

T h e U n i v e r s i t y o f K a n s a s

**Information and Telecommunication
Technology Center**



Annual Report
Fiscal Year 2003

The ITTC *V*ision

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.

Our Focus is Your Future!

The ITTC *M*ission

- 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.

The Information and Telecommunication Technology Center (ITTC) is a KTEC Center of Excellence, funded in part by the Kansas Technology Enterprise Corporation. ITTC is a division of the University of Kansas, which is an entity of the State of Kansas separately managed and distinct from the Kansas Technology Enterprise Corporation.

Photographs on the Cover

❖ The background photo is an aerial view of the Greenland mountain range. It was taken by Dennis Sundermeyer, ITTC's electronics technician for the PRISM project, from the window of a C-130 airplane as the ITTC team arrived in Greenland on June 24, 2003.

❖ The inset photo on the front cover shows ITTC's 802.11b wireless network setup on the ice sheet in Greenland. The photo was taken at midnight, July 13, 2003, by ITTC graduate student Nandish Chalisehar. (Note: That's the sun in the upper left corner.)

Director's Welcome



Welcome to ITTC's FY2003 Annual Report, and thank you for your interest in the Center. We have had another productive, successful year and would like to share with you some of its highlights. Our associated faculty and staff continue in their leadership roles within the technical community at both the national and regional levels. Their work has prompted us to focus on **leadership** as the theme for this Annual Report.

In the following pages, we will feature ITTC-affiliated faculty who have managed research programs at NASA and DARPA, helping set the national research agenda. This tradition continues with Professor **Joseph Evans'** two-year tour as a program director with NSF, beginning in August 2003.

The Center's researchers also have participated on national advisory boards. **Gary Minden**, for example, recently chaired the DoD's Defense Science Board task force. His group's report offered recommendations for future wireless research and development areas. **Prasad Gogineni** is part of an expert panel identifying new technologies needed for the successful implementation of NASA's Earth Science Enterprise (ESE) research strategy in the next decade and beyond.

Our expertise has led elite organizations such as the Bluetooth Special Interest Group (SIG) to seek out our services. ITTC became an independent testing facility for the evaluation of the interoperability of this new wireless communication technology. The SIG is a trade association that is driving Bluetooth's development.

We also feel it is important to help establish and maintain a regional support system for IT companies. We have been leaders in the development of such organizations, and ITTC's faculty and staff continue to serve on the boards of regional associations. **Tim Johnson**

was active in the startup of ITKC, a Kansas City-based information technology networking organization, and serves on the group's steering committee. In addition, Johnson is currently treasurer of the Lawrence Technology Association (LTA), an independent, industry-led organization created to promote growth of the technology sector in the greater Lawrence, Kansas, area. I also serve on the LTA board.

As you look through this Annual Report, please take special note of the achievements attained by students, faculty, and staff at ITTC. Their accomplishments continue to demonstrate leadership in the areas of computing, communication, and sensor technologies.

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

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Fiscal Year 2003 Overview

"Research in information technology is not a national initiative, it's a national imperative."

— Rita Colwell, Director of the National Science Foundation

Averaging more than \$6 million per year in expenditures over the past four years, ITTC is the largest university-based telecommunications and information technology (IT) research and development organization in Kansas. The IT research infrastructure that ITTC has acquired over two decades is world class in diverse technology areas that include wireless communications, radars and remote sensors, networking, e-learning, information management, and lightwave transmission systems. Thus, ITTC provides Kansas industry with a unique resource for expertise in information technology research and development.

Throughout the last decade, ITTC has committed itself to leveraging research and transferring technologies that are important to Kansas and its economy. During Fiscal Year 2003, as the state's leading institution in IT research and development, ITTC continued to make significant contributions toward fulfilling its mission of research, education, and service.

ITTC continues to provide strong leadership and support for a combination of education and industry needs. Currently, approximately 135 students are actively working within ITTC, enhancing their education while providing a valuable resource to ITTC and the state. Today's students will be the industry leaders of tomorrow.

ITTC successfully partnered with industry, other universities, and state

and federal agencies to obtain funds for key, cutting-edge research projects in its core technology areas. The majority of funding for ITTC comes through programs that use the peer-review proposal process to ensure a high standard of activities. ITTC had another exceptional year, attracting more than \$7.8 million in total support, yielding an estimated leveraging ratio of more than \$11 for every state dollar invested by KTEC (Kansas Technology Enterprise Corp.). ITTC's research portfolio is expected to continue to grow and diversify.

It should be noted that ITTC is currently working on a record number of new National Science Foundation (NSF) projects. Also notably, ITTC researchers were awarded two U.S. patents this past fiscal year, both in fiber-optic technologies: one, for an all-optical clock recovery system; the other, for a device to compensate for polarization-mode dispersion. (Read more about these inventions on page 18.)

ITTC also focused on several technology transfer projects and provided assistance with a number of local companies' research and development needs. Highlights include industry projects with the following Kansas companies:

- Sprint
- Bluetooth SIG firms
- Sunflower Broadband
- Cadstone
- Today Communications
- Veatros
- Ambient Computing, Inc.
- Burlington Northern

Other activities included work with two start-up companies built on ITTC-developed technologies, and the transfer of several technologies resulting from Kansas-industry-funded research projects within ITTC.

The Center's activities during FY2003 yielded three new licenses, equity positions in three ventures, three new patent applications filed, and

Key Performance Indicators: Results for Past Three Fiscal Years

<u>Key Indicators</u>	<u>FY 2001</u>	<u>FY 2002</u>	<u>FY 2003</u>
R/D&C Industry Funds Leveraged	\$ 660,584	\$ 685,656	\$ 132,834
R/D&C Federal Funds Leveraged	<u>\$ 3,706,281</u>	<u>\$ 5,101,914</u>	<u>\$ 6,685,733</u>
Total R/D&C Industry and Federal Funds	\$ 4,366,865	\$ 5,787,570	\$ 6,818,567
New Technologies Commercialized in Kan.	3	4	7
Licenses Awarded	5	5	3
License Fees/Royalties	\$ 139,757	\$ 172,215	\$ 67,212

aggregate technology transfer revenue of \$67,212. Additionally, seven technologies were commercialized in Kansas. In the chart at the bottom of page 2, note that the significant change in ROI (return on investment) from last year's license fees is primarily due to new equity positions taken instead of cash royalties received, and the transfer out of a revenue-generating technology to establish a new Kansas start-up company.

During FY2003, ITTC strengthened its position by accomplishing the following:

- Increased research activities focusing on bioinformatics and life sciences.
- Gained support from the University to hire additional research faculty to strengthen critical technical areas within ITTC.
- Established a Kansas City satellite office.
- Created the Bluetooth Research Facility at ITTC.
- Continued regional leadership as a founding sponsor of the Kansas City ITTC organization.
- Developed interactions with the KU School of Business.

FY2003 Events at ITTC

● **Peer Review of ITTC by KTEC Completed**

The Kansas Technology Enterprise Corporation (KTEC) organized a peer review for ITTC in April. As a KTEC Center of Excellence, ITTC receives an evaluation from reviewers every other year. This year the review was very positive, focusing upon the Center's direction, processes, and strategy for technology-based economic development. The review was conducted by three professionals experienced in the aspects of moving research toward commercialization. The reviewers' favorable observations are a tribute to the Center's accomplishments and the outstanding people of ITTC.

● **ITTC's Annual Industry Advisory Board Meeting Held in May**

On May 20, the Center held its annual Industry Advisory Board (IAB) meeting, which 19 members attended. The meeting had many objectives, including (1) a review of the state of the Center, current Center initiatives, and the current role of University/industry research collaborations and their natures; and

(2) an exploration of new models of industrial collaboration and critical long-term technical problems.

ITTC IAB members are listed on page 8.

● **ITTC Presents Technology Review Day**

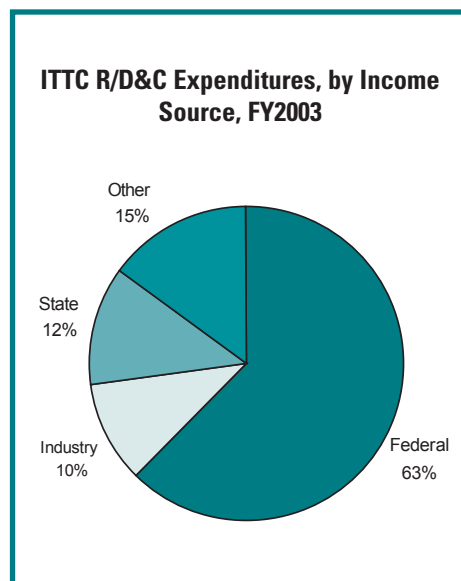
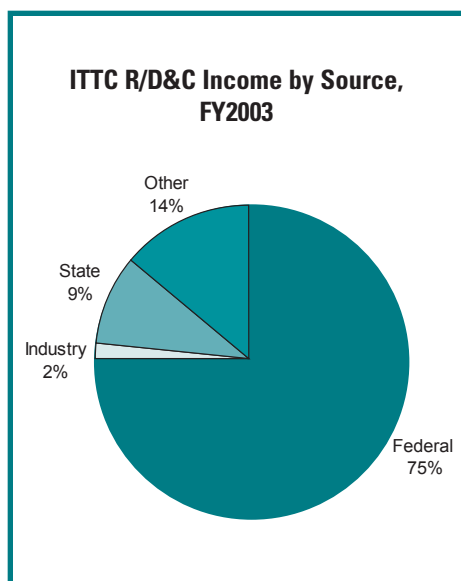
On May 19, ITTC IAB members and other invited guests attended the ITTC Technology Review Day. Throughout the day, ITTC investigators provided summaries of their research to almost 100 attendees. Researchers spoke on bioinformatics, radar and lightwave communication, e-learning, wireless systems, and information security. Participants met the Center's students and learned about their research during the student poster session. Thirty ITTC projects were showcased in the lobby of Nichols Hall.

● **KU/Sprint Collaboration Celebrates 10th Anniversary**

The University of Kansas celebrated its 10-year anniversary of access to Sprint's fiber-optic network. At ITTC's IAB meeting in May, KU honored the partnership by giving Sprint a U.S. patent plaque for the company's latest collaboration: Sprint and three KU researchers were acknowledged for their patented all-optical clock recovery device, which reduces the space and power needs of fiber-optic networks. The collaboration has furthered development in the speed and efficiency of fiber-optic technology for long-distance communication. (Please see "Method and Apparatus for Recovering an Optical Clock Signal" on page 18.)

As Ben Vos, Sprint's director of technology planning and integration, noted, "Sprint has had an exceptionally rewarding experience with KU in applied optical research. It has also led to joint intellectual property develop-

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ment and an available hiring pool of talented optical engineers."

Strategic Actions

ITTC has maintained strategic partnerships with local industries, while ITTC principal investigators (PIs) have expanded their collaborative efforts. Within the region the Center's PIs have developed collaborations with Kansas State University, University of Missouri—Kansas City, and Haskell Indian Nations University, to mention only a few. On national and international scales, the Polar Radar for Ice Sheet Measurements (PRISM) project, sponsored by NSF and the National Aeronautics and Space Administration (NASA), includes the University of Alaska—Fairbanks, NASA's Jet Propulsion Laboratory, The Ohio State University, the U.S. Army Cold Regions Research and Engineering Laboratory, the University of Chicago, the University of Copenhagen (Denmark), the Alfred Wegener Institute (Germany), the University of Bristol (England), the Antarctic Climate and Ecosystems Cooperative Research Center (Australia), and the Phoang Institute of Technology (Korea). (A list of ITTC's FY2003 collaborators is on page 32.)

ITTC continues to assist local technology organizations such as the Lawrence Technology Association (LTA), the Enterprise Center of Johnson County (ECJC), the Lawrence Regional Technology Center (LRTC), and ITKC. The ITTC Kansas City satellite office, located within the ECJC, is up and running to broaden the scope of ITTC's strategic partnerships.

Several specific actions from ITTC's Strategic Plan have been taken. As is made clear in the Plan, our growth is constrained by the number of our PIs, so we have hired (non-teaching) research assistant professors and are in the process of hiring additional ones.

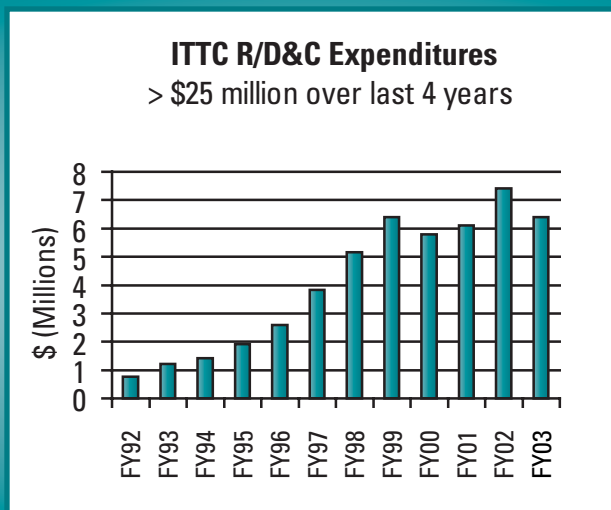
During FY2003, ITTC accomplished the following, notable as progress toward the Center's strategic goals:

- Advanced its development of capabilities in bioinformatics, where IT is an enabling area that cuts across disciplines in the life sciences.
- Increased space by 35% for a total of 27,319 ft².
- Increased support from NSF.
- Added 1 research assistant professor (for a total of 3).
- Launched an initiative for a cyber protection center to provide local government and industry businesses with the most updated information protection research results.

- Engaged in wireless systems 802.11 activities in conjunction with area industry.
- Advanced development of systems-level approaches to address systems-level security requirements.

Research centers have been identified as the most important factor in incubating high-tech industries. Based on U.S. Department of Commerce indicators, the Association of American Universities estimates that each \$1 million invested in research and development in Kansas produces about 41 jobs in the state. Using that estimate, ITTC research alone led to more than 300 jobs in Kansas this year.

The challenge ahead is to continue, and build on, the success that ITTC has been experiencing, while maintaining the infrastructure needed to grow and continue to serve the State of Kansas. The Center's success to date is largely due to the efforts expended and seeds sown and cultivated over many years. Based on available statistics (and as indicated by the bar graph at the top of page 7), ITTC is performing at a very high level, compared with state and national averages for R&D organizations. ■



At the National and International Levels...

● **Federal Agency Program Managers**

ITTC researchers have served in prominent positions within federal government agencies.* During their tenure they developed new research programs and helped create national policy. Continuing the tradition, **Joseph Evans**, Charles E. Spahr professor of electrical engineering and computer science (EECS), begins a two-year leave to work at the National Science Foundation (NSF) in August 2003. He will lead programs within the Division of Advanced Networking and Infrastructure.

● **Wireless Technology Workshops**

ITTC/KU's **Gary Minden** and **Joseph Evans** led two national workshops on the advancement of wireless technology. These events are featured on page 37:

- Workshop on the Future of Spectrum: Technologies and Policies (co-sponsored by NSF/Federal Communications Commission). See <http://spectrum.ittc.ku.edu/>.

***Past Federal Program Managers from ITTC:**

- **Glenn Prescott**, Sharp professor of engineering, EECS, served as Associate Director for Technology (Information Systems) at NASA Earth Science Enterprise, May 1999 through mid-August 2000.
- **Prasad Gogineni**, Deane E. Ackers distinguished professor of EECS, was Manager of the Polar Program for NASA Headquarters, January 1997 through January 1999.
- **Gary Minden**, professor of EECS, served as Program Manager for the Defense Advanced Research Projects Agency (DARPA) Information Technology Office, June 1994 through June 1996.

- NSF Wireless Networking Workshop. See http://wireless.ittc.ku.edu/wireless_nets/.

● **Publications of Note**

● **Gary Minden** chaired the Department of Defense's Defense Science Board (DSB) task force on wideband radio frequency systems. The DSB's report, released in July 2003, cites the future research and development areas and policy issues for the Department.

● **Minden** also has written one of the most cited articles published in 1997, according to *ResearchIndex*. "A Survey of Active Network Research," in the January issue of *IEEE Communications Magazine*, makes the list at number nine in computer science and 10th in networking.

See <http://citeseer.nj.nec.com>.

- **Ken Demarest**, co-director of ITTC's Lightwave Lab, was featured in *Light Reading*, a telecom industry publication. "Kansans Reset the Clock," highlighted ITTC's work with the all-optical clock-recovery device. (See also page 18.)
- *Laser Focus World*, July 2003 issue, describes EECS Associate Professor **Ron Hui**'s work in optical waveguides, in an article titled "Gallium Nitride Carries Infrared Light." The ITTC researcher and Kansas State University scientists have found a use for GaN-based materials in the infrared spectral region.

● **RSL Radars in International Use**

KU Radar Systems and Remote Sensing Laboratory's innovative radar designs from a few years ago are being routinely used for research in an Australian Antarctic program. **Victoria Lytle**, a principal research scientist from the University of Tasmania, where the radars are being used, spent a week at ITTC in March 2003. She is one of many researchers from around the world who collaborate with ITTC's investigators. Working to improve their design of radar for the polar regions, ITTC researchers are receiving advice in geophysics from Lytle and her fellow researchers at the Antarctic

Climate and Ecosystems Cooperative Research Center (ACECRC). The ACECRC is providing needed information on the physical processes and phenomena of the Earth, including properties of snow and sea ice such as grain size, density, and crystal structure. This knowledge will help to keep radar designs from ITTC's Radar Systems and Remote Sensing Lab at the forefront of international research.

At the Regional Level...

● **Regional IT Support**

The Center's faculty and staff continue to aid in the development of a regional support system for IT companies.

- ITTC served as a founding member of ITKC, an information technology networking organization for the greater Kansas City area. **Tim Johnson**, ITTC's executive director, helps foster the organization's growth with his work on the steering committee.

ITKC: <http://www.itkc.org>.

- ITTC maintains its leadership role in the Lawrence Technology Association (LTA). **Tim Johnson** serves as treasurer on the executive board, and ITTC Director **Victor Frost** also serves on the board.

LTA: <http://www.lawrencetech.org>.

● **Internet Class Taught**

Professors **Evans**, **Frost**, and **Minden** taught a one-day class on the Internet and networking technology to more than 30 Navy reservists at the Naval Reserve Center in Kansas City, in April 2003. The professors presented the foundations for information technology (IT) before going on to more difficult IT topics.

● **ITTC Technologies Reviewed**

High-level research at ITTC was in evidence at the Center's Technology Review Day in May (see page 3). ITTC researchers spoke on current projects ranging from data mining in bioinformatics for improved diagnosis of melanoma, to improving the usable capacity of fiber-optic links through simulation, fiber transmission measurements,

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Continued from page 5.

and component development using novel materials. ITTC aimed to strengthen ties between the Center, its Industry Advisory Board, and representatives in IT through the technology review.

In Many Significant Research Areas...

● **PRISM Field Tests in Greenland**

ITTC researchers are developing a system that gathers data on polar ice sheets for analysis of the relationship between ice sheet melting and global climate change. Please see page 36 for progress on the Polar Radar for Ice Sheet Measurement (PRISM) project.

See also <http://www.ku-prism.org/>.

● **System-Level Design Language, Rosetta**

EECS Associate Professor **Perry Alexander** leads the Rosetta standards committee. This system-level design language, developed at ITTC, has been donated to Accellera, a California-based nonprofit industry group. Rosetta could one day help build a new foundation for making faster, stronger, and more efficient electronics.

Read more about Rosetta on page 7.

● **Bluetooth Technology**

Find details on pages 7 and 34 about this innovative means of communication between electronic devices, which is expected to be in wide use by 2006. ■

Technology Transfer, FY2003

Considering the dynamics of our local and national economies, and since new products arise from new fundamental ideas as well as from new applications of existing technology, the necessity for supporting research is evident. However, support of research is not enough. That support must be coupled with a creative technology transfer capability because inventions are of little value to society unless and until they are utilized by society. To quote Thomas Edison: "The value of an idea lies in the using of it."

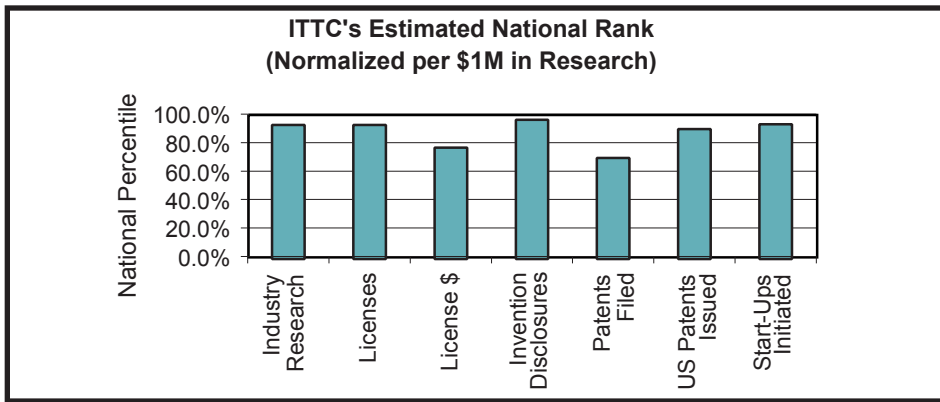
Focus on Commercialization

ITTC leverages its unique information technology research and development facilities in a continuous effort to use the ideas that flow from our research, bringing value to our society and improving the Kansas economy. Throughout the last decade, ITTC has committed itself to the development and commercialization of technologies important to the economic development of Kansas. We are currently positioned to leverage the value of our research and intellectual property portfolio and enjoy a number of significant successes. With continued support, ITTC will further develop its commercialization enterprise and, in so doing, facilitate the continued economic success of Kansas.

Each year, ITTC invests in a number of the most promising technology development projects and targets them for commercialization. Existing projects are progressing well and will continue to completion throughout FY2004, with new projects beginning. ITTC approves new internal technology development projects only after a positive review by staff and our Industry Advisory Board (IAB) members. These projects must have commercial potential and must be in areas of ITTC's technical expertise. In the past, such projects have led to spin-off companies and licensed technologies and have enhanced the Center's knowledge base, which is then applied to support other commercialization opportunities and 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 Association of University Technology Managers (AUTM). ITTC is currently performing at this level compared to national averages, as can be seen in the table below and the graph at the top of the next column.

Annual Average (AUTM 2000 Data)	National Average	ITTC Avg. (99-02)
Research \$ to generate 1 License	\$7,118,971	\$2,755,935
Research \$ to generate 1 Start-up	\$69,554,270	\$12,401,706
# Licenses per \$10M in Research	1.40	3.60
# Invention Disclosures per \$10M in Research	4.21	15.70
# Patent Applications per \$10M in Research	3.32	3.60
# Patents Issued per \$10M in Research	1.27	2.80



Highlighted Successes in Commercialization

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

Bluetooth®

● Bluetooth

ITTC researchers finished their first round of tests for the Bluetooth Special Interest Group (SIG), which is based in Overland Park. The Bluetooth SIG represents 3Com, Agere, Ericsson, IBM, Intel, Microsoft, Motorola, Nokia, Toshiba and hundreds of associate and adopter member companies. Researchers did almost 400 measurements on products containing Bluetooth hardware from these companies. The University teamed up with the Bluetooth SIG this year to test technology that allows for wireless transfer of information between electronic equipment such as computers, cell phones, and printers. (Read more about Bluetooth on page 34.)



● Rosetta

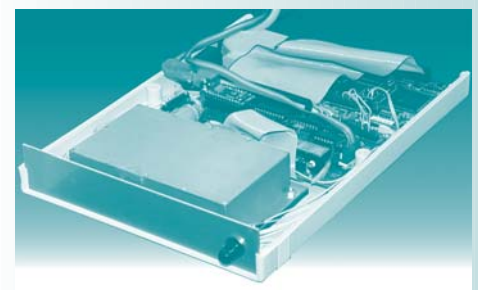
ITTC/KU faculty member **Perry Alexander** is developing the Rosetta language. Rosetta is an emerging systems-level design description language useful for describing various aspects of computer systems. Technically, Rosetta supports simultaneous specification of the heterogeneous systems models. It is domain and technology neutral, allowing specification of software, hardware, and mechanical systems.

As one of our internal technology development/commercialization efforts, we focused upon building a Rosetta analysis environment based on static and traditional simulation-based analysis techniques. In so doing, we have developed a collection of tools that together provide a suite of operational and static analysis techniques. This effort has resulted in the collection of three technologies that have been transferred from the University to Cadstone, Inc. Cadstone is a University spin-off, Lawrence-based company with a business model built around the further development of the Rosetta technologies.

● Optical Spectral Analyzer

Optical network management is becoming increasingly important as the number of channels increases in wavelength division multiplexed (WDM) optical systems, and as the complexity increases in optical networks. One of the key components in optical network management is performance monitoring, which determines whether the network is within the specified performance limits. A key tool required for network management and performance monitoring is a high-resolution optical spectral analyzer (OSA).

KU has developed and demonstrated an OSA, which illustrates another example of the fruits born from an ITTC internal technology development/commercialization project. The work on this project is nearing completion with the development of a marketable OSA prototype. The system's performance meets and exceeds initial expectations and reinforces our belief that the commercial potential of the device is significant. ITTC has patented this technology, and we are enthusiastic about the value it will bring to the optical industry. ■



KU's optical spectral analyzer (OSA), pictured above, aids network management by determining whether the network is within the specified performance limits. Because of its compactness and high resolution, the OSA can also be used as a sensor for optical spectroscopy.

Industry Advisory Board

Far right, behind rail, left to right:
T. Lezniak, S. Norris, J. Hansen.

Left section, back row: G. Minden,
A. Mushegian, G. Mastin, G. Wilson.

Second row from back: J. Strand,
W. Morgan, B. Ruf.

Second row from front: G. Georg,
V. Frost, J. Lewis, D. Nicol.

Front row: T. Johnson, M. Epard,
B. Ewy, J. Fuller, M. McClorey, K. Carr.

*Photo by Wally Emerson, May 20, 2003, at IAB
meeting, KU's Burge Union.*



ITTC's **Industry Advisory Board (IAB)** members provide guidance for the Center's future. They bring knowledge and experience from a variety of companies, organizations, and U.S. Government agencies.

Following is the list of IAB members for Fiscal Year 2003:

Gary Alexander, Alexander Open Systems, Lenexa, Kan.

Phil Anderson, Alden McDuffie, Lawrence, Kan.

James Baxendale, KUMC Research Inst./KUCR, Kansas City, Kan.

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

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

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

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

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

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

Jeff Fuller, Honeywell FM&T/KCP, Kansas City, Mo.

Gunda Georg, Medicinal Chemistry, University of Kansas.

Bennett Griffin, Griffin Technologies, Lawrence, Kan.

Russel Hailey, Secure Network Group, Inc., Lawrence, Kan.

John Hansen, Cerner Corporation, Kansas City, Mo.

James Isaacs, TAC, Ft. Wayne, Ind.

Gordon Johnston, NASA Headquarters, Washington, D.C.

Patrick Knorr, Sunflower Broadband, Lawrence, Kan.

Paul T. Kelly, Molecular Biosciences, University of Kansas.

Bob LaGarde, LaGarde, Olathe, Kan.

Tom Lezniak, The Boeing Company, Wichita, Kan.

John Louis, Information Services, University of Kansas.

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

Gary Mastin, Lockheed Martin Management & Data Systems, Reconnaissance Systems, Litchfield Park, Ariz.

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

Wayne E. Morgan, Midwest Research Institute, Kansas City, Mo.

Rodler F. Morris, U.S. Army, Washington, D.C.

Arcady Mushegian, Stowers Institute, Kansas City, Mo.

David Nicol, Verisign Telecommunication Services, Overland Park, Kan.

Susan Norris, SN Technology Planning and Development, Lenexa, Kan.

Maurice O'Sullivan, Nortel Broadband Networks, Ottawa, Ontario, Canada.

Stan Pierson, IFR Systems, Inc., Wichita, Kan.

James Roberts, KU Center for Research, Lawrence, Kan.

Brian Ruf, Ruf Strategic Solutions, Olathe, Kan.

Michael F. Sobek, Information Control Systems, Inc., Overland Park, Kan.

John Strand, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Ben Vos, Sprint, Overland Park, Kan.

Gerald J. White, BV Solutions Group, Overland Park, Kan.

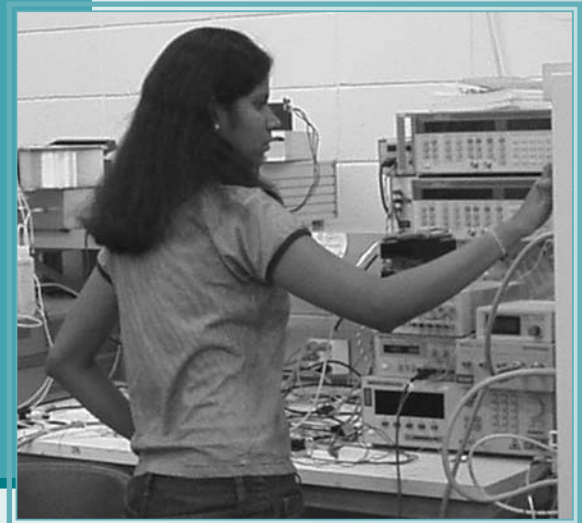
George Wilson, Chemistry/Pharmaceutical Chemistry, University of Kansas. ■

Labs Overview



Muhammad Dawood, research assistant professor, adjusts an optical power meter to measure the laser power received through a telescope. He is conducting experiments to improve the coupling efficiency between the telescope and fiber-optic cable for an upcoming Radar Systems and Remote Sensing Laboratory (RSL) research proposal.

(Below) Graduate student **Ashvini Ganesh** sets up the 40 Gbps system to observe the sensitivity of the degree of polarization (DOP) to polarization-mode dispersion (PMD). She is working in the Lightwave Lab, on the development and characterization of 40 Gbps NRZ optical signal on 108 km of buried single-mode fiber.



More than 35 faculty and staff members and 135 students conduct research at ITTC. Investigators from chemical, computer, electrical, and mechanical engineering; computer science; mathematics; and physics advance knowledge and develop technologies in telecommunications, information technology, radar systems, and remote sensing. ITTC technologies have diverse applications in many areas including business, biomedicine, education, agriculture, and finance.

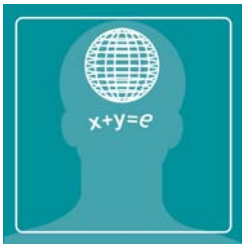
Students involved in ITTC research gain practical experience under the direction of faculty researchers in projects conducted in the following labs:

- 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)

During the past year, ITTC has grown physically. The Center has added 7,125 square feet of space in Nichols Hall, permitting the creation of new laboratory areas. Researchers in a new Bluetooth facility are administering tests on this short-range wireless technology. For more information on ITTC's work with Bluetooth, please see pages 7 and 34.

The Center also houses the Cerner Software Engineering facility, featuring hands-on tools, software applications, and computers. The Cerner Corporation, a leading supplier of health care information technology solutions, provided funding for the new laboratory facilities. **Arvin Agah**, associate professor of EECS, and **John Hansen**, Cerner's engineering director, team-teach an EECS special-topics course, Software Engineering Tools, in the lab. ITTC researchers hope to begin a research project with Cerner. ■

e-Learning Design Lab (eLDL)



Lab Directors:

*John Gauch
Ed Meyen*

The e-Learning Design Laboratory 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
- Authoring tools
- On-line assessment tools
- e-Learning evaluation services

Intelligent Systems and Information Management Lab (ISIML)



Lab Director:

Costas Tsatsoulis

The Intelligent Systems and Information Management Laboratory 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:

- AI development tools
- CATV link
- CORBA
- 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*

The Lightwave Communication Systems Laboratory develops, evaluates, and applies new lightwave systems and technologies to enhance optical communication and sensing applications. 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-wavelength WDM system
- 40-Gbps BERT
- 12-Gbps BERT
- 20-GHz and 50-GHz sampling oscilloscopes
- 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 the Sprint fiber network

Networking and Distributed Systems Lab (NDSL)



Lab Director:
Joseph Evans

The Networking and Distributed Systems Laboratory engages in analytical, simulation, and experimental research to increase our understanding of the behavior of networks and systems. NDSL conducts research on innovative high-performance networks and systems. Projects have a particular emphasis on performance measurement, modeling, and improvement of networks and systems; network control and signaling; and integration of lightwave and wireless technologies into systems. Work on the control of networks includes the development of active networks, off-board signaling platforms, and other innovative control and signaling architectures. With the support of other ITTC laboratories, NDSL develops strategies and implementations for the integration of both lightwave and wireless technologies into system-level solutions. In the course of NDSL investigations, hardware and software are developed, designed, and tested in prototype networks.

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 test bed
- Extensive high-speed networking infrastructure
- High-speed WANs
- Sprint test bed connections at 40 and 2.4 Gbps
- Miscellaneous routers, switches, and network interfaces
- Several carrier-class Cisco IP routers
- Several ATM switches and concentrators
- Linux PC array and Sun workstation test beds
- Network system evaluation software and configuration servers
- Direct access to Internet2 and PlanetLab
- Direct fiber link to Sprint network

Radar Systems and Remote Sensing Lab (RSL)



Lab Director:
Christopher Allen

The Radar Systems and Remote Sensing Laboratory develops, evaluates, and applies new radar systems and other related sensing technologies for remote sensing of the land, sea, ice, and atmosphere. Laboratory activities of a broad range 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
- Arbitrary waveform generators
- Wide-bandwidth antennas
- High-speed data acquisition systems
- Printed circuit board milling machine
- High-speed oscilloscopes
- 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)



Lab Director:
Glenn Prescott

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 real-life applications. WDSPL performs both basic and applied research in collaboration with the government and international industrial leaders. The laboratory has been successful in demonstrating intelligent wireless communication systems for government and commercial applications and is currently engaged in applying digital signal processing technology to 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
- 20-GHz synthesizer
- 2-GHz digital sampling scope
- Miscellaneous 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 ■

Students—Leading in Research

For students, working at ITTC provides opportunities for unique educational experiences and achievements. Performing research on interesting, often one-of-a-kind projects in leading technology areas under the direction of accomplished principal investigators (most of whom are also KU faculty members) prepares students for career work in critical fields and often leads to special achievements.

Described below are just a few recent accomplishments of ITTC students.

Brandon Heavey



KU graduate student **Brandon Heavey** is spending fall 2003 at sea in the southern polar region. With research assistant professor **Pannirselvam Kanagaratnam**, he is conducting field experiments, evaluating two radars developed at ITTC. The primary radar will measure the snow on top of the ice sheets. This will provide information scientists need to determine the net gain or loss between the amount of water accumulating as snow on the world's ice caps, like Antarctica, and the amount of water entering the ocean as melt water or icebergs.

The second radar measures sea ice thickness, which plays an important role in the Arctic and Antarctic climates. Sea ice insulates the warm ocean water from the cold polar air—a function vital for the survival of underwater aquatic life in the Arctic region.

Heavey and Kanagaratnam continue the innovative work of ITTC's Radar Systems and Remote Sensing Laboratory (RSL). RSL researchers have gained an international reputation for technology they have developed, supporting the missions of NASA, the U.S. Army, and the Office of Naval Research.

Abdul Jabbar Mohammad



Graduate student **Abdul Jabbar Mohammad** has developed one of the first dependable data connections for scientists working in remote areas of the polar regions. The prototype system, tested successfully at the North Greenland Ice Core Project (NGRIP) field camp this summer, allowed scientists there to have Internet access for the first time.

Mohammad used multiple iridium satellite links with modems to make communication faster. The links transport information from the computer at the site to satellites. These satellites carry the information until it reaches the Iridium Gateway in Hawaii. Once the signal touches down in Hawaii, it is a simple, automatically dialed telephone call to room 213 in Nichols Hall and connection to the ITTC computer server.

The remote communication system may eventually provide reliable, continuous access to data for other polar expeditions.

For more on this project, see "PRISM" on page 36.

Heather Amthauer



Ph.D. student **Heather Amthauer** has received one of the University's Self Graduate Fellowships. The four-year award is worth upwards of \$100,000, covering tuition, fees, and living expenses. The Fellowship is given to students who have the promise of making significant contributions in their fields of study and to society, according to its Web site, <http://www.ku.edu/~selfpro/home/index.html>.

EECS Professor **Costas Tsatsoulis** recommended Amthauer for the award, and the EECS department nominated her. The four years of funding appealed to Amthauer along with training for the future via the Self development program. Self Fellows hone their skills in communication, leadership, management, and innovation through participation in the development program.

At ITTC, Amthauer is developing a new research project with Tsatsoulis. For her master's thesis, she worked with Tsatsoulis on an integrated case-based reasoning and information retrieval system that analyzed medical incident reports. Amthauer has yet to determine her research focus for her doctorate work.

**Timothy
Newman**



Graduate student **Tim Newman** is working with KU Professor **Gary Minden** on the wireless spectrum project, Flexible Wireless Systems for Rapid Network Evolution. They are looking for "empty pockets" within the radio frequency (RF) spectrum. While wireless communication devices such as cellular telephones and radio and television broadcasts claim most of the RF spectrum, pockets of unused frequencies still exist. Newman, under the supervision of Minden, will locate these pockets and use them to create a system with better bandwidth/power characteristics.

In May 2003, Newman participated in the workshop on RF spectrum and its future, led by Minden and KU Professor **Joseph Evans**, in Alexandria, Va. The workshop was sponsored by the National Science Foundation (NSF) and Federal Communications Commission (FCC). Newman heard researchers and policy makers discuss technology and regulatory issues and learned about their concerns with regard to the wireless spectrum and its regulation. The conference allowed Newman to meet different people from around the nation who work on similar projects—a highlight for the ITTC student and a significant boost to his involvement in this advanced research.

For more information on this project, see page 37.

**Vijaya
Chandran
Ramasami**



Vijaya Chandran Ramasami recently earned a NASA Fellowship for his graduate education and research. He is the 16th student affiliated with ITTC's Radar Systems and Remote Sensing Laboratory (RSL) to receive this fellowship. Ramasami was one of 55 students out of 219 applicants to earn the honor.

His doctoral research will focus on the development of algorithms from airborne radar data to estimate the snow accumulation rate of polar ice sheets. The snow accumulation rate is important in determining ice sheet mass balance and predicting effects of global climate change on the polar ice sheets.

The accumulation rate can be estimated using density and thickness information from the ice sheet internal layers ("isochrones"), which are similar to the annual rings found in trees. Each year, snowfall forms a new layer, which is gradually compressed by the weight of succeeding layers. Layers have varying densities and thicknesses, and knowledge of their density/thickness profiles allows scientists to compute the snow accumulation rate.

It is difficult to conduct field operations in these remote regions, so remote sensing methods are necessary to provide better spatial and temporal coverage. Ramasami's research will develop the algorithms to unearth the critical information.

**Jason
Bengel**



Graduate student **Jason Bengel** is helping develop "ChatTrack." ChatTrack, spearheaded by **Susan Gauch**, associate professor of EECS, aims to resolve problems associated with the retrieval of electronic chat conversations, more commonly known as instant messaging (IM). The hazards of exposing children to the Internet, and the need to monitor informal chat for early security warnings have led to the development of ChatTrack.

While products designed to store and retrieve instant messages have been ignored until recently, ITTC researchers are developing a framework that can be integrated within almost any client- or server-based chat system. ChatTrack offers stream indexing, XML archiving, and the possibility of integration with both client-based and server-based chat architectures, Bengel said.

ChatTrack can track electronic meetings that take place over the span of several days or weeks. It can also record chats to meet required policies such as providing an audit trail for how decisions are made.

Bengel presented ChatTrack at ITTC's Technology Day's student-poster session in May. His was one of the 30 posters displayed in the lobby of Nichols Hall. Bengel said he benefited from the visitors' instant feedback, and it provided the group with ideas to consider as they move forward in their research. ■

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 been principal investigator on 31 research projects and has published more than 100 journal and conference articles. Frost has served as a guest editor for the *IEEE Communications Magazine* and *IEEE Journal on Selected Areas in Communications*. He 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*.

Frost's research interests are in the areas of network quality of service, integrated communication networks, and high-speed networks; they have included projects such as MAGIC and AAI high-speed, wide-area testbeds. 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 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 has made four presentations to committees of the Kansas Legislature. He is a member of the Board of Trustees for KU's Center for Research, Inc., and a member of the Board of the Lawrence Technology Association.



Tim Johnson

Executive Director ❖



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 positions with a variety of industry and

university concerns, including Kansas Power and Light; Kansas State University; Computer Sciences Corporation in Falls Church, Va.; and the University of Wyoming in Laramie, Wyo. In 1991, Johnson joined the Center for Excellence in Computer-Aided Systems Engineering (CECASE) at KU, where he assisted with 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.

Johnson is a founding member, board member, and treasurer for the Lawrence Technology Association (LTA) and a founding member and steering committee member of ITKC. His research, technology transfer, and commercialization activities have resulted in more than 35 presentations, technical articles, reports, and refereed journal publications. He is a member of the Association of University Technology Managers (AUTM) and an IEEE member whose professional memberships have included the IEEE Communications Society, Signal Processing Society, Computer Society, and Engineering Management Society.

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

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 consult-

ing 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; Sigma Gamma Tau, the engineering honor society; and the Association of University Technology Managers (AUTM). ■



Technical and Support Staff

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 (JPL), 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. Becker is also a graduate student at KU, working toward his master's degree in EECS.

Paula Conlin

Facilities Coordinator ❖



As facilities coordinator for Nichols Hall, Paula Conlin has managed the logistics for ITTC's recent and ongoing expansion within the building. Paula handles all tele-

phone-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 building's Web site. Paula became an official ITTC employee in 1999 after eighteen and a half years as the Nichols Hall receptionist and secretary to the manager of the building's research facilities. 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 joined ITTC as a software engineer in 2001. She has worked on technology transfer projects. She currently focuses on applied technology projects

involving the development of Web database applications using Web technology integrated with RDBMS. She received bachelor's degrees in accounting and in computer information systems, both from Washburn University of Topeka. Cozad, a certified public accountant, was a manager in a public accounting firm for over 12 years prior to completing her computer information systems (CIS) degree.

Daniel DePardo

RF Electronics Engineer ❖



Dan DePardo supports the Wireless Communications and Digital Signal Processing Lab and other Center electronic hardware needs. His areas of expertise

include microstrip antenna design, surface acoustic wave (SAW) delay line and filter design, photolithography techniques, clean-room procedures, hybrid circuitry design, environmental testing techniques, Mil-spec soldering and assembly, radio frequency interference (RFI) and electro-magnetic interference (EMI) suppression techniques, along with radio frequency and microwave components, circuitry, and systems in general. His research interests have included developing prototype transceivers for the DARPA Rapidly Deployable Radio Network (RDRN) project; implementing computing, audio, and video hardware in support of the NSF/DARPA Ambient Computational Environments (ACE) project; and construction of various ice measurement radars to support NASA investigations. He is currently focusing on the NSF-sponsored development of frequency-agile orthogonal frequency domain multiplexing (OFDM) transceivers, spectrum mapping, and wide-band wireless systems.

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 data-

base 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 ❖



Annie Francis joined ITTC in April 2002. As ITTC's office specialist, Francis manages student appointments and room assignments. She maintains student information in

ITTC's database and on the Web site, and helps with designing database forms, reports, and queries. Francis coordinates ITTC hospitality, including in-house conference logistics. Prior to ITTC, Francis was a senior office administrator for the KU Biological Survey. She worked several years in medical/biochemistry-related research labs at the Veterans' Affairs and KU Medical Centers.

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 pay-

roll, plans travel, organizes conferences, and edits all published RSL articles and technical reports. She has also assisted faculty with the editing of an international professional newsletter and a conference-related 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. Graham retires from ITTC in November 2003.

Nancy Hanson
Assistant to Executive Director ❖



Nancy Hanson aids Tim Johnson in the daily operations and strategic development of the Center, with a focus on KTEC-related and applied-technology matters. She tracks

proposals and external funding of ITTC projects and provides support for technology transfer 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.

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 joined ITTC in 1998 as an undergraduate research assistant. She received her B.S. in computer science and M.S. in computer science at KU in 1999

and 2002, respectively. She became a full-time software engineer with ITTC in January 2002. Her areas of expertise include three-tier systems engineering, object-orientated software design, relational database modeling, and Web application development. She is working on projects related to KTEC technology development, commercialization, and transfer. She also meets with Kansas companies and provides technical assistance.

Kelly Mason

Office Specialist, PRISM Project ❖



Kelly Mason became the office specialist for the Polar Radar for Ice Sheet Measurements (PRISM) project in May 2002. She helps administer budgets, purchasing, and appointments for various 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. He is developing the adaptive performance evaluation testbed for the Distributed Scheduling Aspects for Time-Critical Targeting project. He also works on the KU Technology Evaluation Satellite (KUTESat), and the new National Radio Networking Research Testbed (NRNRT) 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.

Dennis Sundermeyer

Electronics Technician ❖



Dennis Sundermeyer joined ITTC in January 2003 as the Electronics Technician for the Polar Radar for Ice Sheet Measurements (PRISM) project. He brings 25 years of experience in electronics to the project. He is helping ITTC students with their designs for PRISM radar, especially the mechanical portions. He packaged the electronics for this past summer's fieldwork in Greenland and other projects. Dennis traveled to Greenland and assisted in the radar's testing.

Michelle Ward

Public Relations Coordinator ❖



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

Peggy Williams

Assistant to the Director ❖



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. ■

ITTC faculty investigators have earned national recognition and University praise for their work in Fiscal Year 2003.

Patents

ITTC Lightwave Communication Systems Laboratory Co-Directors **Chris Allen** and **Ken Demarest** and ITTC faculty investigator **Ron Hui** received two U.S. patents:

● Method and Apparatus for Recovering an Optical Clock Signal

This all-optical system holds the promise of making fiber-optic networks more cost effective. ITTC's is unique because it can process multiple signals on a fiber simultaneously. Normally, one clock recovery is needed for each channel. Typically, there are up to a hundred optical data streams transmitted along a fiber. The ability to extract the clocks of each of these signals simultaneously in the same device would represent a huge cost saving compared to present-day optical networks. The all-optical device also completely bypasses the optical-to-electrical-to-optical process, making communication faster.

● Method and Apparatus to Compensate for Polarization Mode Dispersion

The ITTC researchers have neutralized the harmful effects of polarization-mode dispersion, or PMD, which can corrupt data traveling over high-speed fiber-optic networks. They developed a card to unscramble data at the receiving end of transmissions. Currently, PMD is so small that it goes unnoticed; but it will be a significant problem for the high-speed fiber-optic cable of the future. The higher data rates are needed to provide greater network capacity and faster communication.

Achievements

Hui received a third patent for a microscopic optical wireless technology he developed. Hui has earned eight U.S. patents and has four pending. His inventions have been licensed to such corporations as Sprint and Nortel Networks.

Awards

● HOPE Award

University awards include **Bozena Pasik-Duncan's** HOPE Award—Honor for an Outstanding Progressive Educator. Each year, senior class members select the winner by ballot and interviews. The winner receives a monetary award and recognition on a permanent plaque displayed in the Kansas Union. Pasik-Duncan is the first math professor to win the award, which was established by the KU graduating class of 1959.

● Harry Talley Award

David Petr received the Harry Talley Excellence in Teaching Award from graduating seniors in the EECS Department. The award honors a professor who has contributed significantly to undergraduate education and has developed a strong rapport with students.

● Miller Awards

KU Miller awards were presented in May 2003. Each Miller award provides \$4,000 to the recipient.

Three ITTC-affiliated EECS associate professors—**Perry Alexander**, **John Gauch**, and **Susan Gauch**—were honored with Miller Faculty Development Awards.

Kim Roddis, Professor of Civil, Environmental, and Architectural Engineering, was selected to receive the Miller Professional Development Award

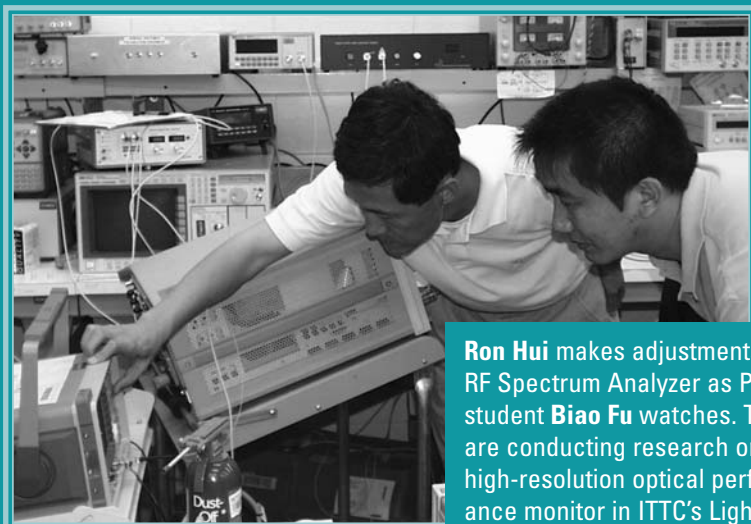
for Service. Roddis is involved on a variety of national and international committees such as NSF's National Earthquake Engineering Simulation (NEES) Consortium and the International Society of Computing in Civil and Structural Engineering. She is also a six-year appointee (October 2002–October 2008) to the Executive Committee of the Technical Council for Computing and Information Technology of the American Society of Civil Engineers.

● New IEEE Fellow

James A. Roberts became a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) in November 2002. He was presented with the award at the IEEE Frontiers in Education conference in Boston. Roberts is professor of EECS and KU's Interim Vice Provost for Research. ■



Bozena Pasik-Duncan poses with students in her Calculus II Honors course. The group meets every morning in Snow Hall. Pasik-Duncan was the first math professor to earn a HOPE Award.



Ron Hui makes adjustments to the RF Spectrum Analyzer as Ph.D. student **Biao Fu** watches. The two are conducting research on a high-resolution optical performance monitor in ITTC's Lightwave Laboratory.

Arvin Agah

Associate Professor, EECS ❖

Research Interests:

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



Education:

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

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

Honors and Awards include the KU Henry E. Gould Award for Outstanding Teaching, 2000; KU Miller Faculty Development Award*, June 2001; Engineering Expo 2001 Educator Award, February 2001.

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<http://people.ku.edu/~agah/>

Perry Alexander

Associate Professor, EECS ❖

Research Interests:

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



Education:

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

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

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

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Cristopher Allen

John & Winifred Sharp

Associate Professor, EECS ❖

Research Interests:

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



Education:

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

Teaches circuits, electronic circuits, senior design laboratory, fiber optic communication systems, 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; KU Miller Faculty Development Award*, 2001; W.T. Kemper Fellowship Award for Excellence in Teaching, 2001; Ned N. Fleming Trust Award for Excellence in Teaching, 2001; KU Miller Professional Development Award for Research, 1999; KU EECS Harry Talley Excellence in Teaching Award, 1998; Center for Teaching Excellence honoree, 1998.

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*Miller awards are presented through the KU School of Engineering. Recipients of the Miller Faculty Development Award are known as Miller Scholars.

Victor Andrade
Postdoctoral Research
Associate ❖

Research Interests:

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



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"

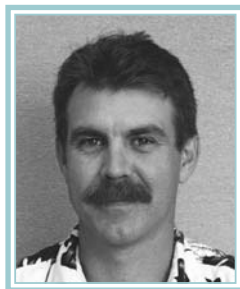
Honors and Awards include National Physics Honor Society, University of Kansas; National Physics Honor Society, California State University, Northridge; American Physical Society, since 1997.

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David L. Andrews
Associate Professor, EECS ❖

Research Interests:

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



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., 1990.

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Ronald J. Aust
Associate Professor, Teaching
& Leadership ❖

Research Interests:

Designing and developing—

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



Education:

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

Teaches designing multimedia learning environments and instructional design.

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David A. Braaten
Associate Professor of
Atmospheric Science,
Geography ❖

Research Interests:

- Snow accumulation
- Ice-sheet processes
- Remote sensing



braaten@ku.edu

Education:

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

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

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

Swapan Chakrabarti
Associate Professor, EECS ❖

Research Interests:

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



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Education:

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

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

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

Muhammad Dawood
Research Assistant
Professor ❖

Research Interests:

- Development of ultra-wideband (UWB) radar and remote sensing systems
- Signal processing and algorithms for parameter estimation



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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 (all at UNL) First Prize, graduate student paper competition, 1999; Best Project Award, undergraduate research project, 1985; Best Performance Award, Radar Technology diploma course, 1980.

Daniel Deavours
Research Assistant
Professor ❖

Research Interests:

- Performance and dependability evaluation
- Markov models and numerical methods
- Discrete-event simulation
- Modeling languages
- Data-flow architectures
- Reconfigurable computing machines



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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www.ittc.ku.edu/~deavours

Kenneth Demarest

Professor, EECS ❖

Research Interests:

- Lightwave communication systems
- Electromagnetic theory
- Antennas



Education:

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

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

Honors and Awards include Eta Kappa Nu.

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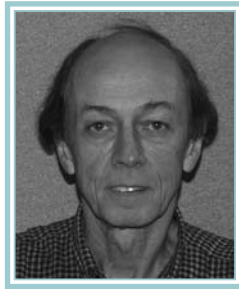
<http://www.ittc.ku.edu/~demarest/>

Tyrone Duncan

Professor, Mathematics ❖

Research Interests:

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



Education:

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

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

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

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Joseph B. Evans

Charles E. Spahr Professor,
EECS ❖

Research Interests:

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



Currently on a two-year leave from ITTC to serve as a Program Director in the Computer and Information Science and Engineering Directorate at the National Science Foundation

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 Professional Development Award for Research, 1996; AT&T Bell Laboratories Ph.D. Scholarship, 1984–1988; Garden State Graduate Fellowship, 1983–1987.

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

Research Interests:

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



Education:

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

Teaches communication networks and systems.

Honors and Awards include KU Miller Faculty Development Award, 2002; Dan F. Servey Distinguished Professor of Electrical Engineering and Computer Science, 1996; IEEE Fellow, 1998; National Science Foundation Presidential Young Investigator Award, 1984; KU Miller Professional Development Award for Service, 1991; KU Miller Professional Development Award for Research, 1986.

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John M. Gauch
Associate Professor, EECS ❖

Research Interests:

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



Education:

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

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

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

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Susan E. Gauch
Associate Professor, EECS ❖

Research Interests:

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



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 Miller Faculty Development Award, 1999, 2000, 2003; KU Miller Professional Development Award for Research, 1998; Office of Naval Research Fellowship, 1988; QU N.F. Dupuis Prize in Mathematics, 1978.

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Prasad Gogineni
Deane E. Ackers Distinguished
Professor, EECS ❖

Research Interests:

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



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; KU Miller Faculty Development Award, 2002; NASA Group Award to Antarctic

Mapping Mission, 2000; KU Miller Professional Development Award for Service, 2000; IEEE Fellow, 1999; NASA Terra Award, 1998; Best-of-Session Award from the Third International Airborne Remote Sensing Conference, 1997; KU Miller Professional Development Award for Research, 1991; Taylor and Francis Best Letter Award, 1991.

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Jerzy Grzymala-Busse
Professor, EECS ❖

Research Interests:

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



Education:

Doctor Habilitatus, Engineering, Technical University of Warsaw, Poland, 1972

Ph.D., Engineering, Technical University of Poznan, Poland, 1969

M.S., Mathematics, University of Wroclaw, Poland, 1967

M.S., Electrical Engineering, Technical University of Poznan, Poland, 1964

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

Honors and Awards include KU Miller Faculty Development Award, 2002.

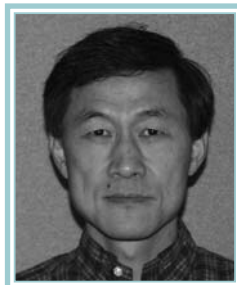
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<http://lightning.eecs.ku.edu>

Rongqing Hui
Associate Professor, EECS ❖

Research Interests:

- Fiber-optic communications
- Photonic devices
- Optical sensors



Education:

Ph.D., Electronics Engineering, Politecnico di Torino, Torino, Italy, 1993

M.S., Lightwave Technology, Beijing University of Posts and Telecommunications, Beijing, China, 1988

B.S., Microwave Communications, Beijing University of Posts and Telecommunications, Beijing, China, 1982

Teaches fiber-optic communication systems and networks, optical measurements, microelectronic circuits, semiconductor

materials and devices, general electric circuits.

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

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Jeremiah James

Assistant Professor, EECS ❖

Research Interests:

- Distributed systems
- Concurrent objects
- Data consistency
- Distributed-system models
- Reproducing concurrent executions
- Real-time and embedded systems



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, concurrent systems, programming.

Honors and Awards include UCSB Computer Science

Department Travel Scholarship, 1995–1996, 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.

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Pannirselvam Kanagaratnam

Research Assistant

Professor ❖

Research Interests:

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



Education:

Ph.D., Electrical Engineering, University of Kansas, 2002

M.S., Electrical Engineering, University of Kansas, 1995

B.S., Electrical Engineering, University of Kansas, 1993

Honors and Awards include the Dorothy Haglund Prize for Outstanding Doctoral Dissertation, 2003; Honors for Ph.D. dissertation, July 2002; NASA Fellow, 1998–2001; Honors for Master's thesis, December 1995; Dean's Honor Roll, fall 1992.

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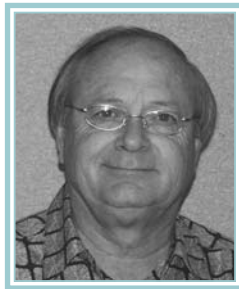
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Ed Meyen

Professor, Special Education ❖

Research Interests:

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



Education:

Ph.D., 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, instructional design, instructional technology, graduate seminars.

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<http://elearndesign.org/meyen>

Gary J. Minden

Professor, EECS ❖

Research Interests:

Large-scale systems, including

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



Education:

Ph.D., Electrical Engineering, University of Kansas, 1982

B.S., Electrical Engineering, University of Kansas, 1973

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

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

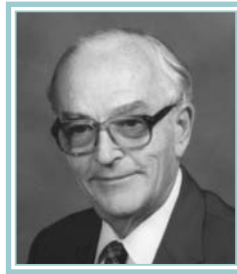
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<http://www.ittc.ku.edu/~gminden>

Richard K. Moore
Distinguished Professor
Emeritus, EECS ❖

Research Interests:

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



Education:

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

Teaching Duties: Advises graduate students.

Honors and Awards include Australia Prize (for remote sensing), 1995; Italian Center for Remote Sensing Award, 1995; Fellow AAAS, 1993; National Academy of Engineering, 1989; KU Irvin Youngberg Award in the Applied Sciences, 1989; KU Louise E.

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

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R. Douglas Niehaus

Associate Professor, EECS ❖

Research Interests:

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



Education:

Ph.D., Computer Science, University of Massachusetts at Amherst, 1994

M.S., Computer, Information and Control Engineering, University of Michigan, 1981

B.S., Computer Science, Northwestern University, 1980

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

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Bozenna Pasik-Duncan
Professor, Mathematics ❖

Research Interests:

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



Education:

Doctor Habilitatus, Mathematics, Warsaw School of Economics, 1986

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

M.S., Mathematics, Warsaw University, 1970

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

Honors and Awards include KU Honor for an Outstanding Progressive Educator (HOPE) Award, 2002; 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 Award for Excellence in Research and Teaching, 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; IEEE Control Systems Society Distinguished Member Award for significant technical contributions and outstanding long-term service.

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<http://www.math.ku.edu/ksacg/bozenna.html>

David Petr

Professor, EECS ❖

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



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 EECS Harry Talley Excellence in Teaching Award 2003; KU School of Engineering Sharp Teaching Professorship, 2000–2002; Visiting Erskine Fellowship, University of Canterbury, New Zealand, 2000; Excellence in Teaching Award, KU Center for Teaching Excellence, 1999; Member of Sigma Xi, 1992; Senior Member of IEEE, 1991; KU nominee for NSF Presidential Faculty Fellow, 1991; Ben Dasher Best Paper Award for the ASEE/IEEE Frontiers in Education conference, October 2000.

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Glenn Prescott

Professor, EECS ❖

Research Interests:

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



Education:

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

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

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

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<http://www.eecs.ku.edu/~prescott/>

James Roberts

Interim Vice Provost for
Research;

Professor, EECS ❖

Research Interests:

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



Education:

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

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

Honors and Awards include Chair, Douglas County Commission ECO2 (Ecology/Economic Development) Committee (appointed by Douglas County Commission), 2003; Member, Economic Development Board of Lawrence and Douglas County (appointed by Douglas County and Lawrence City Commissions), 2003; 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.

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W. M. Kim Roddis

Professor, Civil Engineering ❖

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
- +++



Education:

Ph.D., Civil Engineering, Massachusetts Institute of Technology, 1988
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 KU Miller Professional Development Award for Service, 2003; KU Miller Faculty Development Award, 2002; National Special Achievement Award for Web-Enhanced Teaching of Steel Design, American Institute of Steel Construction, 2002; Executive Committee, Technical Council for Computing and Information Technology, American Society of Civil Engineers (ASCE), 2002–2008; KU Docking Scholar, 1999; KU School of Engineering Bellows Fellow, 1999; ASCE Fellow, 1997; KU Miller Professional Development Award for Research, 1997; Fannie and John Hertz Fellow, 1986–1988; American Institute of Steel Construction Fellowship, 1987; ASCE O.H. Ammann Research Fellow, 1986.

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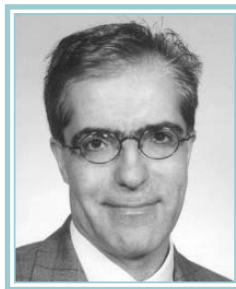
Hossein Saiedian

Professor and Associate Chair, EECS ❖

Research Interests:

Software engineering, including

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



Education:

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

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

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

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

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

Research Interests:

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



Education:

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

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

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

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

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

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James Stiles

Associate Professor, EECS ❖

Research Interests:

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



Miller Professional Development Award for Research, 2001; KU EECS Harry Talley Teaching Award, 2000.

jstiles@itc.ku.edu

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 Miller Professional Development Award for Research, 2001; KU EECS Harry Talley Teaching Award, 2000.

Costas Tsatsoulis

Charles E. Spahr Professor and
Chair, EECS ❖

Research Interests:

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



Big-12 Faculty Fellowship; State of Kansas AT&T Engineering Education Excellence Award, 1995; KU Miller Professional Development Award for Research, 1994; Bellows Fellowship, 1999; Senior Member of IEEE, 1998.

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<http://www.itc.ku.edu/~tsatsoul/>

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;

Victor L. Wallace

Professor Emeritus, EECS ❖

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



IEEE; Eta Kappa Nu; Upsilon Pi Epsilon; Tau Beta Pi; Sigma Xi; *Who's Who in Science and Technology*; *Who's Who in America*.

wallace@ku.edu

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,

New Investigators Starting FY2004:

Xue-wen Chen

Assistant Professor, EECS ❖

Research Interests:

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



Education:

Ph.D., Electrical and Computer Engineering, Carnegie Mellon University, 2001

M.S., Opto-electronics, Sichuan University, 1992

B.S., Physics, Sichuan University, 1986

Teaches bioinformatics, computer science.

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Trevor Sorensen

Associate Professor, Aerospace Engineering ❖

Research Interests:

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



Education:

D.E., Aerospace Engineering, University of Kansas, 1979

M.S., Aerospace Engineering, University of Kansas, 1976

B.S.A.E., Aerospace Engineering, University of Kansas, 1973

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

Honors and Awards include American Astronautical Society Fellow, 2003; NASA/ASEE Summer Faculty Fellowship, 2001, 2003; AlliedSignal Aerospace Bold Thinking Award '97, 1998;

University of Kansas Aerospace Engineering Alumni Honor Roll, 1997; NASA Medal for Exceptional Scientific Achievement, 1994; Engineer of the Year nominee, *Design News Magazine*, 1994; AlliedSignal Technical Service Corp's Special Recognition Award, 1994; NRL Certificate of Appreciation for contribution to SDIO/LACE Program, 1991; McDonnell-Douglas Certificate of Merit for contribution to Shuttle Program, 1985; NASA Group Achievement Award (STS-41C Rendezvous and Proximity Operations), 1984.

tsorensen@ku.edu ■

Sponsors and Collaborators

A variety of government agencies and industries sponsor research at ITTC. 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 institutes, both inside and outside the U.S.

Sponsors

The following entities provided funding for ITTC research projects that were active during Fiscal Year 2003.

● U.S. Government-Affiliated Agencies:

- Defense Advanced Research Projects Agency (DARPA)
- Department of the Air Force, including
 - Air Force Research Laboratory (AFRL)
 - Office of Scientific Research (AFOSR)
- Department of the Army, including
 - Army Research Office (ARO)
 - Center for Army Lessons Learned (CALL)/University after Next (UAN), Fort Leavenworth
 - Communications-Electronics Command (CECOM)
- Department of Energy (DoE)
- Naval Research Laboratory (NRL)
- National Aeronautics and Space Administration (NASA)
- National Science Foundation (NSF)

● Industry:

- Ambient Computing, Inc.
- BioComp Systems
- Bluetooth Special Interest Group, Inc.
- Burlington Northern Santa Fe Railway
- EDaptive Computing, Inc.
- Harris Corporation
- Honeywell-Federal Manufacturing and Technologies, LLC
- ITT Defense
- LaBarge, Inc.
- Medtronic, Inc.
- Science Applications International Corporation
- Sprint Corporation
- Today Communications

● State of Kansas:

- Kansas Technology Enterprise Corporation (KTEC)

Collaborators

ITTC projects active during Fiscal Year 2003 included collaborative work with the following universities, departments, and organizations.

● KU Schools and Departments:

- Center for Research on Learning/Education
- Ecology and Evolutionary Biology
- Electrical Engineering and Computer Science
- Mathematics

- KU Medical Center
- Geography
- Physics and Astronomy
- Psychology

● Beyond KU:

- Alfred Wegener Institute (Germany)
- Antarctic Climate and Ecosystems Cooperative Research Center (Australia)
- Centro de Estudios Científicos (Chile)
- Columbia University
- Enterprise Center of Johnson County
- Haskell Indian Nations University
- ITKC (for Information Technology–Kansas City)
- Kansas State University
- KCCatalyst
- Lawrence Berkeley National Laboratory
- Lawrence Regional Technology Center
- Lawrence Technology Association
- Jet Propulsion Laboratory
- The Ohio State University
- Oregon 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
- University of Missouri–Rolla
- University of Wisconsin
- U.S. Army Cold Regions Research and Engineering Laboratory
- Washington University ■



Students in the new Cerner Software Engineering facility discuss last-minute details before their final presentations. Cerner, a leader in healthcare information technology, provided funding for the facility in Nichols Hall. ITTC researchers are working toward a research project with Cerner.

Bioinformatics Research

(Right) **Xue-wen Chen** has joined the University of Kansas as an assistant professor with an emphasis in bioinformatics, a field of science in which biology, computer science, and information technology merge into a single discipline. Chen came to the University because of its interdisciplinary collaboration between departments. At ITTC, Chen will develop computer algorithms based on mathematical/statistical models to analyze biological data. For example, his work will help find genes responsible for specific diseases.

(Background) Digital photograph of a microarray, or gene chip (greatly magnified). Though not much larger than a postage stamp, a microarray may contain hundreds of thousands of genes.

Photo compliments of the U.S. Department of Energy/National Institutes of Health Human Genome Program. More information at http://www.ornl.gov/sci/techresources/Human_Genome/home.shtml.



KU's Electrical Engineering and Computer Science Department hired its first bioinformatics faculty member, **Xue-wen Chen**, to start in August 2003. Chen, assistant professor of EECS, brings his work with microarray data analysis to ITTC.

Microarrays, more commonly known as gene chips, are devices that contain hundreds of thousands of genes. The chips, which are not much larger than postage stamps, permit researchers to conduct numerous genetic tests simultaneously on one sample. Scientists can then observe the interactions of different cells and the system as a whole.

It is believed that genes, the fundamental units of heredity, function in a precise and complicated manner that sustains living organisms. But technology has previously allowed molecular biologists to work only on a "one gene in one experiment" basis, which means that the big picture of gene function is hard to obtain.

Improvements in technology are leading to more fruitful investigations of the body's inner workings. The Human Genome Project is identifying thousands of genes in human DNA and determining the sequences of billions of chemical base pairs that make up DNA. These DNA sequences are helping scientists address questions about the essential processes of living systems.

But now the challenge is to mine the huge amount of data generated by the Genome Project. Chen and other researchers are developing algorithms that analyze genes' expressions or reactions under specific conditions. Genes, in effect, have "on/off" switches. Scientists need to understand what initially activates these switches and how the turned-on genes affect other molecules in the body.

For example, Chen is working with cancer classification. He is developing software that can help in the early detection of this disease. In the case of breast cancer, cells in the breast tissue divide

and grow without the usual controls on cell death and cell division. But Chen hopes doctors will eventually be able to diagnose the cancer before its virulent spread, with the careful monitoring of the genes associated with this disease.

Another benefit of the microarray data analysis will be the individualized treatment of patients. While patient "A" and patient "B" may both have lung cancer, only patient A will benefit from a certain medicine. Patient B will need another type of drug to effectively treat her cancer. This is because the two lung cancers have different origins. If the gene sources can be located, each patient can receive her most effective treatment immediately and avoid trial and error with a series of drugs.

Cancer detection and treatment are just two of the numerous potential benefits from microarray data analysis. Other life science applications, such as drug discovery and research on aging, will also gain from microarray data analysis. ■



ITTC researchers are testing devices' interoperability, investigating how computers, printers, cell phones, PDAs, and other devices with installed Bluetooth chips work together. **Dan Deavours, Joseph Evans, and Leon Searl** have developed a detailed evaluation process that tracks, among other things, the number of minutes, tries, and level of difficulty in activating the technology. After these initial tests, work on the Bluetooth project will be expanded.

ITTC is helping evaluate the short-range wireless communication system known as "Bluetooth." This technology enables devices people use every day such as cell phones, headsets, personal digital assistants (PDAs), laptops, and cars—to automatically and wirelessly share information.

The Bluetooth chip inserted into electronic devices permits, for example, mobile telephones, handheld devices, and personal computers to share address books and schedules. In another example, a cell phone could become a "universal remote," opening garage doors, printing documents from computers, or programming TVs.

ITTC researchers evaluated a variety of appliances to ensure they worked correctly with the chips. They also tested the devices' interoperability, seeing how Bluetooth-enabled machines interacted with one another.

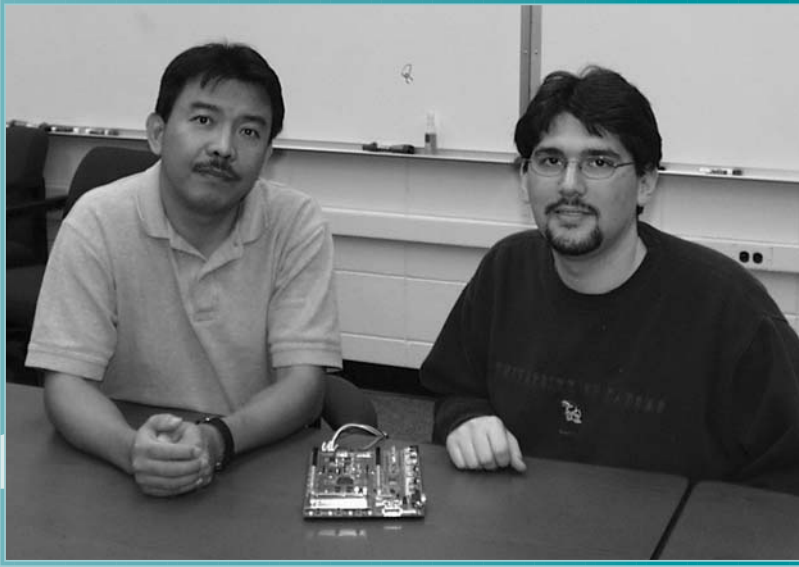
Joseph Evans, director of ITTC's Networking and Distributed Systems Laboratory, oversaw the project, conducted by researchers **Leon Searl** and **Dan Deavours**. They developed a detailed evaluation process that tracks, among other things, the number of minutes, tries, and level of difficulty in activating the technology.

The ITTC team presented their findings to the Bluetooth Special Interest Group (SIG), a trade association that is driving the technology's development and establishing a standard for all Bluetooth-enabled devices. The standard will allow machines from different manufacturers to interoperate. The SIG has over 2,000 member companies from the computing, networking, and telecommunications industries, including 3Com, Ericsson, IBM, Intel, Microsoft, Motorola, and Nokia.

The SIG's goal is to provide devices that can be installed within five minutes of their removal from the box. About 1.3 billion Bluetooth chips are expected to be in products by 2006. That should generate incremental revenue of \$12 billion for technology and telecommunication companies, according to Zelus Research Group LLC in San Francisco.

ITTC is negotiating a new contract to conduct more advanced testing on additional Bluetooth devices. Work with the SIG will most likely be expanded, and students will eventually examine Bluetooth technology and learn to design software and applications for the technology. ■

Bluetooth technology was named after the Danish king Harold Bluetooth, who peacefully joined two Scandinavian nations into a single kingdom in the 10th century. Bluetooth is similarly joining telecommunications and computing.



Ph.D. student **Razali Jidin** (far left) and graduate student **Mitch Trope** are shown with a Virtex II development board they are helping to develop. They are testing hardware/software co-design on the board for **David Andrews'** newly funded NSF project.

An embedded computer controls the operation of a larger system, such as an airplane, automobile, or manufacturing machine. Designers of embedded systems are challenged to provide new capabilities that can meet the expanding requirements and increased computational needs of proposed applications, but at a decreasing price/performance ratio. ITTC researchers continue to address these challenges through two new National Science Foundation (NSF) grants.

Jerry James and **David Andrews** will advance sensor web research with their NSF Information Technology Research (ITR) grant.

Sensor webs—collections of sensors with communication capabilities—pass data between individual sensors to better detect and track objects of interest. They could help detect and

track terrorists, military movements, shipments of suspect materials, and other information critical to the nation's defense, said James, principal investigator (PI) on the project and assistant professor of EECS.

With their project, Computation and Communication in Sensor Webs, James and Andrews, Co-Investigator (Co-I) and EECS associate professor, will investigate new architectures for sensor webs that have reduced power consumption requirements while producing better intelligence than current architectures.

Andrews will serve as the PI on a second newly funded NSF project, Extending the Thread Execution Model for Hybrid CPU/FPGA Architectures. Andrews, along with **Douglas Niehaus**, Co-I and associate professor of EECS, will develop system software for new

hybrid chips that contain both a general-purpose central processing unit (CPU) and a field-programmable gate array (FPGA). These chips will make it easier for CPUs, which execute the instructions specified in a computer program, and FPGAs, which are integrated circuits that can be programmed in the field, to interact under a single software model. These new hybrids are integral to the creation of commercial, easily obtainable hardware platforms for future real-time embedded control (RTEC) systems.

The ITTC project will result in faster times to market, reduction of overall costs, and the chips' accessibility to systems programmers. The software will allow programmers with no expertise in hardware development to specify custom components on the FPGA. ■

Polar Radar for Ice Sheet Measurement (PRISM)

ITTC researchers traveled to Greenland for the Polar Radar for Ice Sheet Measurements (PRISM) project in late June 2003. In less than one month, they surpassed their expected goals of collecting data to refine their radar, all-terrain rover, and communication systems designs.

This NSF/NASA/KTEC-funded project will optimize the individual sub-systems by using data the researchers gathered. During the next year, more than 40 ITTC faculty, staff, and students will combine radar, rovers, and communication systems into an integrated system that will measure ice thickness and determine bedrock conditions. The data that the system eventually collects will help scientists analyze the status of the polar ice sheets and their possible future impact on sea-level rise.

The KU PRISM group became one of the first to provide a dependable Internet connection for scientists working in remote field locations in the polar regions. Their successful test of a prototype remote communication system permitted Internet access at the North Greenland Ice Core Project (NGRIP) field camp for the first time. (See **Abdul Jabbar Mohammad**, page 12.)

The communication system the KU team developed is an improvement on previous systems that rely on commercial communications satellites. The pre-existing Iridium satellite system, with 66 low Earth-



(Above) **Torry Akins** works with the depth sounder radar. This equipment measures surface ice thickness and maps deeper layers to help scientists determine polar ice flow and its history.

This photo was taken by Rodrigo Zamora.

(Right) **Nandish Chalishazar** stands with KU's GPS radar equipment. He used GPS to help develop an 802.11b wireless link for communication between rovers.

Dennis Sundermeyer took the photo.



(Above) KU's all-terrain rover traverses the ice sheet, with **Hans Harmon** at the controls. Affectionately known as "Marvin," the rover is to carry the three radars that make up the KU PRISM team's radar system.

The photo was taken by Arvin Agah.



orbiting satellites, is the only system with true pole-to-pole coverage. But it was designed to provide primarily voice service and is too slow to support scientists' accessing the Internet or downloading software from the field in a timely way. ITTC researchers used four Iridium satellite links with multiple modems to make communication faster.

A KU PRISM team member, graduate student **Nandish Chalishazar**, established a wireless link over an 8-km range by modifying 802.11b technology. This technology provides a reliable, high-data-rate, wireless communication system that connects vehicles, allowing data, videos, and photographs to be exchanged between rovers on the ice. (Only one rover was tested in Greenland this summer, but two all-terrain vehicles will eventually carry the radar system.)

The KU PRISM group integrated the Iridium links and 802.11b wireless technology; and by the end of their three-week stay, the entire camp had wireless Internet access.

Researchers tested the rover's functionality and performance, including its ability to maneuver around obstacles and its response to the extreme weather conditions. The final-stage rover is expected to carry a synthetic aperture radar (SAR), a

depth sounder radar, and accumulation radar—all tested as prototypes at the Greenland site by the KU PRISM team.

The SAR will produce images of the ice bed that will help scientists determine conditions at the interface between the bottom of the ice sheet and bedrock. If a layer of water exists between the ground and ice, the ice might slide faster toward the oceans.

The depth sounder radar measures ice thickness to depths of more than 3 km and maps deeper layers with coarse resolution. Scientists need ice thickness information to determine how much of the ice is flowing into the ocean, while layering information helps scientists understand the ice sheet's flow history.

For fine-resolution data, PRISM researchers developed an accumulation radar that can gather detailed data on near-surface internal layers to a depth of about 200 meters. By comparing data taken over several years, scientists can estimate the amount of snow deposition by watching the internal reflecting layers move downward as more snow is accumulated each year.

As a part of the project's outreach program, researchers logged daily experiences of the field team and reported the progress of the experiments at <http://www.ku-prism.org/>. ■

KU Prism Team, Greenland, 6/23-7/20/03

Students:

- Nandish Chalishazar and Abdul Jabbar Mohammad, Communications
- Hans Harmon and Richard Stansbury, Robotics
- John Paden, Radar

Faculty and Staff:

- Arvin Agah
- Torry Akins
- David Braaten, Team Leader
- Pannirselvam Kanagaratnam
- Dennis Sundermeyer

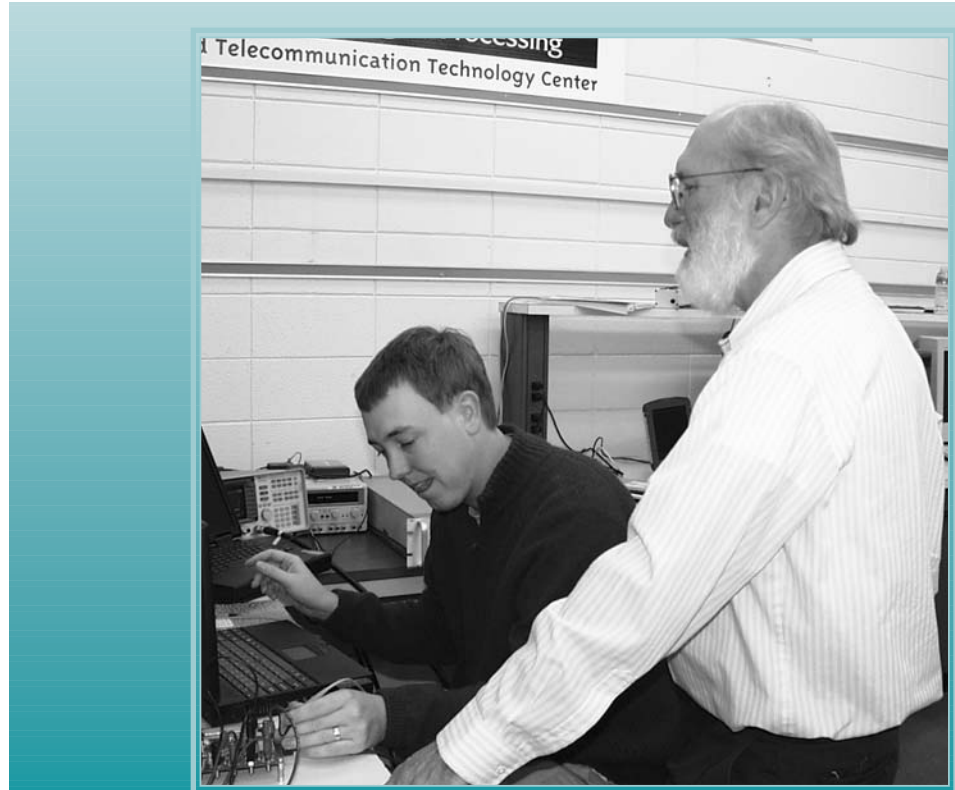
Wireless Networking Research

Cell phones, radio and television broadcasts, and satellite communication systems all clamor for space on the radio frequency (RF) spectrum. These different wireless technologies create a high demand for the finite frequencies. This demand, coupled with the Government's classification of spectrum as a "scarce resource," has led to exorbitant costs for use of the spectrum.

During the past year, **Gary Minden** and **Joseph Evans** conducted two National Science Foundation (NSF) workshops on the future of spectrum and wireless networking. In May 2003, the NSF and the Federal Communications Commission (FCC) sponsored a by-invitation-only conference in Alexandria, Va., which was attended by more than 60 participants. The Future of Spectrum Workshop attendees worked to clearly define the problems inherent in matching available spectrum with community needs. The workshop explored new research areas and gathered ideas about ways to manage the spectrum; the results were submitted to NSF.

The NSF Wireless Networking Workshop, held in Chicago, Ill., in July 2003, focused on the current state of the art in flexible and wide-bandwidth radios and directions in spectrum management policy. Minden and Evans discussed with the invited attendees proposals for wireless network management and control and network architectures and capabilities. Participants brainstormed on opportunities for new end-user applications, services, and scientific applications.

The spectrum may be thought of as a series of hills and valleys. Those devices positioned on the hills' peaks, such as television broadcasts, receive the most powerful signals. Most channels used for TV broadcasting possess high information capacity along with low signal distortion, making them the most desirable. Conventional ultra-wideband devices (UWB) and others are relegated to the valleys and must use very low-power transmissions to prevent disturbing other media using the same frequencies at higher ranges.



Graduate student **Tim Newman** probes the FPGA board, checking for a signal. He is making sure the appropriate response is coming from the board that he programmed. Professor **Gary Minden** watches as Newman conducts the experiment in the Wireless Lab.

Even as a plethora of wireless devices compete for prime spectrum space, "empty pockets" still exist within these higher, more powerful areas: space within the spectrum is not used efficiently.

At ITTC, Minden is creating a new, agile radio system addressing use of these empty pockets. Researchers will develop a hyper-orthogonal frequency domain multiplexing (H-OFDM) system based on software radio techniques.

Since H-OFDM systems, which emit very narrow signals, carefully avoid interfering with each other and other radios, their use will allow many more people and businesses to have their own local wireless networks. This will make it easier for people to exchange information between computers and share communal resources such as printers.

This technology may also be of use to the military in covert operations. Military personnel could hide the lower-power signal between two higher-powered ones.

Tim Newman, a graduate student working on the H-OFDM project, said people would have to know exactly where to look to uncover the signal.

ITTC researchers will have working prototypes within three years, but it may take far longer for this system to be ready for the market.

Minden will help evaluate new wireless technologies through a recent \$1.8 million NSF grant. The National Radio Networking Research Testbed (NRNRT) will gather specific data on how and where the RF spectrum is currently used. This will provide radio designers and companies with information necessary to build new types of radios and develop new radio services. ■

Projects Active during FY2003

AAL2 Call/Connection Control Signaling

Sprint
J. Evans

Acquisition of Equipment to Support Lightwave and Microwave Research

National Science Foundation (NSF)
C. Allen, with P. Gogineni, G. Prescott, R. Hui

Ambient Computational Environments (ACE)

Sprint
J. Evans, with A. Agah, V. Frost, J. James, G. Minden

Architecture and Prototype of an Ambient Computational Environment

Defense Advanced Research Projects Agency
(DARPA)-U.S. Air Force Research
Laboratory (AFRL)
G. Minden, J. Evans, with A. Agah, J. James

Architecture for Space Based Internets (SBI)

NASA-Glenn Research Center
G. Minden, with J. Evans

ATM Call Model for Traffic Engineering

Sprint
D. Petr, with S. Chakrabarti, V. Frost

Automated Test Generation in Intelligent Systems (GENISYS; Phase II)

EDaptive Computing, Inc.
W.P. Alexander

Biodiversity and Ecosystem Informatics (BDEI): Biodiversity Information Organization Using Taxonomy (BIOT)

NSF
S. Gauch

Broadband Wireless Local Loop

Sprint
J. Evans

CAREER/EPSCoR: Cooperative Agents for Conceptual Search and Browsing of World Wide Web Resources

NSF
S. Gauch

Case Reflective Negotiation Model

U.S. AFRL
C. Tsatsoulis, with R.D. Niehaus

Case Reflective Negotiation Model

U.S. Air Force
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 and
Engineering (CISE)
G. Minden, with A. Agah, F. Brown, J. Evans,
S. Gauch, C. Tsatsoulis

CISE Research Instrumentation: Ambiguity Resolution for Intelligent Systems Using a Cognitive Robot

NSF
F. Brown, with A. Agah, T. Schreiber, J. Gauch

Collaborative Project: Expansion and Enhancement of the Center of Excellence in Information Assurance Program

NSF
H. Saiedian

Collaborative Research: An Initiative for a Cyber Protection Center

NSF
H. Saiedian

Complexity, Implementation, and Management Trade-Offs for Traffic Aggregation in Future Networks

Sprint
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

Development and Evaluation of a Range- Gated Step-Frequency Radar

National Aeronautics and Space
Administration (NASA)-Jet Propulsion
Laboratory (JPL)
S.P. Gogineni

Development Multilink PPP Technologies from Iridium

Harris Corp.
V. Frost

Development of a Fused Ice Classification Scheme

U.S. Department of the Navy
C. Tsatsoulis

Development of a Hybrid RF/Laser Radar

NASA
C. Allen, with S.P. Gogineni

Development of a Micropower Impulse Radar Based System for Detecting Vehicles at Railroad Crossings

LaBarge, Inc.
S. Lohmeier

Development of a Monostatic/Bistatic Synthetic Aperture Radar System for Two Dimensional Mapping of Basal Ice Conditions

NASA-Goddard Space Center (NASA Earth
System Science Fellowship Program)
S.P. Gogineni (Ph.D. student: John Paden)

Distributed Scheduling Aspects for Time- Critical Targeting

Washington University
R.D. Niehaus

eCIS (Enterprise Component Integration System) Tool Development, Phase II

EDaptive Computing, Inc.
W.P. Alexander

Electronic Sensor System Engineering and Capture Environment (ESSENCE)

EDaptive Computing, Inc.
W.P. Alexander

Enhancement of the KU PNNI Performance Evaluation Tools-TP&I

Sprint
R.D. Niehaus, with V. Frost, J. Evans

Extending the Thread Execution Model for Hybrid CPU/FPGA Architectures

NSF
D. Andrews, with R.D. Niehaus

Forty (40) Gbs

Sprint
R. Hui, with K. Demarest, C. Allen

Functional Programming Environment for Design and Implementations of High Performance Radio and Synthetic

Aperture Radar Processing Functions

DARPA
G. Minden, J. Evans, with R.D. Niehaus, M.
Ashley, G. Prescott

Future of Spectrum: Technologies and Policies Workshop

NSF
G. Minden, with J. Evans

Generating a Rule-Base for Sea-Ice Classification

Naval Research Laboratory (NRL)
C. Tsatsoulis, with J. Gauch

Grant to Support Research

ITT Defense
G. Prescott

High Speed WDM Sub-Carrier Multiplexed Optical Fiber Communication Systems

Sprint Corp.
R. Hui, C. Allen, with K. Demarest

Ice-Thickness Measurement over the Patagonian Glaciers and the Pine Island and Thwaites Glaciers, Antarctica

NASA-Goddard Space Center
P. Kanagaratnam, with S.P. Gogineni

Information Systems Technologies for the Earth Science Technology Office

NASA
G. Prescott

Innovative Active Networking Services

U.S. AFRL
G. Minden, with J. Evans

Integrated Evaluation of Network, System, and Application Software Architecture and Performance Issues in ATM Networks

Sprint
R.D. Niehaus

Intelligent Knowledge Management Environments

Center for Army Lessons Learned
(CALL)/University after Next (UAN)
R. Aust, with J. Gauch, S. Gauch, E. Meyen

Investigation of AQUA Response to Stratiform Precipitation Systems

University of Wisconsin
D. Braaten

Investigation of FPGA Rapid Prototyping of Military Software Radio Systems

U.S. Air Force
G. Prescott

IP QoS

Sprint Corp.
D. Petr

ITR Collaborative Research: Enabling the Science Environment for Ecological Knowledge

NSF/KTEC
J. Beach, with A.T. Peterson, S. Gauch, D. Vieglais

Kansas Participation in Sea Winds Instrument Activities

NASA
R.K. Moore

KU Antenna Range Capability Upgrade

Honeywell-Federal Manufacturing and Technologies (FMT), LLC

C. Allen

KU Antenna Range Improvements

Honeywell-FMT, LLC
C. Allen

KU High Altitude Balloon Experiment System and the KUBESat-1 Project

Honeywell-FMT, LLC
T. Sorensen

Low Coherent, High Resolution WDM Reflectometry for Fiber Length Measurement

NSF EPSCoR/K*STAR
R. Hui, with C. Allen

Measurement of Thickness of the Greenland Ice Sheet and High Resolution Mapping of Internal Layers

NASA
S.P. Gogineni, with D. Braaten, J. Stiles

Model-Based Data Inversion to Estimate Accumulation Rate of Polar Ice Sheets

NASA (Fellowship Grant)
S.P. Gogineni (Ph. D. Student: Vijaya Ramasami)

Model-Based Signal Processing Algorithm for MIDP GPR, MIDP GPR Proposal

NASA-JPL
S.P. Gogineni, with M. Dawood

Modeling Ultra-Dense, Ultra-High Speed WDM Fiber Networks

Sprint
K. Demarest, with R. Hui, C. Allen

Multi-Dimensional Signal Processing Algorithms for Sparse Radar Arrays

Air Force Office of Scientific Research (AFOSR)
J. Stiles, with J. Gauch

Multidisciplinary Research in Mine Detection and Neutralization Systems

University of Missouri-Rolla/Army Research Office (ARO)
J. Stiles, with S.P. Gogineni

Network Monitoring for Performance Analysis and for Enabling Network-Aware Applications

U.S. Dept. of Energy (DoE) (collaborator: Lawrence Berkeley National Laboratory)
J. Evans, with V. Frost

NSF Workshop for High School Teachers of Mathematics and Science

NSF
B. Pasik-Duncan

Open Control Architectures

Sprint
J. Evans

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

Science Applications International Corporation (SAIC)
J. Stiles

PMD Characterization on an Active Fiber Link

Sprint
C. Allen, with R. Hui, K. Demarest

PNNI Simulator: Performance Evaluation Studies and Continued Development

Sprint
D. Petr, with R.D. Niehaus

Polar Radar for Ice Sheet Measurements (PRISM); also ITR/SI+AP: Mobile Sensor Web for Polar Ice Sheet Measurements

NSF/NASA/KTEC
S.P. Gogineni, with C. Allen, V. Frost, D. Braaten, G. Prescott, C. Tsatsoulis, A. Agah

Protocol, Profile, and Interoperability Testing of Bluetooth Devices

Bluetooth Special Interest Group (SIG), Inc.
J. Evans, with D. Deavours

Quality Access to Online Health Information Based on User Profiles ("VitalSeek")

Today Communications
S. Gauch

Quality of Service Translations

Sprint
J. Evans

Quantifying the Temporal Characteristics of Congestion Events in the Internet

NSF-CISE
V. Frost, with T. Duncan

Radar Sounder for Measuring Sea Ice Thickness—A Feasibility Study

California Institute of Technology (with JPL)
S.P. Gogineni, with B. Holt, R. Kwok (of JPL), J. Maslanik (of University of Colorado)

Radar Sounding and Airborne High-Resolution Mapping of Near-Surface Layers of the Greenland Ice Sheet

NASA-Goddard
S.P. Gogineni, with D. Braaten

Reporting System to Improve Safety of the Blood Supply

Columbia University (Dept. of Health and Human Services)
C. Tsatsoulis

RF Channel Simulator for Wireless Communications

Medtronic, Inc.
G. Prescott, with J. Roberts

Rosetta Tools & Techniques IR&D-2001

EDaptive Computing
W.P. Alexander

Scalable Performance Models for Large Scale Networks with Correlated Traffic

University of Missouri-Kansas City (UMKC)/NSF
V. Wallace

SGER: System-Level Network Modeling

NSF
W.P. Alexander

STI: Flexible Wireless Systems for Rapid Network Evolution

NSF
J. Evans, with G. Minden

Stochastic Adaptive Control and Related Topics

NSF
T. Duncan, with B. Pasik-Duncan

Stochastic Systems and Control

NSF
T. Duncan, with B. Pasik-Duncan

Stochastic Theory and Control Workshop

NSF
B. Pasik-Duncan

Swept Stepped-FM Vehicular Mounted Ground Penetrating Radar for Anti-Tank Mine Detection

U.S. Army-Communications-Electronics Command (CECOM)
J. Stiles

System Level Design of Embedded Systems

NSF
W.P. Alexander

System Support and Performance Evaluation of Conventional and Real-Time ORBs

Sprint
R.D. Niehaus

Traffic Modeling for Network Engineering

Sprint Corp.
D. Petr, with S. Chakrabarti

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

NSF
R. Hui (with H. Jiang, J. Lin, of Kansas State University)

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

Burlington Northern Santa Fe Railway
C. Tsatsoulis

Validation of AMSR Snow Depth on Sea Ice Retrievals Using an Airborne Pulse Radar

NASA-Goddard Space Flight Center
S.P. Gogineni, with G. Prescott

Verification of UML Meta-Models

U.S. AFRL
W.P. Alexander

Wireless Extension to the ACT ATM Internetwork

Sprint
J. Evans, with V. Frost, G. Prescott

Wireless Smart Devices and Their Coordination

Ambient Computing, Inc.
V. Frost ■

Books and Book Chapters

A Comparison of Rough Set Strategies for Pre-term Birth Predicting.

J.W. Grzymala-Busse, L.K. Goodwin, W.J. Grzymala-Busse, X. Zheng; *Technologies for Constructing Intelligent Systems*; ed. B. Bouchon-Meunier, G. Gutierrez-Rios, L. Magdalena, R.R. Yager; Springer Verlag, 2002, pp. 239–252.

Data Mining Based on Rough Sets.

J.W. Grzymala-Busse, W. Ziarko; *Data Mining: Opportunities and Challenges*; ed. J. Wang; Idea Group Publications, January 2003, pp. 142–173.

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Acronyms Used Undefined (on Pages 1–39)

AAI	ACTS ATM Internetwork	ITR/SI+AP	(NSF's) Information Technology Research/Scalable Information Infrastructure for Pervasive Computing and Access + Applications in Science and Engineering
AAL2	ATM Adaptation Layer 2	ITTC	Information and Telecommunication Technology Center
ACM	Association for Computing Machinery	K*STAR	Kansas Science and Technology Advanced Research
ACT(S)	(NASA's) Advanced Communications Technologies (Satellite)	KTEC	Kansas Technology Enterprise Corporation
AI	Artificial Intelligence	KU	University of Kansas
AMSR	Advanced Microwave Scanning Radiometer (of NASA's EOS)	KUCR	KU Center for Research, Inc.
API	Application Programming Interface	LAN	Local Area Network
AQUA	Second EOS Observatory; NASA Earth Science satellite mission to collect information about the Earth's water cycle (land, sea, and atmosphere)	LLC	Limited Liability Company
ASEE	American Society for Engineering Education	MAGIC	Multidimensional Applications and Gigabit Internetworks Consortium
ATM	Asynchronous Transfer Mode	Mbps	Megabits (millions of bits) per Second
BERT	Bit Error Rate Tester	MIDP	Mobile Information Device Profile
CAREER	Faculty Early Career Development (NSF program)	NASA	National Aeronautics and Space Administration
CATV	Cable-Access Television	NRZ	Non Return to Zero
CBR	Case-Based Reasoning	NSF	National Science Foundation
DS-CDMA	Direct Sequence Code Division Multiple Access	ORB	Object Request Broker
CISE	Computer and Information Science and Engineering	PC	Personal Computer
CORBA	Common Object Request Broker Architecture	PMD	Polarization Mode Dispersion
CPU	Central Processing Unit	PNNI	Private Network-to-Node Interface
DARPA	Defense Advanced Research Projects Agency	PPP	Point-to-Point Protocol
(D)EPSCoR	(Defense) Experimental Program to Stimulate Competitive Research (U.S.) Department of Defense	PRISM	Polar Radar for Ice Sheet Measurement
DoD	(U.S.) Department of Defense	PSD	Power Spectral Density
DSP	Digital Signal Processing	QoS	Quality of Service
EECS	(KU's) Electrical Engineering and Computer Science Dept.	RDBMS	Relational Database Management System
EOS	Earth Observing System (NASA program)	R&D	Research and Development
FPGA	Field-Programmable Gate Array	R/D&C	Research, Development, and Commercialization
GaN	Gallium Nitride	RF	Radio Frequency
Gb/s, Gbps	Gigabits (millions of bits) per Second	SAR	Synthetic Aperture Radar
GHz	GigaHertz (billions of cycles per second)	SGER	Small Grants for Exploratory Research (NSF program)
GPR	Ground-Penetrating Radar	STI	Strategic Technologies for the Internet (NSF program)
HOPE	Honor for an Outstanding Progressive Educator	TP&I	Technology Planning and Integration
IEEE	Institute of Electrical and Electronics Engineers	UML	Unified Modeling Language
IP	Internet Protocol	UMTS	Universal Mobile Telecommunications System
IR&D	Independent Research and Development	UNITE	Organization to provide continuing graduate education for engineering and science professionals through distance learning
IT	Information Technology	WAN	Wide Area Network
ITKC	Information Technology networking organization based in Kansas City	WDM	Wavelength-Division Multiplexing

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Ph.D. student **John Paden** helps deliver test equipment to its setup site on the Greenland ice sheet, in summer 2003. From left to right on the sled are a generator, box of fiber cable, latched case containing radar system (topped by a tool for checking fiber quality), and a blanket-covered LCD screen (which also has a heater to prevent its freezing). The sled is pulled by a snowmobile (behind Paden, not shown). *The photo was taken by Arvin Agah.*



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