FINAL SCIENTIFIC REPORT
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Texas A&M University – Commerce.

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Project Title: Advanced Artificial Science. The development of an artificial science and engineering research infrastructure to facilitate innovative computational modeling, analysis, and application to interdisciplinary areas of scientific investigation. S. Saffer, Ph.D. (PI), Derek Harter, Ph.D., (Co-PI), Sang Suh, Ph.D., (Co-PI), Shulan Lu, Ph.D., (Co-PI), Frank Miskevich, Ph.D., (Co-PI).

Summary Description: The objectives of this proposal were: (1) the development of a shared high performance cluster computing resource for A&M-Commerce and neighboring industries; (2) the development of a bank of computational tools and the development of an interdisciplinary curriculum of study for the Computational Sciences with an advanced degree program in the computational sciences that offers core courses in computational methods and tools; and (3) the development of an interdisciplinary research center for computational science at A&M-Commerce by which computational models for study and analysis using computational science tools can be presented and taught. This research center is designed to support interdisciplinary collaborations between academic department and neighboring industries, and to provide educational opporutnities for graduate and undergraduate students.

Potential Impact and Merit: The establishment of a high performance computing cluster, accompanied by a knowledgeable staff of students and faculty, will greatly expand the research capabilities of many academic science departments here at Texas A&M University-Commerce. This computing cluster presents a learning opportunity by which faculty investigators and students, not familiar with parallel computing, can gain experience with new computational techniques. This capability will also be expanded to scientific investigators in surrounding industry. The computing cluster will allow a vast number of problems, that has escaped traditional solutions, to be revisited using Computational Science techniques, which are becoming an increasingly important aspect of scientific investigation in industries involved in national defense, health care, financial, and many others.

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We have seen an increasing number of graduate and undergraduate students wanting to explore the the practical applications of artificial intelligence methodologies, and the newer technologies offered by cluster computing and modeling. In addition, industry has seen and increased demand for employees skilled in computational modeling and high performance computing. As a result, we are gradually revising academic course material to accommodate such interest. This interest

is also shown in our faculty wanting to explore possible problem solutions offered by high performance grid computing. Thus, because this works extends a positive educational influence on both students and faculty alike, we are listing an educational component as part of the broader impact of this work,.

Goals and Accomplishments:
Goal #1: The development of a shared high performance cluster computing resource for A&M-Commerce and neighboring industries. **This GOAL was met.**

The High Performance Computing Cluster (HPCC) is fully functional and has been operating for a number of years. The equipment consists of the following:

Master Server (2Quad Core Intel Xeon, 3GHz CPU, 1.33MHz bus, 16GB memory)
I/O Data Server (2 Quad Core Intel Xeon 3GHz CPU, 1.33MHz bus, 16GB memory)
58 compute nodes (2 Quad Core Intel Xeon 3GHz CPU, 1.33MHz bus, 16GB memory)
48 port GbE switch
GigE Cabling and interconnects
Network accessible storage (NAS) 2TB
Racks & Rack Components with Management Rack and Compute Node Rack

More simply stated, this facility consist of a 512 CPU parallel processing cluster. Extra storage and miscellaneous equipment has been added since the initial equipment purchase, along with a long term (4 year) equipment maintenance support contract.

The HPCC is currently supporting projects from various scientific departments (Physics, Chemistry, Computer Science, Psychology and Counseling & Special Education) here at A&M Commerce. One research project, listed below as **Research Project #7**, involves various departments from outside institutions such as UT Southwestern Medical Center, and the VA North Texas Health Care System.

We have developed substantial user documentation that allows new users (faculty and students) to utilize the power of this 512 CPU parallel processing cluster. Past and current and future projects are listed below in the **Projects Section** below.

Goal #2: The development of a bank of computational tools and the development of an interdisciplinary curriculum of study for the Computational Sciences with an advanced degree program in the computational sciences that offers core courses in computational methods and tools. **This GOAL was met and is ongoing.**

Starting in 2009-2010 , work began to develop a Master's degree in Computational Science and it's correcponding curriculum. Approval for the Master's degree was submitted in 2011-2012 and it was approved to begin accepting students starting in Spring 2013. The progrm has three tracks: The Information Visualization and Data Analytics (IVDA) Track; The Intelligent Information Systems (IIS) Track; and The Computational Security (CMS) Track. Although the new program is housed in the Computer Science Department, it is an interdisciplinary program shared by the collaboring departments, Biology, Physics, and Mathematics. The

Computational Science Master's degree program is an interdisciplinary program involving and dealing with complex real world problems whose solution can best be found through a multidisciplinary approach. This scientific focus identifies complex problems and applies computer applications of mathematical modeling, quantitative analyses, and established computational methods in artificial intelligence. More information can be obtained from the following link:
http://www.tamuc.edu/academics/graduateschool/programs/sciences/computationalscience.aspx

GOAL #3: The development of an interdisciplinary research center for computational science at A&M-Commerce by which computational models for study and analysis using computational science tools can be presented and taught. **This GOAL was met and is ongoing.**

The HPCC research center is fully functional and is currently being used by faculty and students in the Departments of Chemistry, Physics, Computer Science and Information Systems, and Psychology Counseling & Special Education. This is an ongoing goal. As more faculty members learn of the capabilities of the HPCC, it is anticipated that more University researchers will become interested in the HPCC as a research tool.

Our newly established Computational Science Master's program is operational, and as the program matures, it is anticipated that students with Bachelor degrees in Physics, Chemistry, and Biology, will participate in the Computational Science Master's program. There are plans to establish a doctoral program in Computational Science in the near future. If successful, this will be the only Ph.D. degree program in the sciences at Texas A&M University-Commerce. A brief description of the current research projects being performed on the HPCC, and associated publications and grant funding, is given below in the PROJECT SUMMARY section.

Objective within GOAL #3: To develop computational techniques which utilize the existing GEO database microarray datasets to characterize calcium regulated gene networks in order to understand the key parameters or genes which allow calcium ions to control very different responses in different cell types. **This OBJECTIVE was NOT met.**

This objective was designed to help develop an interdisciplanary expetise among faculty and students within the Biology Department and the Department of Computer Science, involving searching and gathering algorithms and genetic expression data. This attempted was stalled when Frank Miskevich, Ph.D., our resident genetics expert, left the Biology Department. An attempt was made to reestablish this goal with Dr. Miskevick's successor, but he also left the University within a very short time of his arrival. There is still interest in collaborating with faculty members from the Department of Biology in the future. Other projects designed to help develop an interdisciplanary expetise among faculty and students, have taken the place of this objective. Please see **PROJECT** SUMMARY of the Research currently being performed on the HPCC below.

Objective within GOAL #3: To develop a model of complex electromagnetic wave transmission, propagation, and reception, and analyze that model using Computational Science methods within the virtual computing environment. **This OBJECTIVE was NOT met.**

This objective was designed to foster a closer working relationship between L3 Communications, located in nearby Greenville, Texas, and A&M-Commerce. The main supporter of this collaborative project, Jim Turner, left L3 Communications. Although we did not find a replacement researcher at L3 with similar collaborative enthusiasm, the HPCC cluster did spark interest which resulted in a $25,000 donation from L3 to help purchase other equipment that enhanced our current direction in cluster computing and Computational Science. We continue to look for other avenues of collaboration with L3 Communications and industry in general.

Objective within GOAL #3: To hire a Computational Science Post-Doc Research Assistant to assist in setting up the HPCC, to help in the development of a Computational Science degree program, and to help stemulate appropriate research conducted on the HPCC. **This OBJECTIVE was only PARTIALLY met.**

We initially had difficulty in finding a qualified candidate who was interested in coming to our campus. A Post-Doc was hired in 2010 and stayed until 2011. He was instrumental in helping to initiate research projects from Physics and Chemistry, and was successful in developing a Computational Science Lecture series, which introduced the HPCC to various scientific departments at the University. He was also helpful in creating HPCC documentation and with various planning documents for the Computational Science Master's degree program which was finally approved in 2012.

After he left, we extended an invitation to another candidate to come to campus as a Post-Doc research assistant. He accepted, but on the day of his arrival, decided to leave and go back home. No explanation was given for his decision. We were not able to attract another Post-Doc applicant, and no one else was hired to fill the Post-Doc position. In 2014, a "Post-Masters" student was hired to help direct an upcoming research project in infrared imaging. After four months of non-productivity, his contract was cancelled.

PROJECT SUMMARY of the Research currently being performed on the HPCC.

1) Research Activities: Laurence Angel, Ph.D. Department of Chemistry, Texas A&M University – Commerce.
Methanobactins (mbs) are a class of small molecules with high Cu-binding affinity and redox activities which are secreted by methane-oxidizing bacteria, known as methanotrophs. Our research has studied the Cu-binding and redox activity of mbs and a series of analog methanobactin (amb) peptides, which have potential as therapeutics for alleviating disease where abnormal metabolism of copper concentrations are involved, such as in Wilson's and Menkes disease. The research combines instrumental analyses and theoretical molecular modeling for studying the molecular mechanisms of Cu-binding specificity and redox activity. Our research has (1) designed and synthesized copper-binding peptides based on 2His-2Cys coordination sites and the mb-OB3b peptide from *Methylosinus trichosporium* OB3b; (2) conducted a series of gas-phase, solution-phase, and *in silico*-phase studies to elucidate the interrelationship between Cu(I/II) selectivity, redox activity, oligomerization and structural functionality; and (3) develop new optimized cultivation methods for isolating pure mb-OB3b.

Publications resulting from this work on the HPCC.

1. **Redox activity and multiple copper(I) coordination of 2His-2Cys oligopeptides** Choi, D.; Alshahrani, A.; Vytla, Y.; Deeconda, M.; Serna, V. J.; Saenz, R. F.; Angel, L. A., *J. Mass Spectrom.* **in press**.

2. **The pH dependent Cu(II) and Zn(II) binding behavior of an analog methanobactin peptide** Sesham, R.; Choi, D.; Balaji, A.; Cheruku, S.; Ravichetti, C.; Alshahrani, A.; Nasani, M.; Angel, L. A., *Eur. J. Mass Spectrom.* **2013**, *19*, 463.

3. **Analysis of Methanobactin from *Methylosinus Trichosporium* OB3b via Ion Mobility Mass Spectrometry**Choi, D-W.; Sesham R*; Kim, Y.; and Angel, L.A. *Eur. J. Mass Spectrom.* **2012**, *18*, 509.

Pending grant resulting:
Title: RUI: Selective Copper Ion Recognition and Redox Activity of Methanobactin Analog Peptides
Source: National Science Foundation: Chemistry of Life Processes
Total Award Amount Requested: $404,490
Award Period: 06/01/2015-05/31/2018
Location of Project: Texas A&M University - Commerce

2) Research Activities: Allan Hedley, Ph.D., Department of Chemistry, Texas A&M University-Commerce.
Computational studies have been carried out to analyze the transition states for the hetero Diels-Alder reactions. Since the discovery of the asymmetric Diels-Alder (DA) in 1979, catalytic asymmetric DA reactions have emerged as a powerful atom-economical method for the stereoselective construction of functionalized six membered rings with control of regio-, diastereo-, and enantioselectivity. Only a few chiral catalysts have been successful to give high yields of products with desired enantioselectivity. In this project, the singe-point energy calculations, geometry optimizations and vibrational frequencies, transition states and possible stereochemical products were carried out in vacuo using DFT with the B3LYP function and the 6-31G(d) basis set as implemented in Spartan 14 for different reactants and organocatalysts synthesized in our lab . The results indicate that molecular modeling is a very promising tool to assist in the prediction of the stereochemical outcomes of the DA reaction.

3) Research Activities: Bo An Li, Ph.D., Department of Physics, Texas A&M University – Commerce. Dr. Li is the Principal Investigator of a variety of work in the field of Physics currently being performed entirely on the HPCC.

Below is a list of publications of work completely done on the HPCC, and resulting grants.

(1) Influence of neutron skin thickness on $π^{-}/π^{+}$ ratio in Pb+Pb collisions
G.F. Wei, **Bao-An Li**, Lie-Wen Chen and Jun Xu, Phys. Rev. C90, 014610 (2014).

(2) Disentangling effects of collision geometry and symmetry energy in U+U collisions

Jun Xu, Zachary Martinot, **Bao-An Li**, Phys. Rev. C86, 044623 (2012).

(3) Magnetic effects in heavy-ion reactions at intermediate energies
Li Ou and **Bao-An Li**, Physical Review C84, 064605 (2011).

b) New grants obtained in proposals where HPCC is listed as a computing resource available
(1) Research Experience for Undergraduates (REU) in Physics and Astronomy
Bao-An Li (PI) and Matt Wood, NSF, $285,887, May 1, 2014-April 30, 2017

(2) CUSTIPEN-the China-U.S. Theory Institute for Physics of Exotic Nuclei
Bao-An Li (PI) and Pawel Danielewicz, DOE, $141,000, May 1, 2013-April 30, 2016

4) Research Activities: Abdullah Arslan, Ph.D., Nikolay Sirakov, Ph.D., Department of Computer Science and Information Systems, Texas A&M University – Commerce.

HPCC is being used in one part of a large project entitled "Automatic Firearms Identification and Threat Assessment" initiated by Dr. Salvatore Attardo and Dr. Nikolay Metodiev Sirakov several years ago . The project team later included Dr. Abdullah Arslan, Dr. Christian Hempelmann, and Dr. Grady Blount. The project aims to create and maintain ontology of firearms, and develop a system capable of automatically detecting a weapon carried by a suspect, identifying the weapon, and calculating the threat that could be posed by this weapon to the public. The system has several components which require a lot of computations. Parallelism is needed to deliver results in real time. The team currently explores parallelizing the search component of the system. Two students are developing programs for parallelizing a sequential program that finds matches in the ontology to a shape extracted from a given input. In doing so, the different subtrees (clusters) of a (shape-based) visual hierarchy built from the ontology are searched in parallel. The project team published 6 peer reviewed papers in top symposiums and in one journal. One paper was the recipient of the Lockheed-Martin Best Paper Award at the International SPIE Symposium Defense Security and Sensing- Automatic target Recognition – 2013. There is no publication reporting results by using HPCC yet. However, the team expects that there will be one in the future. The team is seeking external funding for the project, and results from HPCC will be helpful in showing the (real-time) capabilities of the system being built.

5) Research Activities: Derek Harter, Ph.D., Department of Computer Science and Information Systems, Texas A&M University – Commerce, and Shulan Lu, Department of Psychology, Counseling & Special Education, Texas A&M University – Commerce.

Brains can be viewed as networks, and their structural properties as well as their functional dynamics can be modeled and understood using the tools of network science. In particular, the architecture of large-scale complex networks appear to be important in the functional organization of many complex networks, including brain networks. Brain nervous systems appear to have small-world architectures, as well as many properties of scale-free network organizations. The computational simulation tools, and support for personnel of this grant, has supported our research into the computational neurodynamical effects of architectures on brain processing dynamics. In particular, several simulations have been built and modeled using the

cluster resources, that would not have been possible without it. These simulations have included connectionist and neuroscientific models, using Izhekevich neurons, to simulation the synchronization dynamics of brain networks under varying architectural constraints. Several graduate students and a postdoctoral fellow worked on aspects of these simulations, and others, that combined neurodynamical models with simulated robotic embodied entities.

The resources for this grant have also supported our research into the cognitive aspects of event perception and risk taking when using virtual environments. In this research effort, we have looked at how risk and other aspects of embodied cognition might enhance the feelings of presence and immersion when using virtual environments. Presence is important when using virtual environments, as it is linked to measures of engagement and learning gains, when using such simulations for serious purposes. This grant has supported several student's research into these questions. The cluster equipment was used for some of our virtual environment simulations, as well as some more complex data analysis of position tracking data gathered from experiments in our virtual environments.

Publications resulting from this work using the HPCC.

Harter, D. (2014). Spike Synchronization Dynamics of Small-World Networks. Preprint, ArXiv 1390.5660 cs.NE.
Harter, D. (2013). Hierarchically arranged mutualism of neural circuit ecosystems. Advances in Brain Inspired Cognitive Systems Lecture Notes in Computer Science. Springer, 7888, 255-260.
Harter, D. (2012). Evolution of small-world properties in embodied networks. Advances in Brain Inspired Cognitive Systems Lecture Notes in Computer Science. Springer, 7366, 102-111.
Harter, D. (2013). Nested Mutual ism of Brain Information Processing Networks. Proceedings of the 2013 International Joint Conference on Neural Networks (IJCNN 2013).
Harter, D. (2011). Functional and Physical Constraints for Evolving Small-World Structure in Embodied Networks. Proceedings of the 2011 International Joint Conference on Neural Networks (IJCNN 2011).
Harter, D. & Zhang, L. (2010). Parallelization of Genetic Optimization for Large Network Simulations on a Cluster Computer. Proceedings of the Society for Design and Process Science 2010.
Lu, S., Harter, D., Kotturu, P. and Kosito, P. (2014). Developing Low Cost Virtual Training Environments: How do Effector and Visual Realism Influence the Perceptual Grounding of Actions? Journal of Cognitive Education and Psychology, (13) 1, 3-18.
Lu, S., Harter, D., & Pierce, D. (2011). Potentials and challenges of using virtual environments in psychotherapy. Annals of Psychotherapy and Integrative Health. 1, 56-66.
Lu, S., Harter, D. and Graesser, A. (2009). An empirical and computational study of perceiving and remembering event temporal relations. Cognitive Science. 33: 344-373.
Harter, D., Lu, S., Kosito, P., & Kotturu, P. (2012). How controller embodiment effects task performance in computer simulated training. To appear in Proceedings of the 7th International Conference on Human Computer Interaction.
Harter, D. & Lu, S., Kotturu, P. and Pierce, D. (2011). An Immersive Virtual Environment for Varying Risk and Immersion for Effective Training. Proceedings of the ASME 2011 World Conference on Innovative Virtual Reality.

Pierce, D., Lu, S. and Harter, D. (2011). Risk taking differences affect outcomes in virtual training scenarios. Proceedings of the ASME 2011 World Conference on Innovative Virtual Reality.
Pierce, D., Lu, S., & Harter, D. (2010). Perceiving events in simulated environments: The role of expectation driven processes. Proceedings of the World Conference on Innovative Virtual Reality 2010. New York: ASME Publishing.
Pierce, D., Lu, S., & Harter, D. (2009). Enacting actions in simulated environments. In S. Garbaya (Eds.), Proceedings of the Inaugural World Conference on Innovative Virtual Reality. New York: ASME Publishing.

This research as involved these students:
Pratyush Koturu, MSc, PhD, 2006-2014.
Paweena Kosito, PhD, 2011-2013
Terry Rawlinson, PhD, 2009-2012
Devin Pierce, PhD, 2007-2010.
Chris Jones, MSc, 2009-2012.
Gideon Mazambani, MSc, 2008-2010.
Terry Rawlinson, MSc, PhD, 2007-2013.
Mei Jiang, Ph.D. 2007-2009.
This research has involved this Postdoctoral Associate:
Linbao Zhang, postdoctoral associate, 2010-2011.

6) Research Activities: Stephen Starnes, Ph.D., Department of Chemistry, Texas A&M University-Commerce.
Design & Synthesis of Receptors for Anions and Molecules with Biomedical and Environmental Significance.

The Starnes research group is working towards the development of receptors for chiral guests. This activity is a multidisciplinary work at the interface between organic chemistry and biological, analytical, and separation chemistry. With this project, the synthesis and study of meso-functionalized porphyrins have been recently reported for the recognition of non-chiral anions.1 The meso-substituted porphyrin hosts were designed to complement the shape of anions such as nitrite, nitrate, perchlorate, sulfate and phosphate. The group proposed that the hosts bind guests through an induced-fit binding mechanism similar to that of enzymes. The current efforts with the project are focused on the development of chiral porphyrins for the recognition of chiral anions such as amino acids, pharmaceutical agents and chiral amines. The Starnes group has recently reported several hosts that exhibited selectivity in the recognition of chiral carboxylates.2,3 In order to learn more about the rules governing chiral recognition, the research team has used the A&M Commerce High Performance Computer Cluster (HPCC) for analyzing the hosts' structures in a simulated environment. Computational results are critical to obtaining a better understanding of the structures of the compounds since this information is typically only available through either x-ray crystallography (which is only good for solid state structures and only obtainable if the compound is crystalline) or computational methods (which can model systems in the solid, solution or gaseous states). Further investigation using the A&M Commerce High Performance Computer Cluster will be the simulation of the circular dichroism

spectrum of the porphyrin hosts, which could provide a deeper understanding of the structures of these compounds and their complexes.

Publications resulting from work performed on the HPCC:

[1] Wienkers, M.; Ramos, J.; Jemal, H.; Cardenas, C.; Wiget, P.; Nelson, A,; Free, S.; Wu, J.; Roach, R.; Vulcan, M.; Waynant, K.; Fort, K.; Vladimirova, A.; Sun, J.; Hunt, S. E.; Rudkevich, D. D.; Starnes, S. D. "Enhanced Shape-Selective Recognition of Anion Guests through Complexation- Induced Organization of Porphyrin Hosts," Org. Lett. 2012, 14, 1370-1373.

[2] Wu, Xiaowen; Starnes, Stephen D. "L-Nipecotic Acid-Porphyrin Derivative: A Chiral Host with Introverted Functionality for Chiral Recognition," Org. Letters, 2012, 14, 14, 3652-3655. http://pubs.acs.org/toc/orlef7/14/14

[3] Nandipati, V.; Akinapelli, K.; Koya, L.; Starnes, S.D. "Recognition of Mandelate Stereoisomers by Chiral Porphyrin Hosts: Prediction of Stereopreference in Guest Binding a Priori Using a Simple Binding Model?," Tetrahedron Letters, 2014, 55, 985-991.

7) Research Activities: Mutlu Mete, Department of Computer Science, Texas A&M University-Commerce; Jeffrey S. Spence, Center for Brain Health, University of Texas at Dallas; Michael D. Devous, Sr., and Thomas S. Harris, Department of Neurology, UT Southwestern Medical Center; Bryon Adinoff, VA North Texas Health Care System and the Department of Psychiatry, UT Southwestern Medical Center.

Successful Classification of Cocaine Dependence Using Brain. Imaging: A Machine Learning Approach.

Dr. Mutlu Mete, Assistant Professor of Computer Science Department, has been using cluster for classification of cocaine depended and control patients. His collaborated from UT Dallas and UT Southwestern Medical Center and Dr. Mete develop software for SPECT (Single Photon Emission Computerized Tomography) and fMRI (functional Magnetic Resonance Imaging) images, where each patient has approx. 200,000 x 300 voxels. In their classification framework search, they are searching for optimum brain networks using information theoretic algorithms, such as Information Gain and Density based clustering. A Java-based parameter search program is used to tune the parameters of voxel-search and classification methods.

Grants supporting this research:

This research supported by NIDA DA031292-01, DA10218, DA11434, DA023203, DA023203, Texas A&M University-Commerce Graduate School Research Grant, and the UT Southwestern Center for Translational Medicine UL1TR000451.

Master's Thesis related: "Independent Component Analysis of fMRI of Cocaine Addicted Patients," Anilkrishna Bandapelli, Department of Computer Science (January 2012 – August 2013).

8) Pending Research Activities: S. Saffer, Ph.D., Mutlu Mete, Ph.D., Jinoh Kim, Ph.D., Unal Sakoglu, Ph.D., Nikolay Sirakov, Ph.D., Department of Computer Science, Texas A&M University – Commerce.

Infrared Thermal Imaging Project is intended to promote faculty and student research and to provide for a training environment for students and faculty who want to explore computational tools. The purpose of the lab is to encourage interdisciplinary graduate and undergraduate research among students in Computational Science, Computer Science, Math, Physics, and Biology. Digital images of varying infrared wavelengths will be will be processed using artificial intelligent techniques and other computational tools, such as neural networks, adaptive learning algorithms, Fourier and wave-let transforms. The computational work will be performed on the multi-processor A&M Commerce HPCC which was originally funded by a grant from the U.S. Department of Energy. This work will begin in Spring 2015 and will also be a source of future grant proposals and possible funding.

CONCLUSION: Our three main GOALS, the development of a shared high performance cluster computing resource, the development of a bank of computational tools and the development of an interdisciplinary curriculum of study for the Computational Sciences with an advanced degree program in the computational sciences, and the development of an interdisciplinary research center for computational science at A&M-Commerce by which computational models for study and analysis using computational science tools can be presented and taught, have all been met and are ongoing. Our interdisciplinary Master's program in Compuataional Science is established and there is continuting work toward a Ph.D. degree program in Computational Science for the future. If successful, this doctoral program will be the only doctoral program in the College of Science and Engineering here at A&M Commerce. Our HPCC cluster is currently hosting research projects involving faculty and students from the Departments of Computer Science and Information System, Chemistry, Physics, Psychology, Counseling & Special Education here at A&M Commerce, and from various departments from outside institutions such as UT Southwestern Medical Center, and the VA North Texas Health Care System. This grant from the Department of Energy has been a tremendous boost for A&M Commerce, especially in aiding our transition to a University that is more productive in terms of research and discovery.