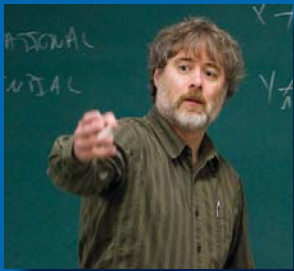
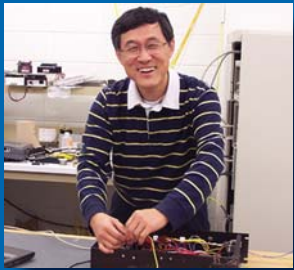


Information and Telecommunication Technology Center

Annual Report
2008-09



“The peer review team commends the Center on its overall efforts and accomplishments in an environment of limited resources. The team agrees that ITTC is a high quality research center, and that it is a valuable resource not only to the State of Kansas, but to the nation.”

—Independent KTEC Review Team



ITTC is a KTEC Center of Excellence,
funded in part by the
Kansas Technology Enterprise Corporation.

ITTC is a division of the
University of Kansas,
which is an entity of the State of Kansas
separately managed and distinct from the
Kansas Technology Enterprise Corporation.

On the Cover

Down from top left:

Ron Hui, Professor, EECS; Communications and Networking Systems Lab,
Bioinformatics and Computational Life-Sciences Lab

Perry Alexander, Professor, EECS; Acting Director ITTC (September 2009),
Computer Systems Design Lab Director, Information Assurance Lab Director

Jamie Jenshak, the first ITTC student to receive a prestigious DoD Science,
Mathematics And Research for Transformation (SMART) Scholarship for Service

Paula Conlin, Nichols Hall Facilities Manager ■

The Center and Our Accomplishments

Perry Alexander, Acting ITTC Director



What a year it has been! ITTC became a federally designated center of excellence for information security. An independent peer review found the Center to be a valuable resource for Kansas and the nation, and ITTC Director **Joseph Evans** took a leave of absence to continue his entrepreneurial work on the Tactical Ground Reporting System for the federal government. The multimedia reporting system gives soldiers on the ground an effective and efficient way to collect and share information. In his absence, I have been appointed as acting director.

As a Midwest native and small business owner, I understand the importance of creating and keeping high-tech jobs in the state. My spin-off company, Cadstone, gives me unique insight into the opportunities and challenges of technology commercialization. Thus, ITTC is working hand-in-hand with other members of the

Kansas Technology Enterprise Corporation (KTEC) network to make the commercialization process easier and more efficient. We want our technologies out of the laboratories and into the hands of Kansas' entrepreneurs. Collaborative efforts, led by KTEC, are working! According to *Cyberstates 2009*, Kansas had the nation's fastest tech employment growth rate in 2007.

We strive to expand ITTC areas of expertise and applications of our research. Joe Evans and I led an effort to be designated as a National Center for Academic Excellence in Information Assurance (IA) Education. The National Security Agency and Department of Homeland Security approved our proposal this spring. We brought together diverse IA expertise and academic resources across KU. The new ITTC Information Assurance Lab is the centerpiece of a holistic approach to securing the national information infrastructure. It will serve as a regional center for cyber security and will no doubt lead to industry opportunities through commercialization.

As a KTEC Center of Excellence, ITTC undergoes biennial independent peer reviews. This spring a trio of experts assessed technology maturation, commercialization and other KTEC-funded components. They commended ITTC for its substantial intellectual property portfolio, including invention disclosures, U.S. patents and start-up companies. Reviewers noted the significant investment in new faculty, who are bringing creative and innovative talent to bear on critical problems. Additionally, I am hoping to streamline the ITTC infrastructure to better accommodate changing industry needs and utilize interdisciplinary ITTC resources for larger federal research efforts.

Integrating research, education and technology commercialization, ITTC researchers are developing the technologies and the technology leaders of tomorrow. ■

Valued Staff Say Goodbye

Two long-time KU staff members retired during the past fiscal year.

After 31 years at KU, **Nancy Hanson**, program assistant for ITTC's Technology Commercialization Office, retired in July. Co-workers miss her warm smile, willingness to help and genuine interest and caring in others. Nancy's knowledge of grammar and attention to detail made her a superior editor and program assistant.

"It has been my pleasure, in all my years of service with KU, to work with the most congenial, talented and professional staff and co-workers anyone could ever hope to find," Hanson says. "My work with ITTC has been varied, interesting and educational: I will miss that, but mostly I will miss the people."

Annie Francis joined ITTC in 2002 as an office specialist. Her duties included managing student appointments, adding content to the ITTC website, coordinating events and meetings and proofreading. She

enjoyed meeting and working with students and faculty from around the world. As a thank you, ITTC researchers often brought back foreign stamps or currency for Francis, an avid collector. She retired in June 2009.

We thank them for their dedication and service and wish them all the best in retirement! ■

Office Specialist Annie Francis poses with the cake made for her retirement party in June. Annie loves the ocean and collecting sea shells. ITTC program assistant Pam Farr made the cake, all the way down to edible shells.



Program Assistant Nancy Hanson shows off one of her retirement presents from ITTC faculty and staff. After more than 30 years at KU, Hanson retired in July 2008.



Former ITTC Director Earns NSF Position

Former ITTC Director **Victor Frost**, Dan F. Servey Distinguished

Professor of EECS, has become a program director within the Computer and Information Science and Engineering Directorate at the National Science Foundation (NSF).



Victor Frost

He is working with the Networking Technology and Systems (NeTS) program.

NeTS research supports the development of pervasive networks, available anytime, anywhere. Accessible from any communication device, future networks will be resilient to failures and malicious attacks. These dynamic architectures, protocols and technologies will evolve to accommodate growth and change.

Frost began the two-year appointment in January. He is the fifth ITTC faculty investigator (**Joseph Evans, Ron Hui, Gary Minden** and **Glenn Prescott**) to work within federal research agencies.

"Victor is a great source of vision and direction," says **Cory Beard**, former Frost Ph.D. student and current University of Missouri-Kansas City associate professor. "He has a keen sense of the big picture of where technology is headed, then knows how to communicate this vision clearly with direction on practical steps on how to move forward. He will provide NSF with that same leadership that he has provided for ITTC." ■



ITTC Receives National Honor for its Work on Fighting Cyber Warfare

The National Security Agency (NSA) and Department of Homeland Security (DHS) have designated ITTC/KU a National Center for Academic Excellence in Information Assurance Education.

The ITTC/KU designation comes at a time when experts at the National Academy of Science and policymakers have identified cyber security as a key component to protecting the wired lives of Americans. By educating the next generation of practitioners, performing fundamental research and reaching out to the community, KU serves as a regional center of expertise in support of the ongoing fight to protect the U.S. information infrastructure.

ITTC and the Department of Electrical Engineering and Computer Science together form the core of KU's program. In working toward center of excellence designation, ITTC developed the Information Assurance (IA) Lab.

"This is a testament to our national prominence in information assurance and cyber security education," said **Perry Alexander**, director of ITTC's IA Lab. "The hard work and strategic vision of numerous KU faculty members and staff led to the University being accepted into this elite group."

The lab serves as a university-wide focal point for information assurance education, research and implementation. The new interdisciplinary lab includes researchers from the Electrical Engineering and Computer Science Department, Mathematics Department and Business School as well as KU's IT Security Office, which is responsible for implementing information security on campus. ■

"The intellectual property portfolio is impressive. Numerous invention disclosures have been filed and several patents have been awarded. Several start-up companies have spun out of the Center."

—Independent KTEC Review Team

Achievements from ITTC's Technology Commercialization Office

Moving forward into the next decade, ITTC has identified four emerging technology clusters where continued KTEC support will lead to significant opportunities for the Kansas IT economy. Smart grids will enable efficient power generation and distribution. Information assurance will protect online data from disclosure or tampering. Cognitive radios will enable a new generation of mobile communication devices. Health informatics will allow medical professionals to effectively and efficiently utilize online health data. Equally important, existing Kansas IT companies provide a regional demand for these technologies, and thus a basis for new business opportunities.

Continued KTEC support is critical to maintaining ITTC's technology commercialization infrastructure. KTEC-supported commercialization staff identify and support commercialization opportunities and create synergy between basic research and commercialization. ■

ITTC, KU Law Collaborate on Innovative Search Tool

Subscription-based databases dominate online legal research services. In addition to the prohibitive costs, the databases require special training, notes **Michael Hoeflich**, distinguished professor of law.

Hoeflich envisioned a user friendly "one-stop shop" for legal research and approached ITTC's Technology Commercialization Office (TCO) because of its software development experience. With support from KTEC, ITTC

Research Engineer **Danico Lee** worked with Hoeflich to develop the search engine known as *MetaJuris*. The software simultaneously searches legal databases for cases, statutes and literature citations.

"My purpose was to provide a fast, free search capability which would permit not only lawyers, but everyone access to crucial legal documents," Hoeflich said. "*Metajuris*, I believe, does that."

ITTC supports and hosts the currently free service at <http://metajuris.ittc.ku.edu>. Users enter search words from which *MetaJuris* creates and submits queries to targeted legal databases. Version 2.0 mines six databases including *PreCYdent* (which includes U.S. Supreme Court cases), *kscourts* and *Legalbitstream* (which searches Internal Revenue Service rulings).

In fall 2008, law students were asked to evaluate *MetaJuris*.

"MetaJuris helps me find the most influential and authoritative cases on a particular issue," said **Brian Jansen**, a first-year law student who used the metasearch. ■

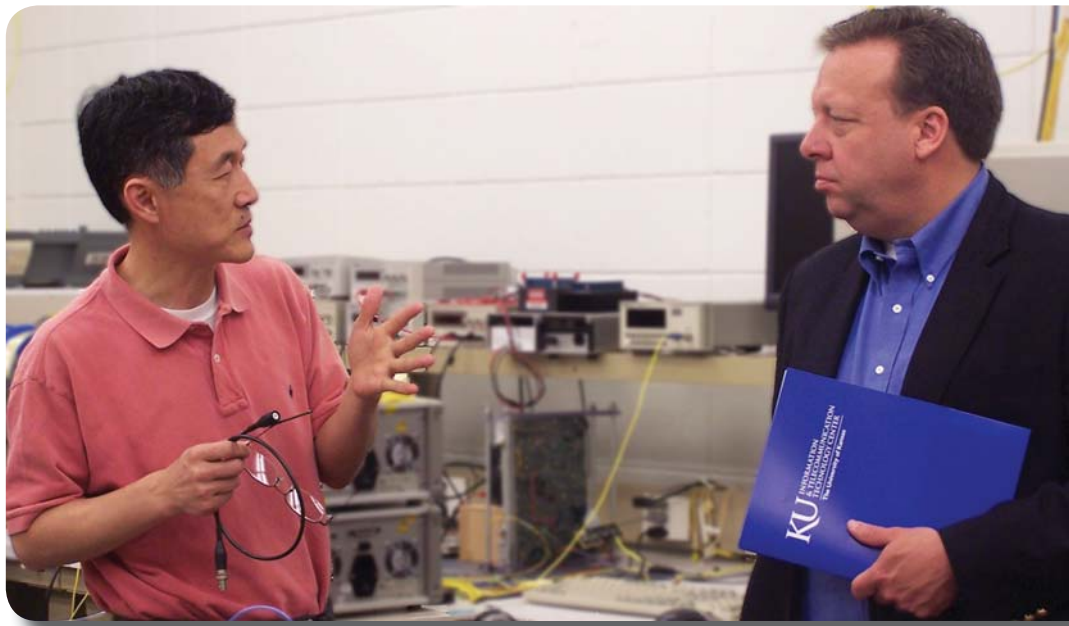


A collaborative project between the KU Law School and ITTC led to the development of *Metajuris*, a search engine that enables "one-stop shopping" for legal research. KU law students, such as those above, tested the prototype.

Photo by Mindie Paget

“I have personally licensed three technologies from the University of Kansas and spun out two companies based on my research as a faculty member. Both companies grew in Kansas and were ultimately acquired. Each of the technology transfer activities resulted in jobs within Kansas and revenue back to the University and the State. None of this would have been possible without the support from KTEC [Kansas Technology Enterprise Corporation] to ITTC.”

—Susan Gauch, former ITTC investigator/ KU professor and current Rodger S. Kline leadership chair professor and head of Computer Science & Computer Engineering at the University of Arkansas



ITTC investigator Ron Hui (left) explains his laser systems research to new KTEC Board member Kansas Senator Tom Holland. Holland toured ITTC in May.

Three U.S. Patents Issued to ITTC

ITTC’s Technology Commercialization Office (TCO) received notice of three U.S. patents in FY 2009. “We are excited about the commercial potential of each, and plan to work with our local business partners to develop them,” says **Keith Braman**, director of TCO.

Xue-wen Chen, director of ITTC’s Bioinformatics and Computational Life-Sciences Lab, received a patent for his “Method of Classifying Data Using Shallow Feature Selection.” The new computational algorithm can detect genes related to a specific biological mechanism, such as biomarkers for cancers. It performs better than most of the existing methods in detecting biomarkers, molecules that signal a disease or condition.

ITTC investigator **Ron Hui** marks his 14th patent with “Laser System for Photonic Excitation Investigation.” Conventional Coherent Anti-Stokes Raman Spectroscopy (CARS) provides high-quality three-dimensional (3D) images of living cells. CARS imaging requires the use of two expensive laser sources, which must be synchronized and maintained. To enable greater accessibility of the powerful imaging tool, Hui and his students developed an affordable, compact and wavelength-tunable laser system. The ITTC system can be easily transported and used on current biological imaging microscopes.

Due to the efforts of ITTC Research Associate Professor **Daniel Deavours**, ITTC/KU has become a recognized leader in radio frequency identification (RFID) technology development. Deavours’ latest invention, “Virtual Short Circuit for Providing Reference Signal in RFID Tag,” enables more efficient and inexpensive manufacturing of RFID tags for asset tracking. It also provides better performance than competing technologies. It is one of several novel ideas ITTC is pursuing that creatively expand the utility of RFID tags. ■

Bioinformatics and Computational Life-Sciences Lab

BCLSL researchers are developing advanced methods to examine and analyze immense biological data sets, allowing researchers an unprecedented “big picture” view of humans’ internal processes. ITTC-developed technologies will lead to earlier diagnoses, personalized treatment and assessment plans and drug discovery. BCLSL research enables a greater understanding of how biological systems work and how they relate to disease. The multidisciplinary research involves researchers from EECS, mathematics, life-sciences and medicine. ■

Henry Leads Upgrade of Powerful Computer Cluster

Information Systems Analyst **Charles Henry** was hired in November to oversee a substantial upgrade of the ITTC Computer Cluster Facility. Funded by the National Science Foundation, KU Research and Graduate Studies and the Kansas Technology Enterprise Corporation (KTEC), the cluster expansion improves the performance time of data-intensive research, such as genome or misfolded protein analysis. The facility provides KU scientists with advanced local high-performance computing available at other top tier research universities.

“In addition to supporting local research, such facilities can attract faculty and pave the way for interactions with industrial partners,” said ITTC Director **Joseph Evans**.

The integrated research platform is receiving an additional 384 cores across 48 computer nodes, for a total of 1,024 cores (processors) and 208 nodes, and InfiniBand, a high-speed interconnect between nodes in the cluster. Currently, KU researchers from ecology and evolutionary biology, chemistry and molecular biosciences, molecular graphics and modeling and mechanical engineering use the facility. ■



ITTC Information Systems Analyst Charles Henry works on the computer cluster. He is overseeing a substantial upgrade of the research platform.

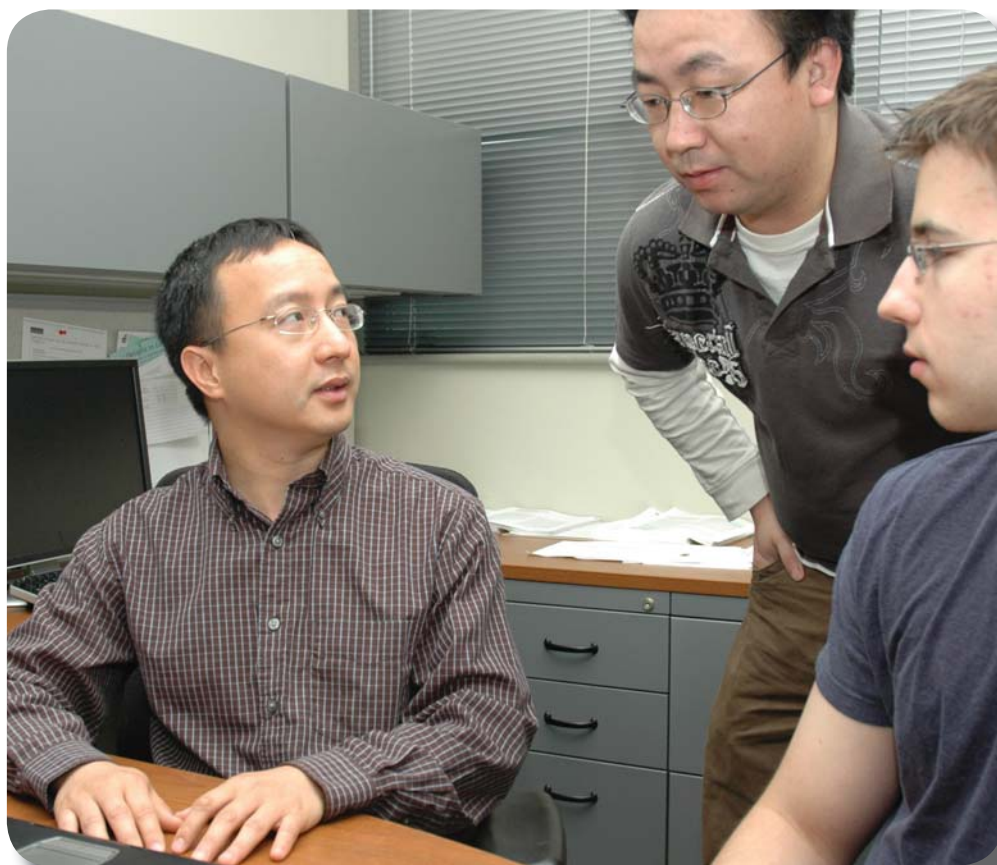
Bioinformatics and Computational Life Sciences Lab Director Xue-wen Chen received a CAREER award in 2007. Chen is developing software to find needles in a haystack. His machine learning methods are extracting patterns and recognizing biological networks within massive data sets.

NSF Honors Huan for Exemplary Research and Teaching

Early this summer, **Jun “Luke” Huan** was awarded a Faculty Early Career Development (CAREER) award. One of the highest honors conferred by NSF, the CAREER award recognizes promising junior faculty members who will likely become the academic leaders of tomorrow. The \$500,000 grant— paid out over five years—will advance his research, teaching and public education.

The ITTC investigator is developing tools to better analyze interactions between chemicals and biological systems. A class of organic chemicals, known as “small molecule probes,” is critical to exploring basic cellular functions at a holistic level. By developing screening libraries of these chemical compounds, Huan is accelerating drug discovery and design, and improving environmental chemical toxicity monitoring.

For Huan, 2009 has been a banner year! This spring one of his graduate research assistants, **Brian Quanz**, was awarded a NSF Graduate Research Fellowship. For more on Quanz’ fellowship and research, see page 14. ■



ITTC researcher Jun “Luke” Huan (left) meets with Ph.D. students Jintao Zhang and Brian Quanz in his office. They are developing software and tools to aid life-sciences researchers in drug discovery. Huan’s group is working to improve environmental monitoring as well.

Photo by Jill Hummels

Communications and Networking Systems Lab

CNSL researchers have earned national and international acclaim for pioneering research on intelligent, agile communication systems. The laboratory integrates leading-edge research with practical implementation and applications. Software defined radios, transmitter and receiver design, optical systems, high-capacity networks and reliable, robust mobile networks are areas of CNSL expertise. ■

CNSL researchers work on high-speed fiber optical networks and rapidly configurable wireless networks that seamlessly move information. We understand that information is needed where we are, not where our computers reside.

KS Universities Build NASA Communication Systems

Future Lunar and Martian surface communication systems will transmit large amounts of scientific and operational data while adhering to severe size, weight and power (SWaP) constraints. The NASA-sponsored research project, "Lunar and Martian Surface Communication Systems with Efficient Miniature Antennas," will develop communication systems for future space missions. Researchers at ITTC, the University of Alabama and Wichita State University (WSU) received a three-year NASA Experimental Program to Stimulate Experimental Research (EPSCoR) Cooperative Agreement Notice (CAN) award. The NASA EPSCoR CAN program addresses high-priority NASA research and technology development needs. EECS Assistant Professor **Erik Perrins** serves as ITTC's principal investigator for this NASA EPSCoR project.

Perrins and his students will develop miniaturized hardware for four specific scenarios: astronauts to surface assets in immediate vicinity, astronauts to the main hub (assuming line of sight) back-up link for astronauts to the main hub (assuming no line of sight), and main hub to Earth. Most of the antenna research will be conducted at Alabama with WSU leading system integration and testing.

"This is an exciting opportunity to combine communications research with future manned space missions," says Perrins. "This project will enable these missions, and the technological output will also have promising applications closer to home." ■



ITTC researchers are helping develop communication systems that adhere to severe power and size constraints and will be able to transmit volumes of data efficiently from space.

Photo Courtesy of NASA

ITTC Innovations Help Pave Way for Future Internet

I TTC investigator **James P.G. Sterbenz** understands the difficulty of long-distance relationships. He collaborates with researchers across the United States and Europe on the development of networking technologies for the future Internet. However, technology often limits their collaborative research efforts, including large scale experiments with shared infrastructure. The rigid architecture of the current Internet cannot support emerging applications nor associated mobility, security, privacy, usability and resilience. The National Science Foundation has launched an initiative to develop a new flexible infrastructure able to support large collaborative research. Global Environment for Network Innovations (GENI) will promote innovations that pave the way for the Future Internet.

Sterbenz is the principal investigator on the multi-institution “Great Plains Environment for Network Innovation” (GpENI) project under GENI. GpENI is developing and deploying flexible programmable network infrastructure to support interdisciplinary research and development of future Internet architectures. It will provide an experimental platform for a number of research projects.

GpENI is centered on a fiber-optic interconnection among KU, Kansas State University, University of Missouri-Kansas City, University of Nebraska-Lincoln, Lancaster University in the UK and ETH Zürich (Swiss Federal Institute of Technology). GpENI is being extended regionally to the Great Plains Network, a consortium of universities in the Midwest across the Kansas and Missouri Research and Education Networks, as well as approximately 40 international institutions. Each partner institution hosts a GpENI node cluster, which is designed to be as flexible as possible at every layer. Ciena and Qwest are industry collaborators.

“This is an important project that will enable new network research in the great plains region and foster wider collaborations, leveraging investments in optical infrastructure by the states of Kansas, Missouri and Nebraska,” says Sterbenz. ■



Researchers involved in NSF's Global Environment for Network Innovation (GENI) project are developing a national framework to enable thousands of research experiments to run simultaneously. As part of GENI, the “Great Plains Environment for Network Innovation “ project, led by ITTC investigator James P. G. Sterbenz, is developing and deploying flexible programmable networking infrastructure.

Image by Nicolle Rager Fuller, National Science Foundation

“The NSF program, Global Environment for Networking Innovations (GENI), is a new bold research platform allowing researchers to experiment with concepts for the 21st century Internet. It is one of the core strengths of the Center.”

Computer Systems Design Lab

CSDL researchers develop predictable, robust systems critical to the nation's economy, security and quality of life. Research focuses on the development and implementation of complex, high-assurance embedded computer systems, such as radios, controllers and sensors. Investigators provide advanced languages and techniques for compilation and synthesis, profiling and verification and high assurance, real-time performance. ■

ITTC Hosts International Programming Contest

By holding the international championships for functional computer programmers in June, ITTC joined an elite list of schools. Past hosts have included Harvard, Cornell, Penn and Virginia universities.

"That's one of the reasons I wanted to do this," said ITTC investigator **Andy Gill**. "This group here at KU has been doing some very interesting language research, but it hasn't been noticed as such. This helps put KU on the map. It gives us some good visibility."

More than 850 teams entered the competition. Programmers had to move imaginary satellites to points in the solar system on a specific time schedule. The final challenge consisted of linking 12 satellites around the galaxy with one main satellite.

"There are programmers from organizations, such as NASA and Google, that have entered teams. There are all these very talented people from top-tier institutions playing a game that was created at KU. That's very cool," said **Nick Frisby**, an ITTC graduate research assistant.



ITTC hosted the 2009 International Conference on Functional Programming (ICFP) programming contest in June. Faculty, staff and students organized the event, which also showcased ITTC functional programming research. Back row: Ph.D. student Nicolas Frisby and KTEC Scholar Garrin Kimmell. Middle row: Ph.D. student Wesley Peck, graduate student Michael Jantz, ITTC Research Engineer Ed Komp, ITTC investigator Andy Gill and graduate students Brett Werling and Tristan Bull. Front Row: Ph.D. students Megan Peck and Mark Snyder and graduate student Kevin Matlage.

The entire competition took place over 72 hours, and the teams did not know what the scenario would be until the competition began. A tremendous amount of work is completed in a short period of time.

"To say that they are competing for prestige is too nice a word, too finessed a word," Gill said. "They really are competing for bragging rights. In a sense, you are competing for the programming language that you use."

Contest winners will be announced in September 2009 at the International Conference on Functional Programming in Edinburgh, Scotland. ■

CSDL Director Perry Alexander also leads the new Information Assurance Lab. Cross-fertilization between computer systems design, information assurance and other research areas better protects the U.S. information infrastructure.

Couple Shares Project, Lab and Even Tiny Office

Face time is not a problem for **Megan Peck** and her husband, **Wesley**. The Kansas natives often leave their apartment together for work at ITTC. The doctoral students are working on the same project in the same ITTC lab where they share a small office.

“It can occasionally get a little cramped, especially if we’re trying to work together. Good headphones definitely help—both for us and for others in the lab—if we get cranky with each other,” Megan says with a laugh.

A whirlwind might best sum up Megan’s 2006! She graduated with a 3.94 GPA in May, planned her wedding that summer, married and began her Ph.D. coursework in the fall.

She is working with her advisor, **Perry Alexander**, director of ITTC’s Computer Systems Design Lab, on a dissertation topic. With a strong interest in mathematics, her research will most likely focus on mathematical applications to better define components’ interactions within Rosetta. Different vocabulary and engineering processes hamper communication among functionality, power and other subsystems within complex electronics. Rosetta, a system-level design language, allows designers to better understand how these components interact, enabling faster, more accurate production.

Wesley is developing the Rosetta language as well and specializes in the development of field programmable gate array-based (FPGA) operating systems. The chips can be programmed to perform specific functions without the delay or associated costs of creating specialized chips. In addition to the hardware, Wesley and ITTC researchers are writing software to compile Rosetta code to hardware/software co-design systems.

Megan, who grew up in Leavenworth, plans on graduating in 2012. Wesley, a Derby native, will graduate in 2010. ■



Megan Peck, left, and her husband, Wesley, usually do not have to look far to find one another. The two share a small office in ITTC’s Computer Systems Design Lab where they work on the system-level design language Rosetta.

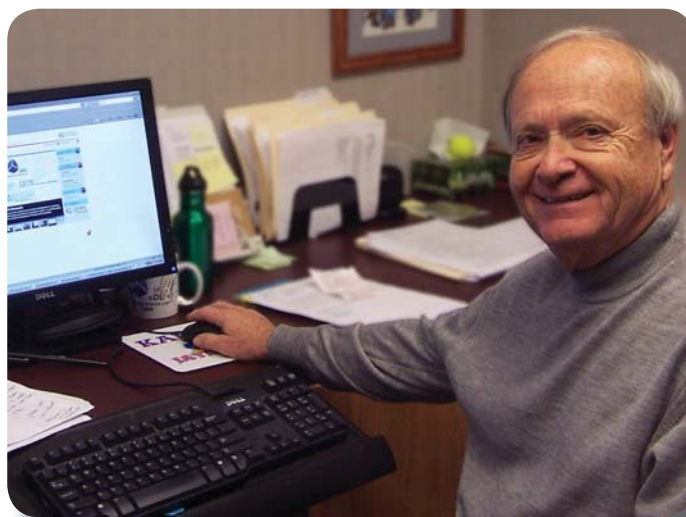
e-Learning Design Lab

The e-Learning Design Laboratory creates solutions to emerging challenges and opportunities to optimize the application of technology to enhance learning in educational and professional development settings. This involves the study, development and research of new designs, principles, practices, tools, policies and learning environments. ■

Meyen: Kansas Schools, Students Benefit from e-Learning

Nearly 85,000 students and 250 school districts in Kansas are participating in eDL's Blending Assessment with Instruction Program (BAIP). Hundreds of online tutorials aligned with federal math standards are designed for K-12 students. BAIP includes lessons for students, management and monitoring tools for teachers and resources for parents. eDL co-director **Ed Meyen** points to the program, developed in conjunction with KU's Center for Educational Testing and Evaluation, as one of eDL's biggest successes.

Meyen, a professor in special education, discussed the development of eDL over the last eight years. eDL is a collaboration between ITTC and the Center for Research on Learning (CRL).



Professor of Special Education Ed Meyen is co-director of ITTC's e-Learning Design Lab.

What have been the biggest changes?

Originally, the lab had a focus on post-secondary education. About four years ago, we moved to a K-12 focus. We started developing lessons and tutorials that aligned with the federal standards of No Child Left Behind. We joined with the State [Kansas State Department of Education] to create the Blending Assessment with Instruction Program (BAIP). The success of our math program has led us to create a science-based BAIP. A large number of rural schools and parochial schools in Kansas use BAIP. Online instruction gives students—all students—access to high quality resources. Geography is no longer a boundary.

What can you tell us about the future of e-learning?

The dramatic growth of online instruction has caused a lot of assumptions to be made about the needs of students. As online education research continues to grow, I think you will see a lot of changes in the field. We will test our assumptions and find more effective ways to teach students. It is an exciting time for e-learning.

The last report I saw said there were 3.9 million post-secondary students. Universities with the best online programs will attract students. In addition to education, online instruction could benefit staff development and training in various fields. There are numerous opportunities within e-learning. ■

From correspondence courses to online classes, distance learning has always provided an alternative to the traditional classroom. e-Learning offers greater freedom and independence to students who are often juggling family, work and other commitments.

KU Researchers Develop Virtual World to Teach Social Skills

Soap operas have nothing on middle school. Surging hormones, shifting alliances and increasing peer pressure create high drama. As social interactions grow more complex, students with Asperger Syndrome (AS)—a high functioning form of autism—become more isolated. University of Kansas researchers have developed A “Virtual Environment for Teaching Social Skills” (AViSSS) to help students with AS learn how to better interact with others and practice real-world situations independently.

Students with AS are often visual learners and can learn social skills through computer-based exercises. AViSSS primary investigator **Sean Smith**, associate professor in special education, and co-investigator **Jim Miller**, co-director of eDL, collaborated on the design and development of the virtual environment. **Justin Ehrlich**, a doctoral student working for Miller, was the lead developer on the project.

In AViSSS, students encounter various everyday situations such as someone accidentally bumping into them in the hall or someone sitting in their favorite seat on the bus. If they choose the best response, they move forward. If not, an “inner voice” explains why the choice is incorrect and encourages the student to try again. In conjunction with role playing and other educational activities, AViSSS helps teach general social skills and how to use them.

KU’s Department of Special Education will begin testing AViSSS this fall. According to the Centers for Disease Control and Prevention, approximately 1-in-150 children have an autism spectrum disorder in the United States. Additionally, AViSSS can be tailored to meet the needs of other special education groups. A number of commercialization opportunities are expected. ■



Students with Asperger Syndrome, a high functioning form of autism, struggle with communication and social skills. A virtual environment developed through interdisciplinary KU research allows students to learn social skills and practice real-world situations independently.

Intelligent Systems Lab

The Intelligent Systems Laboratory is creating smarter and more user-friendly environments and devices. Comprised of sensors, software and computers embedded in machines and devices, intelligent systems emulate and enhance human reason and action. Intelligent systems allow machines to anticipate requirements and deal with complex, dynamic environments. ■

NSF Bets on Quanz' Predictive Analysis



Doctoral student Brian Quanz, left, and ITTC investigator Jun "Luke" Huan discuss their predictive software. Quanz earned a NSF Graduate Research Fellowship this spring.

Brian Quanz wanted to conduct innovative research that provided real-world solutions for his doctoral degree. He sought out a school that would give him opportunities to work on challenging problems and provide support in transferring those technologies to the marketplace. The strong technology commercialization efforts at ITTC/KU led the North Carolina native to choose Kansas.

The ability to predict cargo security, genetic predisposition and other outcomes led the National Science Foundation to select Quanz for a Graduate Research Fellowship (GRF) this spring. Quanz was awarded a \$30,000 annual stipend plus tuition and discretionary funds for up to three years.

"The NSF GRF is a great achievement for Brian. It also reflects the strong graduate program that we have at KU," says Quanz' mentor ITTC investigator Jun "Luke" Huan, assistant professor of electrical engineering and computer science.

At ITTC, Quanz is devising artificial intelligence (AI) tools to process data collected from various sources in sensor networks. The data analysis is the foundation for a threat detection system used on ITTC's Transportation Security SensorNet (TSSN) project, which involves five faculty members and more than 10 students at ITTC.

His AI algorithms also have applications in bioinformatics research. Genes, in effect, have "on/off" switches. ITTC investigators are examining why these genes, such as those in cancer cells, are expressed in some people while not in others. Quanz is attempting to expose the role that diet, stress and other environmental factors have in turning on those switches. ■

Data mining, pattern recognition, machine learning and information assurance are critical elements of intelligent systems and are ITTC areas of expertise. The interdisciplinary nature of ITTC enables researchers to address data collection, analysis and security for a broad range of applications.

New ITTC Researcher Explores Enhanced Computer Vision

After his high school art teacher challenged him to recreate shadows, reflections and other subtle details in drawings, **Brian Potetz** began to see the complexity of vision. After all, a human retina transmits 10 million bits of data per second! Context and reasoning allow us to make sense of an overwhelming amount of information. While computers crunch data much faster than humans, they do not possess common sense. An inability to understand what is being viewed has tripped up computer vision. Potetz, now an ITTC investigator, is working to capture nuances and process images.

Facial recognition in surveillance systems, rover navigation on Mars, tumor detection and object inspection on assembly lines all use computer vision. Numerous variables, including lighting and size, complicate image analysis. With the correct data, subsequent 3D representations improve quality, resolution and depth perception. It becomes much easier to tell if something is a shadow or an object of interest. Traditional flat images too often lose information or misrepresent objects.

Potetz has developed an algorithm to make computers more flexible in their analysis. Previous approaches to estimating 3D shapes from images have operated deterministically, by forming a single hypothesis and slowly refining it. This rigidity made computer vision inefficient. Potetz's algorithm simultaneously considers many possible 3D shapes, weighing the evidence to slowly refine its belief in each one. This more holistic approach has enabled Potetz to solve depth inference problems that have stumped researchers for decades. ■



Twin Mars Exploration Rovers Spirit, pictured above, and Opportunity study the history of water on Mars to see if life could have existed on the Red Planet. Computer vision algorithms, such as those being developed by ITTC investigator Brian Potetz, enable the rovers to navigate the harsh Martian environment.

Photo Courtesy of NASA/JPL-Caltech

Radar Systems and Remote Sensing Lab

The primary focus of the lab is radar remote sensing research, including imaging, detection and tracking. Researchers investigate signal processing and system-level approaches to solving current radar problems. They explore potential new modalities of radar operation, such as simultaneous multimode operation, the exploitation of radar scattering to facilitate low probability of intercept communications and radar waveform design techniques. ■

Soldiers to Gain New Reliable Covert Communication

American soldiers in hostile territory generally find it difficult to maintain communications with friendly forces, especially when they do not want to betray their location. Radio frequency (RF) emissions can be detected by devices “sniffing” the RF spectrum. Eavesdroppers then intercept messages. There is a great need for a reliable covert communication system. ITTC technology will enable soldiers’ transmissions to “piggyback” on existing signals, masking them from eavesdroppers. The covert communication method exploits high power emissions from friendly

and/or hostile radar systems.



In March, Commanding Officer 3rd Battalion, 8th Marine Regiment Lt. Col. David Odom, U.S. Marine Corps, and Abdul Majid, an Afghan National Police officer, discuss increased security measures in Delaram. ITTC technology will give Odom and other soldiers a new way to communicate covertly with friendly forces while in hostile territory.

Photo by Chief Warrant Officer Philippe Chasse, U.S. Marine Corps

Current covert communication requires hundreds of radar pulses to convey just one communication symbol resulting in a very low data rate. In contrast, Blunt embeds a communication symbol into each individual radar pulse. Preliminary results suggest the potential for operation at data rates 1,000 times faster than current radar-embedded communication systems while offering at least the same level of security.

ITTC investigator **Shannon Blunt** is developing the intra-pulse radar-embedded communication technology through a U.S. Air Force Young Investigator Award. He is in the second year of the three-year award.

“This is exciting research that could dramatically help soldiers in the field as well as fundamentally alter the way in which radars operate,” says Blunt. ■

When transmitted radio signals come into contact with an object, they are scattered in many directions. Radar systems then collect the reflected signals along with interference, which can mask hidden messages. Interference helps enable covert communication but also hampers reception, especially in dense urban areas. Buildings, bridges and other structures make it extremely difficult to correctly reconstruct transmissions.

“As combat moves more into urban environments, it becomes absolutely critical to maintain communication contact among friendly forces and to sense the locations and dispositions of everyone else,” says Blunt. ■

Recent Ph.D. graduate Jamie Jenshak began his new classified research position at the Department of Defense. In 2006, Jenshak became the first ITTC student to receive a prestigious DoD Science, Mathematics And Research for Transformation (SMART) Scholarship for Service.

Biggs Comes Home to Kansas

Meet **Casey Biggs**—consultant. He is among a growing number of young Kansans who are returning home. Biggs moved back in 2007 to pursue a master's in electrical engineering from his alma mater. The consulting work was something that could help pay the bills during grad school, but one job kept leading to another opportunity. After graduating this spring, Biggs has turned his full attention to building his consulting firm in Lawrence. He specializes in field programmable gate array (FPGA) design, signal processing and web application development.

"KU is a great school, and I knew I wanted to come back here for my master's," says Biggs. "When I graduated in 2000, there weren't many high-tech job opportunities in Kansas. There has been quite a bit of growth over the last decade. I have a number of friends who have found high-tech jobs instate or have stayed in Kansas by becoming consultants."



The Abilene native went to Colorado after graduating from KU in 2000. He spent two years at Lockheed Martin in Denver and four years in Boulder at Timing Solutions. When Timing Solutions was bought out, he saw it as an opportunity to go back for his master's degree.

The solid foundation and critical thinking skills he developed during his undergraduate years led Biggs to return to KU. While pursuing his graduate degree, Biggs worked

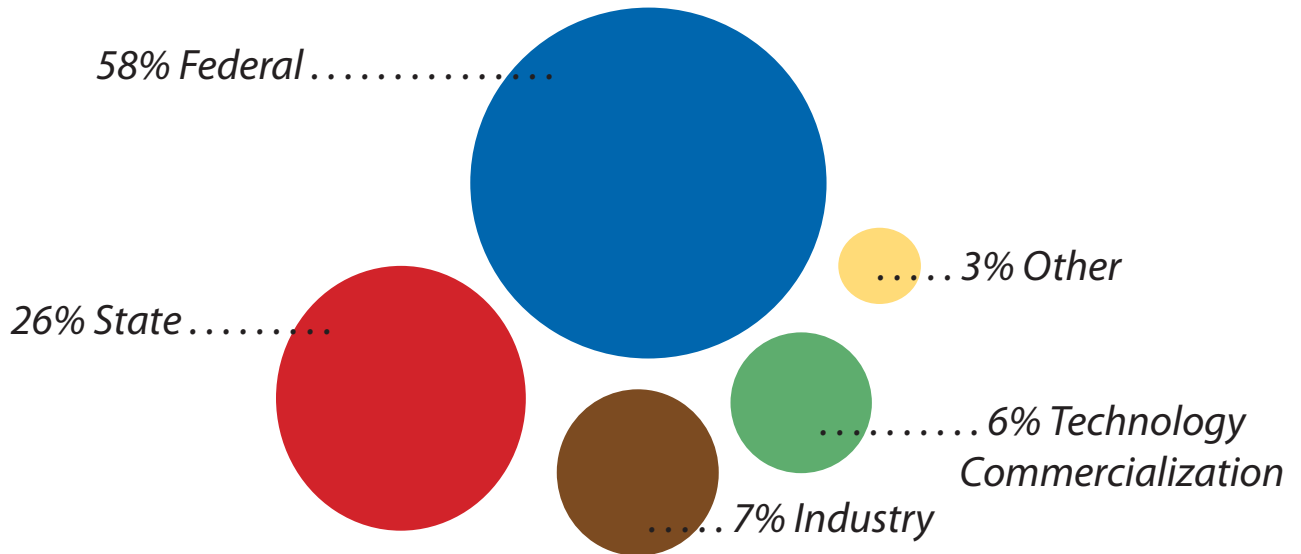
as a graduate research assistant in ITTC's Radar Systems and Remote Sensing Lab (RSL). He conducted research on ITTC investigator **Shannon Blunt's** radar-embedded communication project. (See article on adjoining page.)

"Casey was a hard-working dedicated student. We made tremendous progress on the communication system," says Blunt, "Local efforts in technology-based economic development are giving more of our students a chance to remain in Kansas."

"Working at ITTC, I had the opportunity to conduct state-of-the-art research," says Biggs. "I was able to work with and learn from great faculty and fellow students. My time at ITTC enhanced my understanding and knowledge in many areas and will make me a more effective engineer." ■

ITTC by the Numbers

ITTC Research, Development & Commercialization Expenditures by Source



ITTC triples, and frequently quadruples, national averages for technologies licensed, inventions disclosed and start-up companies generated according to the activity metrics published by the Association of University Technology Managers (AUTM).

TOTAL EXPENDITURES FROM ALL INCOME	\$4.1M
TOTAL REVENUE FROM ALL SOURCES	\$4.5M
ACTIVE ITTC-AFFILIATE TENURE TRACK FACULTY	37
FACULTY IN LEADERSHIP POSITIONS	7
RESEARCH PAPERS PUBLISHED	180
ACTIVE SPONSORED RESEARCH PROJECTS.....	77
PATENTS FILED	7
PATENTS ISSUED	3
NEW INVENTIONS DISCLOSED	6
TECHNICAL SUPPORT STAFF	7
POST-DOCS	3
STUDENTS EMPLOYED	77
PHD STUDENTS	38
MS STUDENTS	46
UNDERGRADUATE STUDENTS	15

ITTC Industry Advisory Board



ITTC held its annual Industry Advisory Board meeting in April. IAB members help guide ITTC's research and development initiatives. **Front row: Keith Braman**, ITTC, University of Kansas, Lawrence, KS; **Marc Epard**, Horizon Analog, Lawrence, KS; **Matt McClorey**, Lawrence Regional Technology Center, Lawrence, KS; **Tom Crook**, Engineer, Overland Park, KS; **COL Wayne A. Parks**, U.S. Army Combined Arms Center, Ft. Leavenworth, KS. **Back Row: Joseph Evans**, ITTC, University of Kansas, Lawrence, KS; **Mike Sobek**, Store Financial, Overland Park, KS; **Mike Swink**, Ascend Intelligence LLC, Arlington, VA; **John Strand**, Axis Solutions, Leavenworth, KS; **Eric Mokole**, U.S. Naval Research Laboratory, Washington DC; **Tim Johnson**, IDEA Center, Manhattan, KS; **Susan Norris**, Norport Technology Management Consulting, Lenexa, KS; **Kevin Carr**, Kansas Technology Enterprise Corporation, Topeka, KS; **Brian Ruf**, Ruf Strategic Solutions, Olathe, KS.

Not pictured: **James Baxendale**, KU Center for Technology Commercialization, Lawrence, KS; **Gerry Canavan**, Road 9, Greenwood Village, CO; **William Duncan**, Kansas City Area Life Sciences Institute, Kansas City, MO; **Jeffrey Fuller**, Honeywell, Kansas City, MO; **Marshall Greenspan**, Northrop Grumman Corporation Electronic Systems, Norwalk, CT; **Bennett Griffin**, Griffin Technologies, Lawrence, KS; **David Hardin**, Rockwell Collins, Cedar Rapids, IA; **Wayne Morgan**, Netchemia, Lenexa KS; **Chris Murrish**, Cerner Corporation, Kansas City, MO.



Industry Advisory Board member Eric Mokole (right) and ITTC Ph.D. student Matt Cook share a laugh at the Student Poster Session after the IAB meeting. Cook is working on ways to implement Continuous Phase Modulation (CPM) framework into radar codes. CMP will improve efficiency and power in transmissions.

“Industry is highly complimentary of the work done by the Center, and at the same time believes there is a good deal of untapped potential. There is potential for growth in terms of funding, depth of capability and ultimately, economic impact on the state. The [Industry Advisory] Board is actively supportive, and this can be leveraged into greater financial and university support and long term industry relationships.”

—Independent KTEC Review Team

ITTC Principal Investigators

Arvin Agah

Professor, EECS, Associate Chair Graduate Studies; Intelligent Systems Lab Director
Distributed and biomedical robotics; multi-agent systems; autonomous mobile robots

W. Perry Alexander

Professor, EECS; Computer Systems Design Lab Director, Information Assurance Lab Director
Systems-level design, formal specification and verification; IP reuse; specification and programming languages

Christopher Allen

Professor, EECS; Radar Systems and Remote Sensing Lab
Microwave remote sensing; radar system design and analysis

Ronald Aust

Associate Professor, Educational Leadership & Policy Studies; e-Learning Design Lab
Designing and developing multi-state educational networks and technologies to support collaborative learning

Shannon Blunt

Assistant Professor, EECS; Radar Systems and Remote Sensing Lab
Adaptive signal processing; interference cancellation; multistatic radar

Swapan Chakrabarti

Associate Professor, EECS; Bioinformatics and Computational Life-Sciences Lab, Intelligent Systems Lab
Neural networks and fuzzy systems in bioinformatics; signal processing; True 3-D display systems

Xue-wen Chen

Associate Professor, EECS; Bioinformatics and Computational Life-Sciences Lab Director, Intelligent Systems Lab
Bioinformatics; human-computer interaction; machine learning; statistical data analysis

Daniel Deavours

Research Associate Professor, ITTC; Computer Systems Design Lab, Communications and Networking Systems Lab, Information Assurance Lab
RFID privacy and security design and development; low-profile, planar, UHF RFID tag technology; performativity modeling specification

Kenneth Demarest

Professor, EECS; Radar Systems and Remote Sensing Lab
Computational electromagnetic techniques; lightwave systems

Tyrone Duncan

Professor, Mathematics; Communications and Networking Systems Lab
Stochastics of mathematical finance; stochastic analysis and its applications; stochastic adaptive control of linear partial differential equations; applied mathematics seminar; differential equations; probability theory

Güneş Erçal-Özkaya

Assistant Professor, EECS; Communications and Networking Systems Lab, Information Assurance Lab
Modeling and predicting "selfish" behavior systems; engineering cooperative, intelligent and resilient communication systems

Joseph Evans

Deane E. Ackers Distinguished Professor, EECS; ITTC Director, Communications and Networking Systems Lab, Information Assurance Lab
Networks; ubiquitous computing environments; adaptive systems

Jianwen Fang

Director, Applied Bioinformatics Lab; Bioinformatics and Computational Life-Sciences Lab
Genomics using statistical and machine learning approaches; structure prediction; sequence and domain analysis of proteins; phylogenetic analysis

Victor Frost

Dan F. Servey Distinguished Professor, EECS; Communications and Networking Systems Lab
Internet QoS and traffic management; integrated broadband networks

Andy Gill

Assistant Professor, EECS; Computer Systems Design Lab, Information Assurance Lab
Functional languages and technologies

Jerzy Grzymala-Busse

Professor, EECS; Intelligent Systems Lab, Bioinformatics and Computational Life-Sciences Lab
Data mining; machine learning; rough set theory

Jun "Luke" Huan

Assistant Professor, EECS; Bioinformatics and Computational Life-Sciences Lab, Intelligent Systems Lab
Bioinformatics and data mining

Rongqing Hui

Professor, EECS; Communications and Networking Systems Lab, Bioinformatics and Computational Life-Sciences Lab
Optical communication systems; photonic devices; optical measurement and sensors

Prasad Kulkarni

Assistant Professor, EECS; Computer Systems Design Lab
Static and dynamic/adaptive compilers; embedded systems; machine learning; computer architecture

Bo Luo

Assistant Professor, EECS; Intelligent Systems Lab, Information Assurance Lab
Information security and privacy; XML and conventional database systems

Gerald Lushington

Director of Laboratories, Medicinal Chemistry; Bioinformatics and Computational Life-Sciences Lab
Computational simulation of chemical systems; computational chemistry, biochemistry and materials science

Ed Meyen

Professor, Special Education; e-Learning Design Lab co-Director
Online instructional design and web tools; emerging instructional technologies

James Miller

Associate Professor, EECS; Computer Systems Design Lab, e-Learning Design Lab coDirector
Visualization, geometric and solid modeling for computer-aided design; computer graphics

Gary Minden

Professor, EECS; Communications and Networking Systems Lab Director, Information Assurance Lab, Computer Systems Design Lab
Digital systems; microprocessors; artificial intelligence

Richard Moore

Distinguished Professor Emeritus, EECS
Radar systems; scatterometry, radar oceanography and meteorology; spaceborne radars; radio wave propagation

Douglas Niehaus

Associate Professor, EECS; Computer Systems Design Lab, Intelligent Systems Lab
Real-time conventional distributed systems; operating systems; high performance networking

Bozena Pasik-Duncan

Professor, Mathematics; Courtesy Professor, EECS; Communications and Networking Systems Lab
Stochastic adaptive control and mathematics and science education

Erik Perrins

Assistant Professor, EECS; Communications and Networking Systems Lab
Digital communication theory; advanced modulation techniques; channel coding; MIMO

Dave Petr

Professor, EECS, Associate Chair Undergraduate Studies; Communications and Networking Systems Lab
Performance analysis; traffic integration; congestion control; resource management; QoS

Brian Potetz

Assistant Professor, EECS; Intelligent Systems Lab
Computer vision; machine learning; computational neuroscience and natural scene statistics

Glenn Prescott

Professor, EECS Chair; Radar Systems and Remote Sensing Lab, Communications and Networking Systems Lab
Digital signal applications and low probability of intercept communication

James Roberts

Professor, EECS; Communications and Networking Systems Lab
Wireless, spread-spectrum communications and information theory and coding

Hossein Saiedian

Professor, EECS, Associate Chair Edwards Campus; Computer Systems Design Lab, Information Assurance Lab, Intelligent Systems Lab
Software architecture; software processes, management; agile software development

Sam Shanmugan

AT&T Distinguished Professor, EECS; Communications and Networking Systems Lab
Channel modeling; WCMA over satellite links; communication systems simulation

James Sterbenz

Associate Professor, EECS; Communications and Networking Systems Lab, Computer Systems Design Lab, Information Assurance Lab
Survivable, resilient and disruption tolerant networking; programmable active networks

James Stiles

Associate Professor, EECS; ITTC Associate Director, Radar Systems and Remote Sensing Lab Director
Radar remote sensing and propagation; scattering of electromagnetic waves in random media

Victor Wallace

Professor Emeritus, EECS; Communications and Networking Systems Lab
Interactive graphics; virtual reality and human interface design; distributed and real-time systems; computer network performance modeling ■



ITTC Mission Statement

To advance knowledge and create innovative technologies in information systems, networking and communications, bioinformatics and radar;

To educate and train students for technology leadership;

To transfer knowledge and innovative technologies to Kansas companies and national industries

—by providing an excellent interdisciplinary research and development environment.

Information and Telecommunication Technology Center

2335 Irving Hill Road
Lawrence, KS 66045-7559
Tel: 785.864.7354
Fax: 785.864.0387
info@ittc.ku.edu
www.ittc.ku.edu

Editor: Michelle Ward

Publisher: Laura A. Green

Photographs: Jason Daily, Michelle Ward, Jill Hummels, and Mindy Paget. Additional photographs as cited.



The ITTC Vision

**To be a global leader
and strategic partner
in the creation and
commercialization of
innovative technologies
in telecommunications,
information systems,
bioinformatics, and radar.**



The University of Kansas

2335 Irving Hill Road
Lawrence, KS 66045-7559

Our focus is your future