal, named in honor of the state bird of Ohio, is a collaboration between OSC and Dell Technologies, Intel and NVIDIA and features the latest technologies from these vendors. In both capabilities and capacity, the new cluster will be a substantial upgrade from the system it will replace, the Owens Cluster launched in 2016.

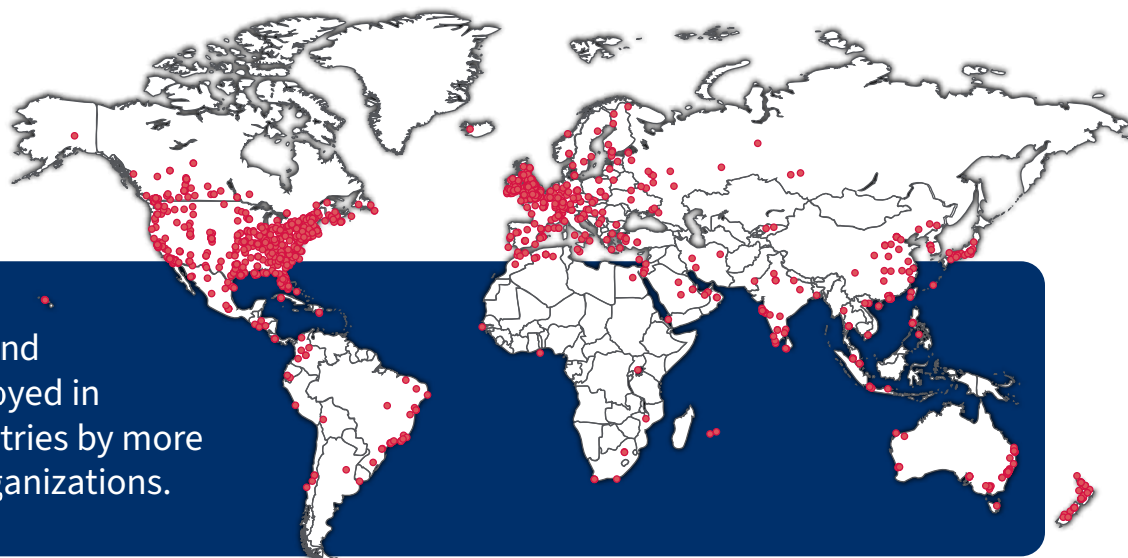
ONDEMAND

Open OnDemand version 3.0

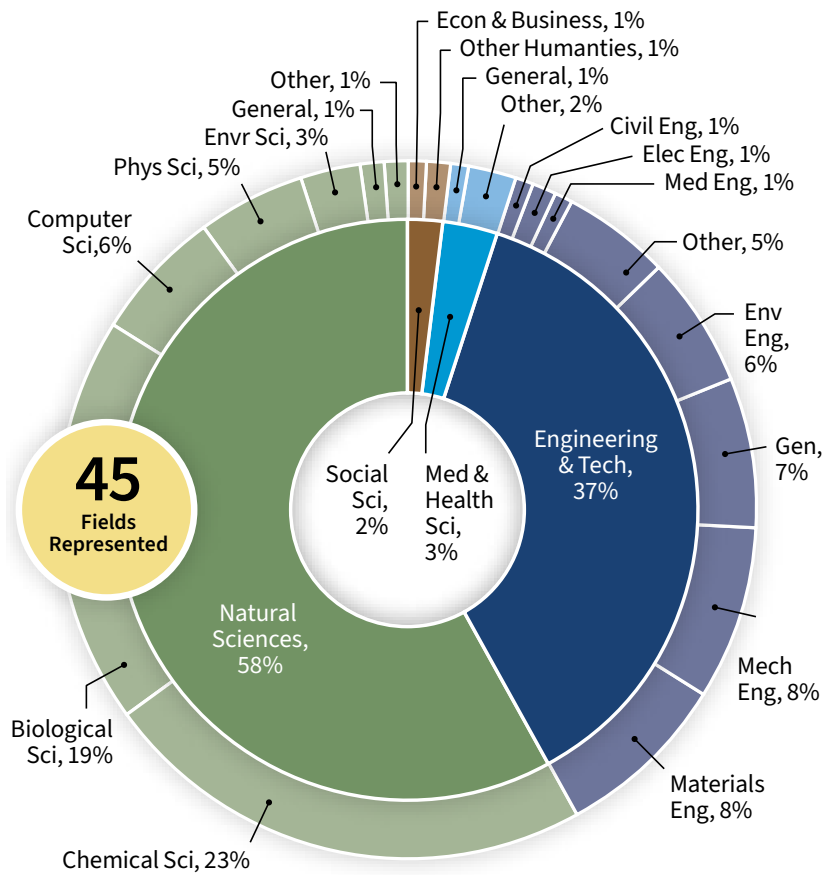
Version 3.0 of Open OnDemand, OSC’s web-based client portal used by HPC centers around the globe, was released in April 2023 to offer clients easier ways to customize and manage their work. Open OnDemand developers at OSC and project partner institutions Virginia Tech, University of Buffalo and the Massachusetts Green High Performance Computing Center worked with HPC community members at institutions such as Harvard University and CSC Finland to make significant advancements to the platform to continue to improve the user experience.

Sustainability planning for Open OnDemand

In September the NSF awarded OSC \$1.5 million to create a new governance organization for Open OnDemand to ensure the long-term viability of the online portal. The Center is using the funding to support the addition of program management, security and QA expertise. This enhanced structure will strengthen the ability of the community of Open OnDemand developers, contributors and clients to grow and sustain the portal.



USAGE BY FIELD OF STUDY



CLIENT SCHOLARSHIP

1,102 PUBLICATIONS

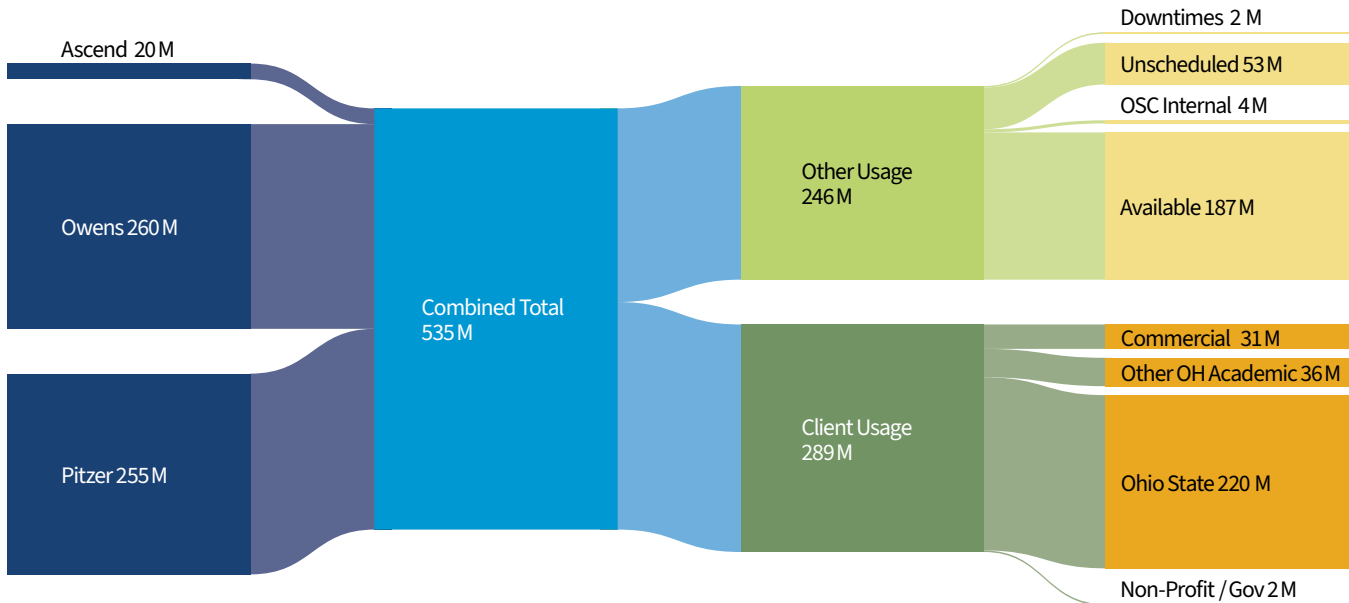
370 VENUES

7,672 CITATIONS

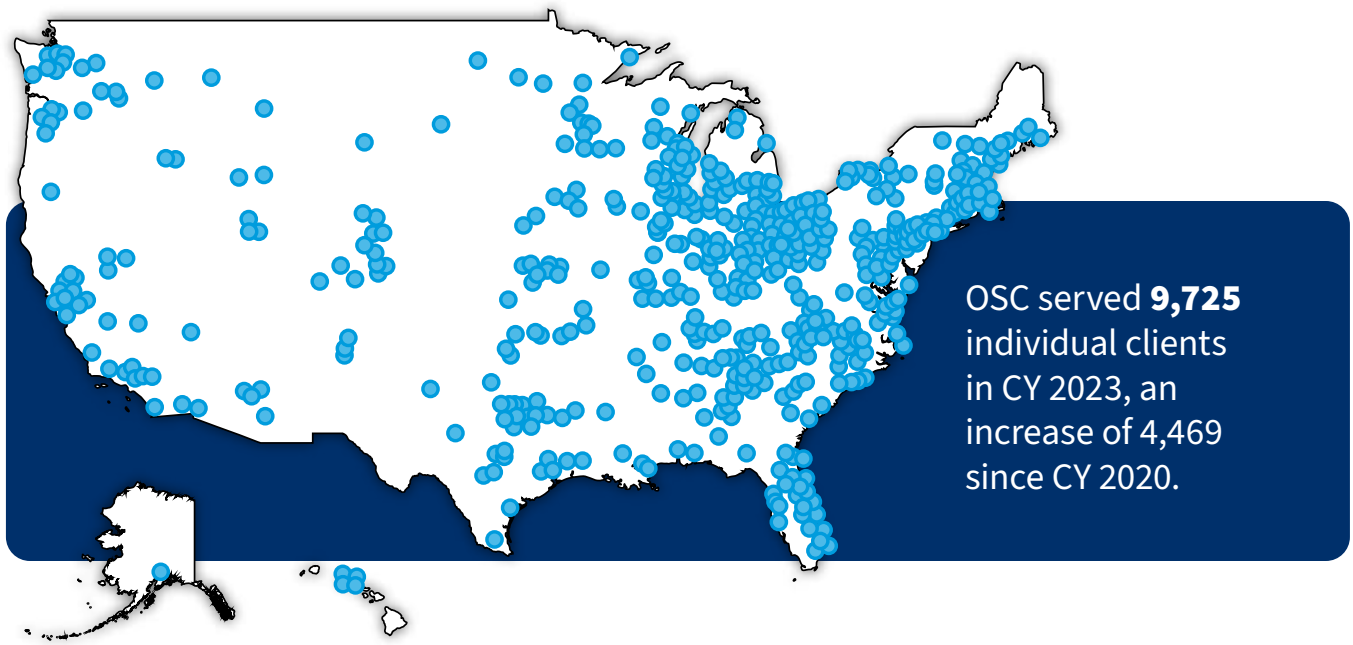
Data from CY2020-CY2022

OVERALL SYSTEM USAGE

in millions of core hours*



* All data: CY2023



AI PROJECTS

NSF award supports AI experts

Case Western Reserve University, the Ohio Supercomputer Center and the University of Cincinnati are optimizing the use of AI and machine learning by making trained experts available to researchers statewide thanks to a \$5.1 million grant from the NSF. The Ohio effort is part of a broader plan by the NSF to bring AI and machine learning to researchers at as many academic institutions as possible nationwide, and to ensure the technology is reliable, understandable and valuable. With its \$1.5 million portion of the award, OSC can hire a research machine learning engineer and spearhead an internship and fellowship program that will train faculty and information technology staff from the partner institutions on large-scale machine learning research projects.

AI bootcamp for HPC professionals

OSC completed a two-year pilot project, funded by an NSF grant, to train more HPC professionals in AI technologies. In 2022 and 2023, staff at dozens of supercomputing research facilities across the nation participated in the AI Bootcamp for Cyberinfrastructure Professionals workshops, which focused on topics such as machine learning, deep learning and data science. OSC offered a

Common Foundations Track for new cohorts and developed a Software and Data-Facing Track for returning attendees, providing a more detailed look at best practices for managing the AI pipeline, state-of-the-art software and tools, common pitfalls, troubleshooting and lessons learned.

ICICLE advances AI projects

As the \$20 million, five-year funded AI institute for Intelligent Cyberinfrastructure with Computational Learning in the Environment (ICICLE) entered its third year, OSC hosted a meeting of all 14 project partners in November to introduce new project proposals, identify valuable areas of collaboration and strategize the upcoming year's work, aligned with the theme of "Innovate, Integrate and Generalize on the Path to Global Scale!" Year two activities included the release of software components and educational outreach.

ENGAGEMENT & OUTREACH

New OSC community forums

OSC announced two new events designed to foster HPC community engagement in Ohio. The OSC Research Symposium, which debuted in April 2024, allows faculty, staff and students from higher education institutions to demonstrate the results of their research and share findings within



Interest in OSC's summer education programs, which offer Ohio teens hands-on STEM experiences, remained strong in 2023. Summer Institute welcomed 20 high school students in June.

6,750 enrollees

from **30** organizations participated in courses using OSC resources



the community. The OSC Community Briefing, to be held in fall 2024, will provide updates on the Center's services and initiatives and also will serve as a venue for client questions and feedback. The events, an evolution of the long-standing Statewide User Group (SUG) biannual meetings, will feature in-person and virtual attendance opportunities.

Summer youth education programs

Interest in OSC's summer education programs, which offer Ohio teens hands-on STEM experiences, remained strong in 2023. Summer Institute attracted 20 high school students who tackled team projects on the subjects of machine learning, data analytics, cybersecurity and web app development. Young Women's Summer Institute (YWSI) allowed 18 middle school students to collect and analyze water quality data from the Battelle Darby Creek Metro Park. Both programs strive to cultivate interest in STEM subjects and help students identify education and career pathways in this fast-growing field. In 2024, YWSI became the Youth Watershed Summer Institute, open to all 6th and 7th graders in Ohio.

Participation in national conferences

Staff participated in five large research computing-focused conferences where academic researchers and industry came together to share advancements

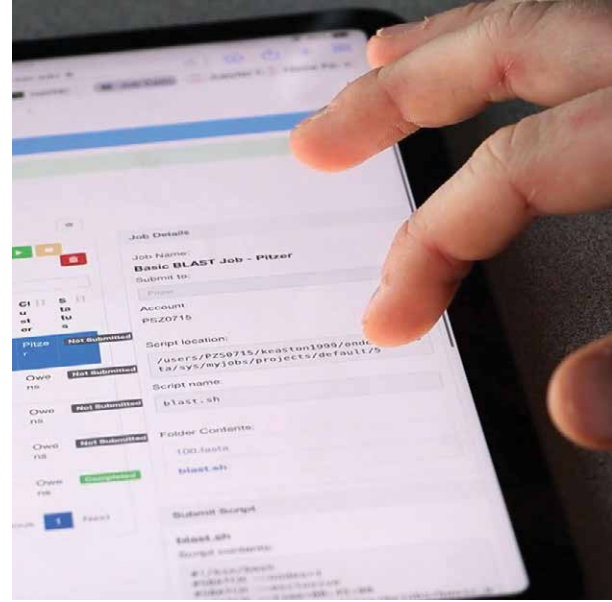
in the HPC field. The conferences included ISC High Performance, Gateways, PEARC, CASC and SC. Staff were involved with conference planning and panel discussions, delivered talks and provided interactive demonstrations of the Open OnDemand portal. Conferences help OSC remain engaged with the national and international HPC community, learn about new developments in HPC and share its most recent initiatives.

State fair, COSI outreach

OSC expanded its public education and outreach activities in 2023, participating in the COSI Big Science Celebration for the second time and making an appearance at the Ohio State Fair for the first time as part of the Ohio Technology Consortium/Ohio Department of Higher Education exhibit. The Center allowed visitors to take virtual tours of its data center and peek inside its HPC projects, and also offered a hands-on activity that spotlighted the parts of a supercomputer node. The exhibit was located in the Lausche Building, which hosted higher education institutions and science and technology organizations and companies in Ohio such as Intel.



OSC offered a virtual tour of its data center and examples of its high performance computing projects to visitors at the Ohio State Fair in summer 2023. The activity was part of the new Ohio Technology Consortium/Ohio Department of Higher Education booth in the science, technology and education exhibit hall.



Top left: Clients from 45 fields of science use OSC's resources and services to advance their research, technology innovations and teaching.

Top right: Clients can access the supercomputing power of HPC centers with Open OnDemand installed any time from any location.

Center right: The inner workings of the OSC data center, where three clusters provide high performance computing power for thousands of clients.

Bottom left: The Ascend cluster features dedicated GPUs to support artificial intelligence research.

CLIENT RESEARCH SPOTLIGHTS

OHIO UNIVERSITY

Tags: Research Landscape

Ohio University faculty member Basil Masri Zada worked with OSC to host Stable Diffusion Automatic 1111, a popular open-source generative artificial intelligence (AI) software, for students to access in the university’s new digital arts and technology courses. The art students learned how the materials used to train AI can impact the software’s behavior, as well as how they can incorporate AI tools into their creative workflow. Through OnDemand, OSC’s remote access platform, the students can use the software on any device, with privacy and control over the data they generate.

Read more: osc.edu/digitalart



Alyssa Vandale, a student in ART 3110 Digital Art + Technology II, used Adobe Premiere, Illustrator, Photoshop, After Effects, Fresco, Audition and batch processing on Stable Diffusion to create a video. The above photo is a still image from the video.

IDAHO NATIONAL LABORATORY

Tags: Research Landscape, Invention/Discovery

After adopting the Open OnDemand platform on their systems, HPC system administrators at the Idaho National Laboratory published a research paper that confirmed Open OnDemand’s significant positive impact on HPC usage in their organization. Having experienced initial resistance from their own community, the administrators wanted to help others trying to justify shifting to a science gateway for HPC. The research showed that Open OnDemand reduced the time between account setup and first job submissions.

Read more: osc.edu/inlstudy

TAGS

InnovateOhio Sectors	Area of Study
Aerospace	Advanced Materials
Agribusiness	Biological Sciences
Automotive	Environment
Aviation	Industrial Engagement
Energy/Chemical	Research Landscape
Invention/Discovery*	
Manufacturing	

InnovateOhio—the DeWine Administration’s commitment to leading an aggressive, innovative path towards a better and stronger Ohio—has outlined these traditional areas of innovation strength throughout the state’s history.

*Invention/Discovery describes InnovateOhio’s Edison category.

QUSTOMAPPS LLC

Tags: Industrial Engagement, Invention/Discovery

Texas software company QustomApps LLC provides two specialized software programs, WoundSIM and QustomWeld, used in precision weld simulation and composite pressure vessel modeling. QustomWeld is used to simulate welds varying in scale, from large nuclear reactors to the electronics within smart phones. Simulating these welds with high precision is computationally intensive and requires the use of HPC. As some clients needed to run QustomApps software on the Linux operating system, the company worked with OSC to compile code within the Center's Linux-based machines. This allowed the company to continuously develop and update its software without the added struggles of maintaining its own Linux machine.

Read more: osc.edu/qustom

UNIVERSITY OF CINCINNATI

Tag: Research Landscape

Matthew Bayliss, an assistant professor of physics at the University of Cincinnati, has been using OSC for several years to teach undergraduate and graduate students about star structure and evolution in the universe. The work of understanding these celestial objects requires quite a bit of computation. While students could puzzle through such equations on a whiteboard or on a personal laptop, Bayliss has found that using OSC's classroom resources is an easy and effective approach. Bayliss cites Open OnDemand, file storage and client support as key benefits of working with the Center.

Read more: osc.edu/bayliss



Staff Scientist Emre Firlar loads cryopreserved specimens into the electron microscope at the Rutgers Cryo-EM & Nanoimaging Facility.

ECOSYSTEM FOR RESEARCH NETWORKING

Tags: Biological Sciences, Energy/Chemical

The Ecosystem for Research Networking (ERN), which includes members from Rutgers University, MGHPCC, Omnibond, Virginia Tech, UMass Amherst, Penn State University and Pegasus, is developing a way to improve online access to high-cost, specialized scientific equipment to advance national research initiatives. The ERN Cryo-EM Federated Instrument Pilot Project, in partnership with Rutgers University, is creating a portal, built upon Open OnDemand, that enables the remote control of cryo-electron microscopes and analysis of electron microscopy data. The portal allows for large amounts of data collected by the instruments to be processed in real time using a closed-loop system between remote operator, instrument and off-site HPC cluster.

Read more: osc.edu/cryo-em

THE OHIO STATE UNIVERSITY

Tag: [Agribusiness](#)

Jessica Cooperstone, an associate professor at The Ohio State University, leads a research laboratory focused on understanding the factors that create the health benefits found in fruits and vegetables, with the aim of helping the agriculture and food industry cultivate crops that improve overall human health. The laboratory utilizes an analytical method called metabolomics to better understand the nutritional profile of certain crops. Because metabolomics generates a lot of data, Cooperstone works with OSC to harness its enhanced computational power to analyze crops such as apples and tomatoes.

Read more: osc.edu/food

NORTH DAKOTA STATE UNIVERSITY

Tags: [Research Landscape](#), [Invention/Discovery](#)

The Center for Computationally Assisted Science and Technology (CCAST) at the North Dakota State University is the largest academic supercomputing facility in the state. When the global COVID-19 pandemic hit, the center introduced Open OnDemand, which has since become CCAST's front door for HPC access. Open OnDemand has lowered barriers to access for new users, enhanced educational opportunities and allowed CCAST to offer popular and requested interactive apps, such as RStudio and Jupyter Notebook, into the environment with minimal effort. Open OnDemand has aided researchers and allowed educators to more easily integrate supercomputing into the classroom.

Read more: osc.edu/ndsu

UNIVERSITY OF MAINE

Tag: [Biological Sciences](#)

With the help of OSC's HPC resources, University of Maine scientist Pauline Kamath conducts research on infectious diseases that can spread among wildlife. Kamath analyzes genetic, ecological, immunological and epidemiological data to study the evolution and transmission of harmful pathogens in animals such as zebra and deer to better understand how to treat and control infections. One data collection method involves taking tissue samples from which all of the genomic DNA is extracted and sequenced within the sample without any specific criteria. Using the OnDemand portal, Kamath's team draws on OSC's HPC capabilities to analyze and store the data.

Read more: osc.edu/kamath

KENT STATE UNIVERSITY

Tag: [Research Landscape](#)

Kent State University's master's degree in AI allows students to tackle large-scale, real-world projects—on topics such as natural language processing, cancer detection and deep learning-based image analysis—that will position them for work in the AI field, said Arvind Bansal, a professor of computer science who directs the program. To manage the workload associated with the large data sets, Kent State has drawn on OSC's AI resources, including the Ascend cluster's GPUs and deep learning software frameworks TensorFlow, Pytorch and Keras. Kent State's Campus Champion, Philip Thomas, provides tutorials to the students on how to use OSC's systems and serves as a liaison to the Center for technical questions.

Read more: osc.edu/bansal

RESOURCES

Current and prospective clients can take advantage of OSC's many technical resources, from computing clusters and hardware services to software packages and web portals. OSC also supports clients by providing easy access to technical expertise, workshops, training sessions and educational and networking events.



290 M+
CLUSTER CPU
CORE HOURS



1.8 M+
GPU HOURS
CONSUMED



92%
OF JOBS STARTED
WITHIN 30 MINUTES



99.6%
AVAILABILITY



26 PB
TOTAL DATA
STORED



3 PB
DATA TRANSFERRED



1,667
SOFTWARE
PACKAGE VERSIONS

EDUCATION & TRAINING

Workshops and Training

Clients and potential users can register for workshops, one-on-one classes, web-based training and consulting services. Topics include getting started using OSC, containers for research computing and performance tuning.

Virtual Computer Labs

Faculty and instructors can request classroom accounts for students to use HPC resources in research or coursework at no cost.

Research Symposium

Students, faculty and staff can present their research at the spring Research Symposium, which allows researchers from across Ohio to share their findings and learn about advancements in supercomputing.

Youth STEM Programs

Middle school and high school teens in Ohio can apply to participate in the Summer Institute (SI) or Youth Watershed Summer Institute (YWSI) to gain experience with STEM research that can help them choose educational and career paths.

CLIENT SUPPORT

Office Hours

Speak directly with OSC experts through virtual consultations. Visit osc.edu/events to see the full schedule of office hours and sign up for a time.

Technical Support

Get support for training, onboarding for new users, system status updates and resolution of issues such as debugging, software installation and workflow improvements.

- Getting Started Guide: osc.edu/start
- Technical Support: osc.edu/support
- OSC Help Desk: Basic and advanced support, Monday through Friday, 9 a.m. to 5 p.m., oschelp@osc.edu or 614-292-1800.
- Real-time System Status Updates: Follow [@HPCNotices](https://twitter.com/HPCNotices) on X



The Youth Watershed Summer Institute (YWSI) allows Ohio youth to participate in hands-on research experiences to help them explore education and career paths in the STEM field.

Consulting

Consult with OSC staff experts on HPC and software engineering issues, including optimizing code and debugging.

Research Collaboration

Find collaborators on the OSC staff for various research and education projects, including major new grant-funded interdisciplinary initiatives.

SOFTWARE & WEB PORTALS

Software

Utilize a broad selection of applications, including more than 1,500 software packages that OSC staff update and test, as well as getting started guides.

OSC OnDemand

Remotely use OSC's web-based portal, ondemand.osc.edu, from any device. Based on the OSC-developed Open OnDemand platform, supported by the National Science Foundation, features include file management, command-line shell access, job management and monitoring across multiple batch servers and resource managers, and graphical desktop environments and applications. No software installation required.

MyOSC

Manage your account through OSC’s client portal, my.osc.edu. Clients can adjust passwords and contact information, manage project access, report funding and publications and run custom usage reports. The OSC team continually updates MyOSC to enhance the user experience.

HARDWARE SERVICES

Cluster Computing

With flexible and scalable clusters rivaling those found at National Science Foundation centers and other national labs, OSC supercomputers provide a peak computing performance of 7.5 Petaflops. OSC routinely upgrades its clusters to ensure that researchers can access top-of-the-line supercomputing resources.

Research Data Storage

Researchers can access upgraded storage services and a tape backup infrastructure capable of redundantly storing up to 23.5 PB of data. Protected Data Service (PDS) addresses the most common security control requirements encountered by researchers. Protected data types include International Traffic in Arms Regulations (ITAR), Export Administration Regulations (EAR), Health Insurance Portability and Accountability Act of 1996 (HIPAA), personally identifiable information (PII) and proprietary data.

Globus Server

This free cloud-based service allows clients to move, share and discover research data through a single interface, regardless of its location or number of files or size. Globus is used extensively at supercomputer centers and major research facilities.



SUPERCOMPUTERS

OSC’s supercomputers are the Owens cluster, named for American Olympic hero and Ohio State graduate Jesse Owens; the Pitzer cluster, whose namesake, Russell M. Pitzer, co-founded OSC and taught as a professor of chemistry at Ohio State; and Ascend, which was named to honor the state of Ohio’s long history of advancements in the aviation and aeronautics fields.

Compute	OWENS 2016	PITZER 2018	PITZER EXPANSION 2020	ASCEND 2022	TOTALS
Cost	\$7 million	\$3.4 million	\$4.3 million	\$1.8 million	\$16.5 million
Theoretical Performance	~1.6 PF	~1.3 PF	~2.6 PF	~2 PF	~7.5 PF
Nodes	824	260	398	24	1,506
CPU Cores	23,392 Intel Broadwell	10,560 Intel Skylake	19,104 Intel Cascade Lake	2,304 AMD Milan	55,360
RAM	~120 TB	~71 TB	~94 TB	~24 TB	~308 TB
GPUs	160 NVIDIA Pascal P100	64 NVIDIA Volta V100	102 NVIDIA Volta V100	96 NVIDIA Ampere A100	422

ENGAGEMENT



Research Symposium

Present your research findings and share information with others in the Ohio HPC community during this annual spring event.



Campus Champions

Advocate for OSC's HPC resources at your academic institution and receive project accounts with no-cost access to a range of OSC services.



Community Briefing

Join OSC leadership each fall to learn about major new initiatives; provide feedback about services, products and needs.



Client Continuity





Inquire about opportunities to continue to use OSC resources at your next institution or private sector employer.



Media Mentions

Share media coverage of your work using OSC so we can amplify the coverage in our channels.

osc.edu/engagement

-  x.com/osc
-  facebook.com/ohiosupercomputercenter
-  linkedin.com/company/ohio-supercomputer-center
-  osc.edu

