

# Information and Telecommunication Technology Center (ITTC)

## ANNUAL REPORT FISCAL YEAR 2006

*Decade One of Progress—1996–2006*



## 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 ITTC MISSION

- ▶ **To advance knowledge and create innovative technologies** in telecommunications, information systems, 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.**

*Our Focus is Your Future!*

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The Information and Telecommunication Technology Center (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.

# DIRECTOR'S WELCOME



ITTC Director  
Victor S. Frost

**T**he timeline shown on pages 8 and 9 highlights ITTC's evolution from the formation of its precursor organizations—the Remote Sensing Laboratory (1964), Telecommunications and Information Sciences Laboratory (1983), and Center for Excellence in Computer Aided Systems Engineering (1989)—through the 30th

license issued based on ITTC-developed technology, in 2006.

**ITTC is succeeding** in each component of its mission—research, education, and technology transfer. Our researchers investigate fundamental questions to find solutions that have potential to improve IT technology. Under faculty direction, students conduct research on multidisciplinary projects. Experience at ITTC helps prepare these students to become technology leaders. Pioneering ITTC research often generates innovative technologies, which we transfer to Kansas industry, thus helping to build a stronger, more diverse economy within the State.

**The Center's premiere facilities and resources** attract talented investigators. We have grown from 19 affiliated faculty investigators to 43 as of June 30, 2006. Investigators from aerospace engineering, medicinal chemistry, computer science, computer engineering, education, electrical engineering, geography, and mathematics conduct research at the Center. In fact, 12 new researchers, including 5 who specialize in bioinformatics, have joined ITTC in the last three years. These new researchers invigorate the Center and will help us build upon our first decade of success.

**Federal agencies recognize** the proficiency of ITTC researchers. Defense Advance Research Projects Agency (DARPA), National Aeronautics and Space Agency (NASA), and National Science Foundation (NSF) have invited ITTC-affiliated faculty to become program managers. Such managers ultimately decide which projects in their program are funded, thus helping to shape national investments in research. In fall 2006, **Ron Hui** began directing NSF's Electronics, Photonics and Device Technologies (EPDT) program.

**The combination of first-rate researchers** and facilities has allowed ITTC to blossom. Over the past 10 years, the Center has exceeded \$55 million in research expenditures. The following highlights each prong of our mission.

## Research

**ITTC is conducting research in emerging** technologies. In February, MIT's *Technology Review* released its annual report on ten emerging technologies. Of the ten, ITTC investigators are contributing fundamental research in four—networking, wireless communications, Internet security, and molecular biology. The first three have long been staples of KU research, even predating ITTC. In 1992, DARPA funded the Multidimensional Applications and Gigabit Internet Consortium (MAGIC I) and MAGIC II projects. The government/industry/university consortium would develop Gigabit-per-second, wide-area networks, enabling the organization, movement, visualization, and analysis of massive data from multiple sites. Early testbeds like MAGIC laid the foundation for today's Gigabit-per-second Internet backbone. Our work on MAGIC led to other prominent DARPA projects such as the Global Mobile Information Systems (GloMo) and ACTS ATM Internetwork (AAI). The former developed new wireless communication and computing devices, while ITTC evaluated the control and management of technologies for high-performance networks in AAI.

**Today, we continue leading development** in networking and wireless technologies. Our researchers investigate how to use the radio frequency spectrum more efficiently, as cell phones, Blackberries, television signals, and other devices engulf the spectrum. We are building reprogrammable and dynamically configurable “agile radios” that survey their environment and select the best protocols and frequencies for data transmission. ITTC investigators are making it possible for radar transmissions to share spectrum with communication devices: adaptive receivers will effectively separate the return signals from multiple radars. (Previously, receivers' strict sensitivity requirements have made coexistence impossible.) ITTC's investigators also conduct performance tests on various radio frequency identification (RFID) tags and release objective benchmarks on the technology that is improving supply-chain efficiency and security.

**While diverse applications have been created** to ensure privacy and security on the Internet, predators exploit individuals or sites that offer inadequate protection. ChatTrack, developed at ITTC, provides a permanent record of instant messaging and chat room exchanges that can be reviewed. The software's profile and retrieval mechanisms provide new safety and security tools for parents, the gov-

ernment, and businesses. Additional ITTC projects are integrating networking, security, and other components to improve wireless networks' safety and privacy.

**In recognizing the evolution of technology**, ITTC, itself, has expanded and evolved. In 2003, the Center included the evolving discipline of bioinformatics in its areas of expertise. ITTC researchers are helping molecular biologists and other scientists explore humans' inner workings, including DNA and proteins. Research conducted in ITTC's Bioinformatics and Computational Life-Sciences Laboratory (BCLSL) includes protein misfolding, microarray data analysis, genomes, protein dynamics, data management, and high-performance computing.

### Education

**ITTC students help solve significant**, real-world problems. For example, Self Fellow **Heather Amthauer** is developing computational tools to pinpoint probable locations of genetic regulatory networks. These networks, which can contain hundreds to thousands of genes, will help bioinformatics researchers understand not only normal biological development but also mutations, such as cancer. Another ITTC student, **Jamie Jenshak**, a Department of Defense fellow, is ensuring that radar collects information-rich data. The radar has only a few seconds to capture critical intelligence; the process must be efficient. ITTC researchers and facilities attract talented students who gain experience and knowledge at the Center; after graduation, many become technology leaders.

**Former ITTC students spearhead programs** at companies such as Sprint, Microsoft, and Intel. **Tim Kelley**, an ITTC alum and director at Sprint, continues research collaborations with the Center. **Brian McClendon** worked at TISL, a precursor of ITTC. He was one of the founders of Keyhole Corporation, which Google acquired and renamed Google Earth. We were honored to have Brian visit ITTC in April and give a presentation. Our auditorium could barely contain all of the faculty, staff, and students who wanted to hear Brian. We were not disappointed; it was an excellent talk. Our alumni often send ITTC faculty e-mails about job openings, alerting current students to possible opportunities. Other former students have become colleagues within academia. **Luiz DaSilva** is an associate professor in electrical and computer engineering at Virginia Polytechnic Institute and State University, while **Andrew Williams** serves as an assistant professor in computer and information sciences at Spelman College. **Cory Beard** is an associate professor at the University of Missouri, Kansas City. This cross section of successful alumni highlights the caliber of students who come out of ITTC.

### Technology Transfer

**As the State's IT Center of Excellence**, ITTC works with small Kansas firms, like Lenexa-based Rush Tracking Systems, and global corporations such as Sprint. Rush Tracking Systems and the RFID Journal partnered with ITTC to create the RFID Alliance Lab, which conducts unbiased third-party performance testing of RFID technologies. RFID tags greatly improve supply-chain security and efficiency, in part by allowing goods to be constantly monitored and tracked via the Internet. In addition to creating industry buzz and speaking at national events, ITTC researchers have developed a U.S. patent-pending RFID tag and a new privacy system to protect consumers.

**We profile our relationship with Sprint** on page 39. Our collaborations have generated three U.S. patents and scores of technologies. The ITTC-Sprint alliance illustrates a successful university-industry partnership. ITTC research strives to directly improve Sprint's competitive edge, while sponsored projects help educate the next generation of technology leaders for Sprint.

**ITTC invests in a number of its most promising** technology development projects and prepares them for commercialization. We approve new internal development projects only after a positive review by staff and selected members of our Industry Advisory Board (IAB). These projects must have commercial potential and be in an area of ITTC technical expertise. Such projects have led to the ITTC spin-off companies Veatros and Cadstone, and licensed technologies. By working to promote industry growth, ITTC is helping build the high-tech sector that will diversify the State's economy. This will allow more of our students to stay within the State and continue developing this growing area.

**The Center has planted the seeds** for future bountiful harvests. New faculty and students energize our efforts. The evolution of ITTC laboratories has positioned the Center and its investigators to continue producing cutting-edge research results.



Dr. Victor S. Frost  
Dan F. Servey Distinguished Professor,  
Electrical Engineering and Computer Science  
Director of ITTC



# ITTC OVERVIEW—DECADE ONE OF PROGRESS

As a Kansas Technology Enterprise Corporation (KTEC) Center of Excellence, ITTC has as part of its mission a focus on economic development for Kansas. KTEC funds coming to ITTC directly support IT economic development through technology maturation of KU inventions and technical assistance to companies. ITTC's accomplishments supporting our KTEC and overarching research mission are summarized in the following pages.

ITTC started FY06 with the addition of eight new faculty, who promise to help grow the Center's depth of research and commercialization opportunities. Throughout FY06, ITTC secured \$4.2M in sponsored research. During the same period, ITTC investigators submitted 62 proposals totaling more than \$17.9M in additional proposed research.

Additionally, ITTC continued to work with and support local technology organizations such as Lawrence Technology Association (LTA), the Enterprise Center of Johnson County (ECJC), the Lawrence Regional Technology Center (LRTC), and ITKC (an IT-focus group in Kansas City). ITTC's Kansas City satellite office, located within the Enterprise Center of Johnson County (ECJC), continues to provide a valuable service to the Kansas City area and has helped expand the presence and awareness of ITTC throughout the region. ITTC also continues to interact with a number of local companies, which have included:

- BBN Technologies
- Cadstone, LLC
- E-Learning Creations
- Fundamental Technologies, LLC
- Honeywell
- Nortel Networks
- RFID Journal
- Rush Tracking Systems
- Science Applications International Corp. (SAIC)
- Sprint
- Veatros, LLC

These are only a few examples of the far-reaching strategic partnerships in which ITTC is involved.

ITTC continues to be recognized as a national leader in its areas of expertise, and the Center's technical focus is more economically relevant than ever. According to a recent business magazine article (below), ITTC is working in areas associated

with six (see bold text) of the ten fastest-growing jobs between now and the year 2014.

## ITTC Annual IAB Meeting and Strategic Plan Update

At the ITTC Industry Advisory Board (IAB) meeting on April 7, 2006, the Center's eight newest faculty members introduced themselves and their research programs to the ITTC Board. IAB members learned of investigators' initial successes, including obtaining funding and support for research activities. Our newest faculty did well during their first year at ITTC. EECS Assistant Professors **Shannon Blunt** and **Erik Perrins** obtained external research funding. Blunt, affiliated with ITTC's Radar Systems and Remote Sensing Lab (RSL), is developing ways in which multiple radars can operate cooperatively with one another in the same spectrum. Perrins, an investigator with the Center's Communications and Networking Systems Lab (CNSL), is collaborating with researchers from the KU Natural History Museum and Biodiversity Research Center. They are developing ways to transport and then store data from the field, to assist in monitoring environmental change on the Central Plains. Blunt and **Weichao Wang**, an investigator in the CNSL and assistant professor of EECS, aided **Dan Deavours**, ITTC assistant research professor, in developing new security concepts for RFID tags and readers. **Alex Wyglinski**, ITTC assistant research professor, served as a guest editor for an *IEEE Communications Magazine* special issue on cognitive radio technology and dynamic spectrum access networks.

ITTC's strong growth and development were discussed at the meeting, and the Center's five-year Strategic Plan was presented to the IAB. Board members discussed the Center's revised Plan, helping refine ITTC's mission and vision statements. The Board provided additional perspectives on trends and potential opportunities for ITTC. The comments from the ITTC IAB were factored into the final version of the Strategic Plan.

The revised Strategic Plan refocuses our endeavors as related to current technology, funding, and commercialization trends.

**The 10 fastest-growing jobs:** Despite its recent woes, tech remains the fastest-growing sector for jobs. By Owen Thomas, *Business 2.0 Magazine* online editor, and Rob Kelley, *CNNMoney.com* staff writer, May 3, 2006:

**SAN FRANCISCO (*Business 2.0 Magazine*):** If you're looking for a job that's here to stay, here's a counterintuitive piece of advice: Look into tech. It's one of several sectors on our list that is slated to see the sharpest job growth between now and 2014... **We identify ten occupations that are projected to see double-digit growth between now and 2014:**

1. **Network systems and data communications analyst**
2. Physician assistant
3. **Computer software engineer, applications**
4. **Computer software engineer, systems software**
5. **Network and computer systems administrator**
6. **Database administrator**
7. Physical therapist
8. Medical scientist
9. Occupational therapist
10. **College instructor**

As laid out in the Strategic Plan, ITTC's growth is constrained by the number of our principal investigators (PIs). In FY06 ITTC added six tenure-track and one research professor as investigators. We expect to add two additional faculty investigators in FY07.

In addition, ITTC has refined its technical thrust areas, and the initial work of reorganizing the Center's laboratories is complete. With these new and refocused laboratories, ITTC is well positioned to face the challenges of the current research environment and pursue new research opportunities.

As it traditionally does, the IAB meeting day ended with the student poster session, which was the largest to date. Thirty-eight posters filled the lobby and balcony of the second floor, with new faculty serving as principal investigators on nine projects. The session gave IAB members an opportunity to meet new faculty and students.

## Ongoing Key Projects

### SensorNet

ITTC has been working with Oak Ridge National Laboratories (ORNL) in developing a comprehensive sensor management system. The Department of Energy's largest science and energy laboratory is directing the creation of a nation-wide sensor network that will identify and assess chemical, biological, radiological, nuclear, and explosive (CBRNE) threats. SensorNet will process and disseminate critical information to emergency management decision makers and first responders.

Principal investigator **Gary Minden**, director of ITTC's Communications and Networking Systems Laboratory (CNSL), and his team are developing a sensor network that can be rapidly deployed with elements that are controlled by different organizations.

ITTC researchers are studying low-cost sensor nodes in addition to the wireless interconnected network and the overall service architecture. These nodes—tiny, ubiquitous, networked sensors—possess data processors allowing them to perform simple computations, such as chemical detection and video transmission. The partially processed data can be sent on for additional analysis.

### Electronic Bioinformatics Computational Journal

Traditional laboratory notebooks are critical to the discovery process, establishing a permanent and legal research record. Using these notebooks as guides, ITTC researchers are developing software to electronically manage the vast amounts of bioinformatics data being generated through research. The "Bioinformatics Computational Journal" transforms the processing, collection, organization and storage of information. The "journal" makes reproduction of computational experiments easier and enables collaboration among researchers who are geographically separated.

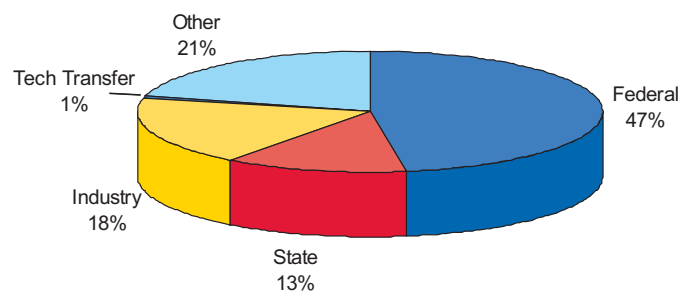
Electronic documentation allows flexible searching of data collected in one's own journal(s) as well as those of other researchers who have permitted access. The journal will aid in collaboration and offer new approaches to analyzing results. If scientists wish to isolate specific data, the journal allows them to easily reorder or exclude information. This tool also organizes and presents large collections of data and relationships among them. Researchers can easily integrate facts and figures into their journals or save downloaded data. The journal time-stamps and houses all generated research, ensuring authenticity and safe storage. The journal enables cross-disciplinary biological studies. The journal's creation is an important milestone in ITTC's "Development of an Integrated Bioinformatics Information Infrastructure" project.

### Waveform Diverse Sensors Project

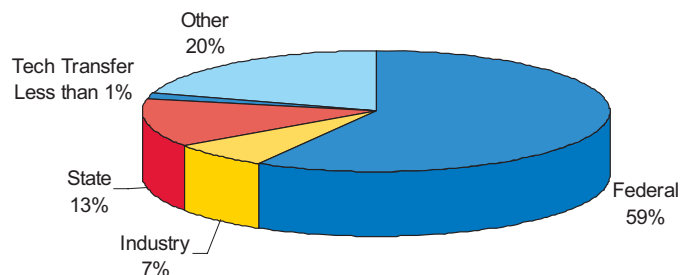
With cell phones, personal digital assistants (PDAs), and other wireless devices devouring the radio frequency (RF) spectrum, the available spectrum for radar is steadily diminishing.

**Shannon Blunt**, assistant professor of EECS, is developing techniques to enable radars to share spectrum, which they traditionally have been unable to do because of strict sensitivity requirements. When sharing spectrum with other radars (and/or possibly communications systems as well), a radar suffers from interference that limits its sensitivity. However, the potential benefit of spectrum-sharing radar is that additional information can be acquired from the environment without the requirement of addi-

ITTC R/D&C Income by Source, FY2006



ITTC R/D&C Expenditures by Income Source, FY2006



tional bandwidth, thus enabling substantial improvements in surveillance capabilities.

Blunt obtained funding for his Waveform Diverse Sensors project from the Office of Naval Research in FY2006. According to Blunt, the purpose of the project is to develop ways in which multiple radars can operate cooperatively with one another in the same spectrum. He is using adaptive receivers to effectively separate the return signals. Blunt, who is affiliated with ITTC's Radar Systems and Remote Sensing Laboratory (RSL), is also investigating how these radar signals interact with communication signals to determine if they can cohabitate spectrum.

Blunt's research has a defense objective, as available spectrum is rapidly diminishing in littoral environments (i.e., coastal regions) where civilian applications such as cellular communications, television, etc., already occupy a considerable portion of the spectrum. To provide homeland defense in these regions, a greater spectral efficiency is needed for defense radar systems. This work is one component of a much larger Department of Defense vision to fully utilize the RF spectrum, says Blunt.

### KU CiteSeer Web Site

Collaborative work on a National Science Foundation (NSF) project led at ITTC by **Susan Gauch**, professor of EECS and director of ITTC's Intelligent Systems Lab (ISL), duplicates the Scientific Literature Digital Library (CiteSeer). The mirror Web site, <http://citeseer.ittc.ku.edu/>, allows ITTC investigators to examine user behavior on a smaller scale. Research will lead to personalized recommendations and searches among the library's 700,000 articles. As part of the Next Generation CiteSeer project, ITTC is helping transform the digital library into a "research assistant."

### Understanding and Forecasting Ecological Change

The ecologically complex Kansas grasslands are serving as a laboratory for assessing and forecasting changes in biodiversity and ecological systems. Biological diversity and ecological processes vary locally and regionally with climate, soils, topography, natural disturbances, and land management. By deploying multiple study sites within rural and urban settings, researchers will gather critical data on the human impact of environmental change. Specifically, the goal is to assess the interactions and reciprocal impacts of socio-economic, biological, and physical factors.

**Leonard Krishtalka**, director of KU Natural History Museum and Biodiversity Research Center, leads the "Understanding and Forecasting Ecological Change: Causes, Trajectories and Consequences of Environmental Change in the Central Plains" project. The National Science Foundation and the Kansas Technology Enterprise Corporation (KTEC) are sponsoring the project, which began in spring 2005. **Erik Perrins**, assistant professor of EECS, and **Victor Frost** serve as investigators. ITTC researchers are developing the required communications infrastructure for this effort.

### Computational Prediction of Beta-Sheet Arrangement

Researchers have linked many neurodegenerative diseases—including Alzheimer's, Parkinson's, Huntington's, and mad cow—to protein "misfolding." Misfolded proteins form aggregates in the cerebral tissue that result in brain cell damage and ultimately death. ITTC Research Assistant Professor **Jianwen Fang's** "Computational Prediction of Beta-Sheet Arrangement" project is developing computer-based technology to aid in the understanding of protein misfolding. While scientists have identified this phenomenon as an important trigger to the onset of neurodegenerative illnesses, they do not understand what activates the conformation transformation. While proteins have hundreds of millions of potential folds, they most often find the correct three-dimensional fold within minutes. But when proteins misfold, they quickly begin converting healthy ones. Fang is developing new computational models to predict the likelihood of the existence of two adjacent  $\beta$ -strands in a  $\beta$ -sheet. Beta sheets are one of the secondary structures that involve long-range interactions within proteins. Fang is developing "smart" tools that will delineate strand arrangement and protein maturation. The long-term objective of the project is a better understanding of inter- and intra-molecular long-range interactions. Greater knowledge of the body's inner workings could provide possible solutions to prevent misfolding of proteins as well as better prediction of 3-D structures of proteins. The Kansas Network of Biomedical Research Excellence (K-INBRE) is funding the ITTC project. The University of Kansas Medical Center leads this multi-institution effort to link scientific partners throughout Kansas and to strengthen biomedical research and the training of researchers within this field. Fang received a pilot grant, which supports a new project in Cell and Developmental Biology. He will use the data to compete for National Institutes of Health (NIH) funds. Fang joined ITTC's Bioinformatics and Computational Life-Sciences Laboratory (BCLSL) in spring of 2005. He holds joint positions, as he continues as a bioinformatics specialist in KU's Bioinformatics Core Facility. His research develops computational methods to analyze data and speed up drug development.

### Outreach Activities

#### KU in the Capitol Day Showcases Service to Kansas

**Michelle Ward**, ITTC's public relations and marketing coordinator, attended KU in the Capitol Day in March 2006. This annual event, which takes place in the Kansas Statehouse and highlights how KU serves Kansas, allows ITTC staff to meet various legislators, state employees, students, and other participants.



## Technology Commercialization

### The RFID Alliance Lab

RFID Alliance Lab researchers went to the RFID Live! conference in Las Vegas this year. At the conference, **Dan Deavours**, ITTC research assistant professor and RFID Alliance Lab director, conducted eight demonstrations on the exhibition floor, gave six talks, led a break-out session, manned a booth for the RFID Alliance Lab, and met with various industry leaders during the three-day conference in May. The event, attended by more than 2,000 people, showcased radio frequency identification (RFID) technology.

Deavours began his conference duties by unveiling ITTC's solution to an alarming, ongoing problem with RFID technology privacy. As *Consumer Reports* documented in its June issue, the RFID industry does not have the safeguards in place to protect consumers' privacy. ITTC researchers have developed a two-layered solution. Deavours says the one-two punch of cryptography and low probability of intercept signaling makes it extremely difficult for information thieves to cull personal information. ITTC Investigators **Shannon Blunt**, Deavours, and **Weichao Wang** collaborated to develop the sound technical, robust approach. The ITTC solution is simpler than current privacy models and enables greater power use, which will allow tags and readers to communicate from longer distances, in addition to the increase in privacy and security.

During the conference, **Keith Braman**, ITTC's associate director for applied technology, and Deavours met with industry leaders about licensing KU-Tag technology. Prior to the KU-Tag (also known as "Adamas-1"; see page 20), RFID communication was stymied when a tag was placed on metal or near liquid. Deavours created the KU-Tag to solve the metal/liquid problem. It currently is the best-performing, least costly, and thinnest tag with this capability. The KU tag technology was very well received at the conference. Braman established more than 35 contacts interested in further discussing commercialization of the technology. Also, Braman and graduate student **Madhuri Eunni** manned the RFID Alliance Lab booth, answering questions and providing additional information on sponsored research and performance reports. Deavours' involvement in RFID Live! provides greater visibility for ITTC and the University while underscoring the Center's leadership in this emerging field.

In Fall 2005, Deavours and his team completed work with Honeywell FMT involving the viability of placing commodity UHF RFID tags on cell phones, and delivered a report detailing the results, including hundreds of thousands of detailed measurements. Excerpts from the work appeared in print in the trade magazine *RFID Journal*.

### Working with Kansas Companies

Understanding genetic differences may one day lead to healthier dogs and cats. An animal food manufacturer in Kansas is exam-

ining how foods and medicines impact animals' inner workings. To quickly identify differences in tens of thousands of genes, the pet science research pioneer turned to ITTC.

The rapid analysis of genetic data required ITTC to combine its bioinformatics software expertise and a cluster of powerful computers. The system drastically reduces turnaround time, from about two weeks to less than day. ITTC's software running on the cluster allows researchers to fragment computations along with the data and perform the calculations in parallel, in this case using 256 processors. Conventional personal computers execute calculations serially, which makes them inefficient for conducting compute- and data-intensive research tasks.

By deciphering the differences in DNA sequences, scientists may have the potential to reveal how genes, basic units of heredity encoded in DNA, contribute to health and disease.

### eLearning Creations

eLearning Creations has licensed a number of KU technologies related to online learning and evaluation. The company was interested in scaling issues of the evaluation technologies. ITTC conducted performance benchmark testing that allowed them to design a business-appropriate architecture capable of supporting the scale of operation they needed to be successful.

### iBridge™

KU's Office of Technology Transfer and Intellectual Property and ITTC have put into place a Web-based platform designed to facilitate the licensing and sharing of technology discoveries from university laboratories. The iBridge™ application serves as a clearinghouse for university innovation and provides an additional channel through which researchers can disseminate university-developed innovations, research methods, and findings (<http://innovationbridge.org/ku>). iBridge™ is a program of the Kauffman Innovation Network—an initiative created by the Ewing Marion Kauffman Foundation to advance innovations through education about best practices, research, and fellowships.

### Internal Commercialization Projects

Each year, ITTC solicits proposals for technology development projects from the University community and invests in a number of the most promising among them, targeting them for commercialization. The Center approves new internal technology development projects only after a positive review by staff and Industry Advisory Board (IAB) members. These projects must have commercial potential and must be in areas of ITTC's technical expertise. In the past, such projects have led to spinoff companies and licensed technologies and have advanced the Center's knowledge base, which is then applied to support other commercialization opportunities and Kansas companies. A number of these projects have matured to the point of commercialization and are being shown to our industry partners.



Through the year we have focused much of our efforts on maturing a number of technologies that we expect to be ready to transfer to our commercial partners early in calendar year 2007.

Below is a partial list of ITTC's internal commercialization project activity during FY 2006.

**Metal-Mount UHF RFID Tag:** ITTC's internal efforts have led to a new RFID tag technology that works on metal objects and objects containing liquids. ITTC is currently pursuing commercial opportunities related to this new RFID tag technology that may lead to a start-up company.

**Algorithm Development for Microarray and Mass-Spectrometer Data Analysis:** Based upon our success, we believe that this method can be used as a successful biomarker detection tool for early cancer diagnosis. Initial results, focusing upon the prediction of ovarian cancer, have proven to be very promising. A prior-art search of relevant references has been completed with favorable results.

**Intelligent AutoFill Form for XML:** This project developed a technology, SmartXAutofill, which is an intelligent data entry assistant for predicting and automating inputs for data entry process based on the contents of historical document collections in the same document domain.

**Miniature Optical Fiber Bragg Grating Sensor Interrogator:** We are developing a miniature interrogator for fiber Bragg grating (FBG)-based optical sensors and sensor arrays. Novel photonic sensors and their interrogators are technology driven. They are especially suitable for small businesses because of their flexibility in terms of design and application.

**Abstract Interpretation of Rosetta Specifications:** The goal of this effort is to develop a prototype abstract interpretation framework for system specifications. Our target domain will be electronic design automation (EDA) for embedded systems. The commercial possibilities for this work are quite high given the interest in Rosetta and systems-level modeling in the EDA industry. Tools and techniques developed by ITTC researchers are being commercialized through Cadstone, LLC, a local company specializing in systems-level design.

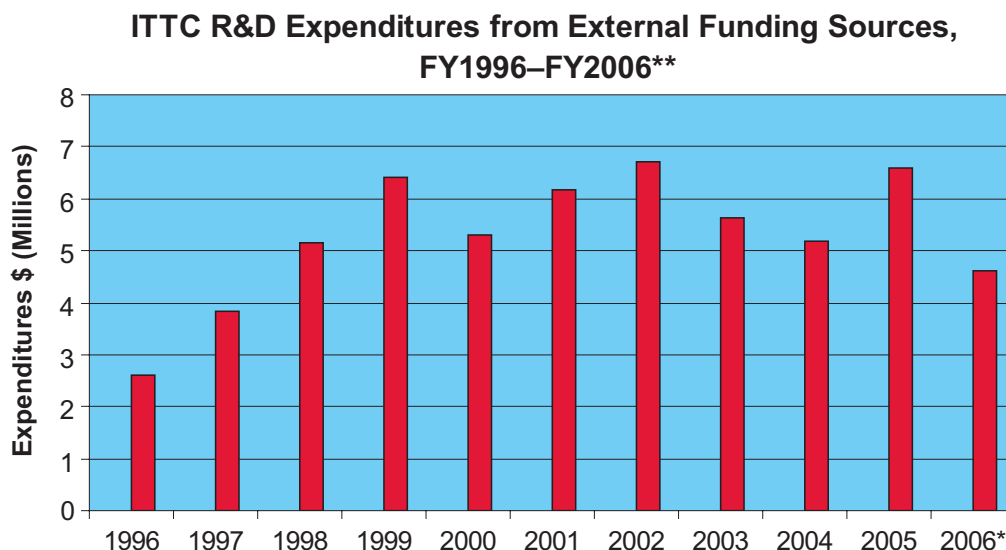
## Patents Filed/Issued

### Filed:

1. "Automated Data Entry System"; Utility; 8/29/2005; pending.
2. "Radio Frequency Identification (RFID) Antenna Techniques"; provisional, 12/14/2005; pending.
3. "Multi-Resonant Planar Microstrip Antenna Array for RFID Tags"; provisional, 4/11/2006; pending.
4. "Wavelength-Tunable Femtosecond Laser Source for Two-Photon Biological Imaging and Correlated Antistocks Raman Spectroscopy"; provisional, 3/16/2006; pending.
5. "System and Method for Low SINR Backscatter Communications"; provisional, 5/17/2006; pending.
6. "Methods for Analyzing Data"; provisional, 5/22/2006; pending.
7. "Simplified Coherent Detection Scheme for FM Chirped Laser Radar (Science and Technology Center)"; provisional, 6/23/2006; pending.

### Issued:

1. "Optical Systems with Diversity Detection"; 6,999,688 B1; 2/14/2006.

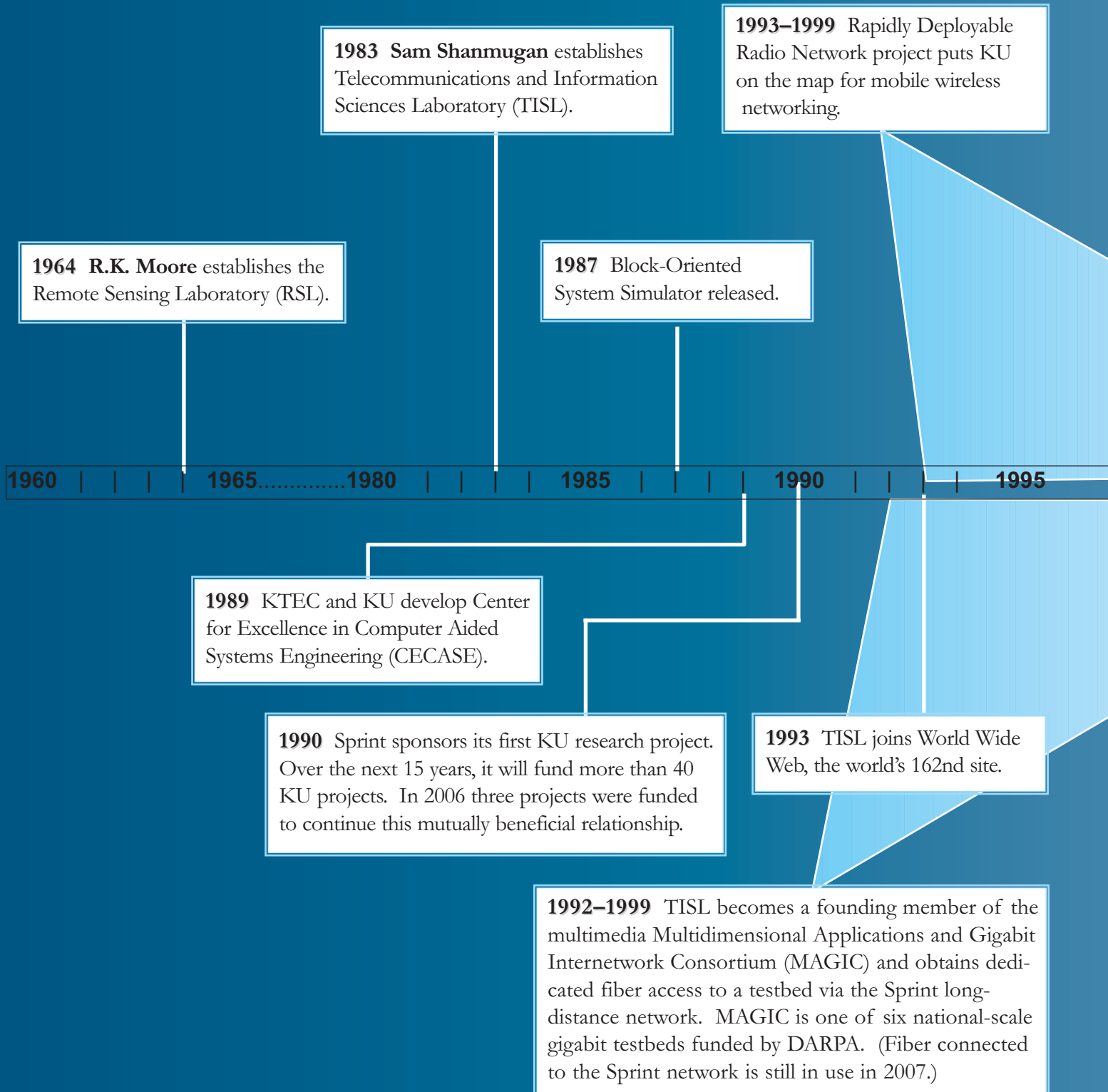


\*In FY2006, the NSF Center for Remote Sensing of Ice Sheets (CReSIS) was established and associated activities transitioned out of ITTC.

\*\*Total expenditures from all funding sources for FY2006: \$5,293,967.

# ITTC HISTORICAL TIMELINE

**Prior to the founding of ITTC in 1996 ...**



# 1996, the founding of ITTC, and thereafter...

**1996** TISL and CECASE merge to form the **Information and Telecommunication Technology Center (ITTC)**.

**2001–2005** NSF, NASA, and KTEC fund the large information technology research (ITR) project, “Polar Radar for Ice Sheet Measurements,” at ITTC’s RSL.

**2001** ITTC receives its 10th U.S. Patent.

**2006** ITTC expands computing and storage capability by completing installation of a 384 CPU cluster and more than 30 TB of storage.

**2006** Eighty-seven companies have sponsored 170+ ITTC projects.

1996 Lightwave Lab Established

1998 RSL Joins ITTC

2001 e-Learning Design Lab Established

2002 ITTC Graduate Fellowship Established

2003 CSDL, BCLSL Established

2004 RFID Alliance Lab Established

1996

2000

2005

**1997** *PC Magazine* names ITTC-developed technology, ProFusion, best metasearch engine.

2000 Founder of LTA

2002 Helps Est. ITC

**2004** ITTC hosts its eighth symposium/workshop.

**2006** ITTC IT research expenditures to date total more than \$55 million.

**1999** NSF- and DARPA-sponsored Ambient Computational Environments project creates “smart rooms.”

**2001** ITTC spins out its first company, Veatros.

**2002** ITTC’s annual research expenditures exceed \$7 million.

**2002** Total ITTC royalty and licensing income to KU exceeds \$1 million.

**2003** ITTC commercializes its 35th technology in Kansas.

**2006** ITTC research results in the Center’s 30th technology license to industry.

# ITTC INDUSTRY ADVISORY BOARD



Pictured here along with two ITTC executive staff members are 13 of the 16 IAB members who attended the IAB meeting of April 7, 2006:

Back row, left to right and up the stairs: **Stephen Schneider, Tim Johnson, Jerry White, Marc Epard, Phil Anderson, Kevin Carr.**

Middle row from far left: **Ben Vos, Bob LaGarde, Susan Norris, Victor Frost, John Hansen.**

Right row, from front right, up the stairs: **Jim Roberts, Brian Ruf, Jeffrey Fuller, Matt McClorey.**

ITTC's Industry Advisory Board (IAB) members were especially helpful with their advice during FY2006 as the Center drew up its Strategic Plan for the next five years. IAB members are drawn from businesses large and small and from KU departments dealing in research and technologies related to ITTC's focuses. IAB members during FY2006 were as follows:

**Gary Alexander**, Alexander Open Systems, Overland Park, Kan.

**Phil Anderson**, D.Eng., Ameriprise Financial Services, Inc., Lawrence, Kan.

**James Baxendale**, KU Center for Research, Inc., Lawrence, Kan.

**Gerard J. Canavan**, CCT, Inc., Englewood, Colo.

**Kevin Carr**, Kansas Technology Enterprise Corp., Topeka, Kan.

**Steve Chaddick**, Ciena Corp., Linthicum Heights, Md.

**Jim Dahmen**, Columbus Telephone Co., Inc., Columbus, Kan.

**William P. Duncan**, Ph.D., Kansas City Area Life Sciences Institute, Kansas City, Mo.

**Marc Epard**, Netopia, Inc., Lawrence, Kan.

**Jeffrey G. Fuller**, Honeywell FM&T/KCP, Kansas City, Mo.

**Marshall Greenspan**, Ph.D., Northrop Grumman Corp. Electronic Systems, Norwalk, Conn.

**Bennett Griffin**, Griffin Technologies, Lawrence, Kan.

**John Hansen**, Cerner Corp., Kansas City, Mo.

**James Isaacs**, Ph.D., ITT Aerospace/Optical Div., Ft. Wayne, Ind.

**Bob LaGarde**, LaGarde Inc., Olathe, Kan.

**John Louis**, University of Kansas, Lawrence, Kan.

**Tom Lyon**, Lyon About, LLC, Palo Alto, Calif.

**Gary Mastin**, Ph.D., Lockheed Martin Integrated Systems & Solutions, Litchfield Park, Ariz.

**Matt McClorey**, Lawrence Regional Technology Center, Lawrence, Kan.

**Mazen Mikha**, Boeing Co., Wichita, Kan.

**Wayne E. Morgan**, Ph.D., Netchemia, Lenexa, Kan.

**Arcady Mushegian**, Ph.D., Stowers Institute, Kansas City, Mo.

**David Nicol**, Ph.D., Solutionary, Overland Park, Kan.

**Susan Norris**, Norport Technology Management Consulting, Lenexa, Kan.

**Stan Pierson**, Aeroflex Test Solutions, Wichita, Kan.

**James Roberts**, Ph.D., KU Center for Research, Inc., Lawrence, Kan.

**Brian Ruf**, Ruf Strategic Solutions, Olathe, Kan.

**Toby Rush**, Rush Tracking Systems, Lenexa, Kan.

**Stephen Schneider**, Sunflower Broadband, Lawrence, Kan.

**Michael F. Sobek**, StoreFinancial, Overland Park, Kan.

**Deborah R. Stokes**, Nortel Networks, Richardson, Texas

**John Strand**, Axis Solutions, Leavenworth, Kan.

**Kathy Suprenant**, Ph.D., University of Kansas, Lawrence, Kan.

**Ben Vos**, Sprint, Overland Park, Kan.

**Gerald J. White**, EDS, Overland Park, Kan.

**George Wilson**, Ph.D., KU Center for Research, Inc., Lawrence, Kan.



# LABS OVERVIEW

ITTC works to create fundamental knowledge and technologies in computing, communications, sensors, and bioinformatics. Researchers from diverse areas give the Center its breadth of activity. As of June 30, 2006, more than 121 graduate and 14 undergraduate students were gaining hands-on experience under the direction of 44\* ITTC-affiliated faculty and staff researchers. The Center is educating the next generation of technology leaders as it focuses not only on solutions to today's complex problems but also on the technological needs of tomorrow. ITTC research is categorized under the following six research laboratories:

- Bioinformatics and Computational Life-Sciences Lab (BCLSL)
- Communications and Networking Systems Lab (CNSL)
- Computer Systems Design Lab (CSDL)
- e-Learning Design Lab (eDL)
- Intelligent Systems Lab (ISL)
- Radar Systems and Remote Sensing Lab (RSL)

The Center houses state-of-the-art facilities, including a high-speed networking lab with a fiber connection to a long-distance network. Researchers work in a digital radio laboratory that provides design and fabrication capabilities along with digital signal processing. The Center possesses an integrated, diverse networking environment and a leading-edge photonics research laboratory. Comple-

menting the hardware facilities, the Center uses some of the best-in-class design, software-development, and bioinformatics tools.

ITTC's computing cluster (new in FY2005), made up of 384 processors with 32 terabytes of storage, permits researchers to fragment computations and perform them in parallel. Such division of labor permits the analysis of genomes with billions of nucleotides, and other data-intensive computations. The multiple machines housed in one location on a high-speed network make the ITTC computing cluster a powerful, integrated platform for researchers.

The Center places great emphasis on realizing the commercial potential of the technologies and expertise developed in its laboratories. As a KTEC Center of Excellence, ITTC has transferred numerous technologies to companies, and it supports companies in their technology development efforts. For example, researchers in ITTC's Communications and Networking Systems Laboratory (CNSL) teamed with Rush Tracking Systems, a Lenexa, Kan.-based firm, and RFID Journal, of Melville, N.Y., to provide objective benchmarking reports on radio frequency identification (RFID) technology. The Center has spun out additional technologies to create start-up companies and continues its successful development of internally funded commercialization efforts. To date, 16 U.S. patents have been granted as a result of ITTC research.

\*Includes 43 faculty principal investigators and 1 staff PI.

**Dan DePardo**, ITTC RF electronics engineer, works on a field-programmable gate array (FPGA) board in ITTC's Communications and Networking Systems Laboratory (CNSL). ITTC faculty, staff, and student researchers develop technologies that foster industry growth and often provide the core for new companies. For example, DePardo recently received a U.S. patent for his HDTV antenna, which offers performance superior to that of conventional TV antennas. The Center is now looking to license the ITTC-developed technology.



# LAB DETAILS

## Bioinformatics and Computational Life-Sciences Lab (BCLSL)

Lab Director (Interim): Victor Frost



The Bioinformatics and Computational Life-Sciences Laboratory (BCLSL) advances methods and tools geared to biological, biochemical, and medical applications. BCLSL investigators work with collaborators in the life sciences to identify, research, develop, and apply key computational approaches. These efforts directly involve the biological and medical domains in areas of modeling, analysis, and data management. In addition, concomitant research in traditional computational methods such as algorithm optimization, data- and compute-intensive methodologies, and statistical methods are pursued to meet the specialized needs of these problem domains. This interdisciplinary work in applied and basic research involves investigators from computer science, electrical engineering, mathematics, and life-science and medical disciplines.

### Lab resources:

In addition to extensive software architecture including applications widely used in the public domain, the BCLSL provides:

Artificial intelligence development tools and languages  
Massively parallel computer clusters, large-memory-capacity computer, terabyte storage systems, reconfigurable floating-point gate arrays  
Databases and data-management systems for genomics data (GUS) and microarray data

Laboratory-data retrieval and management infrastructure  
Parallel development tools including MPI, High Performance Fortran, and Pfortran compilers  
Parallel molecular dynamics programs  
Parallel BLAST Web server for sequence alignment

## Communications and Networking Systems Lab (CNSL)

Lab Director: Gary Minden



The Communications and Networking Systems Laboratory (CNSL) advances knowledge of systems interconnected via radio and other technologies, as well as increasing the performance and protection of Internet-based systems. CNSL also seeks to develop technologies to deliver reliable information to support end-user applications independent of the access technology.

### Lab resources:

DSP rapid prototyping system  
Logic analyzers  
Network analyzers  
Spectrum analyzers  
Oscilloscopes and function generators  
Prototype PC board fabrication tools and facility  
RF signal generators  
Variety of DSP platforms and evaluation tools  
Extensive high-speed networking infrastructure: connected to high-speed, wide-area networks; fiber connection to the Sprint backbone network; cable connection to Sunflower Broadband's cable modem and TV network; Internet2; wide variety of routers, switches, and network interfaces  
Extensive wireless LAN (Wi-Fi) networks

30 km of fiber installed for systems-level testing  
Tunable laser sources and optical filters  
Electro-optic modulators, WDM multiplexers, demultiplexers  
High-speed photodetectors to 40Gb/s  
Commercial WDM systems at OC192 and OC48 data rates  
40Gb/s and 12Gb/s BERTs  
RFID performance benchmarking facilities  
Bluetooth evaluation facilities  
High-speed workstations  
Hardware and software design experience: developed network testing and measurement tools, network simulation and modeling tools, Web applications and servers, and integrated wireless mobile systems with fixed networks; designed and implemented a software-defined radio

## Computer Systems Design Lab (CSDL)

Lab Director: W. Perry Alexander



The Computer Systems Design Laboratory (CSDL) focuses on the design, implementation, and verification of systems whose primary components include computers. CSDL research addresses the design of computing systems ranging from small embedded elements to large distributed computing environments covering all aspects of the system lifecycle from requirements analysis through testing and validation.

### Lab resources:

#### Equipment:

Xilinx FPGA prototyping systems, reconfigurable distributed computing cluster, wireless radio testbed

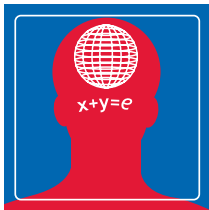
#### Hardware and software design experience:

Rosetta system-level specification language and analysis

tools; KU Real Time (KURT) Linux; hybrid threads; reconfigurable computing platforms; real-time, secure, embedded systems; protocols for ad hoc sensor networks; agile software radios

## e-Learning Design Lab (eDL)

Lab Directors: James Miller, Ed Meyen



The e-Learning Design Laboratory (eDL) responds to the emerging challenges and opportunities in e-learning. eDL studies and develops new learning environments and tools for students of all ages, with a focus on postsecondary and professional development. Particular attention is given to learners with diverse backgrounds whose attributes warrant consideration in the development of e-learning tools, instruction, and environments. This includes the study, development, and research of new designs, principles, practices, and policies.

### Lab resources:

#### Module creation tools

e-Learning instructional design

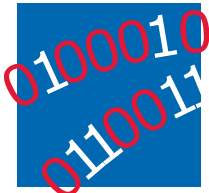
Authoring tools

#### Online assessment tools

e-Learning evaluation tools

## Intelligent Systems Lab (ISL)

Lab Director: Susan Gauch\*



The Intelligent Systems Laboratory (ISL) advances knowledge in artificial intelligence, intelligent agents, information retrieval, data mining, and robotics. ISL is customizing IT services, creating smarter and user-friendlier environments and devices.

### Lab resources:

#### Multiagent development tools:

ACCS, C++, CORBA, Java

#### Information retrieval and Web tools:

KUIR Information Retrieval Library, Php, XMLSpy,

MySQL, Perl

#### Data Mining Tools:

SNOB, Cobweb, ID3, C4.5, statistical analysis packages

#### Artificial intelligence development tools and languages:

Lisp, CLOS, CLIPS, Prolog, GBB, OPS, MEM-1

#### Image processing and computer vision tools:

KUIM image processing library, high-speed video, and data cable/fiber link

#### Human-intelligent system interaction tools:

Mobile robots, VR user interface, head-mounted display, force feedback joysticks

PeopleBot, two Nomad Scouts, three Kheperas, one Pioneer robot

Software packages for virtual prototyping, kinematics modeling, and dynamics modeling (such as VisualNastran 4D and Working Model)

\*ISL Lab Director after August 13, 2007: Arvin Agah.

## Radar Systems and Remote Sensing Lab (RSL)

Lab Director: James Stiles



The Radar Systems and Remote Sensing Laboratory (RSL) conducts research in radar and other electromagnetic sensing problems, including advanced system concepts, radar image formation, adaptive radar signal processing, and radar simulation.

### Lab resources:

50 GHz microwave network analyzer

40 GHz digital oscilloscope

Logic analyzers

Network analyzers

Spectrum analyzers, oscilloscopes, and function generators

Prototype PC board fabrication tools and facility

RF signal generators

Automated ground penetrating radar (GPR) test facility

Outdoor antenna test facility

# RECENT STUDENT SUCCESSSES



Ph.D. student **Daniel Fokum** works on the wireless networking portion of the federal SensorNet project. Oak Ridge National Laboratories (ORNL), the Department of Energy's largest science and energy laboratory, is directing the creation of a nation-

wide sensor management system. SensorNet will identify and assess chemical, biological, radiological, nuclear, and explosive (CBRNE) threats. Quicker dissemination of critical information will better arm emergency management decision makers and first responders.

Under the direction of **Gary Minden**, director of ITTC's Communications and Networking Systems Laboratory (CNSL), Daniel is writing programs that will

integrate personal digital assistants (PDAs) into SensorNet. He is also working on setting up wireless networking equipment to facilitate the communication between PDAs and the rest of SensorNet.

Daniel is a native of the West African nation Cameroon. He graduated from Park University in 2000 with an undergraduate degree in computer science and a minor in mathematics. Following his graduation, he worked with Truman Medical Centers in Kansas City. His primary responsibility was to write queries that were run against the hospital's databases. In 2001, he enrolled part time at the University of Missouri-Kansas City. He graduated in 2005 with a master's degree in computer science, with an emphasis in network architecture and a secondary concentration in telecommunications.



**Jamie Jenshak** has received a Department of Defense (DoD) fellowship. The DoD's Science, Mathematics and Research for Transformation (SMART) award supports the education and training of students who conduct research critical to the

nation's defense. The appointment pays full tuition and fees and an annual salary. Jenshak is one of 32 scholars nationwide to earn the fellowship in 2006.

Jenshak is currently doing research in the area of radar signal processing. The aim of the research is use of infor-

mation-theoretic quantities to maximize the information richness of data collected by the radar system.

Jenshak says he was impressed by the large class selection and research opportunities at KU/ ITTC. He came for a campus visit after being invited by **Jim Stiles**, director of ITTC's Radar Systems and Remote Sensing Laboratory and professor of EECS.

The new DoD fellow received his master's degree from University of Missouri-Rolla and an undergraduate degree from Bradley University in Peoria, Ill., both in electrical engineering.





As a senior software engineer for the Cerner Corporation, **Russell Webb** developed important tracking and monitoring systems for improved patient care. He is continuing this line of research, using technology to advance health care, in his

postgraduate studies in EECS. The first year doctoral student has been awarded the ITTC Graduate and KU Madison and Lila Self Graduate Fellowships.

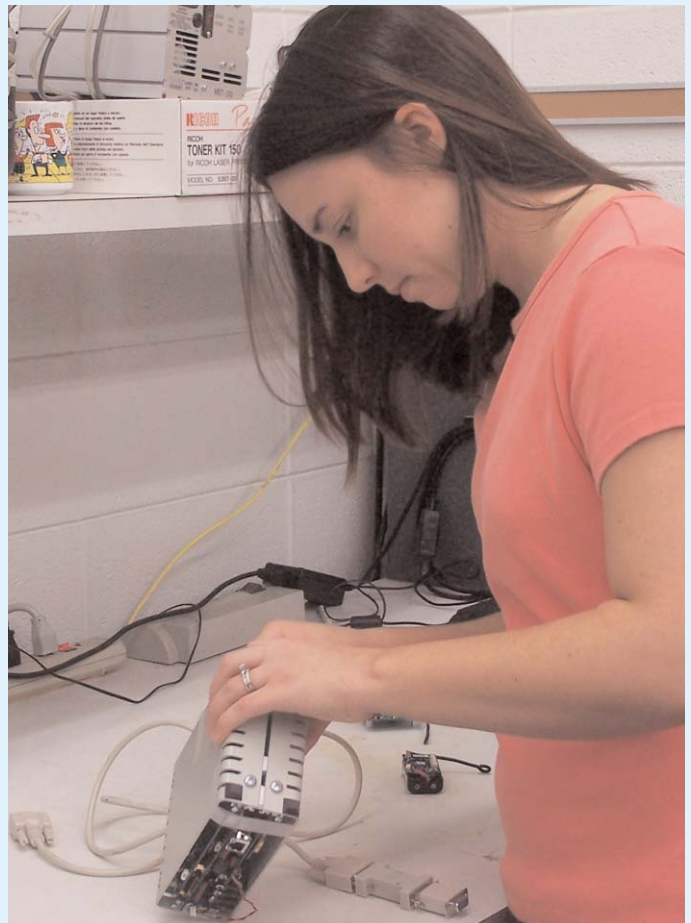
Webb says technology could greatly improve patient care and streamline the health care industry. The paper-based records' system does not allow an efficient exchange of information between various medical personnel and patients. For example, timely access to medical histories may not be available, or handwritten chart orders may be misunderstood. According to the federal government, as much as \$300 billion is spent annually on unnecessary, inappropriate, inefficient, or ineffective health care.

The application of intelligent systems to medical problems could save lives and money. Webb is interested in robotics, specifically how they can aid in rehabilitation or in surgery. He is also examining the creation of a system of metrics that would grade hospitals and doctors based upon clinical data. The "quality of care" assessment would help potential patients choose the best medical personnel and facilities for them.

Both the ITTC Graduate and Self fellowships help recruit highly qualified students. The ITTC honor, which is awarded for two years, includes yearly funding of \$2,500. The four-year Self Graduate Fellowship consists of an annual \$23,000 stipend, full tuition and fees, and a development program.

Webb received his undergraduate degree in computer engineering, graduating with departmental honors, from KU in 2001.

**Megan Peck**, a KU EECS graduate student, works on an agile radio in ITTC's Communications and Networking Systems Lab (CNSL). Her research focuses on writing the radio processing component in VHDL for the KU Agile Radio project, and developing various design tools. The Agile Radio project, which permits dynamic spectrum management, is headed by **Gary Minden**, who also directs the CNSL. The KU radio enables a plethora of wireless devices to peacefully share the finite spectrum.



# ITTC EXECUTIVE STAFF



## **Victor S. Frost**

**Director, ITTC**  
**Dan F. Servey Distinguished**  
**Professor, EECS**

Victor Frost has performed research for many corporations, including Sprint, NCR, BNR, NEC, Telesat Canada, AT&T, McDonnell Douglas, DEC, and COMDISCO Systems. He has been principal investigator on 31 research projects and has published more than 100 journal and conference articles. Frost has served as a guest editor for the *IEEE Communications Magazine* and *IEEE Journal on Selected Areas in Communications*. He is currently an area editor for *ACM*

*Transactions on Simulation and Modeling of Computer Systems*. His research interests are in the areas of network quality of service, integrated communication networks, and high-speed networks; they have included projects such as MAGIC and AAI high-speed, wide-area testbeds.

Frost is a Fellow of the IEEE and received the Presidential Young Investigator Award from NSF in 1984. He has served on State of Kansas NSF EPSCoR and DoD DEPSCoR committees, as well as the Kansas Inc. Telecommunications Task Force. He has made four presentations to committees of the Kansas Legislature. He is a member of the Board of Trustees for KU's Center for Research, Inc., and was a member of the Board of the Lawrence Technology Association.



## **Tim Johnson\***

**Executive Director, ITTC**

Tim Johnson has more than 20 years of industry and university experience in managing, researching, developing, transferring, and commercializing engineering and software technologies.

Since 1996, Johnson has served as executive director for ITTC. He has helped develop policies and procedures and managed the operational, technology transfer, commercialization and selected applied-research activities of ITTC.

Since 1982, Johnson has worked in a variety of industry and university concerns, including Kansas Power and Light; Kansas State University; Computer Sciences Corporation in Falls Church, Va.; and the University of Wyoming in Laramie, Wyo. In 1991, Johnson joined the Center for Excellence in Computer-Aided Systems Engineering (CECASE) at KU; in December 1996, he assisted with the formation of ITTC.

Johnson is active in regional organizations supporting information technology, technology transfer, and economic development. He has served on the Kansas Innovation Center's Advisory Board and Operations Committee, Silicon Prairie Technology Association's Information Technology Committee, and Kansas Technology Enterprise Corporation's Telecommunications Committee and Information Technology Committee.

Johnson is a founding and board member of the Lawrence Technology Association and a founding and steering committee member of Kansas City's information technology support organization ITKC. His research, technology transfer, and commercialization activities have resulted in more than 35 presentations and technical publications. He is a member of the Association of University Technology Managers and an IEEE member whose professional memberships have included the IEEE Communications Society, Signal Processing Society, Computer Society, and Engineering Management Society.

Johnson received his bachelor's degree from Memphis State University in 1982, and his master's in 1985, with continued doctorate studies, while attending Kansas State University—all in electrical engineering.

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\*After July 20, 2007, Johnson no longer with ITTC. He holds an executive position with the IDEA Center in Manhattan, Kan.



### **Keith Braman**

**Associate Director for Applied Technology\*, ITTC**

Keith Braman manages ITTC's technology transfer, intellectual property, and state-affiliated economic development activities. He received a juris doctorate from Washburn University and B.S. and M.E. degrees in aerospace engineering from KU.

Before joining ITTC in 2000, he was a senior manager of information systems and regulatory affairs for the Kansas Department of Social and Rehabilitative Services, Division of Health Care Policy. He has been vice president of operations and general counsel for KVA Product Development Group, LLC, in Topeka, which provided engineering consulting services for the

design and manufacture of medical devices. Prior to working for KVA, Braman practiced law as a solo practitioner for several years, focusing on criminal, intellectual property, and corporate transactional law. He also has worked for McDonnell Douglas Helicopter Co. as a flight controls engineer and technical area chief of flight dynamics. As a serial entrepreneur, and in addition to operating his own law office, Braman has worked as an engineering consultant in the area of flight-test research, software development, computer-aided design, and program management and has held founding positions in construction, real estate, and retail companies.

Braman is a member of the Kansas and Nevada state bars, the American Bar Association, the American Intellectual Property Law Association, the Association of University Technology Managers (AUTM), and the engineering honor society Sigma Gamma Tau.

\*Title after July 20, 2007: Director of Technology Commercialization.

## ITTC TECHNICAL STAFF



### **Brett Becker**

**Network Specialist/System Administrator**

As a network specialist and system administrator, Brett Becker was responsible for the design, operations,

and installation of the Center-wide server infrastructure and network. Becker has conducted wireless network visualization research, which aims to inform the public of security issues inherent in current wireless networking technologies. He completed his master's degree in computer engineering in December 2004. Becker left ITTC at the end of June 2006 to work with Sunflower Broadband.



### **Marilyn Cozad**

**Software Engineer/Webmaster**

Marilyn Cozad worked with ITTC from January 2001 to August 2006. She supported technology transfer projects and was the Center's

Webmaster. She focused on applied technology projects

involving the development of Web database applications using Web technology integrated with relational database management systems (RDBMS). Cozad received both her bachelor's degrees, in accounting and in computer information systems, from Washburn University of Topeka. Cozad now works with the Kansas Health Policy Authority in Topeka.



### **Daniel DePardo**

**Research Engineer**

Dan DePardo supports the Communications and Networking Systems Lab (CNSL) and other Center electronic hardware needs. His areas of expert-

ise include radio-frequency hardware design, construction,

testing, and measurement, with transceiver and antenna design as his primary areas of research interest. Secondary areas of expertise include surface acoustic wave device design, printed circuit board photolithography and assembly, electronics environmental testing, and radio frequency and electromagnetic interference suppression techniques. He has designed, constructed, and successfully demonstrated hardware prototypes in support of numerous defense



programs and academic research projects, ranging from airborne military surveillance systems to NASA-funded sea ice measurement radars, and holds a U.S. patent for a novel wide-band antenna design. His current research efforts

include investigation of digital television interference issues, NSF-sponsored development of software defined transceivers, spectrum mapping, and wideband wireless systems.



### **Adam Hock**

**Senior Systems Administrator,  
Bioinformatics**

Adam Hock is the senior systems administrator for ITTC's integrated bioinformatics information infra-

structure. He oversees system integration, administration, and maintenance for the computer cluster as well as the development of new software tools. Before joining ITTC, Hock was an engineer at Atipa Technologies, a provider of information technology solutions based on the Linux computer operating system.



### **Michael Hulet**

**Senior Systems Administrator**

Michael Hulet is the senior network administrator for ITTC. He provides advanced computer hardware, software, and network support for the

operational and research needs of the Center. Hulet joined

ITTC as a computer systems administrator in 1998. He has a bachelor's degree in electrical and electronics engineering from North Dakota State University and a master's degree in systems management from the University of Southern California. He was employed as an electronics engineer for the Naval Warfare Assessment Division in Norco, Calif., before joining ITTC.



### **David Johnson**

**Systems Administrator,  
Bioinformatics**

David Johnson became the systems administrator for ITTC's integrated bioinformatics information infra-

structure in September 2004. Johnson's duties included administering the bioinformatics database and software and developing new bioinformatics tools. He graduated with his master's degree in computer science from the University of Oklahoma in December 2005. In February 2007 he left ITTC and began working with the Bioinformatics Department at KU.



### **Ed Komp**

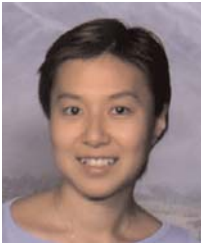
**Research Engineer**

Ed Komp has more than 15 years' experience in designing, implementing, and managing commercial software products. His primary interests

include specialized computer language design for application-specific domains, functional programming, software

development environments, and networking. He joined the Center in 1998. He received his B.A. in mathematics and his M.S. in computer science from KU in 1976 and 1979, respectively. He was the primary software architect for the Block Oriented System Simulator (BOSS) and helped found a local company to commercialize this tool. He also was the primary software architect and manager for the Block Oriented Network Simulator (BONeS), a second commercial product success.





### **Danico Lee**

#### **Senior Software Engineer**

Danico Lee joined ITTC in 2002 and is now a lead software engineer. She manages and works on multiple, select ITTC applied research and development projects. One of the projects she is working on has led to a registered copyright and a pending U.S.

patent. Lee provides technical leadership for requirements, specification, design, implementation, and testing on software projects. Her areas of expertise include applied artificial intelligence, three-tier systems engineering, object-oriented software design, relational database modeling, and Web application development. She also meets with Kansas companies and provides technical assistance. Lee has a B.S. and an M.S. in computer science from the University of Kansas.



### **Wesley Mason**

#### **Network Specialist**

As a network specialist and system administrator with ITTC, Wesley Mason is responsible for the design, operations, and installation of the Center's server infrastructure and network. Mason has

focused his efforts on network security. Before coming to ITTC, he worked for Atipa Technologies as a cluster engineer. He managed hardware and software cluster integration along with onsite installation. He spent nine months as an ITTC student system administrator before joining the Center as a full-time network specialist in the summer of 2005.



### **Leon Searl**

#### **Software Research Engineer**

Leon Searl works on multiple projects as a software and hardware engineer at ITTC. He is working on Agile Radio and related projects. Searl worked at TISL (Telecommunications and Information Sciences Lab,

a predecessor of ITTC) while he was an electrical engineering student at KU. Before returning to KU, Searl worked with TRW Space and Defense Group and Cadence Design Systems. He owned his own ultralight aircraft company. He received his B.S. and M.S. degrees from KU in 1985 and 1987, respectively.



### **Huilin Xiong**

#### **Postdoctoral Researcher**

Huilin Xiong received his Ph.D. degree, majoring in pattern recognition, from China's Huazhong University of Science and Technology in 2000. He spent one year at the Chinese University of

Hong Kong as a researcher and then joined Concordia University in Canada as a postdoctoral fellow. Xiong's research interests include pattern recognition, machine learning, and image processing. At ITTC he was a postdoctoral researcher, from December 2004 to December 2005, working with Xue-wen Chen, assistant professor in electrical engineering and computer science.



### **Jiangsheng Yu**

#### **Postdoctoral Researcher**

Jiangsheng Yu started during FY2005 as a researcher in ITTC's Bioinformatics and Computational Life-Sciences Laboratory (BCLSL). Yu came to ITTC from Peking University's Department of

Computer Science and Technology. His research interests include statistical machine learning and Bayesian data analysis with applications to bioinformatics. Yu has taught courses in such areas as algorithm design and analysis, probability theory and mathematical statistics, decision theory and Bayesian analysis, and artificial intelligence. Yu left ITTC in June 2006.

# RECENT FACULTY ACHIEVEMENTS

EECS Assistant Professors **Shannon Blunt** and **Erik Perrins** have obtained external research funding during their first year at ITTC. Blunt, affiliated with ITTC's RSL, is developing ways in which multiple radars can operate cooperatively with one another in the same spectrum. Perrins, an investigator with the CNSL, and **Victor Frost**, ITTC director and EECS distinguished professor, are collaborating with researchers from the KU Natural History Museum and Biodiversity Research Center. The ITTC researchers are developing ways to transport and store data from the field, which will help assess environmental change on the Central Plains.

**Erik Perrins** received the Best Paper Award (with **T. Nelson** and **M. Rice**) at the 2005 International Telemetering Conference in Las Vegas.

**Victor Frost** has received a Visiting Erskine Fellowship. During the 2007 spring semester, he will conduct research and course development on next-generation wireless network protocols at the University of Canterbury in Christchurch, New Zealand. EECS Professors **David Petr** and **Sam Shanmugan** have served as previous Erskine fellows.

Two ITTC affiliated faculty have been asked to serve as guest editors. **Bozenna Pasik-Duncan**, professor of mathematics, will oversee a special edition on Stochastic Control and Filtering in an issue of the *Communications in Information and Systems Journal*. *IEEE Communications Magazine* will feature articles on cognitive radio technology and dynamic spectrum access networks, for which **Alex Wyglinski**, an ITTC assistant research professor, will be one of the editors.

**Xue-wen Chen**, EECS assistant professor, was tapped for the editorial board of a new peer-reviewed, online journal, *Source Code for Biology and Medicine*. The editorial board, which is made up of an international panel of scientists, will review articles on all aspects of workflow for information systems, decision support systems, client-user networks, database management, and data mining. The journal will publish source code for free distribution, advancing biological and medical research. For more information, please go to [www.scfbm.org/](http://www.scfbm.org/).

In August 2005, **Dave Petr**, an EECS professor, received a W.T. Kemper Fellowship for Teaching Excellence. The award recognizes outstanding KU teachers and advisers. A surprise patrol presented the professor with a \$5,000 check. Petr's honor marks the fourth consecutive year that EECS faculty have garnered at least one Kemper. Past winners include EECS Professors **Susan Gauch**, **Jerzy Grzymala-Busse**, **Chris Allen**, and **Perry Alexander**.

**Ron Hui**, EECS associate professor, is directing the Photonics and Device Technologies Program within the National Science Foundation (NSF). He is developing new research programs and helping create national policy. Hui is the fourth ITTC faculty member to serve as a federal program manager. EECS Professors **Joe Evans**, **Glenn Prescott**, and **Gary Minden** have overseen programs at NSF, NASA, and DARPA.

Professor **Perry Alexander** won the 2006 Harry Talley Excellence in Teaching Award. The award recognizes EECS faculty who have contributed significantly to undergraduate education and have developed a strong rapport with students both inside and outside of the classroom. Graduating seniors choose the winner.

Alexander first won the Talley Award in 2001. Since then, he has collected the ASEE Midwest Region Dean's Award for Teaching Excellence, the Miller Faculty Development Award, and the W.T. Kemper Fellowship for Teaching Excellence.

**Dan Deavours**, assistant research professor at ITTC, has developed the U.S. patent-pending "Adamas-I Tag" (also known as the "KU-Tag"; see also page 6). Prior to the Adamas-I, radio frequency identification (RFID) communication was stymied when a tag was placed on metal or near liquid. The Adamas-I Tag solves the metal/liquid problem and is one of the best performing, least costly, and thinnest tags with this capability. RFID technology tracks consumer goods through the entire supply chain, from the factory to the store. Using a system of readers and tags to communicate information wirelessly, RFID technology also can monitor companies' internal assets.

# ITTC RESEARCH INVESTIGATORS

## FACULTY INVESTIGATORS AFFILIATED WITH ITTC DURING FY2006

### Arvin Agah

Associate Professor and  
Associate Chair for Graduate  
Studies, EECS

#### RESEARCH INTERESTS:

- Autonomous mobile robots for harsh environments
- Biomedical robotics
- Distributed robotics
- Multi-agent systems
- Software engineering



#### Education:

Ph.D., Computer Science, University of Southern California, 1994  
M.S., Biomedical Engineering, University of Southern California, 1993  
M.S., Computer Science, Purdue University, 1988  
B.A., Computer Science, University of Texas, 1986

**Teaches** robotics, artificial intelligence, intelligent agents, software engineering, computer systems design.

**Honors and Awards** include the KU EECS Cerner Teaching Award, June 2004; KU Center for Teaching Excellence Celebration of Teaching Award, May 2004; KU Miller Faculty Development Award, June 2001; Engineering Expo 2001 Educator Award, February 2001; KU Henry E. Gould Award for Outstanding Teaching, 2000.

### W. Perry Alexander

Professor, EECS

#### RESEARCH INTERESTS:

- Formal specification, synthesis, and verification
- Systems-level design
- Systems-level description languages
- System architectures
- Component retrieval



#### Education:

Ph.D., Electrical Engineering, University of Kansas, 1992  
M.S., Electrical Engineering, University of Kansas, 1988  
B.S., Electrical Engineering, University of Kansas, 1986  
B.S., Computer Science, University of Kansas, 1986

**Teaches** digital systems design, programming language paradigms and semantics, formal methods and modeling in software and hardware systems development.

**Honors and Awards** include Kemper Teaching Fellow, 2003; ASEE Midwestern Region Dean's Award for Teaching Excellence, 2003; KU Miller Faculty Development Award, 2002–2003; Harry Talley Teaching Award, KU EECS Department, 2002; Center for Teaching Excellence Honoree, 2002; KU Engineering Expo EECS Department Teaching Award, 2000; Senior Member of IEEE; University of Cincinnati (UC) College of Engineering Neil A. Wandmacher Teaching Award, 1998; UC ECECS Department Teaching Award, 1996–1997; UC Engineering Tribunal Professor of the Quarter, winter 1994, fall 1998; UC ECECS Department Research Award, 1993–1994; UC Electrical and Computer Engineering and Computer Science (ECECS) HKN Professor of the Year, 1992–1993, 1996–1997.

### Christopher Allen

Professor, EECS

#### RESEARCH INTERESTS:

- Microwave remote sensing
- Radar design and analysis
- Synthetic-aperture radar
- High-speed digital circuits and applications
- Fiber-optic communication systems
- Photonic systems and devices



#### Education:

Ph.D., Electrical Engineering, University of Kansas, 1984  
M.S., Electrical Engineering, University of Kansas, 1982  
B.S., Electrical Engineering, University of Kansas, 1980

**Teaches** circuits, electronic circuits, senior design laboratory, fiber-optic communication systems, microwave remote sensing.

**Honors and Awards** include Bellows Scholar, 2005; Eta Kappa Nu; Phi Kappa Phi; Tau Beta Pi; Sharp Teaching Professorship, 2002–2005; KU Miller Faculty Development Award, 2001; W.T. Kemper Fellowship Award for Excellence in Teaching, 2001; Ned N. Fleming Trust Award for Excellence in Teaching, 2001; KU Miller Professional Development Award for Research, 1999; KU EECS Harry Talley Excellence in Teaching Award, 1998; Center for Teaching Excellence honoree, 1998.

## David Andrews

Professor, EECS

### RESEARCH INTERESTS:

- Computer architecture
- Distributed and parallel systems
- Embedded and real-time systems
- Reconfigurable computing



### Education:

Ph.D., Computer Science, Syracuse University, 1992  
 Computer Engineering Degree, Syracuse University, 1990  
 M.S., Electrical Engineering, University of Missouri, Columbia, 1984  
 B.S., Electrical Engineering, University of Missouri, Columbia, 1983

**Teaches** digital design, computer architecture, reconfigurable computing, embedded systems.

**Honors and Awards** include KU Miller Scholar, 2004; Senior Member of IEEE, 2001; Who's Who in Science and Technology, 2001; Outstanding Service Award, Electrical Engineering, University of Arkansas, 1996–1997; Outstanding Researcher Award, Electrical Engineering, University of Arkansas, 1995; General Managers Award, General Electric Co., 1990.

## Ronald Aust

Associate Professor, Teaching and Leadership, Education

### RESEARCH INTERESTS:

- Designing and developing—
- Multi-state educational networks (including UNITE system and Explorer database)
  - Network technologies to support collaborative learning and community publishing of educational resources



### Education:

Ph.D., Curriculum and Instruction, University of Washington, 1984  
 M.S., Education, Western Washington University, 1979  
 B.S., Education, Western Washington University, 1975

**Teaches** designing multimedia learning environments and instructional design.

## Shannon Blunt

Assistant Professor, EECS

### RESEARCH INTERESTS:

- Radar and communications signal processing
- Adaptive pulse compression
- Space-time adaptive processing (STAP)
- Statistical signal processing
- Estimation and detection theory
- Optimization theory
- Electronic circuits



### Education:

Ph.D., Electrical Engineering, University of Missouri, Columbia, 2002  
 M.S., Electrical Engineering, University of Missouri, Columbia, 2000  
 B.S., Electrical Engineering, University of Missouri, Columbia, 1999

**Teaches** digital signal processing, detection and estimation theory, electronic circuits.

**Honors and Awards** include NRL Alan Berman Research Publication Award, 2004; Outstanding Graduate Student Award in Electrical Engineering, University of Missouri, 2001; First Place, Electrical Engineering Lab Exhibit, MU Engineers' Fair, 2001, 1999; Donald K. Anderson Graduate Student Teaching Assistant Award, 2000.



**David A. Braaten**

Associate Professor of  
Atmospheric Science, Geography

**RESEARCH INTERESTS:**

- Snow accumulation
- Ice-sheet processes
- Remote sensing

**Education:**

Ph.D., Atmospheric Science, University of California, Davis, 1988  
M.S., Meteorology, San Jose State University, 1981  
B.S., Meteorology, State University of New York, 1977

**Teaches** introduction to meteorology, dynamic meteorology, advanced dynamic meteorology.

**Honors and Awards** include the Antarctic Service Medal, National Science Foundation and Department of the Navy, 1995.

**Swapan Chakrabarti**

Associate Professor, EECS

**RESEARCH INTERESTS:**

- Designing hardware and software for True 3-D display systems
- High-speed computation of mathematical functions using analog neural networks
- Digital signal processing

**Education:**

Ph.D., Electrical Engineering, University of Nebraska, Lincoln, 1986  
M.S., Computational Physics, University of Nebraska, Lincoln, 1982  
M.S., Physics and Electronics, Calcutta University, India, 1976  
B.S., Physics, Calcutta University, India, 1976

**Teaches** digital logic design, algorithmic problem solving, microcomputer applications, computer architecture, graphics in engineering research, computer vision, digital signal processing (including adaptive systems, neural networks, fuzzy systems).

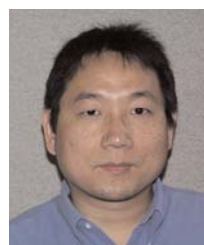
**Honors and Awards** include honorary member, Golden Key National Honor Society, 1996; KU Ned N. Fleming Teaching Award for Outstanding Classroom Teaching, 1992.

**Xue-wen Chen**

Assistant Professor, EECS

**RESEARCH INTERESTS:**

- Bioinformatics
- Machine learning
- Statistical modeling
- Data mining
- Human-computer interaction

**Education:**

Ph.D., Electrical and Computer Engineering, Carnegie Mellon University, 2001  
M.S., Opto-electronics, Sichuan University, 1992  
B.S., Theoretical Physics, Sichuan University, 1986

**Teaches** bioinformatics, computer science.

**Honors and Awards** include Senior Member IEEE, 2004.

**Terry Clark**

Assistant Professor, EECS

**RESEARCH INTERESTS:**

- Bioinformatics
- Data management
- Parallel computing

**Education:**

Ph.D., Computer Science, University of Houston, 1996  
M.S., Computer Science, University of Houston, 1988  
M.S., Chemistry, University of Houston, 1985  
B.S., Chemistry, Western Washington University, 1982

**Teaches** bioinformatics, parallel computing, compilers and programming languages.

## Daniel Deavours

Research Assistant Professor,  
ITTC

### RESEARCH INTERESTS:

- RFID tag-interrogator systems
- Microstrip antennas for passive UHF RFID
- RFID performance evaluation



### Education:

Ph.D., Electrical Engineering, University of Illinois at Urbana-Champaign, 2001  
M.S., Electrical Engineering, University of Illinois at Urbana-Champaign, 1997  
B.S., Computer Engineering, University of Illinois at Urbana-Champaign, 1994

## Kenneth Demarest

Professor, EECS

### RESEARCH INTERESTS:

- Lightwave communication systems
- Electromagnetic theory
- Antennas



### Education:

Ph.D., Electrical Engineering, The Ohio State University, 1980  
M.S., Electrical Engineering, The Ohio State University, 1976  
B.S., Electrical Engineering, John Brown University, 1974

**Teaches** circuits, fiber optic engineering, electromagnetics, microwave systems, noise reduction in electrical systems, antennas, radar engineering, laser engineering.

**Honors and Awards** include Eta Kappa Nu.

## Tyrone Duncan

Professor, Mathematics

### RESEARCH INTERESTS:

- Stochastic adaptive control
- Stochastic optimal control
- Mathematics of finance
- Stochastic analysis
- Telecommunications
- Mathematics education



### Education:

Ph.D., Electrical Engineering, Stanford University, 1967  
M.S., Electrical Engineering, Stanford University, 1964  
B.E.E., Electrical Engineering, Rensselaer Polytechnic Institute, 1963

**Teaches** stochastic analysis and its applications, stochastics of mathematical finance, stochastic control, stochastic adaptive control, fractional Brownian motion and its applications, probability theory.

**Honors and Awards** include IEEE Fellow, 1999; KU Olin K. Petefish Award in the Basic Sciences, 1999.

## Joseph B. Evans

Deane E. Ackers Distinguished  
Professor, EECS;  
Director of Research Information  
Technology, KU

### RESEARCH INTERESTS:

- Mobile networking and wireless systems
- High-performance networks
- Pervasive computing systems
- System implementations



### Education:

Ph.D., Electrical Engineering, Princeton University, 1989  
M.S., Electrical Engineering, Princeton University, 1986  
M.S., Engineering, Princeton University, 1984  
B.S., Electrical Engineering, Lafayette College, 1983

**Teaches** networking implementation, DSP implementation, computer systems design, integrated circuit design, electronics, programming.

**Honors and Awards** include Program Director, Computer and Information Science and Engineering Directorate, National Science Foundation, 2003–2005; Eta Kappa Nu; Tau Beta Pi; KU Spahr Professor, 2000–2003; KU Miller Professional Development Award for Research, 1996; AT&T Bell Laboratories Ph.D. Scholarship, 1984–1988; Garden State Graduate Fellowship, 1983–1987.

**Jianwen Fang**

Research Assistant Professor,  
ITTC

**RESEARCH INTERESTS:**

- Bioinformatics and computational biology
- Machine learning
- Data mining
- Database and software development
- Drug discovery

**Education:**

Ph.D., Chemistry, Wayne State University, Detroit, Mich., 2002  
M.A., Computer Science, Wayne State University, Detroit, Mich., 2000  
B.S., Applied Chemistry, Peking University, Beijing, China, 1990

**Victor Frost**

Dan F. Servey Distinguished  
Professor, EECS;  
Director, ITTC

**RESEARCH INTERESTS:**

- Internet traffic management and quality of service
- High-performance networks
- Network measurement, modeling, control, and simulation

**Education:**

Ph.D., Electrical Engineering, University of Kansas, 1982  
M.S., Electrical Engineering, University of Kansas, 1978  
B.S., Electrical Engineering, University of Kansas, 1977

**Teaches** communication networks and systems.

**Honors and Awards** include Visiting Erskine Fellowship, University of Canterbury, Christchurch, New Zealand, 2006 (for 2007); KU Bellows Scholar, 2005; KU Miller Faculty Development Award, 2002; IEEE Fellow, 1998; Dan F. Servey Distinguished Professor of Electrical Engineering and Computer Science, 1996; KU Miller Professional Development Award for Service, 1991; KU Miller Professional Development Award for Research, 1986; National Science Foundation Presidential Young Investigator Award, 1984.

**John M. Gauch**

Associate Professor, EECS

**RESEARCH INTERESTS:**

- Digital image processing (segmentation, enhancement)
- Computer vision (stereo, motion tracking)
- Multimedia processing

**Education:**

Ph.D., Computer Science, University of North Carolina at Chapel Hill, 1989  
M.S., Computer Science, Queen's University at Kingston, Canada, 1982  
B.S., Computer Science, Queen's University at Kingston, Canada, 1981

**Teaches** algorithmic problem solving, structured programming, computer vision, image processing, computer graphics, digital image processing, multimedia systems.

**Honors and Awards** include KU Miller Faculty Development Award, 2000, 2003; KU Bellows Scholar, 1999, 2002; Archie and Nancy Dykes Award for Undergraduate Teaching and Mentoring, 2001.

## Susan E. Gauch

Professor, EECS

### RESEARCH INTERESTS:

- Multimedia databases
- Intelligent search agents
- Personalized search
- Conceptual search



### Education:

Ph.D., Computer Science, University of North Carolina at Chapel Hill, 1990  
 M.S., Computer Science, Queen's University at Kingston, Canada, 1982  
 B.S., Mathematics and Computer Science, Queen's University at Kingston, Canada, 1981

**Teaches** programming, information retrieval, database systems, software engineering.

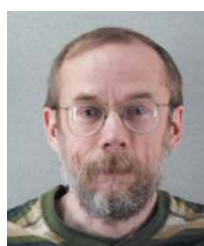
**Honors and Awards** Kemper Award for Excellence in Teaching, 2004; KU Bellows Scholar, 2004; KU Miller Faculty Development Award, 1999, 2000, 2003; KU Miller Professional Development Award for Research, 1998; Office of Naval Research Fellowship, 1988; QU N.E. Dupuis Prize in Mathematics, 1978.

## Jerzy Grzymala-Busse

Professor, EECS

### RESEARCH INTERESTS:

- Knowledge discovery
- Data mining
- Machine learning
- Expert systems
- Reasoning under uncertainty
- Rough set theory



### Education:

Doctor Habilitatus, Engineering, Technical University of Warsaw, Poland, 1972  
 Ph.D., Engineering, Technical University of Poznan, Poland, 1969  
 M.S., Mathematics, University of Wroclaw, Poland, 1967  
 M.S., Electrical Engineering, Technical University of Poznan, Poland, 1964

**Teaches** data mining, expert systems, knowledge acquisition, artificial intelligence, concurrency models, Petri nets, data structures, computer architecture and networking, computer organization, theory of computing, switching theory, automata theory, computability, discrete structures, and probabilistic analysis.

**Honors and Awards** include Kemper Award for Excellence in Teaching, 2004; KU Miller Faculty Development Award, 2002.

## Donna Haverkamp

Assistant Professor, EECS

### RESEARCH INTERESTS:

- Image processing and computer vision
- Artificial intelligence
- Applying artificial intelligence techniques to image interpretation problems



### Education:

Ph.D., Electrical Engineering, University of Kansas, 1997  
 M.S., Computer Engineering, University of Kansas, 1992  
 B.S., Computer Engineering, University of Kansas, 1990

**Teaches** artificial intelligence, databases, information retrieval.

**Honors and Awards** include Ahrens Scholar, 1997; NASA Global Research Fellow, 1993–1996; NASA GSRP Fellow, 1990–1993; Watkins-Berger Scholar, 1986–1990; State of Kansas Scholar, 1986–1990; Distinguished Alumnus Scholar, 1986–1990.

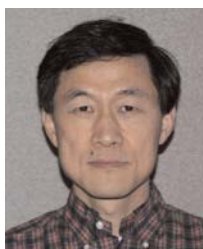


## Rongqing Hui

Associate Professor, EECS

### RESEARCH INTERESTS:

- Fiber-optic communications
- Photonic devices
- Optical sensors



### Education:

Ph.D., Electronics Engineering, Politecnico di Torino, Torino, Italy, 1993  
 M.S., Lightwave Technology, Beijing University of Posts and Telecommunications, Beijing, China, 1988  
 B.S., Microwave Communications, Beijing University of Posts and Telecommunications, Beijing, China, 1982

**Teaches** fiber-optic communication systems and networks, optical measurements, microelectronic circuits, semiconductor materials and devices, general electric circuits.

**Honors and Awards** include KU Miller Professional Development Award for Research, 2002.

**Currently on a two-year leave** from ITTC/EECS to serve as Program Director for the Photonics and Device Technologies Program within the National Science Foundation.

## Gerald Lushington

Director of Labs, Structural Biology Center

### RESEARCH INTERESTS:

- Structure-based drug design
- Quantitative structure-activity relationships as applied to bio-activity and toxicology predictions and chemical library refinement
- Molecular dynamics analysis of proteins
- Quantum chemical and mixed quantum-classical prediction of enzyme activity



### Education:

Ph.D., Theoretical Chemistry, University of New Brunswick, Fredericton, N.B., Canada, 1996  
 B.S., Chemistry and Mathematics, University of New Brunswick, Fredericton, N.B., Canada, 1991.

**Honors and Awards** include first-class honors with B.S. from University of New Brunswick, 1991.

## Ed Meyen

Professor, Special Education

### RESEARCH INTERESTS:

- Online instructional design
- Web-based instructional tools
- Intellectual property issues
- Online instructional applications for students with disabilities
- Emerging instructional technologies



### Education:

Ph.D., Education, University of Iowa, 1968  
 M.A., Special Education, University of Northern Colorado, 1959  
 B.A., Education, University of Northern Colorado, 1958

**Teaches** curriculum design, instructional design, instructional technology, graduate seminars.

**Honors and Awards** include School of Education Faculty Achievement Award, 2006.

## James Miller

Associate Professor, EECS

### RESEARCH INTERESTS:

- Computer graphics
- Scientific visualization
- Geometric and solid modeling
- Technology in education
- Object-oriented technology



### Education:

Ph.D., Computer Science, Purdue University, 1979  
M.S., Computer Science, Purdue University, 1976  
B.S., Computer Science, Iowa State University, 1975

**Teaches** programming, computer graphics, geometric modeling, visualization.

**Honors and Awards** include Boeing Company A.D. Welliver Faculty Summer Fellowship, 2004; KU Center for Teaching Excellence (CTE) Excellence in Teaching Award, 2000; Phi Beta Kappa, 1975; Phi Kappa Phi, 1974; Pi Mu Epsilon, 1974.

## Gary J. Minden

Professor, EECS

### RESEARCH INTERESTS:

- Large-scale systems, including
- Wide-area distributed systems
  - Mobile communication systems
  - Adaptive computational systems
  - Active networking



### Education:

Ph.D., Electrical Engineering, University of Kansas, 1982  
B.S., Electrical Engineering, University of Kansas, 1973

**Teaches** introduction to digital logic design, information security, active networking.

**Honors and Awards** include KU Miller Professional Development Award for Service, 2002; KU Miller Faculty Development Award, 1999, 2000.

## Richard K. Moore

Distinguished Professor  
Emeritus, EECS

### RESEARCH INTERESTS:

- Radar systems
- Radar remote sensing
- Radio wave propagation
- Radar oceanography
- Microwave radiometers



### Education:

Ph.D., Electrical Engineering, Cornell University, 1951  
B.S., Electrical Engineering, Washington University, 1943

**Teaching Duties:** Advises graduate students.

**Honors and Awards** include Australia Prize (for remote sensing), 1995; Italian Center for Remote Sensing Award, 1995; Fellow AAAS, 1993; National Academy of Engineering, 1989; KU

Irvin Youngberg Award in the Applied Sciences, 1989; KU Louise E. Byrd Graduate Educator Award, 1984; IEEE Centennial Award, 1984; IEEE Geoscience and Remote Sensing Society Distinguished Achievement Award, 1982; IEEE Council on Oceanic Engineering Outstanding Technical Achievement Award, 1978; Alumni Achievement Award, School of Engineering and Applied Science, Washington University, 1978; Life Fellow IEEE (Fellow in 1962).

## R. Douglas Niehaus

Associate Professor, EECS

### RESEARCH INTERESTS:

- Real-time and embedded systems
- System and network performance evaluation
- High-performance simulation of computer systems and networks
- Concurrent and distributed programming tools and environments



### Education:

Ph.D., Computer Science, University of Massachusetts at Amherst, 1994  
M.S., Computer, Information, and Control Engineering, University of Michigan, 1981  
B.S., Computer Science, Northwestern University, 1980

**Teaches** introduction to operating systems, advanced operating systems, real-time and embedded system implementation, concurrent and distributed systems.

## Bozenna Pasik-Duncan

Professor, Mathematics

### RESEARCH INTERESTS:

- Identification and adaptive control of stochastic systems
- Science, engineering, and mathematics education for K–12
- Stochastic analysis and its applications to finance, manufacturing, biomedicine, and telecommunications



### Education:

Doctor Habilitatus, Mathematics, Warsaw School of Economics, 1986

Ph.D., Mathematics, Warsaw School of Economics, 1978

M.S., Mathematics, Warsaw University, 1970

**Teaches** probability theory, stochastic processes, mathematical statistics, stochastic modeling, stochastic adaptive control, calculus, stochastic calculus, differential equations, randomness in the modern world.

**Honors and Awards** include appointed member of IEEE Women in Engineering Committee/elected IEEE Control Systems Society Liaison, 2006; elected Chair of Control Education Committee of American Automatic Control Council, 2005–2006; elected KU Distinguished Professors Committee member, 2006–2009; Louise Hay Award, Association of Women in Mathematics, 2004; KU Honor for an Outstanding Progressive Educator (HOPE) Award, 2003; Mortar Board Outstanding Educator Award, 2003; Frank B. Morrison Teaching Award, 2002; IEEE Fellow, 2001; IEEE Control Systems Society Distinguished Member Award, 2000; IEEE Third Millennium Medal for Outstanding Achievements and Contributions, 2000; Leader, China Control Systems Delegation, 2000; Tau Beta Pi; G. Baley Price Award for Excellence in Teaching, 1999; Kemper Fellowship for Teaching Excellence and Advising in Public Outreach, 1996; NSF Career Advancement Award, 1991–1993; International Research Experience (IREX) Fellowship to the United States (Berkeley, Harvard, MIT), 1982; several Chancellor's Awards for research and teaching, Warsaw School of Economics, Poland, 1977–1978; Ministry of Higher Education and Sciences Award for Excellence in Teaching and Research, Poland, 1975.

## Erik Perrins

Assistant Professor, EECS

### RESEARCH INTERESTS:

- Digital communication theory
- Advanced modulation techniques
- Channel coding
- Synchronization in wireless modems
- Complexity reduction in receivers
- Multiple-input, multiple-output (MIMO) communications
- Effective implementation architectures for communication systems



### Education:

Ph.D., Electrical Engineering/Communication Theory, Brigham Young University, Provo, Utah, 2005

M.S., Electrical Engineering/Communication Theory, Brigham Young University, Provo, Utah, 1998

B.S., Electrical Engineering/Signals and Systems, Brigham Young University, Provo, Utah, 1997

**Teaches** digital communications, error control coding, signals and systems.

**Honors and Awards** Best Paper Award (with T. Nelson and M. Rice), International Telemetry Conference, 2005; Best Graduate Student Paper Award, International Telemetry Conference, 2003, 2004; BYU Electrical Engineering Department Research Fellowship, 1997–1998.

## David Petr

Professor and Associate Chair  
for Undergraduate Studies, EECS

### RESEARCH INTERESTS:

- Traffic and congestion management for communications networks
- Traffic integration and quality of service (QoS) for wireless and wireline networks
- Performance analysis and simulation
- Evaluation of students' confidence in answers



### Education:

Ph.D., Electrical Engineering, University of Kansas, 1990  
M.S., Electrical Engineering, Stanford University, 1978  
B.S., Electrical Engineering, Southern Methodist University, 1976

**Teaches** analysis of communication networks, random signal theory, optimization with communication applications, introduction to communication systems, signal analysis, circuits.

**Honors and Awards** include Kemper Fellowship, 2005; EECS Harry Talley Excellence in Teaching Award, 2003; Ben Dasher Best Paper Award for the ASEE/IEEE Frontiers in Education conference, October 2000; KU School of Engineering Sharp Teaching Professorship, 2000–2003; Visiting Erskine Fellowship, University of Canterbury, Christchurch, New Zealand, 2000; Excellence in Teaching Award, KU Center for Teaching Excellence, 1999; Member of Sigma Xi, 1992; Senior Member of IEEE, 1991; KU nominee for NSF Presidential Faculty Fellow, 1991.

## Glenn Prescott

Professor, EECS

### RESEARCH INTERESTS:

- Software radio systems
- Spread spectrum and military communication systems
- Radio and radar signal processing
- DSP applications of field-programmable gate arrays
- Design and implementation of wireless communication systems



### Education:

Ph.D., Electrical Engineering, Georgia Institute of Technology, 1984  
M.S., Electrical Engineering, University of Missouri, 1976  
B.S., Electrical Engineering, Georgia Institute of Technology, 1974

**Teaches** linear systems, electronics design laboratory, senior design laboratory, digital signal processing, digital communications, DSP for communications and radar, advanced modulation and coding.

**Honors and Awards** include NASA Special Service Award, 2000; NASA Terra Award, 2000; KU School of Engineering Sharp Teaching Professorship, 1998–2001.

## James Roberts

Professor, EECS; Vice Provost for Research\*

### RESEARCH INTERESTS:

- Wireless communication systems
- CDMA and spread spectrum systems
- Coding and information theory



### Education:

Ph.D., Electrical Engineering, Santa Clara University, 1979  
M.S., Electrical Engineering, Massachusetts Institute of Technology, 1968  
B.S., Electrical Engineering, University of Kansas, 1966

**Teaches** circuits, electronic circuits, senior design laboratory, fiber optic communication systems, high-speed digital circuit design, microwave remote sensing.

**Honors and Awards** include Ronald J. Schmitz Award for Outstanding Service to the Frontiers in Education Conference, 2004; appointment to the Board and Executive Committee of Kansas BIO, Inc., 2004; Member of the Joint Steering Committee for the Ft. Leavenworth/KU Partnership, 2004; IEEE Fellow, 2002; Tau Beta Pi; Eta Kappa Nu; Sigma Xi; Federal Government Distinguished Station Award (team award), 1987.

\*After July 1, 2007, Roberts no longer Vice Provost for Research.



## Hossein Saiedian

Professor and Associate Chair,  
EECS

### RESEARCH INTERESTS:

Software engineering, including

- Software process improvement
- Formalism in software development
- Object-oriented software development
- Software engineering education
- Software architecture



### Education:

Ph.D., Computing and Information Sciences, Kansas State University, 1989

M.S., Mathematics, Emporia State University, 1984

B.S., Information Systems, Emporia State University, 1981

**Teaches** software engineering; develops and expands software engineering program, EECS; expands EECS programs at Regents Center for Kansas City (KC) metropolitan audience.

**Honors and Awards** include IEEE Certified Software Development Professional, 2002; IEEE Senior Member, 2001; Excellence in Teaching Award, University of Nebraska at Omaha, 2000; Distinguished Research Award, University of Nebraska at Omaha, 2000; top 10 software engineering scholars list, *Journal of Systems and Software*, 1998.

## Ronald R. Sass

Research Assistant Professor,  
ITTC

### RESEARCH INTERESTS:

- Reconfigurable computing
- High-performance computing and networking
- Embedded systems



### Education:

Ph.D., Computer Science and Engineering, Michigan State University, 1999

M.S., Computer Science, Michigan State University, 1992

B.S., Computer Science and Engineering, University of Toledo, 1989

**Teaches** introduction to digital logic.

**Honors and Awards** include IBM Faculty Award, 2004.

**New Location:** Professor Sass left KU/ITTC in July 2006. He now teaches and performs research as an Associate Professor of Electrical and Computer Engineering at the University of North Carolina at Charlotte, N.C.

## K. Sam Shanmugan

AT&T Distinguished Professor,  
EECS

### RESEARCH INTERESTS:

- Smart antenna systems
- Signal (image) processing
- Random signals and communications theory
- Wireless and adaptive communication systems and networks
- Communication systems simulation and analysis



### Education:

Ph.D., Electrical Engineering, Oklahoma State University, 1970

M.S., Electrical Engineering, Indian Institute of Science, Bangalore, India, 1966

B.S., Electrical Engineering, Madras University, India, 1964

**Teaches** communication systems, simulation, probabilistic analysis, signals, and systems.

**Honors and Awards** include EECS Acting Chair, July 1, 2002–July 31, 2003; Visiting Erskine Fellowship, University of Canterbury, Christchurch, New Zealand, 2000; HOPE Award Finalist, 1994; KU Higuchi Award for Research, 1990; Burlington-Northern Outstanding Teaching Award, 1987; KU Henry E. Gould Award for Distinguished Service to Undergraduate Engineering Education, 1982; Amoco Foundation Outstanding Teacher Award, 1982; Society of Automotive Engineers Ralph R. Teetor Outstanding Young Engineer Award, 1979.

## Trevor Sorensen

Associate Professor, Aerospace Engineering

### RESEARCH INTERESTS:

- Student-designed, -built, and -operated satellites
- BalloonSats
- Space environment (Earth and planetary)
- Lunar missions and science
- Remote sensing satellites and missions
- Improvement of spacecraft operations
- Autonomous spacecraft operation
- Long-lived space missions



### Education:

D.E., Aerospace Engineering, University of Kansas, 1979  
M.S., Aerospace Engineering, University of Kansas, 1976  
B.S.A.E., Aerospace Engineering, University of Kansas, 1973

**Teaches** orbital mechanics, spacecraft systems, space system design, spacecraft attitude dynamics and control.

**Honors and Awards** include AIAA Distinguished Service Award, 2005; Chair, AIAA Space Operations and Support Technical Committee, named Most Outstanding Technical Committee in AIAA Space and Missiles Group, 2005; American Astronautical Society Fellow, 2003; NASA/ASEE Summer Faculty Fellowship, 2001, 2003, 2004; AlliedSignal Aerospace Bold Thinking Award 1997–1998; University of Kansas Aerospace Engineering Alumni Honor Roll, 1997; NASA Medal for Exceptional Scientific Achievement, 1994; Engineer of the Year nominee, *Design News Magazine*, 1994; AlliedSignal Technical Service Corp.'s Special Recognition Award, 1994; NRL Certificate of Appreciation for contribution to SDIO/LACE Program, 1991; McDonnell Douglas Certificate of Merit for contribution to Shuttle Program, 1985; NASA Group Achievement Award (STS-41C Rendezvous and Proximity Operations), 1984.

## James Sterbenz

Associate Professor, EECS

### RESEARCH INTERESTS:

- Survivable, resilient, and disruption-tolerant networking
- Mobile wireless networking for ubiquitous personal computing
- High-speed (bandwidth), low-latency networking and communication
- Programmable, active, and cognitive networks



### Education:

D.Sc., Computer Science, Washington University, St. Louis, Mo., 1991  
M.S., Computer Science, Washington University, St. Louis, Mo., 1986  
B.S., Computer Science, Washington University, St. Louis, Mo., 1980  
B.S., Electrical Engineering, Washington University, St. Louis, Mo., 1980  
A.B., Economics, Washington University, St. Louis, Mo., 1980

**Teaches** communication networks; high-performance, mobile wireless, and resilient and survivable networking; introduction to digital logic design.

## James Stiles

Associate Professor, EECS

### RESEARCH INTERESTS:

- Radar signal processing
- Applications of information and estimation theory in remote sensing
- Radar remote sensing of vegetation
- Propagation and scattering in random media
- Ground-penetrating radar



### Education:

Ph.D., Electrical Engineering, University of Michigan, 1996  
M.S., Electrical Engineering, Southern Methodist University, 1987  
B.S., Electrical Engineering, University of Missouri, 1983

**Teaches** electronics, electromagnetics, radar, microwave engineering.

**Honors and Awards** include KU School of Engineering Sharp Professorship, 2004–2007; Interactive Session Prize Paper Award, IEEE Geoscience and Remote Sensing Society, 2002; KU Miller Professional Development Award for Research, 2001; KU EECS Harry Talley Teaching Award, 2000.

## Costas Tsatsoulis

Professor and Chair, EECS

### RESEARCH INTERESTS:

- Multiagent systems
- Case-based reasoning
- Machine learning
- Intelligent image analysis



### Education:

Ph.D., Electrical Engineering, Purdue University, 1987  
M.S., Electrical Engineering, Purdue University, 1984  
B.S., Electrical Engineering, Purdue University, 1983  
B.A., German, Purdue University, 1987

**Teaches** computer system software, artificial intelligence, knowledge-based systems, case-based reasoning, multiagent systems, introduction to database systems.

**Honors and Awards** include KU Spahr Professor, 2000–2003; KU Bellows Fellowship, 1999; Senior Member of IEEE, 1998; Big-12 Faculty Fellowship, 1997; State of Kansas AT&T Engineering Education Excellence Award, 1995; KU Miller Professional Development Award for Research, 1994; Sigma Xi honorary research society, 1992.

## Victor L. Wallace

Professor Emeritus, EECS

### RESEARCH INTERESTS:

- Interactive graphics, scientific visualization, and human interface design
- Queuing theory for modern computer networks and systems
- Analytical performance modeling



### Education:

Ph.D., Electrical Engineering, University of Michigan, 1969  
B.S., Electrical Engineering, Polytechnic Institute of Brooklyn, 1955

**Teaching Duties:** Advises graduate students.

**Honors and Awards** include Computer Graphics Pioneer Award, ACM SIGGRAPH, 1984; Irving Faye Memorial Award, Polytechnic Institute of Brooklyn, 1955; Senior Life Member, IEEE; Eta Kappa Nu; Upsilon Pi Epsilon; Tau Beta Pi; Sigma Xi; Who's Who in Science and Technology; Who's Who in America.

## Weichao Wang

Assistant Professor, EECS

### RESEARCH INTERESTS:

- Information privacy protection in wireless networks
- Key distribution and update
- Representation and visualization of security data
- Self-organized intrusion detection



### Education:

Ph.D., Computer Science, Purdue University, 2005  
M.S., Computer Science, Purdue University, 2002  
M.S., Computer Science, Tsinghua University, Beijing, P.R. China, 2000  
B.S., Computer Science, Tsinghua University, Beijing, P.R. China, 1998

**Teaches:** Cryptography and information security.

**Honors and Awards** include Zhongchuang Communication Ltd. Scholarship, 1999; Graduated with honor from Tsinghua University, China, 1998; Seagate Scholarship, 1996, 1997.

## Alexander Wyglinski

Research Assistant Professor,  
ITTC

### RESEARCH INTERESTS:

- Signal processing for digital communications
- Wireless communications
- Cognitive radios
- Ad hoc wireless networks



### Education:

Ph.D., Electrical Engineering, McGill University, Montreal, Quebec, Canada, 2004  
M.S., Electrical Engineering, Queen's University, Kingston, Ontario, Canada, 2000  
B.E., Electrical Engineering, McGill University, Montreal, Quebec, Canada, 1999

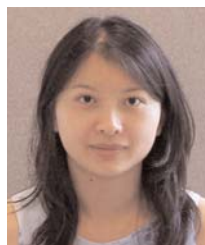
**Honors and Awards** include McGill Alma Mater Student Travel Award, 2003; Motorola Foundation Graduate Award in Electrical and Computer Engineering, 2002; Province of Quebec "Nature and Technologies" Scholarship (doctorate level), 2002–2003; McGill Majors Fellowship, 2002 (declined by recipient); Natural Sciences and Engineering Research Council of Canada (NSERC) Postgraduate Scholarship, 2000–2002; Province of Ontario Graduate Scholarship, 2000 (declined by recipient); Province of Quebec "Nature and Technologies" Scholarship (master's level), 1999–2000; Queen's Graduate Award, 1999, 2000.

## Anne Ya Zhang

Assistant Professor, EECS

### RESEARCH INTERESTS:

- Bioinformatics and computational biology
- Machine learning
- System biology
- Statistical learning
- Data mining/text mining



### Education:

Ph.D., Information Sciences and Technology, Pennsylvania State University, University Park, Penn., 2005  
B.S., Biological Sciences and Biotechnology, Tsinghua University, Beijing, China, 2000

**Teaches** introduction to bioinformatics, bioinformatics and machine learning methods.

**Honors and Awards** include Best paper award, IEEE Workshop on Computer Vision Methods for Bioinformatics, 2005; Third Prize, Challenge Cup Science & Technology Contest, Tsinghua University, China, 1998; Excellent Students Scholarship, Tsinghua University, China, 1997.



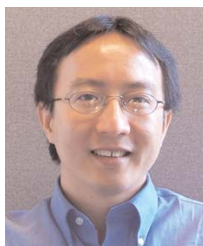
## INVESTIGATORS NEW FOR FY2007

**Jun “Luke” Huan**

Assistant Professor, EECS

**RESEARCH INTERESTS:**

- Bioinformatics and computational biology
- Data mining
- System biology
- Statistical learning



**Luke Huan** joins the Department of Electrical Engineering and Computer Science as an assistant professor. His research interests in bioinformatics include structural bioinformatics, proteomics, and systems biology. In the field of data mining, Huan examines algorithms, systems, and applications. By recognizing patterns in biological data and then building descriptive and predictive models, researchers can more quickly turn raw data into useful knowledge of life processes.

He is teaching mining biological data and introduction to bioinformatics.

Huan earned his Ph.D. in computer science from the University of North Carolina at Chapel Hill in 2006. While at UNC, Huan received the Scholar of Tomorrow Fellowship and the Alumni Fellowship. His undergraduate degree is in biochemistry from Peking University, and he received his master's in computer science from Oklahoma State University.

He has conducted research at Argonne National Laboratory, Nortel Networks, and GlaxoSmithKline.



**Jim Stiles**, director of ITTC's Radar Systems and Remote Sensing Laboratory (RSL), explains a signal processing model for moving targets to Ph.D. student **Geoff Akers**. Akers, a U.S. Air Force officer, is working on his dissertation, for which Stiles is his advisor. Stiles and other ITTC faculty, along with staff researchers, direct research assistants like Akers in collaborative research.

# FY2006 PROJECT SPONSORS

## FEDERAL AGENCIES

Department of Energy (DoE)–Oak Ridge National Laboratory (ORNL)

Department of Defense (DoD)

Department of the Air Force–Test Resource Management Center (through U.S. Army White Sands Contracting Office)

Department of the Army–Edgewood Chemical Biological Center (ECBC)

Department of the Navy–Office of Naval Research (ONR)

National Aeronautics and Space Administration (NASA)

NASA Goddard Space Flight Center

NASA Experimental Program to Stimulate Competitive Research (EPSCoR)

National Institutes of Health (NIH)

NIH Center for Research Resources

NIH Health Resources and Services Administration (HRSA)

National Science Foundation (NSF)

NSF Computer and Information Science and Engineering (CISE)

NSF Experimental Program to Stimulate Competitive Research (EPSCoR)

## INDUSTRY

BBN Technologies (flow-through from Defense Advanced Research Projects Agency/DARPA)

Cadstone, LLC

Fundamental Technologies, LLC

Honeywell Federal Manufacturing and Technologies (FM&T), LLC (including flow-through from DoE)

Nortel Networks

Science Applications International Corporation (SAIC)

Sprint International Communications

## NOT-FOR-PROFIT AGENCIES

J.R. and Inez W. Jay Biomedical Research Committee (via KU Endowment)

## STATE OF KANSAS

Kansas Technology Enterprise Corporation (KTEC)

Kansas Science and Technology Advanced Research (K\*Star)

## UNIVERSITIES

Oregon State University

University of California, Riverside

University of Kansas Medical Center (KUMC)

University of Kansas Medical Center Research Institute, Inc. (KUMCRI)

University of Missouri, Kansas City (UMKC)

Washington University (flow-through from DARPA–Air Force Research Lab)

The National Science Foundation (NSF) and the Kansas Technology Enterprise Corporation (KTEC) are sponsoring the “Understanding and Forecasting Ecological Change: Causes, Trajectories, and Consequences of Environmental Change in the Central Plains” project. Assistant Professor **Erik Perrins**, left, and his graduate student **Balachandra Kumaraswamy** stand on the roof of Nichols Hall with their HughesNet satellite. The proof-of-concept communication system is part of the technological infrastructure ITTC researchers are creating for the project.



# IMPROVED TWO-PHOTON MICROSCOPY

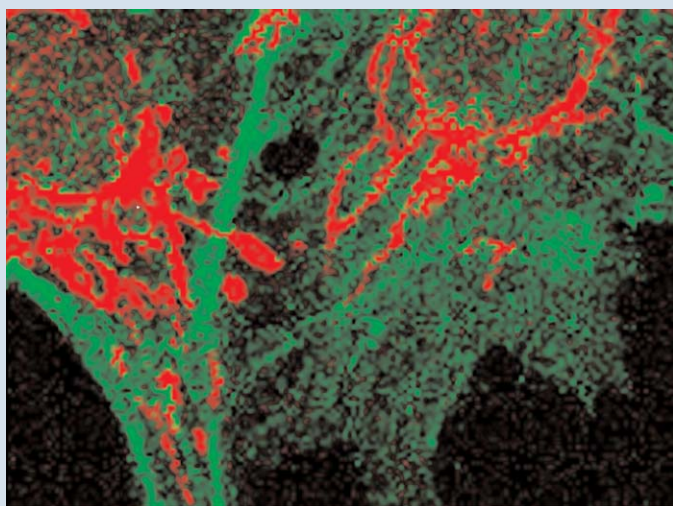
Advances in imaging and microscopic technologies are giving scientists a “big picture” view of biological systems. New techniques, such as two-photon microscopy, produce three-dimensional (3D) images of living cells in thick tissues and live animals at greater depths and higher resolutions than traditional tools. Fluorescent labels are attached to samples and the labels are then activated by two-photon excitation. Via this fluorescent microscopy technique, scientists have observed cell development in hamster embryos, measured calcium in the brains of mice, and monitored the mechanisms in rats’ hearts. Laser-based scanning microscopy also reduces photo damage, permitting study over longer periods of time. However, the high cost and cumbersome size of the ultrafast laser needed for two-photon microscopy severely limits its practical applications.

ITTC Investigator **Ron Hui** is leading multidisciplinary research to develop an affordable, compact laser system that will increase the accessibility of this powerful imaging tool. The National Institutes of Health (NIH) is sponsoring the ITTC project, entitled “Portable and Wavelength-Tunable Two-Photon Microscopy.”

Hui’s team is developing a near-infrared light source, called two-photon, fiber-laser excitation (TP-FLEX), that will simplify the generation of optical pulses needed for two-photon microscopy. An ultrafast laser emits pulsed light, or photons, that excite fluorescent labels, permitting

researchers to detect specific cells. TP-FLEX will integrate a fiber laser and tunable fiber-optic wavelength shifter, which can easily be attached to biological imaging microscopes that have high-quality lenses. In conventional two-photon microscope systems, large lasers are used, rooting the system. The ITTC system, which uses a much smaller fiber laser, is easily transportable. The wavelength tunability of TP-FLEX will allow rapid imaging of the same region at different wavelengths, enhancing imaging capabilities. TP-FLEX permits the simultaneous monitoring of different biochemical functions through multicolor labeling. For example, with biofluorescent markers attached to specific proteins, various protein and molecular configurations can be distinguished and observed. Scientists can observe multiple cellular events at the same time.

The research combines investigators from KU Department of Chemistry and KU Medical Center with expertise in fiber-optic devices, biophysics and spectroscopy, and cell biology and microscopy. KUMC will provide tissue and live cell samples for imaging. TP-FLEX images will be compared to images taken from current two-photon microscopes. The ITTC-developed technology will ensure the same high-quality images, while costing less and being portable. These factors will allow greater accessibility for a wide range of biological, chemical, and analytical applications.



Two-photon microscopy produces three-dimensional (3D) images of living cells, such as the cow cells at left, at greater depths and higher resolutions than traditional tools. The high cost and cumbersome size of today’s ultrafast laser needed for two-photon microscopy limits its practical applications. ITTC investigator **Ron Hui** is developing an affordable, compact laser system that will increase the accessibility of two-photon microscopy.



# SAFER SHIPPING, WITH SMARTPORT

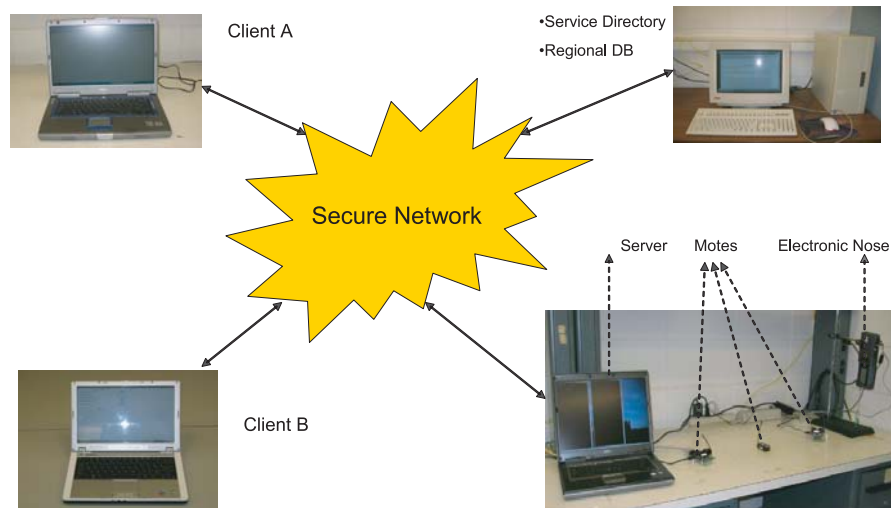
ITTC investigators are developing information technologies that could lead to improving the efficiency of the transport of cargo shipments from Asia-Pacific markets to their U.S. destinations. In 2005 America imported more than a trillion dollars in commodities; of these goods, almost 30 percent were produced in China and Japan, according to the *CIA World Factbook*. The voluminous Asian cargo shipments are creating bottlenecks at western U.S. ports, so freighters have begun docking at Mexican facilities.

ITTC technologies have the potential to assist in the secure and efficient transportation and distribution of goods imported and exported through Mexican ports. Intelligent data-entry, sensing, and communications systems, created at ITTC, will provide the necessary foundation for an information clearinghouse. Applications will include the detection of anomalous activity and unauthorized personnel around critical infrastructure. Such technologies will eradicate “black-holes,” or information vacu-

ums, when goods are en route. The ultimate goal is the integration of information to create a tamper-proof passageway, a trusted corridor, says **Victor Frost**, ITTC director and distinguished EECS professor. Frost leads the research project funded by KU’s Transportation Research Institute (TRI).

ITTC’s efforts under the TRI grant are related to the development of SmartPort. SmartPort is a Kansas City development group that is creating an inland port and international distribution center, leveraging the K.C. metropolitan area’s location and resources. An important element of an inland port is a trusted corridor to improve the efficiency of cargo flow. Routes through Kansas City have the potential to provide a safe and efficient alternative to the congested distribution centers on the West Coast, including ports in Mexico. ITTC-developed technologies have the potential to contribute to the realization of necessary trusted corridors.

## Demonstration of initial implementation



ITTC and KU's Transportation Research Institute (TRI) have partnered with KC SmartPort, a nonprofit economic development group, to assist in creating safer, more efficient supply chains. ITTC technology will control and access sensors, belonging to various organizations, along the “trusted corridor” or tamper-proof passageway. Sensors, such as the electronic nose in this illustration, will detect chemicals and other factors or events and transmit the data through the system to alert clients to unauthorized or anomalous activity.



# SPRINT AND ITTC—A PRODUCTIVE RELATIONSHIP OF MORE THAN A DECADE

The relationship between KU and Sprint illustrates how public and private entities can mutually benefit from collaborative endeavors. Sprint has funded scores of projects at KU over the past 16 years, also providing the Center with access to the company's network. Sprint-sponsored research at ITTC has led to the development of new technologies, including three U.S. patents. ITTC connects Sprint with innovative student researchers, who often join the telecommunications corporation after graduation. Former ITTC students, including Sprint Fellows who have chosen KU/ITTC for their advanced degrees, have advanced within the company. The Center applies its state-of-the-art research and development capabilities to strengthen the competitive position of Sprint.

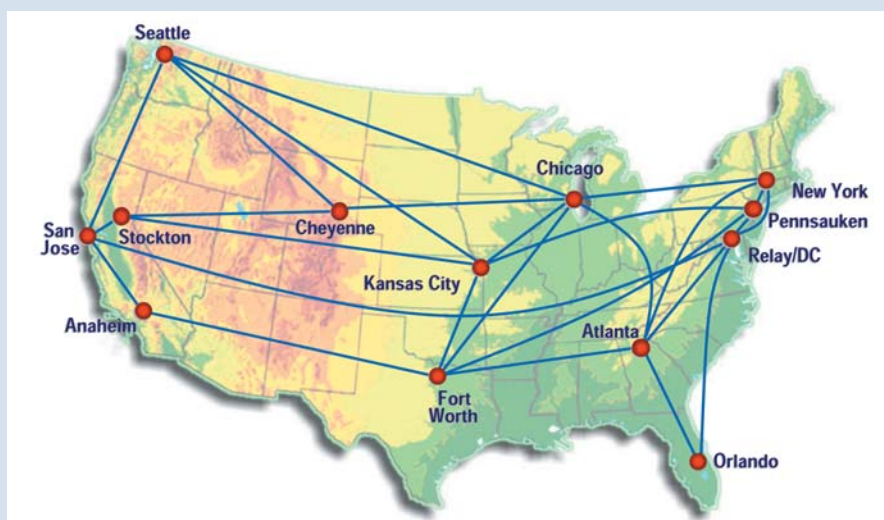
Discussions between KU and Sprint started in 1987, and the University's first Sprint-funded research project began in 1990 at the Telecommunications and Information Sciences Lab (TISL), a predecessor of ITTC. The growing relationship was solidified with the Multidimensional Applications and Gigabit Internetwork Consortium (MAGIC) project in 1992. MAGIC, a government/industry/university consortium, was the sixth national-scale gigabit research testbed. Sprint provided the fiber connection for KU's MAGIC research. While KU and Sprint were conducting joint work, Sprint began direct funding of KU/ITTC research projects on related issues. These projects addressed topics such as asynchronous transfer mode (ATM traffic) management, ATM signaling, the relationship of ATM pricing to traffic management, evaluation of private network-to-network interface (PNNI), and the study of broadband wireless local loops.

Sprint's support for the formation of ITTC's Lightwave Communications Laboratory in 1996 helped ITTC secure matching funds from the National Science Foundation and the Kansas Technology Enterprise Corporation. Patents resulting from Sprint-sponsored research at ITTC's world-class facility include a new optical clock design and a PMD (polarization-mode dispersion) compensator. In addition, student research has led to multiple theses and dissertations, all of which have enhanced fiber-optic technology.

Sprint has benefited from the large number of ITTC students, already familiar with its research and operations, who have joined the corporation. **Tim Kelley, Mo Kashefipour, Steve Oliva, Randy Smischny, and Rick Lett** are examples of ITTC graduates who have reached management positions within Sprint. Additionally, **Victor Frost**, director of ITTC, spent his sabbatical in 1999–2000 at Sprint's Technology, Planning, and Integration (TP&I) organization.

This collaborative relationship continues to evolve. Two students recently completed research at the Sprint Advanced Technology Laboratory (ATL). Ph.D. student **Soshant Bali** conducted design research on high-speed, wireless networks during his six-month internship in the spring. Graduate student **Senthil Shanmugham** worked with ATL's Sprint/Nextel video networking research group for two weeks in February.

Current research in optical systems, wireless networking, and Internet technologies signals a bright future for the ITTC-Sprint relationship.



Sprint research with ITTC in 2001 resulted in an innovative new routing system that allowed packets of information to circumvent extremely busy areas of the regional network. Using algorithms based on the theory of evolution allowed route changes, taking advantage of freer networks and allowing the system to operate more efficiently.

# PROJECTS ACTIVE DURING FY2006

## **Adaptive Distributed Radio Open-Source Intelligent Network (ADROIT)**

G. Minden; A. Agah, J. Evans, A. Wyglinski  
BBN Technologies (flow-through from Defense Advanced  
Research Projects Agency [DARPA])

## **Assessing the User-Base and Expanding the Usability/Reach of the Analytical Sciences Digital Library Through Developmental Workshops**

T. Kuwana; J. Gauch  
Univ. of California, Riverside (flow-through from National  
Science Foundation [NSF])  
(Collaborative with KU Dept. of Chemistry and Univ. of  
Illinois, Urbana)

## **Center for Excellence**

T. Johnson; V. Frost  
Kansas Technology Enterprise Corporation (KTEC)

## **(ITR:) Computation and Communication in Sensor Webs**

D. Andrews; J. James  
NSF

## **Computational Prediction of Beta-Sheet Arrangement**

J. Fang  
Univ. of Kansas Medical Center Research Institute, Inc.  
(KUMCRI) (flow-through from National Institutes of  
Health [NIH])  
(Subproject under Kansas IDeA Network of Biomedical  
Research Excellence [K-INBRE]; collaborative with KU  
Biological Sciences)

## **Computational Proteomics: Protein Interaction Prediction**

(subproject under Protein Structure and Function)

X.-w. Chen; J. Fang  
NIH-Center for Research Resources

## **A Computing Facility for Bioinformatics and Life Sciences Research**

V. Frost; X.-w. Chen, T. Clark  
NIH Health Resources and Services Administration (HRSA)

## **Constructing Gene Networks From Microarray Data for Age-Dependent Epileptogenesis**

X.-w. Chen; E. Michaelis, X. Wang  
J.R. & Inez W. Jay Biomedical Research Committee (via KU  
Endowment)

## **Development of a Fused Ice Classification Scheme**

C. Tsatsoulis  
U.S. Dept. of Navy

## **Development of a High Altitude Balloon Experiment System (HABS) to Fly Standard Interface Payloads Under Controllable Flight Conditions**

T. Sorensen; G. Prescott  
Fundamental Technologies, LLC

## **Development of an Integrated Bioinformatics Information Infrastructure**

V. Frost; G. Lushington, G. Minden, S. Gauch, T. Clark  
U.S. Army Edgewood Chemical Biological Center  
(ECBC)/U.S. Dept. of Defense (DoD)

## **Distributed Scheduling Aspects for Time-Critical Targeting**

R.D. Niehaus

Washington Univ. (flow-through from DARPA-Air Force  
Research Lab [AFRL])

## **(EHS:) Dynamic Hardware Reconfiguration to Accelerate Java-Based Embedded Systems**

R. Sass; D. Andrews  
NSF

## **Enabling the Science Environment for Ecological Knowledge/ITR Collaborative Research**

J.H. Beach; A.T. Peterson, S. Gauch, D. Vieglaiss  
NSF/KTEC  
(Collaborative with KU Natural History Museum)

## **Extending the Thread Execution Model for Hybrid CPU/FPGA Architectures**

D. Andrews; R.D. Niehaus  
NSF

## **Flexible Wireless Systems for Rapid Network Evolution**

G. Minden  
NSF

## **The Future of Spectrum: Technologies and Policies Workshop**

G. Minden  
NSF

## **High-Speed Self-Configuring Networks Based on Cost-Effective Plug-and-Play Optical (PPO) Nodes/NeTS-NR**

V. Frost; R. Hui  
NSF  
(Collaborative with Univ. of Texas, Dallas)

## **(First Award:) Identify Informative Genes for Cancer Classification**

X.-w. Chen  
NSF

## **(SGER:) Index Switchable III-Nitride Planar Lightwave Circuits for Optical Communications**

V. Frost; R. Hui  
NSF

## **Information Systems Technologies for the Earth Science Technology Office**

G. Prescott  
National Aeronautics and Space Administration  
(NASA)/Goddard Space Flight Center

## **Kansas Participation in Sea Winds Instrument Activities**

R.K. Moore  
Oregon State Univ. (flow-through from NASA)

## **Kansas Universities' Technology Evaluation Satellite: The MIST Mission**

T. Sorensen; G. Prescott  
KTEC/NASA Experimental Program to Stimulate  
Competitive Research (EPSCoR)

## **KU High Altitude Balloon Experiment System and the**

**KUBESat-1 Project**

T. Sorensen; G. Prescott  
Honeywell FM&T, LLC (flow-through from U.S. Dept. of Energy [DoE])

**Laboratory Information Management System for****Proteomics Application**

G. Lushington; J. Fang  
Univ. of Kansas Medical Center (KUMC) (flow-through from NIH)  
(Subproject under K-INBRE Bioinformatics Core Facility; collaborative with KU Molecular Graphics & Modeling [MGM] Lab)

**Modular Wireless Avionics System to Autonomous UAVs**

R. Colgren; X.-w. Chen  
Kansas NASA EPSCoR  
(Collaborative with KU Aerospace Engineering)

**National Radio Networking Research Testbed (NRNRT)**

G. Minden; J. Roberts  
NSF

**New Forward Error Correction (FEC) Schemes for Aeronautical TM**

E. Perrins  
U.S. Air Force–Test Resource Management Center (through U.S. Army White Sands Contracting Office)

**(CRI:) Next Generation CiteSeer**

S. Gauch  
NSF  
(Collaborative with Penn State Univ.)

**Non-Destructive PMD Monitoring in Live WDM Optical Systems**

R. Hui; C. Allen  
Sprint International Communications

**Optical-Domain Performance Monitoring for Next****Generation Optical Networks**

R. Hui  
Nortel Networks

**Optimal Space-Time Waveform Design for Adaptive, Multi-Mode Radar**

J. Stiles  
Science Applications International Corporation (SAIC)

**Protein Structure and Function** (subproject under Computational Proteomics: Protein Interaction Prediction)

X.-w. Chen  
NIH  
(Collaborative with KU Higuchi Biosciences Center.)

**Quantifying the Temporal Characteristics of Congestion Events in the Internet**

V. Frost; T. Duncan  
NSF-Computer & Information Science & Engineering (CISE)

**Radio Ice Cerenkov Experiment (RICE)**

D.Z. Besson; D. Andrews, R.D. Niehaus  
NSF  
(Collaborative with KU Physics and Astronomy)

**Rapid Integration of Genomic Data From Multiple Sources**

T. Clark

Kansas NSF EPSCoR/Kansas Science and Technology Advanced Research (K\*Star)

**(CRI:) Reconfigurable Computing Cluster**

R. Sass; D. Andrews, X.-w. Chen  
NSF  
(Collaborative with Arizona State Univ.)

**RFID Tag Analysis and Trade-Studies**

D. Deavours  
Honeywell Federal Manufacturing & Technologies (FM&T)

**(Subcontract to:) Scalable Performance Models for Large Scale Networks With Correlated Traffic**

V. Wallace  
Univ. of Missouri, Kansas City (UMKC)/NSF

**Simulation of Rosetta Representations and Evaluations**

D. Andrews  
Cadstone, LLC

**Stochastic Analysis and Applications**

T. Duncan; B. Pasik-Duncan  
NSF

**Stochastic Systems and Control**

T. Duncan; B. Pasik-Duncan  
NSF

**Support for Wireless Networking Workshop and PI Meeting**

G. Minden  
NSF

**(Phase 1:) Testing of Commercial Passive UHF RFID Tags on Metal Cylinders**

D. Deavours  
(Sponsor anonymous)

**Ultra-High-Capacity Optical Communications and Networking: III-Nitride Wide Bandgap Semiconductors for Optical Communications**

R. Hui; H. Jiang, J. Lin  
NSF

**Understanding and Forecasting Ecological Change: Causes, Trajectories, and Consequences of Environmental Change in the Central Plains**

V. Frost; E. Perrins  
NSF EPSCoR/KTEC  
(Collaborative with KU Biodiversity Institute)

**A Unified Architecture for SensorNet With Multiple Owners**

J. Minden; V. Frost, R.D. Niehaus, D. Petr, D. Deavours  
Oak Ridge National Laboratory

**Unified Data Format for Mass Spectrometry Analysis (UDF)**

J. Lushington; J. Fang, J. Gauch  
KUMC (flow-through from NIH)  
(Subproject under K-INBRE Bioinformatics Core Facility; collaborative with KU MGM Lab)

**Waveform-Diverse Sensors**

S. Blunt  
Office of Naval Research (ONR)

## Books and Book Chapters

### Published:

#### Handling Missing Attribute Values.

J. Grzymala-Busse, W. Grzymala-Busse; *Data Mining and Knowledge Discovery Handbook 2005* (ed. O. Maimon, L. Rokach); Springer-Verlag, 2005, pp. 37–57.

#### LEERS—A Data Mining System.

J. Grzymala-Busse; *Data Mining and Knowledge Discovery Handbook 2005* (ed. O. Maimon, L. Rokach); Springer-Verlag, 2005, pp. 1347–1345.

#### Linear Stochastic Equations in a Hilbert Space With a Fractional Brownian Motion.

B. Pasik-Duncan, T. Duncan, B. Maslowski; *Stochastic Processes, Optimization, and Control Theory Applications in Financial Engineering and Manufacturing* (ed. H. Yan, G. Yin, Q. Zhang); Springer, 2006.

#### Rough Sets and Data Mining.

J. Grzymala-Busse, W. Ziarko; *Encyclopedia of Data Warehousing and Mining* (ed. J. Wang); Information-Science Publishing, July 2005.

#### Rule Induction.

J. Grzymala-Busse; *Data Mining and Knowledge Discovery Handbook 2005* (ed. O. Maimon, L. Rokach); Springer-Verlag, 2005, pp. 277–294.

#### Scientific Parallel Computing: Instructors Manual.

L. Scott, T. Clark, B. Bagheri; Princeton Univ. Press, ISBN: 0-691-12454-X, fall 2005.

#### Waveguides.

K. Demarest; *The Electrical Engineering Handbook, Third Ed.* (ed. R. Dorf); CRC Press, Boca Raton, 2006.

### To Appear:

#### Linear Stochastic Equations With a Fractional Brownian Motion.

T. Duncan, B. Maslowski, B. Pasik-Duncan; accepted for *Control Theory Applications in Financial Engineering and Manufacturing* (ed. H. Yan, G. Yin, Q. Zhang); Springer (Kluwer).

#### Ontology-Based User Profiles for Personalized Search.

S. Gauch, M. Speretta, A. Pretschner; accepted for *Ontologies in the Context of Information Systems* (ed. R. Kishore, R. Ramesh, R. Sharman); Springer-Verlag, 2006.

#### Rough Set Strategies to Data With Missing Attribute Values.

J. Grzymala-Busse; accepted for *Foundations and Novel Approaches in Data Mining* (ed. T.Y. Lin, S. Ohsuga, C.-J. Liao, X. Hu), in *Studies in Computational Intelligence* series; Springer-Verlag.

#### Rough Set Theory With Applications to Data Mining.

J. Grzymala-Busse; accepted for *Real World Applications of Computational Intelligence* (ed. M.G. Negoita, B. Reusch); Springer Verlag.

#### Some Bilinear Stochastic Equations With a Fractional Brownian Motion.

T. Duncan; accepted for *Control Theory Applications in Financial Engineering and Manufacturing* (ed. H. Yan, G. Yin, Q. Zhang); Springer (Kluwer).

#### System Level Design With Rosetta.

P. Alexander; accepted for publication; Morgan Kaufmann Publishers, September 2006.

## Journals

### Published:

#### The 2,6-Diisocyanazulene Motif: Synthesis and Efficient Mono- and Heterobimetallic Complexation With Controlled Orientation of the Azulenic Dipole.

T. Holovics, R. Robinson, E. Weintrob, M. Toriyama, G. Lushington, M. Barybin; *J. Am. Chemical Soc.*, Vol. 128, 2006, pp. 2300–2309.

#### Acetylcholinesterase: Molecular Modeling With the Whole Toolkit.

G. Lushington, J.-X. Guo, M. Hurley; *Current Topics in Medicinal Chemistry*, Vol. 6, 2006, pp. 57–73.

#### Adaptive Pulse Compression via MMSE Estimation.

S. Blunt, K. Gerlach; *IEEE Trans. Aerospace and Electronic Systems*, Vol. 42(2), April 2006, pp. 572–584.

#### Anti-Endotoxin Agents. 3. Rapid Identification of High-Affinity Lipopolysaccharide-Binding Compounds in a Substituted Polyamine Library.

S. Wood, K. Miller, G. Lushington, M. Burns, S. David; *Combinatorial Chemistry and High Throughput Screening*, Vol. 9–10, 2006, pp. 27–36.

#### AVDL: A Highly Adaptable Architecture View Description Language.

J. Ryoo, H. Saiedian; *J. Systems and Software*, Vol. 79(8), pp. 1180–1206.

#### Bit Loading With BER-Constraint for Multicarrier Systems.

A. Wyglinski, F. Labeau, P. Kabal; *IEEE Trans. Wireless Comm.*, Vol. 4(4), July 2005, pp. 1383–1387.



### Capacity Requirements of Traffic Handling Schemes in Multi-Service Networks.

T. Nyirenda-Jere, V. Frost, N. Akar; *Computer Comm. End-to-End Quality of Service Differentiation*, Vol. 28(18), November 2005, pp. 2070–2081.

### Characteristic Relations for Incomplete Data: A Generalization of the Indiscernibility Relation.

J. Grzymala-Busse; *Trans. Rough Sets, Lecture Notes in Computer Science J. Subline*, Springer-Verlag, Vol. 4, 2005, pp. 58–68.

### Characterizing User-Perceived Impairment Events Using End-to-End Measurements.

S. Bali, Y. Jin, V. Frost, T. Duncan; *Int'l J. Communication Systems*, Vol. 18, December 2005, pp. 935–960.

### The Clementine Mission—A 10-Year Perspective.

T. Sorensen et al.; *J. Earth System Science*, Vol. 114(8), December 2005, pp. 645–668.

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**ACRONYMS**

(used without definition in some places in text)

ACTS	(NASA's) Advanced Communications Technologies Satellite
ASEE	American Society for Engineering Education
ATM	Asynchronous Transfer Mode
BER	Bit Error Rate
CRI	Computing Research Infrastructure (a program of NSF)
DARPA	Defense Advanced Research Projects Agency
EHS	Embedded and Hybrid Systems (a program of NSF)
IEEE	Institute of Electrical and Electronics Engineers
FQPSK	Filtered Quadrature-Phase-Shift Keying
ITR	Information Technology Research (an activity of NSF)
KUBESat	Kansas University Balloon Experiment Satellite
LTA	Lawrence Technology Association
MIST	Mission for Imager spacecraft, Space environment spacecraft, and Target/relay spacecraft
NeTS-NR	Networking Technology and Systems-Networking Research (a program of NSF)
PI	Principal Investigator
SGER	Small Grants for Exploratory Research (a program of NSF)
SINR	Signal-to-Interference and Noise Ratio
SOQPSK	Shaped Offset Quadrature-Phase-Shift Keying
UAV	Unmanned Aerial Vehicle
UHF	Ultra-High Frequency
VHDL	VHSIC Hardware Description Language
VHSIC	Very High-Speed Integrated Circuits
WDM	Wave Division Multiplexing (a type of multiplexing used on optical fiber)

# ITTC SUPPORT STAFF

**I**TTTC support staff members help keep the Center functioning smoothly by handling daily administrative details. Below, in alphabetical order, are the FY2006 and current support staff and their responsibilities.

**Paula Conlin**, Nichols Hall Facilities Coordinator. In charge of building maintenance requests, key maintenance, telephone administration, conference room scheduling, courier/mail services/express shipments, and other facility matters.

**Annie Francis**, Office Specialist. Manages new-student check-ins and appointments; maintains student information database; maintains Nichols space-assignment database; provides word processing and proofreading for faculty and staff; coordinates hospitality for workshops, conferences, and events; arranges travel for faculty and staff.

**Pamela Heimerich**, Program Assistant. Acts as assistant to the director of ITTC; coordinates and manages recruitment activities; manages and tracks ITTC accounts; prepares and files immigration and visa documents for staff; organizes workshops, conferences, symposia, and other presentations.

**Nancy Hanson**, Program Assistant. Acts as assistant to ITTC executive director, and associate director for applied technology, for KTEC-related functions; maintains records of Center proposals and awards; calculates annual income and expenditures; designs and executes layout and edits text for *Annual Report* and other publications; coordinates events involving Industry Advisory Board.

**Robin Hinman**, Research Administration Specialist. Manages payroll, accounts payable, and purchasing; tracks finances on all Center projects and performs budget projections.

**Michelle Ward**, Public Relations and Marketing Coordinator. Manages publicity with local news media and state and industry contacts, composes and publishes ITTC's newsletters, writes press releases and the text for *Annual Report*, creates other publicity materials for the Center.



ITTC Support Staff, left to right:  
Back row: **Paula Conlin**, **Nancy Hanson**  
Middle row: **Pam Heimerich**, **Robin Hinman**  
Front row: **Michelle Ward**, **Annie Francis**

Colors used in this report are from the Primary and Secondary Palettes officially designated in KU's *Graphic Identity Standards* (issued in September 2005), as appropriate for use in and with the new KU "signature" and the logos assigned by the University for departmental use. The Pantone colors are Blues 293, 297, and 302; Crimson 186; and Yellow 116.

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### On the Cover:

The background is an enlarged rendering of the image of cow cells, created using two-photon microscopy, featured on page 37.

The five small photos at bottom of front cover are, left to right: students in ITTC's Lightwave Lab (1996); EECS Professor Arvin Agah and students in the ITTC Robotics Lab (2000; both photos by KU University Relations); students on PRISM project in Greenland (2003; photo by Richard Stansbury); ITTC System Administrator Adam Hock and Director Victor Frost with

bioinformatics computer cluster (2005; photo by Megan E. Gannon); and faculty researcher Daniel

Deavours with radio frequency identification (RFID) tag (2005).



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\*Tim Johnson no longer with ITTC after July 20, 2007.

Keith Braman's new title after that date:

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