Template Facilities, Equipment, and Other Resources Document for Michigan State University Institute for Cyber-Enabled Research (ICER)

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Michigan State University (MSU) participants in this project, including faculty, research staff, graduate students, and undergraduate students, will have access to the resources provided by MSU's Institute for Cyber-Enabled Research (ICER; https://icer.msu.edu/).

ICER manages MSU's High Performance Computing Center (HPCC), which maintains five clusters that are available to MSU researchers as a free, shared resource. These clusters comprise a total of 1,044 nodes, which collectively have 79,964 CPU cores, 660 GPUs (including NVIDIA K80, V100, V100S, A100, GH200 and H200s), and 442 TB of memory. The theoretical peak speed of the entire system is approximately 9.2 petaflops for double precision floating-point operations (3.5 petaflops for CPUs, with the remainder from GPUs); for single precision workloads the number is approximately twice that value. The nodes are connected via low-latency InfiniBand EDR/HDR100 (100 Gbit), HDR (200 Gbit), and NDR (400/800 Gbit) and share high-speed parallel file systems with GPFS with a total capacity over 9 petabytes for persistent and temporary storage with aggregate performance above 100 gigabytes/sec. An all-flash VAST file system with 1 PB of raw capacity provides home and high performance project spaces. A specialized data-intensive compute cluster, the MSU Data Machine, is part of ICER's available resources and has high memory nodes, a fast 64 TB solid state disk system, and a large number of NVIDIA A100-80GB GPUs. Supporting infrastructure including high speed networking, firewalls, data transfer nodes, job scheduling, commonly used software, and interactive services are also provided as part of the overall system. MSU researchers have access to this machine and its supporting infrastructure as a shared resource at no cost; however, users may purchase one or more computational nodes to receive priority access to them.

All users of ICER resources are automatically given access to a 100 GB home directory with hourly snapshots and regular offsite replication, as well as 500,000 CPU core-hours and 10,000 GPU node-hours per year that renew annually on January 1st. Research groups are allocated a 3 TB shared disk partition that is replicated offsite. Researchers have access to a shared scratch file system, with each user having a 50 TB quota. This system is not backed up and files older than 45 days may be purged. All of these resources are provided by ICER and the MSU Office of Research and Innovation at no direct cost to researchers or academic departments.

Additional shared research storage space may be leased at rates that are regularly updated. Details can be found at https://docs.icer.msu.edu/filesystem_overview/ .

Opportunities to purchase new computing hardware occur approximately every two years, with the details of the hardware and node cost varying depending on current market conditions. For reference, information about the most recent hardware buy-in opportunity is available at https://icer.msu.edu/users/buy-options . Purchased CPU and GPU computing nodes are operated and maintained by ICER at no additional cost to the user for the duration of the

machine's service contract (typically 5 years) and will continue to be available after that on a "best effort" basis.

In addition to its computational assets, the Institute for Cyber-Enabled Research provides a variety of support services designed to facilitate research. For example, ICER employs a team of research consultants (RCs) who are PhD scientists with expertise in a wide range of computational domains, including bioinformatics, image analysis, data science, physics, machine learning and mathematics. These RCs provide one-on-one consulting to individuals and research groups on topics related to advanced research computing. The RCs have extensive experience in national computational resources, complex workflows, leveraging numerical libraries, and are familiar with many different parallel-programming paradigms. ICERs team also provides training in a variety of computing-related subjects through online course modules and live in-person interactive workshops. Finally, extensive research support (including custom software development, workflow development, etc.) is available to individual PIs as a paid service through ICER's Academic Research Consulting Service (ARCS; https://icer.msu.edu/arcs).