Mississippi State University is an equal opportunity institution.
The High Performance Computing Collaboratory (HPC²) at Mississippi State University is a coalition of member centers and institutes that share a common core objective of advancing the state-of-the-art in computational science and engineering using high performance computing; a common approach to research that embraces a multi-disciplinary, team-oriented concept; and a commitment to a full partnership between education, research, and service. The mission of the HPC² is to serve the university, state, and nation through excellence in computational science and engineering.
The High Performance Computing Collaboratory at Mississippi State University originated as the National Science Foundation Engineering Research Center for Computational Field Simulation, which focused directly on the application of high performance computing for computational field simulation of fluid flow, heat and mass transfer, and structural mechanics for applications to aircraft, spacecraft, ships, automobiles, environmental, ocean, and biological flow problems. Initially funded by the NSF Engineering Research Center Program in 1990 -- one of three funded that year out of 48 proposals - it was the only one with a focus directly on high performance computing. Over the 11-year life cycle as an Engineering Research Center, the MSU center increased its annual funding by an order of magnitude, graduating from the NSF program in 2001, and now continuing as a self-sufficient research unit with funding from a range of federal agencies and industry. As cited by the NSF Director in the January 1999 issue of *ASEE Prism*, the MSU Center was a prime example of a successful NSF Engineering Research Center, noting that it “…effectively demonstrates that you can institute change in a very positive way.”
The HPC² provides an advanced computing infrastructure in support of research and education activities of the collaboratory's member centers and institutes. This infrastructure includes high performance computing systems, a fully-immersive 3-D scientific visualization system, high performance storage systems, a large capacity archival system, high-bandwidth networking systems, and an extensive number of traditional desktop workstations. The primary computational systems consist of a 593 teraFLOPS cluster with 4800 Intel Ivy Bridge processor cores and 28,800 Intel Xeon Phi cores, 72 terabytes of main memory, 4 terabytes of Xeon Phi memory, and an FDR InfiniBand interconnect; a 34 teraFLOPS 3072-core Intel Westmere cluster with 6 terabytes of RAM and quad data-rate InfiniBand interconnect; a 10 teraFLOPS 2048-core AMD Opteron cluster with 4 terabytes of RAM; and a small Cray XT5 for applications development. Data storage capabilities include 8 petabytes of high performance RAID-enabled disk systems, including a large parallel file system, and a 9 petabyte near-line storage/archival system. The HPC² advanced scientific visualization needs are met by an immersive CAVE-like virtual reality environment, dubbed the Virtual Environment for Real Time EXploration or VERTEX.
The networking infrastructure backbone consists primarily of a 10-Gigabit Ethernet network interconnecting the organization’s primary computing and storage systems, as well as an extensive number of high performance edge switches providing connectivity to the organization’s more-than 500 high-end desktops and laptops. This network infrastructure supports full redundancy to all devices and allows for aggregated connections to support high-bandwidth activities. Each of the three facilities obtains wide area (external) network connectivity to the commodity Internet and Internet2 through dual 10 Gigabit/sec connections into the Mississippi Optical Network (MISSION), a regional optical network supporting research activities within the state. The two MISSION network connections are via geographically diverse paths across the state, providing for high-availability and fault tolerant communication channels, and access to the Internet2 connector site in Jackson, Mississippi which supports a potential capacity of more than 8 terabits per second. These robust wide area network connections give the HPC² researchers the ability to share large sets of data with collaborators across the country and around the globe.
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The VERTEX, or Virtual Environment for Real-Time EXploration, is a reconfigurable virtual reality environment. It can be used as a traditional CAVE, in which the walls are configured to form a cube. In this configuration 10ft x 7.5ft stereoscopic images are projected onto the front, left, and right walls as well as the floor. Inertial-ultrasonic motion tracking provides the user with an immersive virtual reality experience. The right wall of the system may also be opened up to align with the front wall to provide a single 20ft x 7.5ft flat vertical display. This system replaced an older Mechdyne CAVE system installed at the HPC² in 1998, and is used for collaborative research in such areas as geosciences, computational fluid dynamics, and computational chemistry.
The High Performance Computing Collaboratory, an evolution of the MSU NSF Engineering Research Center for Computational Field Simulation at Mississippi State University, is a coalition of member centers and institutes that share a common core objective of advancing the state-of-the-art in computational science and engineering through the utilization of high performance computing; a common approach to research that embraces a multi-disciplinary, team-oriented concept; and a commitment to a full partnership between education, research, and service. The HPC² member units are the Alliance for System Safety of Unmanned Aerial Systems through Research Excellence; the Institute for Computational Research and Engineering Science that oversees the Center for Advanced Vehicular Systems, the Institute for Imaging and Analytical Technologies located at Mississippi State, the Center for Advanced Vehicular Systems Extension located in Canton, Mississippi, and the Institute for Systems Engineering in Research located in Vicksburg, Mississippi; the Center for Cyber Innovation; the Center for Computational Sciences; the Distributed Analytics and Security Institute; the Geosystems Research Institute; the Institute for Genomics, Biocomputing & Biotechnology; and the Northern Gulf Institute.

HPC² facilities include two buildings, the Portera Center and CAVS buildings, within the Thad Cochran Research, Technology, and Economic Development Park adjacent to the Mississippi State University campus in Starkville, Mississippi, the CAVS-E building in Canton, Mississippi, and the Science and Technology Center building at the NASA John C. Stennis Space Center (SSC) near Bay St. Louis, Mississippi. The Portera Center is a 71,000 square foot facility designed in an open manner to facilitate multi-disciplinary interactions and houses the organization’s primary data center. The CAVS building is a 57,000 square foot facility consisting of numerous office suites, experimental laboratories housing an extensive array of equipment in support of materials, advanced power systems, and human factors research activities, as well as a small data center. The Science and Technology Center building at the NASA SSC is a 38,000 square foot facility consisting of office space, classroom space, and a data center.
The CAVS-E building located in Canton, Mississippi was built to serve as a facility where business leaders, government officials, educators, and other professionals can gather to plan or train. CAVS-E has state-of-the-art telecommunication capabilities, video conference meeting rooms, manufacturing and quality laboratories, as well as computer class rooms. The Science and Technology Center building at the NASA SSC is a 38,000 square foot facility consisting of office space, classroom space, and a data center.
To honor Mississippi State University’s 16th president and his emphasis on computer research, institution leaders named the HPC building the Malcolm A. Portera High Performance Computing Center.

During the West Point native’s tenure from 1998 through 2001, Portera continually advocated for the National Science Foundation’s Engineering Research Center for Computational Field Simulation on campus. Eventually, the research unit evolved to become the High Performance Computing Collaboratory; a coalition of independent, multi-disciplinary research units focused on the application of high performance computing. The core operations of the Collaboratory are based in the facility, the Malcolm A. Portera High Performance Computing Center, named for the veteran administrator at the dedication in the Thad Cochran Research, Technology and Economic Development Park.

As a result of Portera’s work, enrollment increased as MSU’s research and development capabilities expanded, and key aerospace and automotive development activities have contributed to billions of dollars in capital investment in Mississippi and Alabama.

The center has become central to MSU’s research enterprises.
Thanks to a long-standing partnership between Mississippi State University and the National Oceanic and Atmospheric Administration, the new Science and Technology Center at the NASA Stennis Space Center is home to the world’s seventh NOAA Exploration Command Center (ECC). A state-of-the-art communication hub, it enables research scientists at sea and colleagues on shore to simultaneously view live video streams of the undersea life, sunken treasures, and changing geology. MSU’s High Performance Computing Collaboratory provides the computing infrastructure and technical support for the effort.

The ECC enables scientists aboard vessels to be in constant contact with others on shore through a combination of high-definition cameras and remotely operated underwater vehicles. The network includes an Internet-enabled intercom system for voice communication as the ship’s remotely operated vehicles send a continuous stream of live video and data.
The High Performance Computing Collaboratory's member centers and institutes are focused on multidisciplinary, team-oriented research activities for the application and advancement of computational science and engineering. This effort spans a wide range of application disciplines, including fluid dynamics, structural mechanics, materials modeling, astrophysics, molecular modeling, transportation modeling and planning, weather and ocean modeling, geographic information systems, genomics, and bioinformatics. Additionally, several of these member units have extensive physical and experimental modeling and analysis capabilities to complement their computational efforts.
Mississippi State University’s ASSURE is the Federal Aviation Administration’s Center of Excellence for UAS research. The COE’s vision is to help UAS grow into its multibillion dollar market potential by conducting research that quickly, safely and effectively gets UAS flying alongside manned aircraft around the world. Twenty-one of the world’s leading research universities and over a hundred leading industry, government partners comprise the Alliance for System Safety of UAS through Research Excellence, or ASSURE.

ASSURE possesses the expertise, infrastructure and outstanding track record of success that the FAA Center of Excellence for Unmanned Aircraft Systems demands.
The Institute for Computational Research, Engineering and Science (ICRES) strives to be a world-class center of excellence for research, technology and education equipped to address engineering challenges facing the nation’s industrial base. Utilizing high performance computational resources and state-of-the-art analytical tools for modeling, simulation, and experimentation, ICRES will provide a distinctive, interdisciplinary environment that will support economic development and outreach activities throughout the State of Mississippi and beyond.

The institute is composed of four MSU research/economic development centers - Center for Advanced Vehicular Systems (CAVS) in Starkville; Center for Advanced Vehicular Systems Extension (CAVS-E) in Canton, the Institute for Systems Engineering Research (ISER) in Vicksburg, and the Institute for Imaging and Analytical Technologies (I2AT) in Starkville, Mississippi.

CAVS -The Center for Advanced Vehicular Systems mission is to research and develop manufacturing and design means and methods for producing vehicles of superior quality with advanced features and functions at preferable costs, focusing on computational tools and exploiting the underlying technologies for broader industrial use. CAVS research and development activities are based on: industrial needs and priorities; opportunities for providing added value; and building on the state’s investment by securing external funding related to broadening the reach of technologies.

CAVS is a member research center of the university’s High Performance Computing Collaboratory (HPC²) and has developed a global reputation for interdisciplinary education and research to expand and enhance the design, technology, production and infrastructure necessary for sustainable mobility. At HPC², CAVS researchers have access to one of the world’s most advanced supercomputers. www.cavs.msstate.edu
ISER - The Institute for Systems Engineering Research is a collaborative effort between the U.S. Army Engineer Research and Development Center and Mississippi State University. The goal of ISER’s efforts and products is to mitigate risk, reduce cost and improve efficiency in Department of Defense (DoD) acquisition programs, serve as an additional asset for the state’s industrial base for systems engineering related tasks, and create an environment that draws DoD and civilian industry development to the state of Mississippi. www.iser.msstate.edu

I2AT - The institute for Imaging and Analytical Technologies supports research and outreach activities to develop partnerships with local, regional and national industries. Through collaborative interaction with other institutions and industry affiliates, I2AT leverages state of the art technologies and expertise in a way that is mutually beneficial for all parties. The technological resources and expertise serves R&D, quality assurance and quality control needs facing many life-science, engineering and industrial operations. www.i2at.msstate.edu

CAVS-E - The CAVS Extension Center in Canton, Mississippi provides direct engineering support for Nissan and its major suppliers; engineering extension work for Mississippi’s manufacturers; workforce development, education, and training; and business systems and information technologies. www.cavse.msstate.edu
CCI develops cutting-edge solutions for Defense, Homeland Security and the Intelligence Community. The primary focus of CCI is to research, prototype and deliver cutting-edge cyber solutions that support global national security, homeland security and peacekeeping operations. CCI capitalizes on Mississippi State’s world class strengths in unmanned aerial systems, advanced composites, vehicular engineering, motion imagery analysis and hyperspectral imaging processing to provide top notch solutions to our warfighters and their industry partners.

Located at one of the few universities in the country with every academic accreditation awarded by the National Security Agency, CCI can deliver secure cyber solutions for both offensive and defensive cyber operations.

CCI is supported by one of the fastest high performance computers in the country, and is committed to providing world-class cyber analysis and engineering services and solutions. The ability to test concepts and validate through demonstrations leveraging Test and Evaluation capabilities is critical to CCI’s success.

The T&E capabilities support Title 10 Acquisition, Service Operational Test Agencies (OTA), Combatant Commands (COCOM), Non-Title 10 Acquisition, DOD Staff Agencies, Intelligence Community, FAA, NASA, DHS and etc. MSU’s Secure Compartmented Intelligence Facility will soon be operational, allowing the CCI to work collateral and special compartmented intelligence solutions for government and industry.
The Center for Computational Sciences (CCS) at Mississippi State University is a College of Arts and Sciences center with a mission to foster interdisciplinary research in both the fundamental understanding of and application of all natural sciences. In particular, to model and develop integrated computational crosscutting tools that allow a comprehensive, multi-disciplinary approach to problem solving.

Major activities/initiatives include: Research Experiences for Undergraduates Site in Applied Mathematics and Biostatistics; a Center for Autonomic Computing; Modeling Materials for Sustainable Energy; an NSF funded project on high-Tc superconductivity phenomena in layered organic and inorganic materials; a DOE funded project on rare-earth-free nanostructure permanent magnets; image processing in bio-inspired materials design; and hosting of the Southeastern Theoretical Chemistry Association (SETCA) annual meeting. Major events/proposals include: the Ninth Mississippi State—University of Alabama at Birmingham Conference on Differential Equations and Computational Simulations; and an NSF Proposal for Integrative Graduate Education and Research Traineeship (IGERT) program Cyberinfrastructure (CIF21)-track.

The Center for Computational Sciences contributes to the state of Mississippi in numerous ways. Its programs generate a better-educated populace and a better-trained workforce by educating students at both the undergraduate and graduate levels in interdisciplinary research, providing them with strong skills in computers, modeling, and the application of the scientific method. These skills are required in a multitude of varied industries and businesses. The CCS introduces MSU scientists from diverse fields to different research and new methodologies. This uniquely positions our scientists to fashion multidisciplinary proposals. Such multidisciplinary approaches to problem-solving are often requirements in requests for proposals from federal agencies and industries. CCS thus creates new opportunities for leveraging resources within MSU as well as drawing resources to MSU.
The Geosystems Research Institute (GRI) and the Northern Gulf Institute (NGI) are sister organizations. The NGI was established as a NOAA cooperative institute by GRI. The NGI Program is distinctly identifiable in its own right, but wholly embedded within the GRI framework. This allows both entities to function independently when necessary, but to capitalize as appropriate on the unique strengths of each. GRI supports MSU’s land-grant mission of Research, Learning, and Service by acquiring and disseminating knowledge about earth and its systems, integrating geosciences and engineering, translating geospatial technologies and skills into useful tools, and transitioning science and technology into practice to support our stakeholders and improve policy and public awareness.

GRI has distinctive competencies in agricultural and natural resource systems, coastal and ocean processes, sensor design, systems engineering, remotely sensed data verification and validation, large scale data and information handling, modeling, and visualization.

GRI has developed nationally recognized research strengths with strong relationships and inherent respect from state, regional and national agencies and business entities. Application disciplines encompass typical departmental subject areas – plant pathology, biology, engineering, geosciences, wildlife conservation, etc. GIS and remote sensing include phenomenology, platforms, sensors, and remotely sensed data verification and validation, which are essential to providing unique capabilities and improve competitiveness.

GRI/NGI has developed unique geosystem data streams and modeling capabilities that have responded to sponsor needs, inter-disciplinary perspectives, and systems engineering principles, using advanced geospatial knowledge, observational data, information technology, and modeling utilizing high-end visualization and high performance computing.
Recognizing the need to integrate research and technology to more effectively address the needs of the Northern Gulf of Mexico, NOAA’s Office of Oceanic and Atmospheric Research (OAR) evaluated and awarded the Northern Gulf Institute Cooperative Institute to the team led by Mississippi State University.

The NGI operates pursuant to a Memorandum of Agreement between MSU and NOAA, the NOAA notice of award to MSU, NOAA’s review of MSU administrative and grants processes, and the NOAA Cooperative Institute Interim Handbook. NGI’s approach to Northern Gulf Regional issues, problems and opportunities is closely aligned with NOAA’s strategic and research priorities.

The NGI is also guided in its mission by a number of sources, the White House’s Ocean Action Plan and related orders and comprehensive report of the congressional U.S. Commission on Ocean Policy, the Gulf of Mexico Alliance, and others. The result is an approach that is science driven, regionally focused, and coordinated with other Gulf of Mexico Basin activities. NOAA awarded NGI a second and third five-year cooperative agreements in 2011 and in 2016, after NOAA Science Advisory Board review rated NGI performance as outstanding.

NGI is a consortium of six academic entities led by Mississippi State University. The NGI partnership includes Mississippi State University, the University of Southern Mississippi, Florida State University, Louisiana State University, the Alabama Dauphin Island Sea Laboratory, the University of Alabama in Huntsville, and the National Oceanic and Atmospheric Administration.

Most of the MSU/NGI projects are led by faculty in GRI. NGI conducts research that builds an integrated, comprehensive understanding of natural and human impacts on northern Gulf of Mexico ecosystems and associated economies to improve its management. Research is conducted under four categories: ecosystem management, coastal hazards, geospatial technology and visualization, and climate change impacts. Research-driven transformations in regional ecosystem-based management enable managers and communities to improve the resilience and health of ecosystems and people and the sustainability of resources in the northern Gulf of Mexico.

The Northern Gulf Institute engages nationally and internationally recognized academic experts who provide intellectual and technological capacity to address comprehensive regional ecosystem approaches to science and management in the northern Gulf of Mexico.
The primary focus of DASI is to coordinate, facilitate, and expand research activities across academic and research units involved in the application of high performance distributed computing platforms to the areas of big data analytics, cyber security, and critical infrastructure protection. DASI also provides science-based strategies aimed at increasing our ability to process large volumes of data in a highly secure way over a secure infrastructure.

DASI is a unique multidisciplinary center dedicated to excellence in research and will carry out its mission by:

- Generating high-quality basic and applied research in the areas of distributed computing, big data analytics, and cyber security;
- Bringing together scientific and technical expertise from the private, public, and academic worlds;
- Using state-of-the-art high performance computing technology and analytical procedures to increase the cyber security capability of organizations across the spectrum from local government to federal government, corporations to academia;
- Providing training for first-responders and wounded warriors to put into practice the technology developed in the center.

Specifically, the center helps expand research opportunities and promote economic development that leads to a better quality of life in Mississippi and throughout the nation by integrating and organizing the university’s extensive capabilities and forming relationships with agencies to improve the cyber security awareness and intelligence capabilities at all levels.
The Institute for Genomics, Biocomputing & Biotechnology (IGBB) was formed in 2011, through the merger of two successful Mississippi State University institutes -- specifically, the Life Sciences & Biotechnology Institute and the Institute for Digital Biology -- and integration of the resulting unit into High Performance Computing Collaboratory. The merger and affiliation with the HPC$^2$ has greatly expanded IGBB's and the University's growing role as a leader in cutting edge genomics, proteomics, and computational biology research.

Genomics and Transcriptomics: The IGBB performs “next generation” nucleic acid sequencing.

The IGBB's genomics staff is trained in RNA/DNA isolation, Illumina library preparation, sequence generation, and sequence analysis/annotation. Proteomics: The IGBB can also perform a variety of mass spectrometry and other proteomics services. The IGBB's proteomics staff is trained in protein isolation/purification, sample preparation, mass spectrometry, and data analysis.

Of particular note, the IGBB team is experienced in protein identification; discovery and characterization of post-translational modifications; quantitative proteomics; qualitative and quantitative comparison of the protein complements of different tissues/stages/organisms; proteogenomic mapping; and functional annotation of proteins using Gene Ontology (GO) standards and procedures.

Biocomputing and Bioinformatics: The IGBB has a talented team of computer scientists and programmers who support and advance the institute's biomolecular research. These scientists have expertise in data analysis, algorithm and script development, high performance computing, database development/management, and computer security.