Information and Telecommunication Technology Center



Annual Report Fiscal Year 2002

The ITTC Vision

To be a global leader in, and catalyst for, the unification of computing, communication, and sensor technologies while being a strategic partner for their commercialization.

The ITTC Mission

- To create the fundamental knowledge and technologies required to realize the convergence of computing, communications, and sensors for the expansion of our economy and the improvement of the quality of life.
- To educate the next generation of technology leaders who will drive this convergence.
- To transfer to industry the knowledge and technology that will enable this convergence.

"Our focus is your future!"

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Director's Report -

This year, we are focusing our annual report on collaborations, which are essential to the Center's success. Collaborations enhance our research environment and allow ITTC to remain at the forefront of technology research. We have numerous partnerships that include federal and state agencies along with industry giants and smaller corporations as well as other universities and KU organizations. These diverse interactions allow us to work on a variety of projects. While we recognize the IT industry downturn and have felt its effects with a reduction in industry support, we have been more successful than ever in obtaining prestigious National Science Foundation (NSF) grants.

One of our most important partnerships is with our students. More than 130 student researchers work at ITTC and conduct investigations under the guidance of the faculty. We hope to increase the quality of our students through the establishment of the ITTC Graduate Fellowship. The Center is providing financial assistance to recruit new doctoral students. The Fellowship has a \$2,500 annual stipend along with an opportunity to work at



Victor Frost, ITTC Director

ITTC. John Paden received the first fellowship. To read more about Paden, who is also a NASA Fellow, please turn to page 12.

We value the input of our industrial partners, especially our Industry Advisory Board (IAB). The Board gives us an industry perspective and ideas on how to increase our involvement with companies. We held our annual IAB meeting in May and were fortunate to have excellent attendance, as 28 Board members took part in the day's events. We expanded participation this year to include people involved with the life sciences, both in the Kansas City area and at the University. This included Arcady Mushegian, director of bioinformatics at the Stowers Institute, who spoke about opportunities in the bioinformatics field; and **Bill Duncan**, president of the Kansas City Area Life Sciences Institute, who presented an overview of the life sciences initiative in the Kansas City area. This was the first time we had speakers from outside KU at an IAB meeting, and they stimulated a discussion on research opportunities in bioinformatics. It is interesting to note that Dan Deavours, an ITTC research assistant professor, did his dissertation research on stochastic petri nets, a methodology now being directly applied in molecular biology. Similar research may open doors to additional collaboration between ITTC and the life sciences community.

During the meeting, **Prasad Gogineni**, Deane E. Ackers distinguished professor of electrical engineering and computer science, spoke about his Polar Radar for Ice Sheet Measurements (PRISM) project. This NSF- and NASA-funded research will develop and deploy innovative radar and rovers to measure ice thickness and determine bedrock conditions below the ice sheets in Greenland and Antarctica. Scientists have postulated that excess water is being released from polar ice sheets due to long-term, global climate change, but there are insufficient data to confirm these theories. Understanding the interactions between the ice sheets, oceans, and atmosphere is essential to quantifying the role of ice sheets in sea level rise.

While its primary objective will be to develop radar, the PRISM project includes a strong public outreach program that will partner it with KU's Center for Research on Learning and Haskell Indian Nations University. The current outreach is heavily Web based and gives the public opportunities to learn more about conditions in Greenland and Antarctica, climate change, and global weather. The Web site, www.ku-prism.org, provides information on radar and robotics as well, which we hope will reach kindergartners through 12th graders and science and technology journalism students along with the general public. For more information on PRISM, please turn to page 33.

Gogineni's NSF grant provides an example of a developing trend at ITTC. As the Center has seen a decline in industry funding due to the IT slump, we have continued to support our research through NSF and other federal grants. Often this funding is not as large as some industry efforts but extends for a longer time period, enabling ITTC researchers to pursue longer-term problems. The PRISM project, which will extend through 2006, was one of eight major Information Technology Research (ITR) grants awarded by NSF and was the only large grant given to a university in the Big 12 Conference.

This year brought high-profile projects to ITTC, and the number of our NSF projects testifies to the quality work we do. The Center could not do this groundbreaking research without the interaction with our collaborators. We look forward to continuing these fruitful partnerships.

Victor S. Frost Director, ITTC Dan F. Servey Distinguished Professor, EECS

ITTC is the State's leading institution in information technology (IT) research and development. IT is an essential component for every aspect of education, business, health care, and everyday life and is expected to continue to be of significant importance for the foreseeable future.

The vision of ITTC is to be a global leader in, and catalyst for, the unification of computing, communication, and sensor technologies while being a strategic partner for their commercialization. During the year, ITTC's Industry Advisory Board (IAB) indicated that this vision of technology convergence is likely the core of the next wave of technological development. It looks as if a major national research focus will be on the development of counter-terrorism technologies, in addition to an increased emphasis on life-sciences research.

ITTC is uniquely positioned to make significant contributions in both these areas. The unification of computers, communications, and sensors is recognized as a force multiplier in ITTC's current efforts. This recognition will provide ITTC with significant opportunities, and the new convergence of technologies will be the basis for future economic development and the enhancement of the quality of American society.

ITTC continues to be successful in partnering with local industry and other premier universities and agencies to obtain funds for key, cutting-edge research projects in our core technology areas. ITTC has had another exceptional year, having attracted funding during the year yielding an estimated leveraging ratio of nine dollars for every KTEC state dollar invested in ITTC.

We have also increased our commitment to reach out to the greater Kansas City and Lawrence region by developing strategic relationships. After months of preparation, ITTC, together with several other Kansas City technology leaders, formed an information technology networking organization called "ITKC," for the greater Kansas City Region. ITKC is a Kansas City grassroots effort to support information technology.

ITTC is also a founder and key supporter of the Lawrence Technology Association (LTA). The LTA was formed to facilitate communication among technology companies in Lawrence and the surrounding areas. In addition, we continue our strong support and involvement with KC-Catalyst, Enterprise Center of Johnson County (ECJC), and the Lawrence Regional Technology Center (LRTC).

We have maintained our strategic partnerships with local industry—e.g., Sprint, IFR Wichita, Sunflower Broadband, and Today Communications—while at the same time ITTC investigators have greatly expanded their collaborative efforts. Within the region we have developed collaborations in lightwave communications with Kansas State University (KSU) and in network performance evaluation with the University of Missouri-Kansas City (UMKC). On a large scale, the National Science Foundation (NSF)/National Aeronautics and Space Administration (NASA) Information Technology Research (ITR) effort includes University of Alaska-Fairbanks, NASA's Jet Propulsion Laboratory, Ohio State University, the U.S. Army Cold Regions Research and Engineering Laboratory, the University of Chicago, the University of Copenhagen, the Alfred Wegener Institute (Germany), the University of Bristol, the Australian Antarctic Division, and the Phoang Institute of Technology (Korea).

Including collaborators strengthens our research, and therefore we are members of several teams pursuing some of our long-term efforts. Of most significance to Kansas is the team pursuing the "Learning on the Move" Testbed, which includes KU/ITTC, KU/Center for Research on Learning, SRI, Kansas Research and Education Network (KanREN), Kansas Geological Survey (KGS), Kansas National Guard (KNG), the Kansas Division of Emergency Management (KDEM), Sprint, Nortel, and the Combined Arms Center (CAC) at Ft. Leavenworth.

Several specific actions from the Strategic Plan have been taken. As indicated in the Strategic Plan, our growth is constrained by the quantity of our principal investigators (PIs), so we have hired two research assistant professors and will soon begin the search for another. These additional research faculty will strengthen critical technical areas within ITTC. We have instituted an ITTC graduate fellowship to aid in increasing the quantity and quality of Ph.D. researchers in the Center. Most importantly, the Strategic Plan started investigators thinking about the integration of sensors, computing, and communications; consequently the large NSF/NASA ITR effort focused on this integration.

The challenge ahead is to manage the growth and success ITTC has experienced, while maintaining the infrastructure needed to grow and continue to serve the State of Kansas. Past success is largely due to the seeds sown and cultivated over many years. Based on available statistics, ITTC is performing at a very high level, compared to State and national averages for R&D organizations.

In the long term we see two trends: (1) increased interest in research activities focusing on combating terrorism, and (2) leveraging the IT expertise to assist the bioinformatics/life-sciences activities of the KU-Lawrence campus and in the Kansas City area. To address these trends, ITTC has participated in the Kansas City Life Sciences Institute (KCLSI) bioinformatics needs assessment team, participated in the KCLSI Proteomics Task Force, and developed a Plan for Technology-Enhanced Life-Science Research Collaboration in Kansas City. **Sponsors and Collaborators**

ITTC enjoys support for its numerous research projects from a variety of sources. In FY2002, approximately 51% of ITTC's expenditures came from Federal funding sources, 10% from Kansas governmental agency funding, 28% from industries, one percent from licensing fees and royalties on transferred technologies, and 10% from other sources. On many projects, ITTC investigators are working in collaboration with faculty from various schools and departments at KU and/or with researchers from other universities and prestigious institutes, both inside and outside the U.S.

Sponsors

The following were sponsors of ITTC projects that were active during FY2002.

U.S. Government-Affiliated Agencies

Air Force, including Air Force Office of Scientific Research Air Force Material Command Army, including Center for Army Lessons Learned/University after Next Defense Advanced Research Projects Agency Department of Energy Department of Navy, including Naval Research Laboratory Department of Veteran Affairs Medical Center National Aeronautics and Space Administration, including NASA Glenn Research Center NASA Goddard Space Flight Center NASA Jet Propulsion Laboratory National Science Foundation

Industry

Adaptive Broadband, Ltd. Ambient Computing, Inc. BioComp Systems Burlington Northern Santa Fe Railway EDAptive Computing, Inc. Honeywell Federal Manufacturing & Technologies, LLC Intermetrics, Inc. LaBarge, Inc. Midwest Cellular Telephone Company Nortel Sprint Corp.

State of Kansas

Kansas Technology Enterprise Corporation

Collaborators

ITTC research projects active during FY2002 included collaborative work with the following universities and organizations.

KU Schools and Departments

Center for Research on Learning/Education Chemical and Petroleum Engineering Ecology and Evolutionary Biology Electrical Engineering and Computer Science Mathematics KU Medical Center Physics and Astronomy Psychology

Beyond KU

Alfred Wegener Institute (Germany) Australian Antarctic Division Enterprise Center of Johnson County Haskell Indian Nations University (Department of Mathematics) ITKC Kansas State University **KCCatalyst** Lawrence Berkeley National Laboratory (at University of California) Lawrence Regional Technology Center Lawrence Technology Association NASA Jet Propulsion Laboratory (at California Institute of Technology) Ohio State University Phoang Institute of Technology (Korea) University of Alaska-Fairbanks University of Bristol University of Chicago University of Colorado University of Copenhagen University of Missouri-Kansas City U.S. Army Cold Regions Research and Engineering Laboratory

Nationally, FY2002 has been generally overshadowed by an economic slowdown throughout the technology sector, with the telecommunications sector arguably absorbing a considerable amount of the pain. However, and in spite of the economic environment, ITTC has enjoyed a number of significant successes and a very productive year. During the first half of FY2002, ITTC received a National Science Foundation (NSF) Information Technology Research (ITR) award of \$8.7 million to study the change in mass of the Earth's ice cover and its potential effects on sea level rise. Additionally, we developed 11 new technologies, assisted over 40 companies, received one patent, filed five additional patents, met or exceeded most of our milestone objectives, and leveraged a total of \$6.6 million in industrial and federal funding supporting research, development, and technical assistance.

ITTC continues to support the Kansas Technology Enterprise Corporation (KTEC) mission. FY2002 has been another successful year in terms of return on investment (ROI) from the transfer of ITTC-developed technologies to companies, yielding a return of \$172,215. It should be noted that a significant amount of expected ROI was delayed until later years due to existing licenses that were amended to help struggling IT companies.

We expect to see a downturn in industry support for ITTC, due, in part, to the slowdown in the high-tech telecommunications industry sector and the shakeout of the IT industry in general. By most accounts, this will be a temporary correction cycle, and the long-term outlook continues to be strong. It is anticipated that continued success will lead to yet another strong year in terms of research funds attracted in FY2003.

Other activities included the creation of two start-up companies based on ITTC-developed technologies, and the transfer and patenting of several technologies resulting from Kansas-industry-funded research projects within ITTC. Most projects have involved cooperative development and investment by both ITTC and Kansas businesses.

Key Performance Indicators				
Key Indicators	FY1998–FY2000	FY2001	FY2002	
	<u>3-Year Average</u>	<u>Actual</u>	<u>Actual</u>	
R/D&C Industry Funds Leveraged	\$2,579,213	\$660,584	\$685,656	
R/D&C Federal Funds Leveraged	\$3,112,281	\$3,706,281	\$5,101,914	
Total R/D&C Funds Leveraged	\$5,691,494	\$4,366,865	\$5,787,570	
New Technologies Commercialized in KS	4.67	3	4	
Licenses Awarded	1.67	5	5	
License Fees/Royalties	\$175,564	\$139,757	\$172,215	
New Companies Formed in KS	0	0	2	

ITTC has a record number of new NSF awards:

- Radar Sensor Webs: Large ITR; PI (Principal Investigator), Gogineni
- Lightwave/Radar MRI; PI, Allen
- Lightwave Communications; PI, Hui
- Biodiversity & Ecosystem Informatics; PI, S. Gauch\$
- Scalable Network Performance Models; ITTC/PI, Wallace

The ITTC Strategic Plan, which established our vision of the integration of sensors, computing, and communications, continues to be the catalyst for numerous discussions throughout the Center, as we seek methods, means, and applications for realizing this integration. The NSF ITR represents but one tangible manifestation of this effort, to which ITTC is a significant contributor. ITTC currently has over 14 ongoing multi-year research commitments and continues to explore additional multi-year collaboration and funding opportunities.

We have successfully established our graduate fellowship program with the first award extended during the summer of 2002. The purpose of the ITTC Graduate Fellowship is to attract and encourage individuals who would like to pursue doctoral research at the University of Kansas. This award amounts to \$2,500 each year for a period of two years. The recipient of this award will also be eligible for graduate research assistantship. Enrollment in a Ph.D. program at the University of Kansas is a requirement for receiving the award.

ITTC kicked off an outreach effort this past fiscal year that resulted in over 700 contacts with former ITTC students. We used this opportunity to bring our former students up to speed on the current happenings at the Center, in addition to enlisting their help in identifying new opportunities. We have had a very favorable response and look forward to a plentiful harvest of new opportunities.

We have continued to develop a number of regional collaborator efforts throughout the reporting period with Kansas State University (KSU) and the University of Missouri-Kansas City (UMKC). More specifically, Dr. Ron Hui is collaborating with KSU on a lightwave communication systems and a high-resolution WDM reflectometry for fiber length measurement. Additionally, Dr. Victor Wallace is collaborating with UMKC on the development of scalable network performance models.

ITTC continues to provide strong support for education, technology transfer, industry enhancement, and commercialization. Averaging over \$6 million per year in expenditures over the past three years, ITTC is by far the largest academic telecommunications and information technology research organization in the State. The IT research infrastructure that has been acquired over the past 18 years is world class in areas ranging from wireless communications to lightwave transmission systems, including dedicated fiber access to the Sprint network and routes/switches that model the Internet.

As an indication of quality of the ITTC research infrastructure, **Dr. Russell Chipman** of JDS Uniphase, San Jose, Calif., noted in August of 2001, after a demonstration in ITTC's lightwave laboratory, "This impressive demonstration establishes the group as one of the leading programs working in PMD (polarization mode dispersion) in the US."

The majority of funding for ITTC comes through programs that use the peer-review proposal process. We thus compete with all the major universities in the country. Our success in obtaining funding from NSF, Defense Advanced Research Projects Agency (DARPA), and NASA clearly demonstrates that ITTC is competitive on the national level for research funding. For example, the NSF/NASA Information Technology Research (ITR) Program awarded 308 grants in 2001, eight of which exceeded \$5 million, from more than 2,000 competitive proposals. ITTC's grant was one of those eight; others in that elite group include Carnegie Mellon, Johns Hopkins, and MIT. Clearly, ITTC is currently nationally competitive. The primary resource needed to improve our competitive position is an increase in the number of our principal investigators.

ITTC-affiliated faculty members received four new grants from the National Science Foundation in FY2002, giving the Center a total of seven active NSF-funded projects at the close of the fiscal year¹. The \$8.7-million grant from NSF and NASA, for research on "Polar Radar for Ice Sheet Measurements (PRISM)," is ITTC's largest award to date. This research will help determine why sea levels have been rising for the past century. You may read more about this project on page 33.

Note that the PRISM project is an ideal example of ITTC's strategic direction as defined in our Strategic Plan: the convergence of computers (intelligence), communications (wireless), and sensors.

NSF's Information Technology Research (ITR) program, through which ITTC received this award, spurs fundamental research and innovative uses of information technology in science and engineering.

¹ As this Annual Report goes to print (March 2003), ITTC has a total of 10 active NSF-funded projects.







We must understand that no matter how much money we spend on research and development, the findings are not going to benefit the public unless there are suitable incentives to invest in commercialization. And because no one knows which venture will succeed, we must strive for a society and an environment ruled by faith that the guarantee of reasonable profits from risk-taking will call forth the endless stream of inventions, enterprise and art necessary to resolve society's problems.

-Howard W. Bremer, as quoted in "University Technology Transfer Evaluation and Revolution"

Focus on Commercialization

ITTC leverages its unique information technology research and development facilities to the benefit of Kansas industry. Throughout the last decade, ITTC has committed itself to the development and commercialization of technologies important to Kansas and its economy. We are currently positioned to leverage the value of our heritage and enjoy a number of significant successes. With continued support, ITTC will further develop its commercialization enterprise and, in doing so, facilitate economic development in Kansas.

Existing commercialization projects are progressing well and will continue to completion in FY2003, with other new projects set to begin. ITTC approves new internal commercialization projects only after a positive review by staff

and our Industry Advisory Board members. These projects must have commercial potential and must be in ITTC's technical areas of expertise. In the past, such projects have led to spin-off companies and licensed technologies and have enhanced the Center's knowledge base, which then can be used to help other Kansas companies.

One of ITTC's long-term (five-year) goals is to achieve outcomes in selected key metrics comparable to those of research institutions in the top quartile, as reported by AUTM (Association of University Technology Managers). ITTC is currently performing at this level compared to national averages, as can be seen in the graph to the right and the table below.

ITTC's Estimated National Rank (Normalized per \$1M in Research)



Annual Average (AUTM 2000 Data)	National Average	ITTC Avg. (99–02)
Research \$ to generate 1 License Research \$ to generate 1 Lic. > \$1M recvd.	\$7,118,971 \$252,304,704	\$2,755,935
Research \$ to generate 1 Start-up	\$69,554,270	\$12,401,706
# Licenses per \$10M in Research	1.40	3.6
# Invention Disclosures per \$10M in Research	4.21	15.7
# Patent Applications per \$10M in Research	3.32	3.6
# Patents Issued per \$10M in Research	1.27	2.8

Highlighted Successes in Commercialization

The following summary sets out some of our most significant successes and commercialization efforts:

HDTV Antenna: ITTC filed a patent for an ITTC technology that enhances antenna performance of over-theair, high-definition television broadcasts. Our HDTV antenna solves a number of problems experienced by HDTV signal reception in fringe areas. We believe a significant commercial opportunity exists for this technology, through licensing to either an antenna manufacturer or a (Kansas) start-up manufacturer.

Rosetta: KU/ITTC faculty member **Perry Alexander** is developing the Rosetta language. The Rosetta systemlevel design language (SLDL) continues to receive national and international recognition, acclaim, and interest throughout the Electronic Design Automation (EDA) industry—e.g., Gabe Moretti, "System-Level Design Merits a Closer Look," *EDN Europe*, February 2002; and David Malinial, "Four Killers Are on the Loose," *Electronic Design*, April 2002. ITTC completed negotiations for the assignment of the Rosetta language to Accellera in FY2002. Accellera's mission is to drive worldwide development and use of standards required by systems, semiconductor, and design tools companies that enhance a language-based design automation process. Accellera's Board of Directors comprises representatives from ASIC manufacturers, systems companies, and design tool vendors. KU's Rosetta assignment will facilitate Accellera's standardization and industries' acceptance of the language. The EDA sector is a \$4 billon-a-year industry¹, and commercialization of Rosetta tools represents a significant opportunity ITTC is pursuing.

Veatros, LLC: ITTC/KUCR formalized an exclusive licensing relationship for the ITTC/KU patented technology, "Real-Time, Features-Based Video Stream Distortion Analysis System," more commonly known as VidWatch, with Veatros, LLC. Veatros, LLC, is a Kansas start-up company established by the inventor of VidWatch, **John Gauch**, associate professor of electrical engineering and computer science (EECS). As part of the agreement, KUCR/ITTC has transferred its current Vidwatch license with Turner Broadcasting Systems to Veatros. VidWatch provides easy-to-access, aroundthe-clock, Web-based monitoring of broadcast video worldwide. Development of the VidWatch technology was made possible with the support of KTEC funding and illustrates a complete technology commercialization life cycle.

Today Communications, Inc.: Throughout FY2002, ITTC has, under the direction of Associate Professor of EECS **Susan Gauch**, completed the initial research and development of a Web-based, medical search-engine technology. The resulting technology was transferred to Today Communications. The company has already commercially deployed the technology and continues to expand its market penetration. ITTC continued its relationship with Today Communications through an additional research and development effort focused upon enhancements of the medical search technology. Additionally, Today Communications has expressed interest in employing a number of the students that have been working on the project, upon their graduation.

Cadstone, Inc.: Cadstone was spun out by ITTC/KU as a new start-up company. Cadstone will take advantage of emerging business opportunities in the multi-billion-dollar, system-level design language (SLDL) and computer-aided design industry. This opportunity is based upon KU/ITTC's internationally recognized research expertise and associated technologies currently under development. **Perry Alexander**, associate professor of EECS, is a recognized expert and co-developer of a next-generation SLDL called Rosetta. Dr. Alexander is also chairing an international standards committee tasked to take Rosetta through the standards process. The new company, Cadstone, Inc., will position itself to capitalize on the associated opportunities in developing supporting tools, services, and training.

Highlighted Research Publications

An especially notable technology transfer activity is the publication of outstanding research that has been performed. Highlighted here are two such examples offered during the year.

Dr. Gogineni's Work Appears in *Science*: **Prasad Gogineni**, Deane E. Ackers distinguished professor of electrical engineering and computer science (EECS), was one of five researchers whose work appeared in the Dec. 14, 2002, issue of the journal *Science*. The article, "High Geothermal Heat Flow, Basal Melt, and the Origin of Rapid Ice Flow in Central Greenland," identified two fast-moving ice streams in the Greenland ice sheet. The team determined that geothermal heat, perhaps of volcanic origin, is causing the rapid basal melt.

ITTC Students Win IEEE Paper Contest: Bharath Parthasarathy and **Travis Plummer**'s paper, "Target Simulation for Internal Layer of Greenland Ice Sheet," won first place in the IEEE Student Paper Regional Contest in April. Both students worked with ITTC's Radar and Remote Sensing Lab.

Importance of Students

Currently, more than 135 students are actively working within ITTC, enhancing their education while providing a valuable resource to ITTC and the State. In addition, today's students will be the industry leaders of tomorrow. Read more about ITTC's students and their work on pages 12 and 13.

¹ EDA Consortium Press Release, April 1, 2002.

Industry Advisory Board

Twenty-eight ITTC Industry Advisory Board members met in Nichols Hall on May 15, 2002. Twenty-two IAB members are pictured here, along with ITTC Executive Staff members.

Back row, from left, continuing up the stairs: J. White, J. Strand, G. Wilson, T. Johnson, B. Hattaway, G. Mastin, T. Lyon.

Middle row, from left: B. Brough¹, W. Morgan, G. Minden, D. Nicol, T. Lezniak, B. Ruf, M. Sobek, B. Ewy.

Front row, from left: W. Duncan, B. Griffin, V. Frost, J.Walters², A. Mushegian, J. Roberts, G. Georg, M. Epard.

Photo by Wally Emerson.

ITTC's Industry Advisory Board (IAB) members come from a variety of companies, organizations, and U.S. Government agencies. They provide guidance for the sustainable future of ITTC. Following is the list of Board Members for Fiscal Year 2002.

Gary Alexander, Alexander Open Systems, Lenexa, Kan.

Phil Anderson, Ph.D., Millivision, Inc. (of Amherst, Mass.), Lawrence, Kan.

James Baxendale, University of Kansas (KU) Medical Center Research Institute, Kansas City, Kan.; and KU Center for Research (KUCR), Lawrence, Kan.

Beth Brough¹, Kansas Technology Enterprise Corp., Topeka, Kan.

- Steve Chaddick, Ciena Corp., Linthicum Heights, Md.
- Jim Dahmen, Columbus Telephone Co., Inc., Columbus, Kan.

Peter Distler, Sprint Corp., Overland Park, Kan. William P. Duncan, Ph.D., Kansas City Area Life

Sciences Institute, Kansas City, Mo.

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

Benjamin J. Ewy, Ambient Computing, Inc., Lawrence, Kan.

Gunda Georg, Ph.D., Medicinal Chemistry, KU, Lawrence, Kan.

- Marilu Goodyear, Ph.D., Information Services, KU, Lawrence, Kan.
- Bennett Griffin, Griffin Technologies, Lawrence, Kan.
- Russel Hailey, Secure Network Group, Inc., Lawrence, Kan.

John Hansen, Cerner Corporation, Kansas City, Mo. Brian Hattaway, Accenture, Overland Park, Kan. James Isaacs, Ph.D., TAC, Ft. Wayne, Ind.



Gordon Johnston, NASA Headquarters, Washington, D.C. Patrick Knorr, Sunflower Broadband, Lawrence, Kan. Paul T. Kelly, Ph.D., Molecular Biosciences, KU,

- Lawrence, Kan.
- Bob LaGarde, LaGarde, Inc., Olathe, Kan.
- Rick Lett, Sprint, Overland Park, Kan.
- Tom Lezniak, Boeing Commercial Airplanes Group, Wichita, Kan.
- Tom Lyon, Lyon About, LLC, Palo Alto, Calif.
- Gary Mastin, Ph.D., Lockheed Martin Management & Data Systems, Reconnaissance Systems, Litchfield Park, Ariz.
- Matt McClorey, Lawrence Regional Technology Center, Lawrence, Kan.
- Wayne E. Morgan, Ph.D., Midwest Research Institute, Kansas City, Mo.
- Rodler F. Morris, U.S. Army, Washington, D.C.
- Arcady Mushegian, Ph.D., Stowers Institute, Kansas City, Mo.
- **David Nicol**, Ph.D., Verisign Telecommunication Services, Overland Park, Kan.
- Susan Norris, Sprint PCS, Lenexa, Kan.
- Maurice O'Sullivan, Ph.D., Nortel Broadband Networks, Ottawa, Ontario, Canada
- Stan Pierson, IFR Systems, Inc., Wichita, Kan.
- James Roberts, Ph.D., KUCR, Lawrence, Kan.
- Brian Ruf, Ruf Strategic Solutions, Olathe, Kan.
- Michael F. Sobek, Information Control Systems, Inc., Overland Park, Kan.
- John Strand, Axis Solutions, Leavenworth, Kan.
- John Walters², Honeywell/FM&T, Kansas City, Mo.
- Gerald J. White, BV Solutions Group, Overland Park, Kan.
- George Wilson, Ph.D., Pharmaceutical Chemistry, KU, Lawrence, Kan.

¹Beth Brough is no longer with KTEC. Kevin Carr now represents KTEC on the ITTC IAB.

² ITTC mourns the loss of Mr. Walters, who passed away on December 24, 2002. Jeff Fuller now represents Honeywell/FM&T on the ITTC IAB.

Labs Overview—Labs in Collaboration

ITTC continues to contribute new knowledge to the fields of information technology and microwave remote sensing. Its success is built on a strong foundation of partnerships, both internal and external. More than 35 faculty and staff members and 135 students work in the Center's six major research laboratories. Most researchers work in multiple labs, and this creates a unity among the Center's focus areas. The Center has developed strong alliances with government entities, corporations, and other research organizations. These external partnerships have provided ITTC indispensable resources to continue its valuable research.

Located on KU's Lawrence campus, the Center is developing the next generation of computing, communication, and sensor technologies. ITTC researchers—faculty, staff, and students—work together in ITTC's state-of-the-art laboratories, performing a breadth of research in all areas of the IT field, from fiber optics and wireless systems to applications. ITTC's labs include

- e-Learning Design Laboratory (eLDL)
- Intelligent Systems and Information Management Laboratory (ISIML)
- Lightwave Communication Systems Laboratory (LCSL)
- Networking and Distributed Systems Laboratory (NDSL)
- Radar Systems and Remote Sensing Laboratory (RSL)
- Wireless Communications and Digital Signal Processing Laboratory (WDSPL)

The Center's partnerships have helped it to prosper. ITTC's continued growth has led to more than \$32 million in research and development funding over the last five years. The millions invested in the Center are a testament to the people affiliated with it. Faculty from a variety of disciplines, including engineering, computer science, math, and physics, develop the latest technologies within ITTC.

Researchers' associations with different facets of the Center unite it and create strong internal partnerships. For example, **Chris Allen**, associate professor of electrical engineering and computer science (EECS), heads the RSL and is co-director of the Lightwave Lab. He received an equipment grant in 2002 that provided both labs with \$225,000 from the National Science Foundation (NSF). The faculty worked together because of their overlapping research agendas. Allen said researchers in both laboratories drew on common resources and skill sets, making them highly complementary. Allen's familiarity with both the RSL and Lightwave labs helped him successfully procure the funding for the new equipment, which will support continued cutting-edge research in both labs.

This collaborative research environment capitalizes on partnerships



Graduate student Hans Harmon works with software developed by the Polar Radar for Ice Sheet Measurements (PRISM) team. Harmon and other ITTC researchers are testing the force needed to operate the project's Max ATV Buffalo. The ATV (all-terrain vehicle), nick named "MARVIN," will pull the PRISMdeveloped radar when the team has it in Greenland and Antarctica for testing

with industry and government entities. **Susan Gauch**, associate professor of EECS, has partnered with both Kansas corporations and government organizations in her research. For example, Gauch developed a fundamental new Web technology with her graduate students for Today Communications. Named "Vitalseek," this new technology has been recognized by the *Wall Street Journal*. Vitalseek allows volumes of medical information to be sorted through filters selected by the user. Its Web site, www.vitalseek.com, provides easy access to topical Web searches, via a pull-down list of 50 health-related topics from AIDS to depression to weight loss. Users can filter information by choosing sites that have a high degree of privacy protection, are not commercially sponsored, adhere to traditional rather than alternative medical practice, and so on.

Glenn Prescott, professor of EECS, exemplifies the Center's strong alliance with government organizations. The Wireless Communications and Digital Signal Processing Lab director and member of the RSL wrote a proposal with fellow professor **Prasad Gogineni**, Deane E. Ackers distinguished professor of EECS, to develop an airborne radar. The two received the NASA grant, which will allow them to create radar that measures snow depth from satellites. A better understanding of snow depth will help researchers evaluate conditions of the oceans and atmosphere in relation to global warming. This project is related closely to Gogineni's PRISM project, which will help determine why the sea level has been rising for the last century. For more information on that project, please see page 33.

ITTC prides itself on its collaborative environment. The Center encourages the creation of strong relationships, both internally and externally, which allows for continued excellence in its research abilities. As its acclaim has increased, ITTC looks forward to developing even more partnerships while building stronger ties with collaborators and sponsors.



e-Learning Design Lab (eLDL)

Lab Directors: John Gauch, Ed Meyen

The e-Learning Design Lab studies and develops online instruction with an underlying commitment to identify and institutionalize the most effective elements of online teaching. The Lab assesses the impact of online instruction technologies on the education experience, to learn which of these technologies are most effective as a function of the learner's current knowledge and learning style, the presentation and acquisition of new knowledge, and the

physical learning environment. This knowledge can then be shared with others developing online learning modalities, to improve not just the delivery of online information technology instruction but also the effectiveness of online education in general. eLDL facilities include the following:

- Module creation tools
- e-Learning instructional design

- On-line assessment tools
- e-Learning evaluation services

• Authoring tools



Lab Director: Costas Tsatsoulis

ISIML studies theoretical and applied technology in the areas of artificial intelligence, intelligent agents, and agent-based applications. The Lab also investigates information retrieval from distributed and heterogeneous sources, and data mining. ISIML's researchers develop advanced methodologies for automated characterization of data sources, dynamic

routing, soft- or auto-bots, information fusion and enhanced visualization, image and video processing, profiling, knowledge-based systems, and development tools. ISIML equipment includes the following:

- Al development tools
- CATV link
- CORBA

010001

- Data-mining tools
- KU Image Analysis Program (KUIM)
- KU Information Retrieval (KUIR)

- KU Real Time (KURT)
- NT PCs and Linux workstations
- Proportional time/real-time network testbed
- Robotics assembly shop
- Video recording/transmission systems
- Cluster of 94 Linux CPUs



Lightwave Communication Systems Lab (LCSL)

Lab Directors: Christopher Allen, Kenneth Demarest

LCSL explores lightwave technologies, specifically in the areas of photonic devices (including components and fiber) and lightwave systems. Such research and development is performed in conjunction with government agencies and industry partners to optimize the performance, cost, and reliability of networks and related technologies. Experts within LCSL

investigate lightwave systems and networks, new fiber technologies, advanced photonic devices, network performance improvements, wavelength division multiplexing (WDM) and dense wavelength division multiplexing (DWDM), and reduction or elimination of deleterious transmission effects such as polarization-mode dispersion (PMD). LCSL resources include the following:

- Ciena Multiwave 1600 16-λ WDM system
- 40-Gbps BERT
- 12-Gbps BERT
- 20-GHz and 50-GHz sampling oscilloscope
- Optical spectrum analyzer
- Fiber-optic polarization analyzers
- Tunable lasers

- Hundreds of kilometers of assorted optical fiber
- Erbium-doped fiber amplifiers
- 100-fs pulsed laser source
- Soliton generator
- Fiber-optic recirculating loop
- Optical clock recovery system
- Direct fiber link to Sprint network

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Networking and Distributed Systems Lab (NDSL)

Lab Director: Joseph Evans

NDSL engages in analytical research, advanced simulations, and testbed measurements of large-scale networks and network technologies with an emphasis on networking issues, performance, testing, modeling and enhancements, network control and signaling, and integration of advanced wireless communication and lightwave technologies. Such efforts have had critical impact on the telecommunications industry, networking community, and information service



providers (ISPs). NDSL has produced world-recognized achievements in wireless mobile systems, distributed performance measurement and modeling, network control and management systems, self-configuring networks, optimal data transfer protocols, architectures, reliability, robustness, and ubiquitous systems, as well as improved distributed networking routing, management tools, and cost models. NDSL's available tools include the following:

- Extensive wireless and mobile networking • infrastructure
- 802.11b, 802.11a, and Bluetooth wireless LANs
- ITTC-developed flexible spectrum wireless • networking testbed
- Extensive high-speed networking infrastructure
- High-speed WANs
- Sprint testbed connections at 40 & 2.4 Gbps
- Misc. routers, switches, and network interfaces

- Several carrier-class Cisco IP routers •
- FORE ATM switches and concentrators
- Linux PC array and Sun workstation testbeds
- Direct access to: SprintLink, Internet2, CAIRN, Planetl ab
- Network system software and configuration server
- Direct fiber link to Sprint network
- 2.4 Gbps SONET fiber terminal

Radar Systems and Remote Sensing Lab (RSL)

Lab Director: Christopher Allen

RSL develops, evaluates, and applies new radar systems and other related sensing technologies for remote sensing of the land, sea, ice, and atmosphere. A broad range of laboratory activities are involved, including sensor development, data collection, data analysis and modeling, and data dissemination. Remote sensing areas where RSL has made significant contributions through the years include remote sensing of the ocean, atmosphere, sea ice, polar ice sheets, vegetation, soil moisture, subsurface, and snow. RSL facilities include the following:



- 40-GHz network analyzer
- 22-GHz spectrum analyzer
- 20-GHz frequency synthesizer
- High-speed oscilloscope

- Field-programmable logic development system
- Outdoor antenna measurement range
- Variety of high-end workstations and personal computers

Wireless Communications and Digital Signal Processing Lab (WDSPL)

The Wireless and Digital Signal Processing Laboratory serves as ITTC's focal point for leading-edge research in wireless communications and digital signal processing applications in digital communications and radar. Well integrated with the other laboratories within ITTC, WDSPL performs design, implementation, testing, measurement, and commercialization of wireless systems and components. Innovative digital communication system design bridges the gap between the simulation world and reallife applications. WDSPL performs both basic and applied research in these areas in collaboration with the government and international industrial leaders in this arena. The laboratory has been successful in demonstrating intelligent wireless communication systems for the government and commercial applications, and is currently engaged in employing digital signal processing technology on the problem of radio and synthetic aperture radar signal processing through the use of rapid prototyping techniques. WDSPL resources include the following:

- 40 GHz, 6 GHz network analyzers •
- 22 GHz spectrum analyzer ٠
- 20 GHz synthesizer
- 2 GHz digital sampling scope
- Misc. power meters
- High-speed digital T/R rooftop antenna
- 25 Mbps wireless communications system
- DSP rapid prototyping facility

- Circuit board fabrication facility
- Signal processing workstation
- APTIX FPGA prototype facility
- Synopsys FPGA design tools
- EESof
- MATLAB / Simulink
- Protel PCB layout
- Eagleware RF design



Lab Director: Glenn Prescott

Students in Collaborative Efforts

ITTC attracts students from around the world. ITTC's wide breadth of research areas and expertise leads more than 135 students to fill the Center. They work primarily as research assistants. Most ITTC students are doing research that corresponds with their graduate theses or dissertations. While they gain necessary hands-on experience, these future researchers become part of a collaborative experience as well.

At ITTC, young researchers form alliances with students they may not have met outside of the Center. While they develop internal partnerships with other student researchers, they also collaborate with ITTC professors. Faculty members encourage and mentor students in both research and academia. These strong ties between students and professors help lead to the highest quality research in information technology (IT) and distinguish ITTC as a premiere research facility.

John Paden, a first-year doctoral student in electrical engineering, has partnered with NASA as an Earth System Science Graduate Student Fellow. NASA accepted Paden's proposal for a radar that will help measure ice thickness and determine bedrock conditions below the ice sheets in Greenland and Antarctica. He was one of only 52 applicants to be awarded the Fellowship, which includes an \$18,000 stipend and a \$6,000 allowance for additional expenses.

The prestigious Fellowship will guarantee his continued work with the PRISM (Polar Radar for Ice Sheet Measurement) project. (For more information on the Radar Systems and Remote Sensing Lab's PRISM project, please turn to page 33.) Paden credits his advisors—Chris Allen, associate professor of electrical engineering and computer science (EECS), and Prasad Gogineni, Deane E. Ackers distinguished professor of EECS—with helping him earn the award. Without their support throughout his master's career at the University, Paden said he did not think he could have had this success. Strong partnerships within ITTC gave Paden the necessary skills to secure an external ally and benefactor.

"The stipend will allow both my wife and me to worry less about paying bills and more about our academic careers. Academically speaking, the award will undoubtedly help with other applications and help fund trips to conferences in my area of research," says Paden.



John Paden tests his radar outside of Nichols Hall. The firstyear doctoral student earned a NASA Fellowship and the inaugural ITTC Graduate Fellowship. He will continue work on the PRISM project and radar that will help measure ice thickness and determine bedrock conditions below the ice sheets in Greenland and Antarctica. Photo by Megan E. Gannon.



Ph.D. student Cindy Kong stands in front of a diagram of the Rosetta project. She works as a developer on the systems level design language, which will bring together diverse forms of information in a compatible language environment. The project has moved one step closer to industry acceptance with its donation to Accellera.

As a team member on the Rosetta project—directed by Associate Professor of EECS Perry Alexander—Ph.D. student **Cindy Kong** has collaborated with different universities. Kong is helping develop a completely new language that allows system-level design. The language will bring together diverse forms of information in a compatible language environment.

Kong has worked in partnership with research laboratories at the University of Adelaide and the University of Manchester to build tools for the language. While Rosetta is used on four different continents, the team's closest partners have been in Australia at Adelaide. The two universities have exchanged students, as two Australian researchers visited ITTC, and KU master's student **Garrin Kimmell** went to study in Adelaide.

"It is a little difficult to work with the Australians because their daytime corresponds to our nighttime; but apart from that, it has been quite beneficial," Kong said. "They are experienced in language development and have provided valuable inputs to Rosetta."

Kong and the Rosetta team have received another partner in Accellera, which accepted the donation of Rosetta in spring of 2002. Accellera is a not-for-profit organization that develops standards to allow different computer-based systems to use a variety of software. All major integrated circuit, systems, and design-tool vendors (including Intel, Texas Instruments, and Motorola) belong to Accellera. Kong says that through Accellera a light is being shone on Rosetta, and industries are getting excited. Her experience shows that multiple partnerships are needed to take a project from a concept to a reality.

Brent Stephens received a taste of real-world difficulties with the Burlington Northern and Santa Fe Railway Company (BNSF; of Topeka, Kan.) project. He and fellow graduate student **Todd Blackman** helped develop artificial intelligence (AI) software in ITTC's Intelligent Systems and Information Management Laboratory (ISIML). The prototype software allows for a 65-percent reduction in human error with the railway's intricate billing system.

The two students worked closely together under the guidance of Costas Tsatsoulis, director of ISIML. Members of the group had different schedules and skills, Stephens said, but he thought they did a good job of balancing them. While the group worked out differences internally, it had a greater challenge with its external collaboration. The corporate lingo provided a communications gap that the ITTC researchers had to overcome. They had to learn about the billing system and ways to improve it from the BNSF staff. "I think the most interesting part was the introduction to real-world diffi-

culties," Stephens said. "For example, the people from BNSF still had to carry on with their normal jobs while trying to meet our needs for face-to-face time or data requests so that we could meet our deadlines. They were very giving of their time, and I think that is why the project turned out so well."

Undergraduates **Travis Plummer** and **Bharath Parthasarathy** had a little help on their way to first place in the IEEE (Institute of Electrical and Electronics Engineers) Region Five Student Paper contest. The duo received guidance from ITTC Postdoctoral Research Associate Pannirselvam Kanagaratnam.



Brent Stephens works on the Burlington Northern Santa Fe Railway project. Stephens, along with fellow graduate student Todd Blackman and Costas Tsatsoulis, director of ITTC's Intelligent Systems and Information Management Laboratory, developed artificial intelligence software for the company. The prototype addressed billing challenges and reduced human error by 65 percent.

Kanagaratnam, a former NASA Fellow, mentored the two and helped them prepare a paper on the development of a target simulator. The simulator will test radar that maps the internal layers of the Greenland ice sheet.

This will enable researchers to test the radar's accuracy before taking it north for a NASA-funded study that investigates the melting of polar ice sheets and their relation to global climate change. It is extremely important to know the radar will work before researchers travel to Greenland, which they do only once or twice a year. They cannot test the radar within the continental United States, as it runs on the same frequency as wireless communication systems, including cell phones. And it would be too expensive to take the radar to the ice caps to test its accuracy.

Plummer and Parthasarathy received additional support from Prasad Gogineni, Deane E. Ackers distinguished professor of EECS. Gogineni, who is the principal investigator on the Greenland project, helped the students throughout their project and paper. He aided in their visualization of the concepts for the target simulator all the way through the implementation and testing phase. Parthasarathy said they were thankful for Gogineni's time and patience in reviewing the paper and presentation several times and giving them positive feedback.

The undergraduates could not have been as successful at the paper contest without the strong support and partnerships that ITTC provided them.

Bharath Parthasarathy and Pannirselvam Kanagaratnam pose with the simulator developed in the Radar Systems and Remote Sensing Lab at ITTC. Undergraduates Travis Plummer and Parthasarathy wrote about the simulator and

won the IEEE Region Five Student Paper contest in Houston. Postdoctoral research associate Kanagaratnam, a former NASA fellow, mentored them.





Undergraduates Travis Plummer and Bharath Parthasarathy won the IEEE Region Five Student Paper contest in Houston. They took a tour of the Johnson Space Center during their stay.



Victor S. Frost, Director; 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 published more than 50 journal articles, including one this past year on the reliability of networks in crisis situations. Recently, Frost and Cory Beard, assistant professor at the University of Missouri-Kansas City and former ITTC student, developed a network architecture that would give high-priority users access to critical information at the right time.

Frost has served as a guest editor for the *IEEE Communications Magazine* and *IEEE Journal on Selected Areas in Communications*. He was an associate editor for the *IEEE Communications*

Letters and is currently an area editor for *ACM Transactions on Simulation and Modeling of Computer Systems*. His research interests are in the areas of integrated communication networks, high-speed networks, communication systems analysis, and simulation and have included projects such as MAGIC and AAI high-speed, wide-area testbeds.

He received his B.S., M.S., and Ph.D. degrees in electrical engineering from KU in 1977, 1978, and 1982, respectively. In 1982 he joined KU's Electrical Engineering and Computer Science Department. From 1987 to 1996, he directed the Telecommunications and Information Sciences Laboratory (TISL—a predecessor of ITTC) at KU. He became ITTC's acting director in January 1998, and its official director in August 2000.

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



Tim Johnson, Executive Director for Applied Technology

Tim Johnson has 20 years of industry and university experience in the management, research, development, transfer, and commercialization of engineering and software technologies. Since 1996, Johnson has served as an executive director for ITTC. In his current position, he has provided leadership, developed policies and procedures, and been responsible for the coordination and management of the operational, technology transfer, commercialization and selected applied research activities of ITTC. These related activities help foster technology-based economic development by transferring technology to the public domain, enabling new start-up companies, and supporting established companies.

Since 1982, Johnson has worked in a variety of industry and university positions, 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, where he held several positions until the formation of ITTC in December 1996. Johnson is actively involved in

regional organizations supporting information technology, technology transfer, and economic development activities. He has served on the Kansas Innovation Center's (KIC) 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.

In addition, Johnson is a founding member, board member, and treasurer for the Lawrence Technology Association (LTA). His research, technology transfer, and commercialization activities have resulted in more than 35 presentations, technical articles, reports, and refereed journal publications. He is 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.

Gary J. Minden, Exec. Director for Research/Chief Technologist; Professor, EECS

Gary J. Minden received his B.S.E.E. degree in 1973 and Ph.D. degree in 1982, both from the University of Kansas. He is a professor of electrical and computer engineering at KU and serves on ITTC's core management team.

From 1971 through 1978, Minden was a research engineer at the KU Center for Research, Inc. During that period he worked on problems in the areas of image processing systems, multi-processor computer systems, and general systems theory.

From 1978 to 1980, he was a vice president of CHILD, Inc., where he was a co-designer of the LIGHT-50 computer graphic terminal. In August of 1981, he joined the KU department of electrical engineering as an assistant professor. From 1983 to 1989, he led the implementation of a new computer

engineering degree program within the department. In 1991, Minden completed a sabbatical at Digital's System Research Center, working on gigabit local area networks. He was a principal investigator on the MAGIC gigabit testbed and the rapidly deployable radio network project (RDRN) at ITTC. From June 1994 through June 1996, he was on leave at the Defense Advanced Research Projects Agency (DARPA) Information Technology Office. He served as a program manager in the area of high performance networking systems. While at DARPA, he formulated and initiated a new research program in Active Networking. He has served on several Defense Science Board task forces in areas of battlefield communications and spectrum management.

Minden's research interests are in the area of large-scale distributed systems, which encompasses high-performance networks, computing systems, and distributed software systems, and in dynamic mobile wireless networks and agile radios. He is a member of the IEEE and the Association of Computing Machinery.

Keith B. Braman, Associate Director for Applied Technology

Keith Braman manages ITTC's technology transfer, intellectual property, and state-affiliated economic development activities. He has a juris doctorate from Washburn University in Topeka and B.S. and M.S. 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 the KVA Product Development Group, LLC, in Topeka, where he provided engineering consulting services and operational protocols for the design and manufacture of medical devices. He has worked as an

aerospace engineer for McDonnell Douglas Helicopter Co. and as an engineering consultant in the area of flight-test research, software development, computer-aided design, and program management. He has practiced corporate and intellectual property law.

He is a member of the Kansas and Nevada state bars, the American Bar Association, and Sigma Gamma Tau, the engineering honor society.





Torry Akins, Research Associate



Torry Akins returned to ITTC and the Radar Systems and Remote Sensing Laboratory (RSL) during the summer of 2002. He is helping to develop the sensors needed for the Polar Radar for Ice Sheet Measurements (PRISM) project. He received his B.S. and M.S. degrees in electrical engineering from the University of Kansas in 1996 and 1998, respectively. After earning his master's, he left to join the Radar Science and Engineering section of the Jet Propulsion Laboratory, where he worked on the development of a space-qualified, real-time data processor.

Brett Becker; Network Specialist

As a network specialist and system administrator, Brett Becker is responsible for the design, operations, and installation of the Center-wide server infrastructure and network. Becker has been involved in wireless network visualization research, which aims to inform the public of security issues inherent in current wireless networking technologies.



Paula Conlin, Facilities Coordinator



Paula Conlin handles all telephone-related inventory and work orders, faxes, express deliveries (receiving and sending), key checkout, and other building and maintenance reporting. She is also responsible for all Nichols Hall conference room scheduling and updates on the Web site. She became an official ITTC employee in 1999 after 18-and-a-half years as the Nichols Hall receptionist and secretary to the manager of research facilities at Nichols. She has more than 25 years of office experience with positions at a local real estate office and other departments at KU.

Marilyn Cozad, Software Engineer

Marilyn Cozad is a software engineer at ITTC. She has worked on the VidWatch project and new software development since joining the Center in January 2001. She has focused on the documentation and development of an IP tracking program. Before coming to ITTC, Cozad was an accountant. She received bachelor's degrees in accounting and in computer information systems, both from Washburn University.





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Daniel DePardo, RF Electronics Engineer

Dan DePardo supports the Center's Wireless Communications and Digital Signal Processing Lab. His areas of expertise include Radio Frequency and Microwave circuit design and testing, SAW (Surface Acoustic Wave) technologies, photolithography, prototype fabrication, hybrid and surface mount device technologies, environmental testing, Mil-spec soldering and assembly, as well as RFI (radio frequency interference) and EMI (electro-magnetic interference) suppression techniques. He studied at the U.S. Army Intelligence Center and graduated from the Aerial Surveillance Sensors School, while co-attending the University of Arizona. During his tours of duty, he supported various airborne electronic warfare systems and provided technical support for the Army's Electronic Proving Ground. After his discharge, he worked for a variety of defense electronics organizations.

Michelle Ferguson, Student Office Assistant

Michelle Ferguson is ITTC's student office assistant. Her duties include word processing, copying, filing, answering telephones, faxing, updating spreadsheet and database files, assisting with managing office supplies, occasional errands on and off campus, sorting mail, various creative endeavors to support public relations activities in Nichols Hall, and assisting professors with various requests. The social welfare major, from Liberal, joined ITTC in January 2002. She plans to graduate in May 2005.



Annie Francis, Office Specialist



Donnis Graham, Office Manager, RSL

Donnis Graham has been with the Radar Systems and Remote Sensing Lab (RSL) since 1987. She manages general office tasks, coordinates lab purchasing and payroll, plans travel, organizes conferences, and edits all published articles and technical reports. She has also assisted faculty with the editing of an international professional newsletter and a conferencerelated special issue of a geophysics journal. She has been a technical editor for more than 35 years. Her career has included coordinating marketing for the subsidiary of a large corporation, managing the office and teaching religious school for a small synagogue, and editing positions including ones at a research division of Yale University and at The Johns Hopkins University Press. She received a bachelor's degree in social work from KU after completing more than 90 hours toward a bachelor's degree in English.



Ying Gu, Software Engineer



Nancy Hanson, Secretary for Applied Technology

Nancy Hanson tracks external funding of ITTC projects and provides support for technology transfer operations and Advisory Board-related activities. She also provides support for ITTC publications, including layout design, graphics, and copy editing for the Annual Report and newsletters. She has a bachelor's degree in Spanish from Washburn University, in Topeka, and has studied art and design at KU. She joined CECASE in January 1993, after several years as secretary for KU Center for Research's Flight Research Laboratory.



Michael Hulet, 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 electronic 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 Riverside, Calif., before joining ITTC.

Ed Komp, Research Engineer

Ed Komp joined ITTC in September 1998. He 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 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. Cadence Design Systems eventually purchased the start-up company that Komp co-founded. He stayed with the company and continued to specialize in graphical simulation tools.



Danico Lee, Software Engineer



Danico Lee became a full-time software engineer with ITTC in January 2002. She will continue to work on the development and administration of the client-server tracking system (known as "Phoenix") for intellectual property and research projects. She started at the Center in 1998, as an undergraduate. After earning her degree, she taught JAVA at KU for a year before deciding she wanted to return to the Center. She rejoined ITTC as a graduate research assistant in May 2000 and has worked on such projects as DiscoverMe and Phoenix.

Kelly Mason, Office Specialist for PRISM Project

Kelly Mason became the office specialist for PRISM in May 2002. Her main duties include tracking the budget for PRISM and other projects. She earned her bachelor's degree from Trinity University in San Antonio, Texas, and was a graduate teaching assistant at KU while working on her Ph.D. in English. After graduating in 1997, she moved to Austin, where she worked with the Texas Youth Commission.



Leon Searl, Software Research Engineer

Leon Searl works on multiple projects at ITTC, including Space Based Internet (SBI), Autonomous Negotiating Teams (ANTS), and the Ambient Computational Environment (ACE) project. He returned to a familiar place when he accepted the position of software research engineer at ITTC. Searl worked at TISL (Telecommunications and Information Sciences Lab, a predecessor of ITTC) while he was an electrical engineering student. 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.

Michelle Ward, Public Relations Coordinator

Michelle Ward became the full-time marketing and public relations manager in August 2002. She joined ITTC in June 2001, as an intern. Ward manages ITTC's publicity with local news media and State and industry contacts. She publishes the newsletters and the annual report and writes press releases and newsletter articles.



Peggy Williams, Program Assistant



Peggy Williams became the program assistant to the ITTC director in February 2002. She aids Victor Frost in the daily operations and strategic development of the Center. Her responsibilities include recruitment and coordination processes for ITTC's staff. She also tracks and monitors fiscal information and is involved in special events planning. Williams joined ITTC in March 1997, as a research secretary.

Faculty Awards, FY2002

A number of ITTC faculty and staff have earned awards this past year.

ITTC Director **Victor Frost** and Executive Director for Applied Technology **Tim Johnson** were both selected for the "Tech 50" list compiled by *The Kansas City Star*. The paper noted that ITTC facilitated the founding of the Lawrence Technology Association and that the Center partners with area technology businesses. Both Frost and Johnson have been with ITTC since its inception.

"KU is very proud of ITTC and its faculty and staff," says KU Chancellor Robert Hemenway. "Victor and Tim are clearly nationally recognized experts in information technology; and, together with their colleagues, they have brought national attention to KU. The University plays an important role in establishing a high-tech environment for economic development in Kansas and the Kansas City area."

Prasad Gogineni, Deane E. Ackers distinguished professor of electrical engineering and computer science (EECS), received a Fulbright Scholar Award (one of 11 Fulbrights awarded to KU faculty in academic year 2001–2002) for his research in radar systems and remote sensing. As part of the award, he conducted research at the University of Tasmania's Antarctic Cooperative Research Center in Hobart, Tasmania, Australia, from the end of August through early December 2002. His collaboration with Tasmania will enhance the innovative research and development being carried out for the PRISM (Polar Radar for Ice Sheet Measurements) project. For more information on PRISM, please see page 33.

Gogineni also received an award during commencement in spring 2002. He was honored with the University of Kansas Louise E. Byrd Graduate Educator Award for 2002. The award honors a faculty member who demonstrates extraordinary devotion to graduate students and graduate education, as well as distinguished scholarship.

Jim Roberts, associate vice chancellor and professor of EECS, was elected a Fellow of the Institute of Electrical and Electronics Engineers (IEEE). The grade of Fellow is reserved for those engineers who demonstrate outstanding proficiency and achieve distinction in their profession. Roberts is affiliated with the Wireless Communications and Digital Signal Processing Lab at ITTC. He is the associate vice chancellor for research and public service at KU, and vice president of the KU Center for Research, Inc. Roberts is the seventh ITTC faculty member to be named an IEEE Fellow.

Other faculty members who received awards from the University in spring 2002 are as follows:

Chris Allen, associate professor of EECS, was recognized for his teaching with the John E. Sharp and Winifred E. Sharp Teaching Professorship, which honors an outstanding educator. This award expands Allen's long list of honors already received for teaching and research at KU.

Ron Hui, associate professor of EECS, received the Miller Professional Development Award for Research. He has worked on numerous research projects at ITTC, including acting as the sole principal investigator on eight projects that total \$1.5 million. Since joining KU in 1997, he has filed for seven U.S. patents and written 11 journal papers and eight refereed conference papers.

Gary Minden, professor of EECS and ITTC's executive director for research/chief technologist, earned the Miller Professional Development Award for Service. Minden received the honor for his work that promotes the University's reputation on a national scale. He has served on more than five distinguished technology advisory commissions, including the U.S. Commission on Spectrum Management. Minden has worked with the Department of Defense to develop policies on future research initiatives for communications and information technology.

Bozenna Pasik-Duncan, professor of mathematics, won the Frank B. Morrison Teaching Award from KU's College of Liberal Arts and Sciences. The mathematics professor received the honor for distinguished teaching that has greatly impacted the lives of her students. She is affiliated with ITTC's Intelligent Systems and Information Management Laboratory (ISIML). This is only the second year for the award, established by former chancellor Gene Budig and his wife Gretchen to honor Frank B. Morrison, former governor of Nebraska.

John Gauch, associate professor of EECS, received the Bellows Scholar Award for the second time. He first earned the honor in 1999 and claimed it again this past spring.

A number of ITTC faculty also won Miller Faculty Development Awards. Recipients included Frost, Gogineni, Perry Alexander, Jerzy Grzymala-Busse, and Kim Roddis.

"Being at KU as a faculty member and administrator afforded me the opportunity to work with students, faculty (including IEEE Fellows), and IEEE Fellows around the country and to accomplish some things that enabled me to be nominated [as an IEEE Fellow]. I was tremendously gratified with the support that colleagues at KU and around the country provided."

—Jim Roberts, IEEE Fellow, 2002

Arvin Agah, Associate Professor, EECS

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 Henry E. Gould Award for Outstanding Teaching, 2000; Miller Scholar (School of Engineering), June 2001; Engineering Expo 2001 Educator Award, February 2001.

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Research Interests:

- Autonomous mobile robots for harsh environments
- Distributed robotics
- Human-machine interactions
- Multi-agent systems
- Intelligent user interfaces

W. Perry Alexander; Associate Professor; EECS Education: Ph.D., Electrical I

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

Honors and Awards include KU School of Engineering Miller Faculty Development Award, 2002; Harry Talley Teaching Award, KU EECS Department, 2002; Center for Teaching Excellence Honoree, 2002; KU Engineering Expo EECS Department Teaching Award; Senior Member of

Research Interests:

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

IEEE; University of Cincinnati (UC) College of Engineering Neil A. Wandmacher Teaching Award; UC ECECS HKN Professor of the Year, 1992– 93 and 1996–97; UC Engineering Tribunal Professor of the Quarter, winter 1994 and fall 1998; UC ECECS Department Research Award; UC ECECS Department Teaching Award.

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Christopher Allen, John E. Sharp and Winifred E. Sharp Associate Professor, EECS

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, high-speed digital circuit design, microwave remote sensing.

Honors and Awards include Eta Kappa Nu; Phi Kappa Phi; Tau Beta Pi; Sharp Teaching Professorship, 2002–2005; Miller Scholar for FY2002 for Teaching, Research, and Service; W.T. Kemper Fellowship Award for Excellence in Teaching, 2001; Ned N. Fleming Trust Award for

Excellence in Teaching, 2001; KU Miller Award for Research, 1999; KU EECS Harry Talley Excellence in Teaching Award, 1998; recognized by the Center for Teaching Excellence for excellence in the classroom, 1998.

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



Victor Andrade, Postdoctoral Research Associate



- Education: Ph.D., Physics, University of Kansas, 2002
 - M.S., Computational Physics and Astronomy, University of Kansas, 2001 (thesis research on chaotic transients in satellite motion)
 - M.S., Physics, California State University, Northridge, California, 1998 (thesis research on two-microwave field electron spin resonance)

Ph.D. Dissertation: "Effect of Noise on Phase Synchronization of Chaos and Catastrophic Bifurcation from Riddled to Fractal Basins"

Research Interests:

- Remote sensing and rain-cloud modeling
- Controlling chaos in satellite motion
- Phase synchronization of chaotic systems
- Microwave modulation in magnetic resonance

Honors and Awards include National Physics Honor Society, University of Kansas; National Physics Honor Society, California State University, Northridge; American Physical Society, since 1997.

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David L. Andrews, Associate Professor, EECS

Education: Ph.D., Computer Science, Syracuse University, 1992 Computer Engineer 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, compilers, operating systems.

Honors and Awards include 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., Research Interests: 1990.



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

dandrews@ittc.ku.edu

Ronald J. Aust, Associate Professor, Education

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.

aust@ku.edu

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

David A. Braaten, Associate Professor, Physics and Astronomy

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.

braaten@ku.edu



Research Interests:

- Snow accumulation
 - Ice sheet processes
- Remote sensing

Swapan Chakrabarti, Associate Professor, EECS



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).

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

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

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Muhammad Dawood, Research Assistant Professor

Education: Ph.D., Electrical Engineering, University of Nebraska, Lincoln, 2002 M.S., Electrical Engineering, University of Nebraska, Lincoln, 1998 B.E. (Avionics), NED University of Engineering and Technology, Karachi, Pakistan, 1985

Honors and Awards include First Prize, graduate student paper competition, 1999; Best Project Award, undergraduate research project, 1985; Best Performance Award, Radar Technology diploma course, 1980.



- Development of radar and remote sensing systems
- Signal processing and algorithms for parameter estimation.

Daniel Deavours, Research Assistant Professor



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

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Research interests:

- Performance and dependability evaluation
- Markov models and numerical methods
- Discrete event simulation
- Modeling languages
- Software performance
- Sensor networks
- Secure software engineering

Kenneth Demarest, Professor, EECS

Education: Ph.D., Electrical Engineering, Ohio State University, 1980 M.S., Electrical Engineering, 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.

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Honors and Awards include Eta Kappa Nu.

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Research Interests:

- Lightwave communication systems
- Electromagnetic theory
- Antennas

Tyrone Duncan, Professor, Mathematics



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.

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

Joseph B. Evans, Charles E. Spahr Professor, EECS

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 Eta Kappa Nu; Tau Beta Pi; KU Spahr professorship, 2000–2003; KU Miller Award for Research, 1996; AT&T Bell Laboratories Ph.D. Scholarship, 1984–1988; Garden State Graduate Fellowship, 1983– Research Interests: 1987.

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

Victor S. Frost, Dan F. Servey Distinguished Professor, EECS; Director, ITTC



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 Miller Faculty Development Award, 2002; Dan F. Servey Distinguished Professor of Electrical Engineering and Computer Science, 1996; IEEE Fellow; National Science Foundation Presidential Young Investigator Award, 1984; KU Miller Award for Distinguished

Research Interests:

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

Service to Engineering, 1991; KU Miller Award for Distinguished Service to Engineering Research, 1986.

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John M. Gauch, Associate Professor, EECS

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.

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

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

Susan E. Gauch, Associate Professor, EECS



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 include KU School of Engineering Miller Research Award, 1998; ONR Fellowship, 1988; NF Dupuis Prize in Mathematics, 1978.

Research Interests:

- Multimedia databases
- Intelligent search agents
- Information discovery on the World Wide Web
- Corpus linguistics

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Sivaprasad Gogineni, Deane E. Ackers Distinguished Professor, EECS

Education: Ph.D., Electrical Engineering, University of Kansas, 1984 M.S., Engineering, Kerala University, Trivanfrum, India, 1976 B.E., Mysore University, India, 1973

Teaches radar systems, microwave engineering, Electromagnetics II, senior design lab, electronics design lab, and others as required.

Honors and Awards include Fulbright Scholar, 2002; Louise E. Byrd Graduate Educator Award, 2002; Miller Faculty Development Award, 2002; NASA Group Award to Antarctic Mapping Mission, 2000; KU Miller Award for Outstanding Service, 2000; IEEE Fellow, 1999; NASA Terra Award,

1998; Best-of-Session Award from the Third International Airborne Remote Sensing Conference, 1997; KU Miller Award for Engineering Research, 1991; Taylor and Francis Best Letter Award, 1991.

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Research Interests:

- Radar systems
- RF and microwave engineering
- Radar remote sensing
- Microwave radiometers

Jerzy Grzymala-Busse, Professor, EECS



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 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 Miller Faculty Development Award, 2002.

Research Interests:

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

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Ronguing Hui, Associate Professor, EECS

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 Miller Professional Development Award for Research, 2002.

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Research Interests:

- Fiber-optic communications
- Photonic devices
- Optical sensors

Jeremiah James, Assistant Professor, EECS



Education: Ph.D., Computer Science, University of California at Santa Barbara, 2000 M.S., Computer Science, Brigham Young University, 1993 B.S., Computer Science, Brigham Young University, 1992

Teaches advanced operating systems, programming.

Honors and Awards include UCSB Computer Science Department Travel Scholarship, 1995, 1996, and 1998; UC Trustee's Fellowship, 1993–1997; NSF Fellowship, Honorable Mention, 1993; Phi Kappa Phi National Honor Society, 1991; Golden Key National Honor Society, 1990.

Research Interests:

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- Distributed systemsConcurrent objects
- Data consistency
- Fault tolerance
- Distributed system models

Pannirselvam Kanagaratnam, Postdoctoral Research Associate

Education: Ph.D., Electrical Engineering, University of Kansas, 2002 M.S., Electrical Engineering, University of Kansas, 1995 (thesis research on high-resolution radar backscatter from sea ice and

- range-gated step-frequency radar using the FM-CW concept)
- B.S., Electrical Engineering, University of Kansas, 1993

Ph.D. Dissertation: "Airborne Radar for High-Resolution Mapping of Internal Layers in Glacial Ice to Estimate Accumulation Rate"

Honors and Awards include Honors for Ph.D. dissertation, May 2002; NASA Fellow 1998–2001; Honors for Master's thesis, December 1995; Dean's Honor Roll, Fall 1992.

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- Radar system
- RF and microwave engineering
- Radar remote sensing
- Geophysical signal processing

Stephen P. Lohmeier; Assistant Professor; EECS



Education: Ph.D., Electrical Engineering, University of Massachusetts, 1996 M.S., Electrical Engineering, University of Massachusetts, 1992 B.S., Electrical Engineering, Kansas State University, 1989

Teaches control systems, electromagnetics, adaptive arrays, digital signal processing.

Honors and Awards include Tau Beta Pi.

lohmeier@ku.edu

Research Interests:

- Radar
- Remote sensing
- Wireless communication
- Antennas and propagation

Ed Meyen, Professor, Special Education

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

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

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Research Interests:

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

Gary J. Minden, Professor, EECS



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 Miller Professional Development Award for Service, 2002; KU Miller Scholar, 1999 and 2000.

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Research Interests: Large-scale systems, including

- Wide-area distributed systems
- Mobile communication systems
- Adaptive computational systems
- Active networking

Richard K. Moore, Distinguished Professor Emeritus, EECS

Ph.D., Electrical Engineering, Cornell University, 1951 Education: 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). •



Research Interests:

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

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R. Douglas Niehaus, Associate Professor, EECS



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 software engineering, concurrent and distributed software development, introduction to operating systems, compiler construction, distributed operating systems, advanced operating systems topics.

Research Interests:

- High-performance networks
- Network simulation and performance evaluation tools
- Real-time systems
- Distributed and operation systems

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Bozenna Pasik-Duncan, Professor, Mathematics

Habilitation Doctorate degree, Mathematics, Warsaw School of Economics, 1986 Education: Ph.D., Mathematics, Warsaw School of Economics, 1978 M.S., Mathematics, Warsaw University, 1970

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

Honors and Awards include Frank B. Morrison Teaching Award, 2002; IEEE Control Systems Society Distinguished Member Award, 2002; Leader, China Control Systems Delegation, 2000; Tau Beta Pi; Fellow of IEEE; NSF Career Advancement Award for Excellence in Teaching; Ministry

of Higher Education and Sciences, Poland; several Chancellor's Awards for research and teaching, Warsaw School of Economics; IREX Scholar to the United States, 1982; Kemper Fellowship for Teaching Excellence and Advising in Public Outreach; G. Baley Price Award for Excellence in Teaching; IEEE Third Millennium Medal for Outstanding Contributions to IEEE Control Systems Society.

bozenna@math.ku.edu http://www.math.ku.edu/ksacg/bozenna.html

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



David Petr, John E. Sharp and Winifred E. Sharp Professor, EECS



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

Honors and Awards include KU School of Engineering Sharp Teaching Professorship, 2000-2002; Visiting Erskine Fellowship, University of Canterbury, New Zealand, 2000; Excellence in

Research Interests:

- High-speed, wide-area networks
- Network traffic and congestion management
- Traffic integration for networks
- Performance analysis and simulation
- Evaluation of students' confidence in answers
- Digital signal processing for medical applications

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; Ben Dasher Best Paper Award for the ASEE/IEEE Frontiers in Education conference, October 2000.

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Glenn Prescott, Professor, EECS

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; KU School of Engineering Sharp Teaching Professorship, 1998–2001; NASA Terra Award, 2000.

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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

James Roberts, Associate Vice Chancellor; Professor, EECS



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

Teaches wireless communication systems, information theory, and communication system planning and design.

Honors and Awards include IEEE Fellow, 2002; Tau Beta Pi; Eta Kappa Nu; Sigma Xi; American Men and Women of Science; Who's Who in Science and Technology; Who's Who in the Midwest; Federal Government Distinguished Station Award (team award), 1987.

Research Interests:

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

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W. M. Kim Roddis, Professor, Civil Engineering

Ph.D., Civil Engineering, Massachusetts Institute of Technology, 1989 Education: M.S., Civil Engineering, Massachusetts Institute of Technology, 1987

B.S., Civil Engineering, Massachusetts Institute of Technology, 1977

Teaches structural steel design, structural analysis, knowledge-based expert systems.

Honors and Awards include Miller Faculty Development Award, 2002; National Special Achievement Award for Web-Enhanced Teaching of Steel Design, American Institute of Steel Construction, 2002; KU Docking Scholar, 1999; KU School of Engineering Bellows Fellow, 1999; American Society of Civil Engineers Fellow, 1997; KU School of

Engineering Miller Award for Research, 1997; Fannie and John Hertz Fellow, 1986–1988; American Institute of Steel Construction Fellowship, • 1987; American Society of Civil Engineers O.H. Ammann Research Fellow, 1986.

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Research Interests:

- Design, fabrication, and construction engineering processes
- Applications of artificial intelligence to civil and structural engineering
- Design of computer-aided tools for civil engineering
- +++

Hossein Saiedian, Professor and Associate Chair, EECS



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 KC metropolitan audience.

Honors and Awards include Senior Member of IEEE; IEEE Certified Software Development Professional, 2002; Excellence in Teaching Awards, University of Nebraska at Omaha, 2000;

Research Interests:

Software engineering, including

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

shanmugan@ittc.ku.edu

Distinguished Research Award, University of Nebraska at Omaha, 2000; top 10 software engineer scholars list, Journal of Systems and Software, 1998.

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K. Sam Shanmugan, S.W. Bell Distinguished Professor and Acting Chair; EECS

Ph.D., Electrical Engineering, Oklahoma State University, 1970 Education: 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 H.O.P.E. 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 Research Interests:

Award, 1979.

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



James Stiles, Associate Professor, EECS



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 Interactive Session Prize Paper Award, IEEE Geoscience and Remote Sensing Society, 2002; KU School of Engineering Miller Award for Distinguished Research, 2001; KU EECS Harry Talley Teaching Award, 2000.

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

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Costas Tsatsoulis, Charles E. Spahr Professor, EECS

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; Big-12 Faculty Fellowship; State of Kansas AT&T Engineering Education Excellence Award; KU Miller Award for Research Excellence; Bellows Fellowship, 1999; Senior Member of IEEE, 1998.

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Research Interests:

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

Victor L. Wallace, Professor Emeritus, EECS



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

Taught computer operating systems, interactive graphics, programming languages, and other computer science subjects.

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.

Research Interests:

- Interactive graphics, virtual reality, and human interface design
- Distributed and real-time systems (scheduling and load balancing)
- Network performance modeling (analytical models of correlated traffic and queues)
- Queuing theory for wide-band and multimedia computer networks
- Operating systems theory

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ITTC lists among its goals the preparation of future technology professionals. While this education and training usually take place within Nichols Hall, the PRISM—or Polar Radar for Ice Sheet Measurements—project, funded by the National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA), has a much wider scope. While its primary objective is to develop a radar system for polar research, the program includes a strong public outreach portion, in collaboration with KU's Center for Research on Learning and Haskell Indian Nations University.

The current outreach is heavily Web based and gives the public opportunities to learn more about conditions in Greenland and Antarctica, climate change, and global weather. The PRISM Web site, www.ku-prism.org, provides information on radar and robotics as well, said **Jennifer Holvoet**, a research associate professor with KU's Center for Research on Learning (CRL). The outreach portion will target kindergartners through 12th graders, science and technology journalism students, and the general public.

"For all groups, our goal is to show that science and technology research is exciting and that sea level rise is potentially an important global problem that is linked to the polar ice sheets," said **David Braaten**, coordinator of the outreach program and an associate professor of physics and astronomy at KU. "A specific goal for our general public outreach is to show that the research being conducted by PRISM is important and a good investment of taxpayer money."

Prasad Gogineni, Deane E. Ackers distinguished professor of electrical engineering and computer science, secured grants in late 2001 for the PRISM project, which will measure ice thickness and determine bedrock conditions of the polar ice sheets. The radar, developed at KU, will help scientists better monitor the ice sheets' activities and their possible contribution to rising sea levels.

As part of PRISM's public outreach, CRL is providing teaching materials and lesson plans that include activities and aspects of the polar regions to enhance science and technology education throughout the nation. The Polar Explorer link (from the PRISM Web site) provides K–12 lesson plans designed to meet specific national academic standards. Members of the CRL staff are planning to attend teacher conferences such as the national and regional conferences of the National Science Teachers Association to make teachers aware of the PRISM teaching tools, Holvoet said.

Schoolchildren will follow the PRISM team to Antarctica by using a Virtual Rover being developed. Students will see the environment in the field through an almost-live video feed that will provide facts such as air temperature, wind velocity, global positioning coordinates, and ice thickness. They will be able to use the data to track the rover and learn more about the polar regions. The data will be available on the PRISM site along with environmental news about the Arctic and Antarctic.

Haskel Indian Nations University (HINU) will provide additional information through its Geographic Information Systems (GIS) Laboratory. Haskell has had the lab for some time but had been unable to update it, said **Carol Bowen**, department chair in mathematics at HINU. With PRISM funds, faculty and students returned the lab to a functional level and have continued to upgrade its equipment. They are using the facility to participate in PRISM-related research, including analyzing PRISM data and transforming it into information that can be understood by the general public. Braaten hopes this partnership will get Haskell students interested in graduate school, possibly at KU.

Bowen already sees students flourishing in Haskell's GIS laboratory. "We have talented students. **John Young**, former HINU student from the Seneca tribe, is taking undergraduate courses in KU's geography department," Bowen says. "He is our system administrator and a GIS guru. John is considering a master's degree after he finishes a bachelor's degree at KU. We also have two younger students, **Chris Drymon**, from the Navajo tribe, and **Chris Jefferson** from the Crow tribe. Both "Chrises" are learning GIS by working on projects in HINU's lab while supporting student drop-ins. We



hope to teach GIS skills to more Haskell students over the duration of the grant."

The PRISM project, which is to continue through 2005, will develop the radar to educate scientists about the ice sheets' behavior. At the same time, the project's collaborators will educate young people, future journalists, and the general public.



Jennifer Holvoet, a research associate professor with KU's Center for Research on Learning (CRL), and ITTC graduate student Radhakrishnan Mukkai work together on the Polar Radar for Ice Sheet Measurement (PRISM) Web site. The two are creating the site as part of the project's public outreach program.

KU student Hans Harmon, research associate professor Jennifer Holvoet, associate professor of EECS Arvin Agah, and KU student Richard Stansbury check over MARVIN, the ATV(all-terrain vehicle) that will pull PRISM's radar equipment in Greenland and Antarctica. "MARVIN" stands for "mobile autonomous robotic vehicle for ice navigation."

III-Nitride Wide-Band Gap Semiconductors for Optical Communications—Collaborating Kansas Universities

An unlikely partnership has developed between two in-state rivals. While KU and Kansas State University (KSU, or K-State) are foes on the basketball court and the gridiron, they are allies in developing the latest communication technology.

This KU-KSU association began as ITTC researcher **Ron Hui**, KU associate professor of electrical engineering and computer science, searched for a III-nitride producer to develop his optical packet switch. Hui needed the compound to make the device. III-nitride, a natural semiconductor that combines any two elements from the periodic table's third row with nitride, would be the ideal material for the project, Hui said. While the switch could help manage volumes of information that present switches are not fast enough to handle, KU could not produce the substance. This left the researcher searching for a collaborator, whom he found just down the interstate in Manhattan.

Hui teamed with KSU physicists to present a grant proposal to the National Science Foundation (NSF). The Foundation awarded the researchers a three-year, \$400,000 grant in October 2001, which will support the III-Nitride Wide-Band Gap Semiconductors for Optical Communications project.

"We know the applications, but they know the physics of the material," Hui said. "I knew this device could improve optical system performance but didn't know how to make it. They know the fundamentals of the material but didn't know how to use it."

Lin Jingyu, associate professor of physics at K-State, said the partnership was a perfect match between the two schools. The work put together experts in their respective fields to improve communication, Jingyu said. He added that the new research would be groundbreaking work and applications would include full-color displays, traffic signal lights, and solid-state lighting for the home, which saves energy.

"As far as we know, this is the first project to utilize III-nitride semiconductors for optical communication devices," Jingyu said.

The switch, produced in ITTC's Lightwave Communication Systems Lab, would increase the speed of communication. Optical switches could redirect messages without converting them back to electronic format. The conversion causes messages to be delayed and to shrink because of electronic limitations, Hui said.

The III-nitride switches would redistribute messages from the incoming fiber to different external networks. The switch could do this because of its controllable nature that allows Hui to change the percentages of each element within the material. Hui can control the refractive index and determine the amount of light or information that passes through the optical switch. It would take a nanosecond, a billionth of a second, to complete this transfer of information to another network and then on to the receiver.



Ron Hui, an ITTC faculty investigator; works in the Lightwave Communication Systems Lab on his III-nitride project. He is developing an optical switch with the compound that will maximize network efficiency. KU does not produce III-nitride, but Hui found his collaborator in the Kansas State University physics department.

Wireless Smart Devices and Their Coordination

Partnerships built at ITTC endure long after students earn their degrees from the University. The Center's collaborative nature lends itself to faculty and former students' continuing their research efforts together, as in the case of Ambient Computing, Inc. The company has ties to the ITTC present and past, with **Joseph Evans**, director of the Networking and Distributed Systems Lab, and **Benjamin Ewy**, an ITTC alumnus, among its founders. The start-up company, created in 2000, received a research grant in January 2002 from the National Science Foundation. The NSF money allowed for the continued development of intelligent wireless devices, and ITTC helped in the system evaluations of these smart wireless devices through a sub-award from the company. **Victor Frost**, ITTC director, aided the company in the advancement of the connected and coordinated systems.

"The NSF grant has enabled us to create proof-of-concept systems that utilized our technology innovations. ITTC has a number of great resources that helped with the testing and analysis of these cutting-edge systems," Ewy said.

The company concentrates its efforts on commercial applications of easy-to-use intelligent wireless devices. Initially, Ambient Computing focused on creating devices to control environmental factors such as temperature and humidity. Through the NSF Small Business Innovation Research grant, researchers built energy management systems that give users greater control and flexibility than conventional systems.

"We developed the energy management application because, unlike many network appliance concepts, everyone knows what a thermostat is, and by enabling significant energy savings there is a rapid return on investment for the customer," Ewy said.

Ambient Computing is focused on delivering technologies that make complicated systems easy to use. They are using a variety of technologies to do this—wireless connectivity, smart devices with processing capabilities, sensors, and software that coordinates these technologies and provides support for preferences, location awareness, and security. Members of the Ambient Computing team were well prepared to work in these disparate areas; they gained extensive experience designing and implementing wireless hardware and software while at ITTC.

"By integrating these techniques, we are making it easier for customers to use and manage their informationbased devices," Evans said.

Ambient Computing, Inc. will continue development of wireless smart devices during the next year. Work will focus on the creation and evaluation of OEM (original equipment manufacturer)-ready modules for wireless sensors and controls, and their continued application to environmental solutions, industrial sensors, and security. In addition, the company is using its expertise in wireless technology and software infrastructure to help Kansas network providers deploy new services.

By leveraging its relationship and experiences with ITTC, Ambient Computing is well positioned to be a success in the emerging wireless marketplace.





The above graphic highlights the control and flexibility that users will have with smart devices. With this Ambient Computing creation, people can change their thermostat settings from any computer. The company hopes to have this device on the market in 2003 with the help of a grant it received from the National Science Foundation. ITTC will help with the systems evaluations through a subcontract.

Ben Ewy, co-founder of Ambient Computing, Inc., holds a proofof-concept, smart, wireless device. ITTC alumnus Ewy and Joseph Evans, director of the Networking and Distributed Systems Lab, established the company in 2000.

Using Case-Based Reasoning (CBR) to Identify and Correct Errors in Integrated Waybills

"The BNSF personnel working on this project were pleased with the overall results of the project. It was an exciting experience to be able to work with others not familiar with the business but knowledgeable of the techniques being applied to the business problem. We look forward to any initiative that might bring groups like this together." 3/4 Kevin Benson, Manager; Revenue Process Development, BNSF

ITTC researchers collaborated with Burlington Northern and Santa Fe Railway Company (BNSF), of Topeka, Kan., to solve the corporation's billing challenges. The large railway, which runs through Kansas, transports products into 28 states and Canada. BNSF must track numerous cars' movements and accurately chart the accounts payable and receivable information. To deal with its abundance of information, the company enlisted the help of **Costas Tsatsoulis** and ITTC's Intelligent Systems and Information Management Lab (ISIML).

Tsatsoulis, the director of ISIML, and graduate students **Brent Stephens** and **Todd Blackman** met with representatives from BNSF to discuss problems with the billing. The exchange had the ITTC researchers wading through unfamiliar jargon that needed explaining. The burgeoning partnership brought together two distinct worlds: the railway industry and IT research. They had to help each other understand each other's capabilities and limitations.

"It was very exciting to be working on a project that had the potential to become an operational system for a large corporation," Tsatsoulis said. "The people at BNSF were very knowledgeable in the technologies we were developing and were extremely supportive. It was a pleasure working with them, since they were dedicated to the success of the project."

Stephens said he received an introduction into the real-world difficulties that people at BNSF faced. They still had to meet the demands of their normal workload while helping researchers with data requests and providing them with face-to-face meetings. ITTC met its deadline successfully because of the patience and generosity of people at BNSF, Stephens said. He added that he learned how the development process worked at a non-computer-based company and how to work within it.

"There is definitely something of a communication gap when you are trying to develop an application with people who know so much about their field and are used to talking in corporate lingo," Stephens said. "They were very help-ful in communicating their needs and teaching us enough to really understand the problem we were trying to help them overcome."

The ITTC group developed artificial intelligence software that allowed for a reduction in human error with the intricate billing system. The prototype software eliminated discrepancies in 67 percent of the cases. While the software was adapted mainly from other projects, the group still went through a number of revisions. Blackman and Stephens worked together to decipher large amounts of data. After detecting the problems, the students developed the software under Tsatsoulis' direction. Stephens said that while the three had different schedules and skills, they worked together to find the solution for BNSF.

"I found that getting good results from our efforts was a very good feeling," Blackman said. "Using any artificial intelligence technique to solve a real problem interests me. It's exciting to apply things you've learned and found interesting at the time of learning."



Graduate students Todd Blackman (left) and Brent Stephens meet to discuss their project sponsored by Burlington Northern Santa Fe Railway. Under the direction of Costas Tsatsoulis, director of ITTC's Intelligent Systems and Information Management Lab, the two developed artificial intelligence software to help the company with billing challenges.

Biodiversity Information Organization Using Taxonomy (BIOT)

ITTC Associate Professor **Susan Gauch** has teamed up with the Biodiversity Research Center at KU's Natural History Museum for the "Biodiversity Information Organization Using Taxonomy (BIOT)" project. The NSF-funded project, which began in January 2002, is allowing Gauch and her students **Devanand Ravindran** and **Kiran C.V.S. Kumar** to develop a search engine that will help users pinpoint specific biodiversity information online. Currently, the vast quantity of Web sites makes finding information about a particular species an arduous task, with much of the available information being missed.

Biodiversity, which includes all living things, their behavior, and interactions, encompasses a tremendous amount of information. Web sites providing this information do not take into account users' needs and levels of expertise. A fifth-grader searching for information on butterflies for a homework assignment has much different needs than an entomologist searching the same topic. By identifying and developing the applicable intelligent knowledge management tools, the BIOT research team aims to help users navigate the sea of information effectively.

"People searching for species information on the Internet are from different walks of life," says Ravindran, one of the graduate students conducting the research. "The BIOT project aims to tailor itself to each user according to his or her needs."

The ITTC team is developing the BIOT search engine to adapt its information to comply with users' age, level of expertise, and amount of information required. When users log on to the BIOT site, www.ittc.ku.edu/BIOT/, they must answer questions about these three fields so they may receive the appropriate information. The BIOT classification system will further categorize information according to its format, level of detail, and quality and timeliness of data. It will also associate biodiversity information with the appropriate taxonomic category.

James S. Ashe, professor of entomology/ecology and evolutionary biology and senior curator of the KU Natural History Museum, and his graduate students assist ITTC researchers on the BIOT project. The Natural History Museum provides the biological expertise needed for the project, Ravindran says. When a question arises about a species' classification, Ashe and his students determine the correct category.

"Teaming with the Natural History Museum has allowed us to gain a real understanding of how the taxonomy is built and how it is used," Gauch says. "When developing applications for use in another domain, it is crucial to have experts from that domain to guide you."

Gauch believes this ITTC and KU Natural History Museum collaboration is laying the foundation for further multidisciplinary research at the University.

Susan Gauch, an associate professor of electrical engineering and computer science, works on a diagram for her BIOT project. Gauch and her graduate students, with the help of the KU Natural History Museum, are developing a search engine that will help users find the specific, valuable biodiversity information that they need. The BIOT Web site is www.ittc.ku.edu/BIOT/.



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AAL2 Call/Connection Control Signaling Sprint Corp. J. Evans Acquisition of Equipment to Support Lightwave and Microwave Research National Science Foundation (NSF) C. Allen, with S.P. Gogineni, G. Prescott, R. Hui Advanced Semiconductor Research Group in the State of Kansas Kansas State University K. Nordheden, with R. Hui Ambient Computational Environments (ACE) Sprint Corp. J. Evans, with A. Agah, V. Frost, J. James, G. Minden Architecture and Prototype of an Ambient Computational Environment Defense Advanced Research Projects Administation (DARPA) G. Minden, J. Evans, with A. Agah, J. James Architecture for Space Based Internets (SBI) National Aeronautics and Space Administration (NASA) G. Minden, with J. Evans ATM Call Model for Traffic Engineering Sprint Corp D. Petr, with S. Chakrabarti, V. Frost Autonomous Mobile Radar for Temperate Ice Thickness Measurements Kansas NASA EPSCoR A. Agah Biodiversity and Ecosystem Informatics (BDEI): Biodiversity Information Organization Using Taxonomy (BIÓT) NSF S. Gauch **Broadband Wireless Local Loop** Sprint Corp. J. Evans CAREER/EPSCoR: Cooperative Agents for Conceptual Search and Browsing of World Wide Web Resources NSF-EPSCoR S. Gauch **Case Reflective Negotiation Model** U.S. Air Force C. Tsatsoulis, with R.D. Niehaus, J. James Center for Excellence Kansas Technology Enterprise Corporation (KTEC) T. Johnson Characterize API for Real-Time Computing Systems and Test upon Processor Upgrades (CART) EDAptive Computing, Inc. W.P. Alexander CISE Research Infrastructure: Ambient Computational Environment NSF Computer and Information Science Enbineering (CISE) G. Minden, with A. Agah, F. Brown, J. Evans, S. Gaučh, Tsatsoulis CISE Research Instrumentation: Ambiguity Resolution for Intelligent Systems Using a Cognitive Robot NSF F. Brown, with A. Agah, J. Gauch, T. Schreiber Complexity, Implementation, and Management Trade-Offs for Traffic Aggregation in Future Networks Sprint Corp V. Frost, with J. Evans, J. James, R.D. Niehaus Computer Generation of True 3-D (T3D) View for Medical Images BioComp Systems J. Gauch Determination of the Impact of Advanced Traffic Controls on the Performance of Edge/Core ATM Network Architectures Sprint Corp. V. Frost Determining Fiber Plant Characteristics Using Measurement and Modeling Sprint Corp. K. Demarest

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