Open OnDemand: Connecting Computing Power With Powerful Minds

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ABSTRACT

First introduced in 2013, Open OnDemand [5] (openondemand.org) is an innovative, open-source, web-based portal that removes the complexities of research computing (RC) system environments from the end-client, and in so doing, reduces "time to science" for researchers by facilitating their access to RC resources. Through Open OnDemand, RC clients can upload and download files, create, edit, submit and monitor jobs, create and share apps, run graphical user interface-based (GUI) applications and connect to a terminal, all via a web browser, with no client software to install and configure. Open OnDemand greatly simplifies access to RC resources, freeing domain scientists from having to worry about the operating environment and instead focus on their research. It enables computer center staff to support a wide range of clients by simplifying the user interface and experience. The overall impact is that clients can use remote computing resources faster and more efficiently. In this paper, we describe advances to the Open OnDemand platform since it was publicly released to the research computing world in 2017 [4], the community that has developed around it and our plans to leverage these to build an ecosystem to ensure future sustainability of this popular platform.

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CCS CONCEPTS

• **Human-centered computing** → *Human computer interaction (HCI).*

KEYWORDS

science gateway, research computing, Open OnDemand

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1 INTRODUCTION

The ability to process large sets of data on current research computing (RC) platforms has led to remarkable advances in science and engineering, RC has become an indispensable tool for researchers, industry professionals, and students. Examples include biochemists utilizing cryogenic electron microscopy (Cryo-EM) to quickly understand the underlying structural biology mechanisms of the COVID-19 virus, materials scientists designing new alloys from chemical and physical first principles, art design students creating novel works via the use of generative artificial intelligence (AI) technology, and aerospace engineers improving the performance of drones via computational fluid dynamics modeling.

The importance of RC platforms and tools has been recognized by the highest levels of the United States government. However, for many researchers, RC use and adoption is hindered by the complex

way in which these resources are accessed. While web browsers and smartphones have become the dominant access mechanism for remote consumer and enterprise computing services, the adoption of such mechanisms has lagged for many RC service providers, creating an accessibility gap that impedes further adoption.

Likewise, the National Research Council has witnessed a dramatic increase in the scale and complexity of scientific research [11]. The growing scale of science has been accompanied by a shift toward collaborative research, referred to as "team science." Scientific research is increasingly conducted by small teams and larger groups rather than individual investigators, but the challenges of collaboration can slow teams' progress in achieving their scientific goals.

Funded by the U.S. National Science Foundation (NSF), developed by the Ohio Supercomputer Center (OSC), and first made available to the broader research computing community in 2017 [4], Open OnDemand (openondemand.org) is an open-source portal that enables web-based access to research computing (RC) services. Open OnDemand empowers students, researchers, and industry professionals with remote web access to RC services, thereby simplifying use of those resources and facilitating collaboration. RC systems administrators install Open OnDemand on the RC resource, and subsequently, RC clients can manage files and jobs, create and share apps, run GUI applications, and utilize a traditional terminal all through a web browser from anywhere on any device. Open OnDemand has been shown to reduce impediments to RC use and adoption by empowering researchers, industry professionals, and students. From a client perspective, key features of Open OnDemand are: it requires zero installation (since it runs entirely in a browser); it is easy to use (via a simple interface); it is compatible with any device (even a mobile phone or tablet). From a system administrator perspective, key features are: it provides a low barrier to entry for clients of all skill levels; it is open-source and has a large community behind it; is configurable and flexible for client's unique needs.

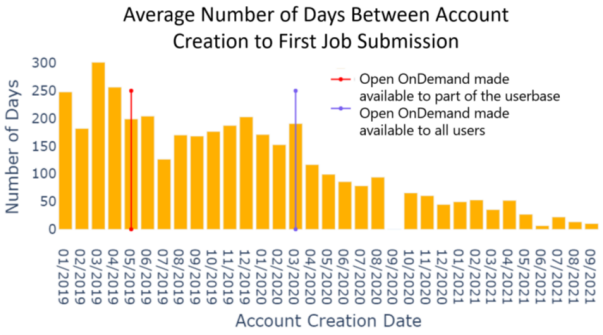

Figure 1: Idaho National Lab researchers had a faster time to science as a result Open OnDemand being made available

The primary goal of Open OnDemand is to lower the barrier of entry and simplify access to RC resources, freeing domain scientists from having to worry about the operating environment and instead allowing them to focus on research. The net result of making Open OnDemand available to researchers is a faster time to science. For example, administrators at the Idaho National Laboratory [22] measured the average number of days between account creation to first job submission on their systems, both before and after they made Open OnDemand available. By the end of the study, that time had dropped by a factor of 19 as shown in Fig. 1. This result has been replicated broadly by public and private academic institutions, government agencies, non-profit organizations, and private industries.

2 COMMUNITY

Open OnDemand v1.0 was released to the general public in August 2017 by developers at the Ohio Supercomputer Center (OSC) under the MIT open-source license via a public GitHub repository. There have been dozens of additional releases, with the most recent version 3.1.1 being released in March 2024 [17]. Funded by an NSF award in late 2018 with planned completion imminent, the Open OnDemand 2.0 project [13] is facilitating the creation of a common accessibility platform for campus and national RC resources, increased integration of RC software and advancement of the science of RC by studying and piloting integration with complementary software solutions.

Figure 2: Open OnDemand Deployments in 2023: 95 Countries / 1,646 Organizations

As a result of these efforts, Open OnDemand has been deployed widely worldwide. As of December 2023, it was in use at nearly 1,700 RC service providers in nearly 100 countries across every continent except for Antarctica, as shown in Fig. 2. This is almost double the number of installations just six months prior, when the tally was 683 organizations across 62 countries. Open OnDemand has been installed at public and private academic institutions, government agencies, non-profit organizations, and private industries. The broad adoption of the platform enables clients to easily scale, with a consistent interface, among a broad range of RC service providers, including:

- Local/campus resources
- National resources (e.g. Pittsburgh Supercomputing Center Bridges 2, Purdue Anvil, National Center for Supercomputing Applications Delta, San Diego Supercomputer Center Expanse, Idaho National Labs Sawtooth)
- Commercial cloud providers (e.g. Microsoft Azure, Amazon AWS, Google GCP)
- Top500 list systems (e.g. CSC Finland LUMI, Riken Fugaku)
- Test bed systems (e.g. Texas A&M Univ. ACES, Indiana Univ. Jetstream2, Stony Brook Univ. OoKami)
- Regional clusters catering to Minority Serving Institutions

In addition to deploying and using the platform, the Open OnDemand community is actively engaged in various monthly and semiannual events, including: (1) monthly "tips and tricks" webinars focusing on individual community contributors; (2) monthly "open office hours" calls with the core developers; and (3) in-person user group meetings at the annual Supercomputing (SC) [23], Practice and Experience in Advanced Research Computing (PEARC) [21], and Science Gateways series of conferences. Average attendance at the calls typically ranges from 30 to 70 participants. At in-person meetings, the audience size (typically 100-150) and lively participation have been extremely encouraging, with time often running out before all of the audience-contributed topics have been addressed. This has motivated the Open OnDemand team to organize a standalone community conference with a pilot planned for early 2025.

As an open-source platform, contributions from the community are welcome and encouraged. To facilitate contribution to the code base, the project team has in place various procedures and processes to enable continuous development, integration, and deployment. These include:

- Versioning everything using git, including system configuration.
- Standard branching workflows.
- Using GitHub's code review tools to ensure every commit is peer reviewed.
- Bug reporting via GitHub issues.
- Feature requests submitted via GitHub issues (often started as a Discourse discussion thread).
- Kan ban principles to visualize work and ensure that each feature or bug is tracked from inception to the moment it is delivered in an official stable release.
- Every commit triggers a continuous integration server to execute unit and integration tests.
- Regular testing of the responsiveness of the design, verifying functionality for multiple browsers and devices.
- Tags added to the master branch trigger the building of release candidate builds (rpms) that can be deployed on demand to a test or production system.
- All releases, including nightly builds, are available to the community through a repository hosted by OSC.
- New stable releases are announced via multiple communications channels and discussed in webinars following the publication of release documentation.

Over 60 individuals have contributed to the main code base since inception [15], resulting in thousands of commits since 2016, as shown in Fig. 3. The source code now exceeds 50,000 lines, the majority of which is either JavaScript or Ruby. In addition, dozens of developers have created additional apps that connect to Open OnDemand, and made them available to the community.

The community is also very active on the project discussion board (discourse.openondemand.org), which averages over 4,000 page views each month by logged-in clients, who created over 2,500 posts in the past year. Likewise, the project team has posted dozens of videos and several hundred articles and presentations. All of these products are easily accessible from the public Open OnDemand website and are regularly accessed by the community [19].

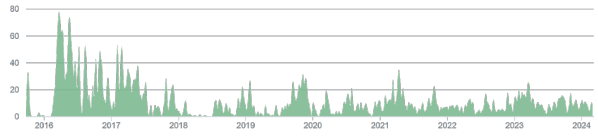

Figure 3: OnDemand GitHub repository code contributions since 2016

3 IMPACT

The key goals of the Open OnDemand 2.0 award are to 1) increase adoption of national RC resources across science domains; 2) streamline transitions from smaller campus resources to national RC resources for researchers, educators, and students; and increase transfer of RC solutions from public to private sectors. This project contributes directly and sustainably to the creation of a National Cyberinfrastructure Ecosystem and the goals of the National Strategic Computing Initiative [18]. An example of the impact across science domains can be seen in Fig. 4, which shows the relative usage of OSC's resources by clients' fields of study in 2017 (left) and 2023 (right). In the six-year period since Open OnDemand was first released there has been a significant increase in usage by the natural, medical, health, and social sciences. In total, OSC's current clients are from 45 different science domains (up from 28 in 2017), including areas such as psychology, anthropology, and horticulture, which have not traditionally made use of large scale RC.

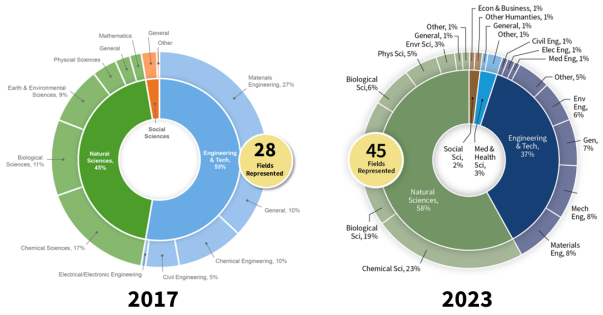

Figure 4: Ohio Supercomputer Center change in usage by field of study from 2017 to 2023 due to Open OnDemand

Open OnDemand also has a positive impact on education, as professors who adopt Open OnDemand in classes report that they use less lecture time on RC technology specifics and more on curriculum. During the COVID-19 pandemic, many academic institutions were able to utilize their Open OnDemand instances as remotely accessible computing labs since students and faculty were not able to access on-campus computing labs [16]. For example, in Ohio, during the 2020-2021 academic year, 5,565 students across 249 courses and 20 academic institutions were able to continue their academic coursework via OSC's Open OnDemand instance. Further examples are discussed in Section 6.

Not only has Open OnDemand proven to be popular with clients, OSC and others have demonstrated quantitatively that it reduces the time to science for new clients (as discussed previously in the Introduction Section). As a result of an analysis of over a dozen academic institutions in Ohio starting in 2021, the project team found that Open OnDemand provides a median of 900 hours per year per institution of additional client productivity as a result of new clients being able to actively submit jobs to research computing resources faster than those who historically utilized traditional terminal-based login methods. The net result is a significant improvement in time to science for RC clients.

This improvement in efficiency applies across institutions of all sizes. While large universities often have staff that are able to offer customized training on Linux, SSH and other RC technologies, smaller schools, including Minority Serving Institutions, frequently lack the budget and staff to offer comparable training. By eliminating the need to know these technologies, Open OnDemand enables increased access to RC, resulting in positive impacts on diversity, equity, inclusion, and accessibility. Additionally, the customizability of Open OnDemand apps allows centers to target workloads to clusters, queues, etc., that are appropriate for the workload. For example, creation of data visualizations that are not compute intensive can be easily shuttled to an interactive queue where the compute resources allocated per job are comparatively small, leaving more of the research computing resources for compute intensive workloads.

4 ARCHITECTURE

Over the past decade the term "science gateway" has been used to refer to RC resources and services that provide higher-level user interfaces, primarily accessed through a web browser, to scientists needing access to computing, data repositories and advanced instruments. There has been a rich history of gateways in the form of general web interfaces and targeted science applications for RC access. A 2019 survey of RC general web interfaces identified 24 different options [3]. The majority are only available as part of a commercial software license or via access to a commercial RC provider. Open OnDemand is one of only a few open-source general web interfaces and the only open-source one in the survey to support remote visualization.

Open OnDemand's architecture is a rich set of core web applications that leverage HTML5 standards and are installed by the RC service provider and securely hosted behind a web proxy providing federated authentication. Clients can access an Open OnDemand installation simply by using a modern web browser to connect to the host RC center and authenticating with their credentials. Upon successful authentication the client is redirected to a dashboard landing page that provides navigation to the default set of core Open OnDemand applications but also to any custom applications installed by the RC service provider (e.g. RStudio, VSCode, or Jupyter on the RIKEN Center for Computational Science Fugaku system, as shown in Fig. 5).

From a technical perspective, a novel feature of Open OnDemand compared to a traditional web service is the per-user web server model where all the web applications are run as the Linux user. This leverages the Linux kernel for security and accounting and greatly simplifies app development. Open OnDemand currently

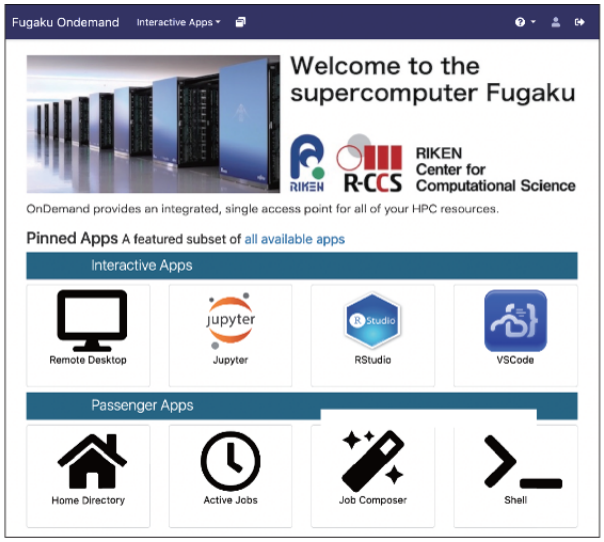

Figure 5: Fugaku OnDemand dashboard interface

supports web applications written in Ruby, Python, and Node.js. It also supports interactive and containerized apps, which consist of a batch job that launches a web application server on a compute node, pre-configured to allow the client to connect directly to it.

In order to ensure quality control, security, and privacy of the Open OnDemand architecture and code, the Open OnDemand team has many continuous development, integration and deployment processes and infrastructure in place, as detailed previously in the Community Section. Many of these are the result of several engagements the team had with Trusted CI, the NSF Cybersecurity Center of Excellence (trustedci.org). The first engagement was in 2018, during which Trusted CI conducted an in-depth vulnerability assessment and identified a few implementation issues that the Open OnDemand developers subsequently addressed [9]. The next engagement was in early 2021 and had three objectives: (1) integrate security automation into DevOps flows; (2) transfer skills for vulnerability assessments; and (3) develop needed security policies, practices, and procedures [10].

5 APPLICATIONS AND INTEGRATIONS

5.1 General Applications

There are a vast number of targeted science applications which are complementary in nature to Open OnDemand. For example, Jupyter Notebook is a web-based interactive computational environment for creating notebook documents, and RStudio Server is an integrated development environment for the R statistical computing language. Open OnDemand can easily interoperate with applications such as these, which are two of the most popular "apps" that RC service providers typically install with Open OnDemand.

Examples of applications that have been integrated with Open OnDemand by the community are shown in Table 1. The breadth and depth of the domains represented is a clear indication of the widespread adoption of the platform.

Abaqus	ANSYS	COMSOL
Grace	Grafana	Grid Engine
IDL	Jupyter	Kubernetes
LSF	Mathematica	MATLAB
Meshroom	NAGIOS	Octave
Paraview	PBS	QGIS
RELION	RStudio	SAS
Shiny	Slurm	Spark
STATA	Tensorboard	Torque
VISIT	VS Code	VMD

Table 1: Example applications integrated with Open OnDemand

5.2 Example Integration: Open XDMoD

Open XDMoD [20] is an open source tool to facilitate the management of RC resources. Open XDMoD has a data warehouse that stores a wide variety of usage, performance and quality-of-service information about RC systems, and a web-based portal that facilitates reporting and analysis of the data. If an RC provider has both Open XDMoD and Open OnDemand installed, the products are naturally integrated in two ways.

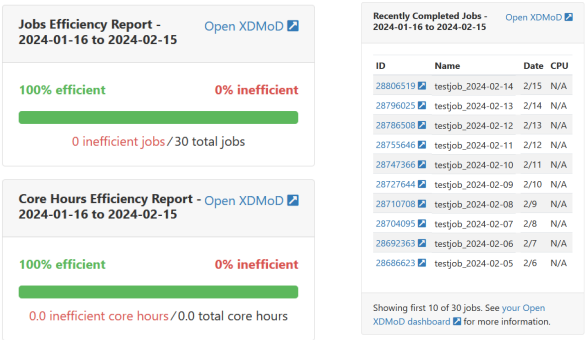

Figure 6: Example Open OnDemand dashboard widgets showing Open XDMoD data and linking to further reports.

Firstly, historical usage and job efficiency reports from XDMoD are available within the OnDemand dashboard and XDMoD supports tracking and reporting on the usage of OnDemand itself. Fig. 6 is an example screenshot of the dashboard report from XDMoD displayed in OnDemand. When a client logs in to OnDemand, the information about their previous jobs is loaded from XDMoD and displayed in the dashboard. Clicking on a job record in the dashboard opens the Job Viewer component of XDMoD which has detailed information about job execution including plots of CPU usage and efficiency metrics.

Secondly, the reporting of OnDemand usage in XDMoD is mainly aimed at compute center staff. Center directors, administrators and client support personnel can use XDMoD to track OnDemand usage. The metrics in XDMoD include the number of OnDemand Apps in use in a given time period, the number of clients and the number of client sessions, and the number of page impressions. The metrics can be filtered and grouped in multiple ways including by client, location, browser, and OnDemand App. For example, Fig. 7 shows the breakdown of usage of OnDemand by app for the top five apps on the Research Cluster at the Center for Computational Research (CCR) in the University at Buffalo.

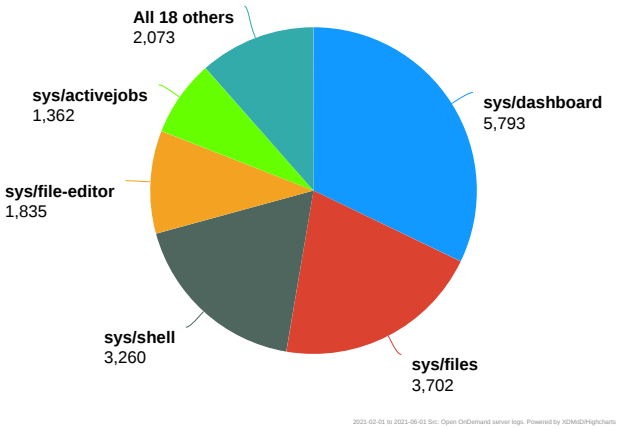

Figure 7: XDMoD plot showing OnDemand app session counts and relative ratios at UB-CCR

5.3 Example Integration: ACCESS

Open OnDemand is a component of the NSF-funded Advanced Cyberinfrastructure Coordination Ecosystem: Service and Support (ACCESS) [2] Support project led by the University of Colorado Boulder. Open OnDemand was included in the support strategy to simplify the researcher experience with using the national resources by the ACCESS program, thereby reducing the support load. To help meet this goal, the Open OnDemand team developed an ACCESS-specific menu (ACCESS OnDemand) and reporting tool that is gradually being deployed on each ACCESS-managed resource.

When activated, the menu provides clients direct links to key external ACCESS resources, such as the support portal and allocations tool. It will eventually also provide links to OnDemand instances at other ACCESS resources. For researchers, this means that they can move between ACCESS resources depending on availability and suitability of particular system hardware and software, but the interface to access these resources will always be ACCESS OnDemand.

The reporting tool, developed in conjunction with the XDMoD team at UB-CCR (who are responsible for ACCESS Metrics), automatically processes OnDemand usage logs at the resource, and sends summaries to the centralized ACCESS XDMoD instance. Details include applications available within OnDemand on that resource and aggregate client utilization of them. For ACCESS resource providers and key stakeholders, this reporting provides additional visibility into how clients are utilizing the systems.

5.4 Example Integration: Globus

Many RC administrators who have deployed Open OnDemand also provide clients access to Globus.[12][1] Globus provides a web application for easily moving data to and from RC systems and can easily handle very large data transfers of tens of terabytes and millions of files. Research projects, particularly those involved in team science, often need to work with data at these scales. The Globus team at University of Chicago contributed an Open OnDemand integration that improves the researcher experience when

both Open OnDemand and Globus are available on a system. The feature adds a new button to Open OnDemand's Files interface. When the interface displays a folder where Globus data transfers are permitted, the button activates. Clicking the button takes the client to the same folder in the Globus web application, where they can easily transfer data to or from another system, as shown in Fig. 8. If the system administrator does not permit Globus data transfers for the folder being displayed, the button is not active. The administrator of the RC resources chooses whether the button appears in Open OnDemand and configures which parts of the system allow Globus transfers. This feature alerts researchers using OnDemand that Globus is available and guides them directly to the right place in Globus, eliminating the need for complicated instructions.

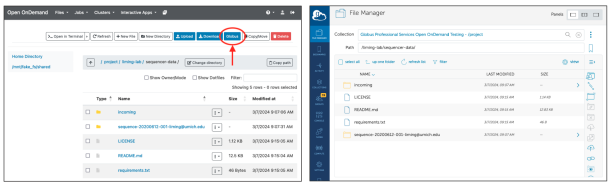

Figure 8: Open OnDemand file browser opening Globus file manager window.

6 CASE STUDIES

In this section, we present several abridged versions of longer case studies available on the Open OnDemand website to illustrate some of the specific successes that the platform has facilitated.

6.1 Classroom Computing

Nick Dusek is a Research Facilitator at The Center for Computationally Assisted Science and Technology (CCAST) at the North Dakota State University (NDSU). CCAST provides RC resources to NDSU and various other institutions within North Dakota. With more than 12,000 CPU cores and 70 GPUs, CCAST is the largest academic supercomputing facility in the state of North Dakota. Managing and ensuring access for clients is a top priority for CCAST. In 2019, when the global COVID-19 pandemic started to disrupt in-person activities, Dusek introduced Open OnDemand, a remote RC platform developed by the Ohio Supercomputer Center (OSC), to the CCAST community [7].

"When we all got sent home in March 2020, everything was in flux and the tolerance for failure was high," Dusek said. "I deployed Open OnDemand from home during COVID and went straight into production. It turned out people really liked it. I don't think we could ever go back." Previously, CCAST had no ability to provide graphical user interfaces to its clients, but Open OnDemand has allowed them to implement various popular and requested interactive apps, such as RStudio and Jupyter Notebook, into the environment with minimal effort. This change has not only impacted researchers but has allowed educators to more easily integrate supercomputing into the classroom, Dusek said.

Previously, teaching large groups of RC clients proved challenging because students use a wide range of operating systems, each with their own methods for RC. Because Open OnDemand is accessible through a web browser, it has helped eliminate these differences, creating a more unified learning process, Dusek said.

6.2 Remote Science

The Ecosystem for Research Networking (ERN), a team consisting of members from Rutgers University, MGHPCC, Omnibond, Virginia Tech, UMass Amherst, Penn State University and Pegasus, is developing a way to use scientific instruments remotely online [6]. Dubbed the ERN Cryo-EM Federated Instrument Pilot Project, the team seeks to improve access to high-cost, specialized equipment to advance national research initiatives. A key element of the project is the creation of an Open OnDemand-based portal that enables the remote control of cryo-electron microscopes and analysis of electron microscopy data.

"Cryo-EM instruments collect images of samples preserved in a state of water called vitreous ice, which is translucent to electrons. The microscope then uses electrons to image samples down to a fraction of a nanometer. This technique allows scientists to view organic matter in its natural environment with extreme precision," said Jason T. Kaelber, director of the Rutgers Cryo-EM and Nanoimaging Facility.

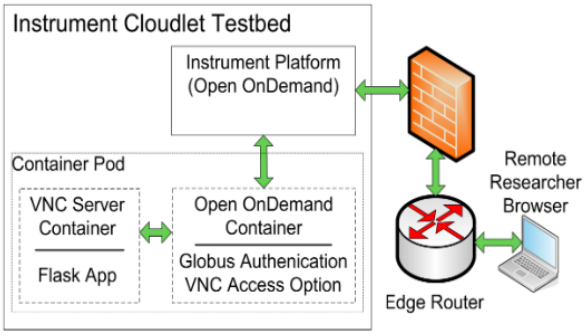

Figure 9: Schematic of the ERN Remote Cryo-EM test bed which utilizes Open OnDemand

Due to the enormous amounts of data collected by the instrument, much of the processing needs to be outsourced to high performance computing clusters. The new portal allows for this data to be processed in real time using a closed-loop system between remote operator, instrument and off-site RC cluster (as shown in Fig. 9). This real-time analysis allows for more accurate data extraction and increased efficiency. Open OnDemand provided an efficient starting point for the development because of its recognition within the research community, robust security measures and adaptability. Since Open OnDemand is deployed worldwide, the team hopes that the community will find it easy to use the new portal.

6.3 Digital Arts

At Ohio University, faculty member Basil Masri Zada has dedicated the past several years to helping develop the coursework for the new concentration in the School of Art and Design, Digital Arts + Technology. This area of study focuses on the constantly developing relationship between technology and art and allows students to

develop their own approaches to creating art in an increasingly digital age. Throughout the courses Masri Zada's students use the software Stable Diffusion, a popular open-source generative AI tool, to inspire, edit and enhance their artwork [8].

Before launching the course in 2023, Masri Zada worked with the Ohio Department of Higher Education's Ohio Supercomputer Center (OSC) to host a version of the Stable Diffusion software on OSC machines. This allows students to easily access the software on any device through OSC's remote access platform OnDemand and offers them privacy and control over the data they generate. "I originally reached out to OSC because I needed to be able give our students who don't have powerful computers access to the Stable Diffusion technology to remotely create work individually and collectively as a class, while having a protected environment," said Masri Zada, assistant professor of instruction, digital art + technology.

Utilizing Stable Diffusion hosted on OSC resources, Masri Zada and his students access their own isolated version of the software, which allows them to explore the impact of training materials on the behavior of AI and to understand biases present in existing training data. Masri Zada also chose Stable Diffusion because of the level of control it gives the artist. Unlike many other generative AI software programs available, Stable Diffusion goes beyond text-to-image prompts and allows for precise editing within the image called "inpainting." This heightened level of control turns the software into a valuable tool that artists can seamlessly integrate into their creative workflow, rather than it being the sole generator of artistic output, Masri Zada said.

Figure 10: Image generated by Ohio University Art Design student Alyssa Vandale with the assistance of Stable Diffusion running in Open OnDemand

As an example of this, Alyssa Vandale, a student in ART 3110 Digital Art + Technology II, used Adobe Premiere, Illustrator, Photoshop, After Effects, Fresco, Audition and batch processing within OSC's Stable Diffusion OnDemand app to create a video (Fig. 10 shows a still image from the video.)

7 FUTURE PLANS

While Open OnDemand is widely adopted with a broad base of clients, it still relies on a handful of staff members at the Ohio Supercomputer Center to provide general management and oversight while also performing the majority of the code development. This poses a significant risk to the long-term sustainability of the software as well as challenges to the further expansion of the client community.

The recently awarded Advocate Led Long-term Gameplan for Open OnDemand (ALL GOOD) project will alleviate those risks by establishing a governance organization that will operate infrastructure and coordinate an ecosystem of developers, contributors, and clients [14]. This effort consists of five major elements: (1) establishing the ecosystem elements that facilitate contributions from the broader community; (2) securing additional, sustainable community partnerships and sponsorships; (3) creating an independent security/QA focus within the dev team; (4) market discovery research; and (5) design and implementation of a governance structure that will facilitate growth and decision-making.

Since one of the most critical components of this new effort involves the various aspects of the governance of Open OnDemand, the team has engaged with NumFOCUS (numfocus.org) who is providing critical expertise. NumFOCUS has a demonstrated track record of such engagements and has a mission to promote open practices in research, data, and scientific computing. They provide a stable, independent, and professional home for the open-source projects powering contemporary scientific inquiry and business processes. As part of that mission, they aim to ensure that funding and resources are available to sustain projects in the scientific data stack over the long haul. NumFOCUS sponsors and supports over 100 open-source projects. These include many of the most widely used applications by the existing Open OnDemand community, such as Jupyter, NumPy, Julia, and Conda.

These efforts, coupled with the existing technical road map, will result in building up and formalizing the community of Open OnDemand developers, contributors, and end clients. As a result of facilitating the long-term sustainability of this critical component of RC infrastructure, more RC service providers will be enabled in their mission to provide scalable and accessible resources with a low barrier to entry.

8 CONCLUSION

Open OnDemand is a mature open-source platform that enables remote web access, via any device, to research computing services, and the community of researchers and systems administrators and contributors that use it has grown explosively in recent years.

A recent survey of the Open OnDemand community found that responding sites recently averaged 1,000 active clients per month. By extrapolating that over the known global installations, it can be conservatively estimated that Open OnDemand actively enables at least a million researchers, industry professionals, and students to make novel and innovative use of RC, resulting in significant advances across many traditional sciences, as well as bringing RC to new communities and domains.

These clients recognize the Open OnDemand logo (seen in Fig. 11) as a valuable platform for Connecting Computing Power with Powerful Minds.

Figure 11: Open OnDemand Logo

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