To bring university research results and expertise to bear in collaborative assistance and training for Department of Defense (DoD) researchers as part of the Department of Defense High Performance Computing Modernization Program (HPCMP).
CENTER FOR DoD USER PRODUCTIVITY ENHANCEMENT AND TECHNOLOGY TRANSFER
DoD High Performance Computing Modernization Program (HPCMP)

MISSION:
The mission of the DoD User Productivity Enhancement and Technology Transfer (PET) program - led by the MSU HPC2 - is to bring university research results and expertise to bear in collaborative assistance and training for DoD users as part of the DoD High Performance Computing Modernization Program (HPCMP).

VISION:
The PET component of the DoD HPCMP is a bold and innovative university/industry/government effort to provide the essential user support and mode of capability enhancement that is necessary to address the wide variety of research and development demands arising from the science and technology programs supporting DoD’s weapons development and warfighting support systems.

LEADERSHIP
DIRECTOR: Joe Thompson
MISSISSIPPI STATE UNIVERSITY
OHIO SUPERCOMPUTER CENTER

THE DoD TECHNICAL AREAS SUPPORTED
- CFD: Computational Fluid Dynamics - UAB
- CSM: Computational Structural Mechanics - UAB
- CWO: Climate/Weather/Ocean Modeling - Texas
- EQM: Environmental Quality Modeling - Texas
- FMS: Forces Modeling and Simulation/C4I - SAIC
- IMT: Integrated Modeling and Testing - OSC
- SIP: Signal/Image Processing - OSC
- CE: Computational Environment - Tennessee
- EOTC: Education, Outreach and Training - Hawaii
- ET: Enabling Technologies - MSU
PET Contract

• Competitive award in 2001

• Other competing teams led by industry

• $108M, Eight years: 2001 – 2009

• $13.5M annual funding
PET Effort

• University/Industry team – MSU prime contractor
  – Ohio Supercomputer Center
  – Texas Advanced Computing Center
  – University of Texas
  – University of Tennessee
  – University of Alabama – Birmingham
  – University of Hawaii
  – SAIC
  – Computer Sciences Corporation
SERVICE

In the traditional tripartite university mission (Service, Learning, Research)

Supporting DoD HPC users (Success measured by their success)

- Technology transfer
- Training
- Collaborative assistance
Team

• Each technical area supported by a team institution

• 74 people at 15 locations from Hawaii to East Coast

• 19 PhD’s located at 9 DoD sites
  
  \((5 \text{ from } HPC^2)\)
Computational Fluid Dynamics

CFD provides the accurate numerical solution of the equations describing fluid and gas motion and fluid dynamics research. Uses include the design of complex combustion and propulsion systems that are inaccessible or too costly to prototype; the dynamics of submarines, subsonic, transonic and supersonic air vehicles, pipe flows, air circulation, missiles, projectiles; and magnetohydrodynamics for advanced power systems and weapons effects.

CFD Strategic Objectives

- Verification and Validation (V&V) of codes.
- Rapid and robust time-critical activities, to include: Improvements in geometry/mesh interfaces.
- Dynamic/automatic and parametric meshing.
- Solution adaptive parallel algorithms.
- Automated feature detection.
- Interoperability of CFD tools.
- Data standards.
- Location and platform independence.
- Frameworks.
- Multidisciplinary Optimization (MDO).
- Simulation Based Acquisition (SBA).
- Simulation Based Design (SBD).
- Time-varying geometries and/or highly unsteady flow fields.
- Multiphysics coupling involving disparate time/length scales.
Computational Structural Mechanics

CSM provides high-resolution, multidimensional modeling of materials and structures subjected to a broad range of state, dynamic and impulsive loading conditions. Uses include effects of explosions on various facilities, underwater explosions and ship response, structural acoustics, structural analysis, propulsion systems, lethality and survivability (aircraft, ships, submarines, tanks), theater missile defense, and real-time, large-scale soldier and hardware-in-the-loop vehicle dynamics.

CSM Strategic Objectives

- Increase reliability and efficiency of CSM simulations by incorporating improved technologies into legacy codes.
- Extract useful information from those simulations.
CWO encompasses accurate numerical simulation and forecasting of oceanic and atmospheric variability for both scientific understanding and for DoD operational use. DoD uses CWO regularly for optimal aircraft and ship routing, flight safety, search-and-rescue, and mission planning in air, ground, sea, and space. CWO is also required for understanding electro-optical propagation and for optimal design of vehicles, instruments, and weapons that operate in these environments.

**CWO Strategic Objectives**

- Improve the performance and scalability of strategic ocean and atmospheric models to enable higher resolution simulations and minimize time to produce forecasts.
- Improve the HPC user environment and tools to enable rapid porting and tuning of strategic CWO codes and of visualization/analysis of CWO data.
- Evaluate and develop new technologies and techniques in code coupling, data assimilation, ensemble calculations, and meshes and coordinate systems for enhancing CWO simulation capabilities and accuracy.
EQM provides high-resolution three-dimensional Navier-Stokes modeling of hydrodynamics and contaminant transport through air, ground, and aquatic ecosystems. Uses include stewardship and conservation of natural and cultural resources; prediction of chemical and biochemical contaminant flows; design and operation of installation restoration; integrated management in support of environmental quality; noise evaluation and abatement; and water quality models.

EQM Strategic Objectives

- Develop and implement new accurate parallel discretizations with adaptivity based on a posteriori error estimators and scalable solvers for environmental quality models.
- Code coupling of multiphysics, multiphase, multicomponent flow and reactive transport. Both loose and tightly coupled models will be considered.
Forces Modeling and Simulation

The Forces Modeling and Simulation (FMS) CTA focuses on the research and development of HPC-based physical, logical, and behavioral models and simulations of battlespace phenomenology in the correlation of forces. These simulations are applied to experimentation, training, operational planning, mission rehearsal, system analysis, and acquisition. The acquisition domain includes research and development, test and evaluation, and production and logistics. The FMS CTA also includes the modeling of C4I systems that impact military decision making in war and operations other than war. For example, FMS simulations model the interrelationships and impact on military operations by phenomena such as the physics of tactical radio propagation, the logical characteristics of network routing algorithms in a lossy environment, and the behavior of networked combat leaders under conditions of uncertainty. A variety of techniques are employed, including parallel discrete event simulation, evolutionary methods, and agent-based simulations that exploit the power of HPC.

FMS Strategic Objectives

• Leverage the HPC experience and techniques within other FAs to improve FMS support to the operational warfighter.
• Identify new technologies appropriate for modeling and simulation of military forces in HPC environments.
• Transition the technologies to operational military programs.
Integrated Modeling and Test Environments

IMT deals with the collection, storage, processing, and analysis of test data, and models for verifying, synthesizing, directing and understanding test results. Primary concerns in the area are high performance computing tools and techniques for live, hardware-in-the-loop and human-in-the-loop testing and evaluation of DoD weapons, components and systems; the ability to store, share and mine large and diverse test data sets; and the use of HPC resources in an interactive manner as part of a larger simulation or exercise.

IMT Strategic Objectives

- Applications of HPC in live tests and hardware-in-the-loop simulations for development test and evaluation.
- Tools and techniques for sharing & mining independently created and stored test data.
- Support for Data Intensive computing and Parallelization of Uniprocessor code.

ON SITE

Dr. Michael Stokes
RTTC
Ohio Supercomputer Center
matokes@osu.edu
256-874-3867

Dr. Ken Yetzer
AEL
Ohio Supercomputer Center
kyetzer@osu.edu
410-278-9651

ADDITIONAL CONTACT

Dr. Ashok Krishnamurthy
Ohio Supercomputer Center
ashok@osu.edu
614-688-4803
**Signal/Image Processing**

SIP provides for extraction and analysis of key information from various sensor outputs in real time. Sensors include sonar, radar, visible and infrared images, and signal intelligence and navigation assets. Uses include intelligence, surveillance and reconnaissance (ISR), avionics, communications, smart munitions, and electronic warfare. Functions include detecting, tracking, classifying, and recognizing targets in the midst of noise and jamming; generating high-resolution low-noise imagery; and the compression of imagery for communications and storage.

**SIP Strategic Objectives**

- Improve techniques for conditioning, transmission, storage, and processing of sensed signals and images.
- Identify, adapt, and efficiently transfer novel methodologies and technologies that support extraction of high-quality information from sensed signals and images.
- Guarantee information superiority to the warfighter, supporting the Network Centric Force, providing tools for Homeland Defense, and ultimately enabling unequivocal US Information Supremacy.
### Computational Environment

Computational Environment (CE) includes all aspects of user interface to DoD HPC resources, including but not limited to: programming environments (debuggers; libraries; solvers; higher order languages; performance analysis, prediction and optimization tools); computing platforms (common queuing, clusters, distributed data and metacomputing); reusable parallel algorithms; and user access tools (portals and web-based access to HPC resources).

### CE Strategic Objectives

- Create a computational environment that is consistent, well documented, and easy-to-use across the DoD.
- Use debugging and performance analysis tools that are scalable and easy-to-use in the DoD environment.
- Support the use of communication and I/O libraries by the DoD community.
Education, Outreach and Training Coordination (EOTC) addresses the efficient and productive delivery of instructional content to DoD HPC users and opportunities for Minority Serving Institutions (MSIs). Educating both novice and experienced HPC users in new and innovative technologies is an essential element of this FA. Activities include, but are not limited to: coordinating on-site training at MSRGs and remote sites; selection of optimal training delivery methods and media; coordination of outreach forums, such as conferences, workshops, seminars, and symposia; establishing and maintaining a coherent framework to integrate undergraduate, graduate students, postdoctoral and visiting scientists/engineers into PET activities; and developing programs and activities to promote careers in computational science and HPC.

EOTC Strategic Objectives

- Provide training across DoD in PET areas, when and where needed.
- Impact future researchers in DoD through educational partnerships.
- Integrate participants from MSIs into mainstream research.

Dr. Susan T. Brown
University of Hawaii
stbrown@hawaii.edu
808-956-2808

Mason Colbert
ASC
Ohio Supercomputer Center
masen.colbert@wyoit.al.mil
937-904-5124

Reginald Liddell
ERDC
CSC
reginald.l.liddell@ercs.usace.army.mil
601-634-3131

Angela Fischer
ARL
HPTi
afischer@hpti.com
410-278-7519
Enabling Technologies

Enabling Technologies (ET) involves advancing the state of tools, algorithms and standards for pre- and post-processing analysis on very large datasets. This FA includes, but is not limited to: scientific visualization (SciViz), data mining and knowledge discovery, image analysis, grid generation, problem solving environments (PSEs), and computational techniques and methods for intelligent extraction of useful information from data.

ET Strategic Objectives

• Serve the DoD HPC community, addressing problems centered on, but not limited to, analytical visualization, remote visualization, data mining, and mesh generation.
• Increase user productivity through software evaluation, deployment, training, and expert support at MSRCs and DCs, while working in concert with any local center support staff.
• Improve or introduce new computational techniques and tools as required to increase HPC-based user productivity.

Dr. Robert J. Moorhead
Mississippi State University
rjm@grl.msstate.edu
662-325-2850

Dr. Rhonda Vickery
ASC
Mississippi State University
rhonda.vickery@wpafb.af.mil
937-904-5110

Dr. Sean Ziegeler
NRL - SSC
Mississippi State University
sean.ziegeler@nrsc.navy.mil
228-688-5574
You know you’ve made an impact when you show up in popular fiction

Jay Gridley was annoyed. More than that—he was angry. He drummed his fingers on the clear plastic table in the holo room as he waited to meet the HPCMP’s liaison and thought about how irritated he was.

So it had finally happened. Net Force was moving out of the ‘feds’ grip and into the military’s. Although Thorn hadn’t had the details, Jay knew that there had been a major systems failure during big simulations. Apparently the powers that be felt there could have been some outside cause of the crash and had been sweating blood trying to track it down. So much so that they’d arranged to take Net Force under their aegis just to make it a priority. That meant it had to be a truly huge event.

What was most irritating was, he’d had to come over here to meet someone physically for a briefing. Hadn’t they ever heard of VR and secure channels? He’d be stuck in traffic for at least an hour on the way home.

Plus, once he arrived, he had to walk the gauntlet: metal detector, explosives sniffer, bio-cellulose. Had to take off the belt Saji had given him for his birthday and let it be examined by guards who let him have it back reluctantly, watching him as though they thought he planned to throttle their computer scientists with it. This on top of having to carry a smart-card badge that would set off an alarm if he went anywhere he wasn’t cleared to go, as well as an armed escort who had walked him to meet the HPCMP’s liaison and who was just across the room, waiting. It was like having a baby-sitter, and it was insulting, to say the least.

Jay knew that it had been that way at many military and government buildings since the 9/11 terrorist attack on New York’s Twin Towers and the Pentagon, of course, and he could understand that—U.S. security had been very lax