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KU Researchers Gain Greater Access to Supercomputing

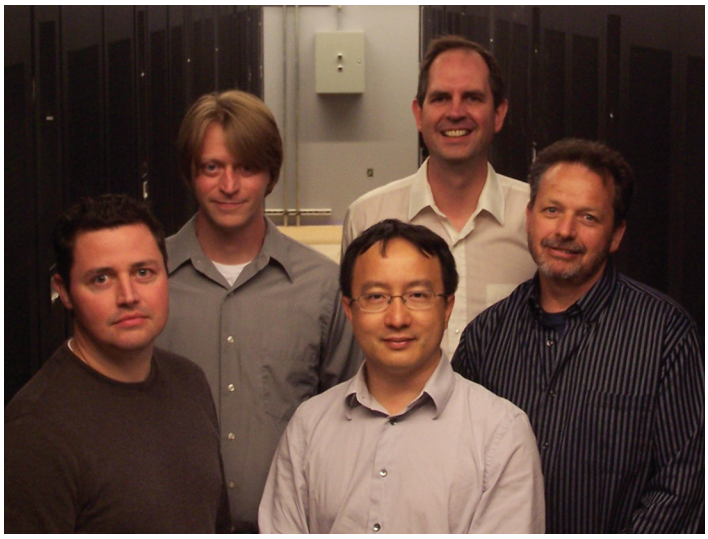
After a two year multimillion-dollar renovation, the expanded Bioinformatics Computing Facility (BCF) will open this summer. The BCF will provide a 20-fold increase in computing power, allowing researchers across KU greater access to supercomputing. The facility supports diverse research from projects dealing with biology and disease to national security and climate change.

"At most universities, researchers work department-by-department or individually to get the computing resources they need," said ITTC Director **Perry Alexander**. "The BCF unites university resources and provides an outstanding staff to maintain a secure, energy-efficient world-class computing facility. Now, KU researchers can spend less time managing computational resources and more time conducting scholarly work."

The BCF renovation was funded through a $4.6 million grant from the National Institutes of Health as part of the American Recovery & Reinvestment Act of 2009. Nearly 6,000 square feet of space was renovated in Nichols Hall. A sophisticated computer-rack cooling system will move unused heat from the BCF into the boiler room, resulting in an expected 15 percent reduction in natural gas use for Nichols Hall.

This spring ITTC received an IBM Shared University Research Award that provided new hardware for the BCF, including five compute blades, a large memory blade, a graphical processing unit blade, two storage servers, and 72 terabytes of disk storage.

The KU-IBM partnership will develop new hardware and software approaches to modeling and simulations of complex real-world systems. Researchers will be able to process and analyze huge volumes of structured and unstructured data, share their findings, explore new approaches, and store the results of their research.



ITTC staff and faculty who spearheaded the renovation stand in the new Bioinformatics Computing Facility. Front Row: System Administrator Paul Calnon and ITTC investigator Jun "Luke" Huan Middle Row: High Performance Computing Systems Administrator Charles Henry and RF Electronics Engineer Daniel DePardo Back row: Senior Network System Administrator Michael Hulet

Advanced systems modeling will enable more accurate predictions and large-scale analyses that incorporate data from multiple disciplines into a single framework with the goal of accelerating scientific breakthroughs.

IBM Systems and Technology Group University Alliances Executive Keith Brown sponsored the award to help ITTC expand its High Performance Computing capabilities.

"We are pleased to help provide KU with the computational framework needed to develop and evaluate a hybrid computing cluster that is optimized for a number of simulation paradigms," said Brown. "Modeling cell processes and structures, predicting the impact of climate change on biodiversity, and exploring massive data sets using visual and analytical techniques are examples of how HPC technology can be used to achieve our goals of helping to create a Smarter Planet." ■

Preamble to Synchronize Transfer of Flight Data

It may just be the upgrade of all upgrades.

The Department of Defense is overhauling the over 50-year-old network used on its test ranges with a high-speed wireless network that will allow multiple aircraft to conduct tests simultaneously, greatly accelerating the delivery of safe, state-of-the-art equipment to military personnel.

But increased efficiency will not happen if information is not correctly collected, which is where ITTC researcher **Erik Perrins** comes in. The expert in wireless communications has received a $450,000 DoD grant to develop a synchronization preamble, which allows a receiver to quickly "lock onto" a burst transmission before it disappears.

The preamble will synchronize the transmitter on the plane with the receiver on the ground as aircraft fly at Mach speeds over hundreds of miles on test and evaluation (T&E) ranges. To maximize efficiency and minimize power consumption, test data will be dispatched in short independent bursts that require rapid coordination between senders and receivers to ensure data collection. Dr. Perrins' compact preamble will ensure such synchronization will occur without substantially increasing the size of the packet and slowing down communication.

The existing network is extremely inefficient; a dedicated block of spectrum is assigned to a test vehicle and the radio transmission is "always on." There are too many vehicles to test and not enough blocks of spectrum to fit them all in, says Dr. Perrins. As the new network moves from an "always on" signal to a burst transmission, Dr. Perrins' preamble will allow a receiver to quickly locate and collect performance data from the aircraft. ■

New ITTC Lab will Expand Communication Capabilities

Finding innovative ways to gather, process, and send information will be the focus of ITTC's new Communications and Signal Processing Lab (CSPL). ITTC researcher **Erik Perrins** serves as CSPL director.

The popularity of YouTube, iTunes, and other bandwidth intensive applications has made maximizing communication efficiency, whether wired or wireless, of critical importance. The trends in government and military applications are the same as in consumer applications: more data, more devices, and less available spectrum.

Dr. Perrins said CSPL will benefit greatly from an equipment upgrade, totaling more than $210,000. ITTC is in the process of purchasing a spectrum analyzer and two signal generators that will enable researchers to take ideas from the design phase all the way to development and commercialization. The International Foundation for Telemetry and KU paid for the new equipment. ITTC researcher **Victor Frost**, Dan F. Servey Distinguished Professor of EECS, helped assemble the support for the upgrade and will use it to conduct wireless networking research.

An example of innovative CSPL research is the development of forward error correction (FEC) technology, which ensures accuracy and reliability over unreliable or noisy communication channels. FEC technology prevents the need for costly and sometimes impossible retransmissions. CSPL researchers have developed a FEC prototype system that can correct errors in extremely faint transmissions during test flights at Edwards Air Force Base.

CSPL research encompasses communication theory, signal processing, information theory, and estimation and detection. Projects include energy-efficient wireless communication, error correction coding, optical communications, waveform diverse radar, receiver synchronization, and audio signal processing. ■

Information and Telecommunication Technology Center (ITTC)
2335 Irving Hill Rd Lawrence, KS 66045-7559
(Fax) 785.864.4896 ◆ 785.864.0387 ■ (e-mail) info@ittc.ku.edu ◆ www.ittc.ku.edu
Link Editor: Michelle Ward ◆ ITTC Director: Perry Alexander, Ph.D. ◆ ITTC Associate Director: James Stiles, Ph.D. ◆ ITTC Director of Technology Commercialization: Keith Braman, J.D.

"ITTC graduates become highly skilled technology workers who lift the tide of economic development, not just through the high value products and services they help deliver but also through investments they make in the communities in which they live."

— Brian Ruf, Chief Information Officer, Ruf Strategic Solutions

'Deconstructing' Signals Earns Blunt International Radar Award

Separating the "wheat from the chaff" (in an electromagnetic sense) has earned a University of Kansas professor an international engineering award.

ITTC researcher **Shannon Blunt** received the prestigious Fred Nathanson Memorial Radar Award during an awards ceremony on May 9 in Atlanta. The Institute of Electrical and Electronics Engineers (IEEE) Aerospace and Electronic Systems Society selected Dr. Blunt for the highly competitive honor that each year recognizes one researcher under the age of 40 for outstanding contributions to the field of radar.

"Given the past recipients of this award and the numerous other deserving candidates, I am deeply honored to stand among them," said Dr. Blunt. "I continue to be amazed at the wide array of new technologies being developed to sense the world around us and I am absolutely thrilled to get to play a part in it."

As a pioneer of waveform diversity research, Dr. Blunt has created innovative techniques to "deconstruct" signals that vary in time, frequency, and space to tease out desired information. He says it is little bit like listening for whispers in a crowded room. Enhanced sensitivity to signals of interest is one of the fundamental goals of radar research.

"I regard him as one of the up-and-coming young stars of the radar community," said Hugh Griffiths, president of the IEEE Aerospace and Electronic Systems Society and a professor at University College London. "In terms of his stature as a result of this work, I can say that he has a truly international reputation. He has made some significant contributions in the new subject of Waveform Diversity – indeed, he is regarded as one of the flag-bearers in this subject."

The broad scope of signal processing, his area of research, allows Dr. Blunt to explore a variety of related problems. For example, while researchers have traditionally looked at ways to minimize interference, Dr. Blunt actually developed a new form of high-speed covert communication that exploits the "crowded room" of radar echoes to embed hidden signals. This new form of communication, developed under a U.S. Air Force Young Investigator Award, may provide soldiers in harm's way a new means to communicate safely.

Dr. Blunt also recently teamed with researchers from the Hogland Brain Imaging Center (HBIC) at the KU Medical Center to explore new methods for brain imaging. Leveraging a technique he had previously developed for radar antenna arrays, Dr. Blunt and KU Med researchers created the patent-pending Source Affine Image Reconstruction (SAFFIRE) algorithm to enable more accurate generation of magnetoencephalography (MEG) images, which can be used to detect abnormalities in brain function and could aid in the understanding and treatment of Alzheimer's disease and other neurological disorders.

"Dr. Blunt has established himself as an expert and valuable resource on a diverse array of radar-related research topics that may benefit from advanced signal processing," said KU Distinguished Professor Emeritus **Richard Moore**, who pioneered the field of radar remote sensing of the environment and founded the KU Radar Systems and Remote Sensing Lab, for which Dr. Blunt is the director. ■

Researcher Joins ITTC Effort to Build More Reliable Software

Neil Sculthorpe began a two-year post-doctoral research position with ITTC's Functional Programming Group in March. He joined the Haskell Equational Reasoning Model-to-Implementation Tunnel (HERMIT) project. ITTC investigator **Andy Gill**'s group is working to dramatically reduce all-too-common bugs and glitches that occur in current software. Finding ways to reduce errors could potentially save billions of dollars annually.

"Neil is a welcome addition to our team. He brings a depth of theoretical understanding of the fundamental ideals behind the construction of high-assurance software. The HERMIT project will build on his previous work. HERMIT uses a combination of software engineering and mathematics to make the evaluation of software more manageable," said Dr. Gill, who received a $500,000 NSF grant this fall for HERMIT. "When you are building large systems with millions of lines of code, finding errors can be very difficult. Unreliable software then hurts companies' reputations and costs them customers."

HERMIT mathematically, or formally, analyzes each step of development, providing rigorous connections between system requirements and the programming details of real applications. While system requirements and programs are typically written in two different computer languages and often evaluated in a third, HERMIT provides a common foundation that generates evidence that the description and action match. These continuous checks and balances make it much harder for errors to be introduced.

Dr. Sculthorpe, who received his Ph.D. in Computer Science this past summer from the University of Nottingham, will focus on worker/wrapper transformation. This is a verification technique for connecting specifications to efficient implementation. He says a major goal of the project is to make applying transformations as painless as possible, allowing the HERMIT tool to be used by non-expert users. ■

KU INFORMATION & TELECOMMUNICATION TECHNOLOGY CENTER
The University of Kansas

Nichols Hall 2335 Irving Hill Rd Lawrence, KS 66045-7559

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