The LINK

NEWS FROM Information and Telecommunication Technology Center

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New Research to Test Communication Tools

ITTC will serve as an independent testing facility for technology of interest to the Bluetooth Special Interest Group (SIG). The Bluetooth technology enables electronic devices to communicate among themselves wirelessly at short range.

The collaboration involves ITTC researchers evaluating nearly 20 products, helping manufacturers advance Bluetooth technology.

Joe Evans, director of ITTC's Networking and Distributed Systems Laboratory, will oversee the project, conducted by researchers **Leon Searl** and **Dan Deavours**. The team will test mobile telephones, headsets, personal digital assistants (PDAs), and desktop computers, then submit a report to Bluetooth SIG.

"We believe our work with the Bluetooth SIG will help accelerate the deployment of its technology worldwide and is a great opportunity for ITTC to gain exposure with the many member companies of the Bluetooth SIG," Evans says.

Cell phones equipped with a special Bluetooth chip could serve as universal "remotes," opening garage doors, printing documents from computers, or programming TVs, says **Victor Frost**, ITTC director.

ITTC researchers will work with Bluetooth-enabled products, testing their ability to communicate with one another.

The chip, no larger than a stamp, can be inserted into many electronic devices, permitting them to communicate without cables. Among other things, the technology would allow telephones, handheld devices, and personal computers to share address books and schedules, Frost says.

After the initial tests, work on the Bluetooth project will most likely be expanded, and students will examine Bluetooth technology and learn to design software and applications for the technology.

The technology was named after a Danish king who unified Denmark and part of Norway into a single kingdom in the 10th century. ■

NSF Grants Fund Two New Research Projects

As the Web continues to develop as a multimedia tool, users sometimes have difficulty downloading audio and visual segments. People may notice "clicks" and "pops" when accessing audio clips. Video transmission impairments can cause color distortion, edge jerkiness, or loss of synchronization between audio and visual.

These problems may occur as networks become congested, when demand for capacity exceeds supply. This overcrowding usually results in the loss of multiple information packets, creating a disjointed reception that affects users' satisfaction with a network's delivered quality of service (QoS).

Most users do not associate common QoS problems, such as delay and packet loss, with having a direct impact on their ability to use the Internet. This link must be made clear, and that is what current QoS research at ITTC will strive to do.

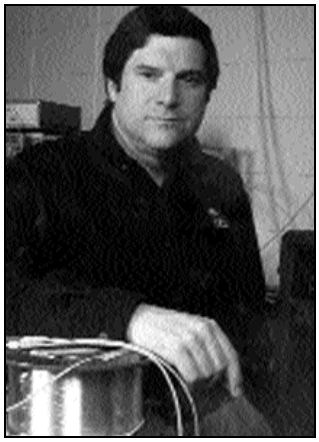
ITTC researchers **Tyrone Duncan** and **Victor Frost** are developing a new QoS metric (or measurement) in an NSF-funded project. The research is aimed at predicting the rate of congestion events per unit of time. This will give network customers a better idea of what QoS their network provides.

The goal is to have a QoS mechanism that network users can easily understand, says Frost, ITTC director.

See NSF GRANTS on page 4

Director's News

A new term that you will be hearing more and more about is "bioinformatics." I realized just how popular it had become in the media on a recent trip to Washington, D.C., when the airline magazine featured an article on bioinformatics.



Director Victor Frost

The increased mainstream publicity can be attributed to the potential benefits of bioinformatics, which uses computing and database technologies to analyze huge amounts of data. While the emerging field has many applications, it will be an enabling technology in the search to find new ways to treat, cure, and even prevent diseases. Bioinformatics can help researchers pinpoint errant genes that cause or contribute to diseases.

Bioinformatics, in fact, has many different meanings. To some it refers to any application of computation in the field of biology, including data management, algorithm development, and data mining. An example is **Susan Gauch's** involvement in the collaborative research project Biodiversity Information Organization using Taxonomy (BIOT). To others, it is the use of computer databases to extract specific information from the mountains of data generated by genomics and proteomics research. In other contexts, it refers to the set of tools or models that allow a scientist to see cause-and-effect relationships between disease and polymorphisms or differences in DNA sequences among individuals. How researchers transform gene data to protein structures and correlate gene and protein functions is also in the realm of bioinformatics.

Bioinformatics also involves applying software or information technology to biology and experimental medicine to discover new knowledge. Researchers must learn how to select and optimize computational biology algorithms. Bioinformatics will provide the needed information and communications technology to bring together diverse groups of researchers from academia and industry, allowing them to collaborate more effectively.

Clearly, bioinformatics encompasses many core areas in computing, including information retrieval, data mining, stochastic modeling, information modeling, distributed algorithms, data bases, multidimensional signal processing, and networking. All are areas of ITTC expertise. The National Science Foundation (NSF) and the National Institutes of Health (NIH) have identified bioengineering and bioinformatics as essential underpinning fields in the 21st Century. These agencies are collaborating on an important high-profile effort to meet the anticipated bioengineering and bioinformatics human resource needs. The Computer and Information Science and Engineering directorate at NSF is sponsoring summer research institutes for bioinformatics, and it is one of the target areas for this year's NSF Information Technology Research (ITR) program. Already, in the Kansas City area, bioinformatics is an important component of the plan for life sciences research. Specifically, it is recognized as a high priority enabling technology—a required foundation for life sciences research.

How is KU responding to the challenges involved in advancing bioinformatics? Tuition enhancement funding will support two new bioinformatics faculty members—one senior and one junior—who will be appointed in the Department of Electrical Engineering and Computer Science (EECS). ITTC investigators have already conducted life-sciences-related research (see ITTC's Summer 2002 *The Link*). They have the expertise and are well positioned to continue bioinformatics research. ITTC research will help the University succeed in enhancing life-sciences-related research, especially in bioinformatics. ■

PRISM Hires New Technician

Dennis Sundermeyer has joined ITTC as the new Electronics Technician for the Polar Radar for Ice Sheet Measurements (PRISM) project. He brings 25 years of experience in electronics to the project. He will help ITTC students with their designs for PRISM radar. While students design the radar, Dennis ensures that the blueprints work correctly.

Dennis Sundermeyer

He is helping with the packaging of electronics for this summer's fieldwork in Greenland. Dennis will travel to Greenland and assist in the radar's testing.

PRISM is developing radar sensors to collect and analyze data about interactions among ice sheets, oceans, and the atmosphere. The results from this project will help scientists refine their understanding of the Antarctic and Greenland ice sheets and how they respond to changes in the climate. ■

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Researchers Record, Analyze Data from Glaciers

Pannirselvam Kanagaratnam participated on a research team investigating the Pine Island Glacier and other glaciers located south of Chile, in the western corner of Antarctica. Researchers from NASA, Centro de Estudios Cientificos (CECS), and the Chilean Navy flew over the ice sheets and recorded data with ice-sounding radar this past November and December.

Because of the ice sheets' remote location, scientists have previously been unable to gather data on these glaciers, which are among the fastest moving and the most prone to instability on the continent of Antarctica.

Scientists will use these data to determine why the ice sheets are thinning. The maps of the ice surface and underground geology created by Kanagaratnam and others will help scientists understand the impact of climate change on glaciers.

Kanagaratnam, a postdoctoral research associate, is processing the data and generating a thickness profile of the ice sheet. The thickness profile consists of the latitude, longitude, and ice thickness at numerous locations. The completed project will give scientists a detailed record of the glaciers to compare with future missions.

Claudio Teitelboim, director of CECS, underlined the importance of obtaining data on the Pine Island Glacier.

"It's in the most remote part of the continent, so we don't know much about it. But it is also where Antarctica is the most unstable, and where any small changes in the Earth's temperature are likely to have a big impact on the ice," he said in a BBC news article on January 6.

Pannirselvam Kanagaratnam, postdoctoral research associate, uses ITTC-developed radar to collect information on glaciers.

A rise in temperature could mean a significant rise in sea level that would have a devastating impact on the world's population, agriculture, and ecosystems, since nearly 60% of the world's population live in coastal regions.

The KU radar gathered the crucial information without hurting the environment. The setup included antennas on both wings of the airplane. One antenna transmitted a signal that penetrated the different layers of the glacier and bounced back after hitting bedrock. The second antenna received the signal, which was then transported through cables to a computer.

ITTC staff member **Torry Akin**s assisted with the assembly of the radar on the P-3 aircraft. Sixteen people were on board the aircraft during each mission. The group flew every other day, giving the crew a chance to rest between 16-hour missions. ITTC investigator Kanagaratnam was in Chile for 25 days and flew on each mission to ensure the radar worked correctly. ■

Tsatsoulis Presents Data-Mining Research in Iceland

Costas Tsatsoulis attended a by-invitation-only, patient-safety workshop in Iceland this past September. The conference, organized by the United States and United Kingdom health care associations, focused on preventive procedures for medical personnel. Organizers asked Tsatsoulis to present his work in data mining of blood incidents.

Costas Tsatsoulis

Tsatsoulis has created data-mining software that analyzes volumes of information and identifies similar recurring problems. The ability to recognize problem clusters can help medical personnel address persistent issues and avoid them.

The same intelligence gathering could prove beneficial in broader issues of patient safety, which Tsatsoulis highlighted at the conference.

With mandatory reporting of incidents in the UK and a push for mandatory reporting in the United States, the number of reports agencies receive may make it difficult to identify problem clusters, Tsatsoulis says. He has begun talks with a UK agency, the Patient and Safety Research Program, and expects to be working with them in the near future.

While most blood "incidents" are benign, like forgetting to perform a step during blood generation, others can be life-threatening, such as giving someone the wrong type of blood or blood that is infected with HIV. Tsatsoulis's tools assess the frequency of these mistakes, from the harmless to the dangerous, providing health care workers with crucial information.

"In recent years many studies have shown that there is a very large number of medical errors that happen daily, and which cause patients to spend more time in the hospital or even suffer permanent injuries," says Tsatsoulis, director of ITTC's Intelligent Systems and Information Management Laboratory. "Because of this, the reporting of medical errors is attracting a lot of interest from the medical community, the regulatory agencies, and even Congress." ■

Faculty, Former Student Earn U.S. Patents for Work

ITTC researchers have developed technology that could make high-speed use of the Internet more efficient. Their work will let greater amounts of information squeeze through the fiber-optic cables that form the basis of today's telephone and data networks. This will allow Internet users to quickly download audio and video from the Web, while making sure information correctly arrives at the receiving end.

For their efforts, ITTC Lightwave Communication Systems Laboratory Co-Directors **Chris Allen** and **Ken Demarest** and ITTC faculty investigator **Ron Hui** were awarded a U.S. patent last fall.

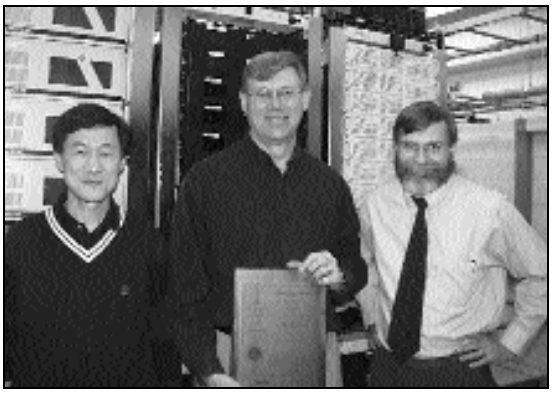
While the development of fiber-optic cable has led to the Internet explosion, the cable, which most telephone companies use as their long-distance lines, is not infallible. Imperfections in the shape and makeup of fiber optics can jumble data traveling through the fiber.

Over a phone line, it might not hurt if the word "hello" sounds, at the other end, like "Jell-O," but if a bank transaction gets scrambled, that is another story.

At current data rates, one form of this disturbance is "polarization-mode dispersion" (PMD), which is so small it goes unnoticed. But the demand for faster transmission of information could lead to problems.

PMD occurs as developers try to increase the speed of the Internet. Researchers are attempting a four-fold increase, shortening the amount of time between the sending of information bits.

Information is sent though fiber cables that are not perfectly circular. One bit may arrive just a fraction of a second late. A fraction of a second can be enough to jumble information when machines are working in trillionths of a second.



Associate Professor Ron Hui (left) stands with Lightwave Communication Systems Laboratory Co-Directors Chris Allen (middle) and Ken Demarest with their patent plaque. The three earned the patent for their PMD compensator.

Imagine two people who are running at the exact same speed. One runs on a clear street while the other runs through the forest. The obstacles placed in front of the second runner slow her down. While she tries to keep up with the other runner, she simply can't. This is one way to think of PMD. Certain bits of information arrive later than others because they must pass through obstructions in the cable. Fiber cable can become distorted because of differences in temperature or even differences in the time of day. When information arrives late, it becomes unreadable.

Allen led a group of ITTC researchers in the development of a PMD compensator, a card that unscrambles the data at the receiving end of transmissions. The compensator will give users access to high-speed communication over fiber-optic cable in the future.

Hui was granted a second patent last fall for work he did more than five years ago with Nortel Networks, a Canadian company that offers networking and telecommunications services. Hui and fellow Nortel researchers developed chips that can quickly encode information, enabling data to be sent through fiber-optic cables with greater speed.

Former ITTC student and Sprint Fellow **Steve Oliva** received a patent for research he did while earning his Ph.D. at KU. His work will provide more effective methods of connection admission control (CAC) for high-speed broadband communications networks. The CAC mode and system will provide efficient network bandwidth management and higher overall use of network links, while ensuring required quality of service. ■

ITTC Helps KU Set Record for Research Expenditures

ITTC exceeded $7 million in total expenditures in fiscal year 2002, setting a new record for resources used to support the Center. ITTC is one of the largest research centers at the University of Kansas. The Center's success helped KU increase its expenditures on research for the sixth consecutive year, surpassing the $243 million mark in FY 2002.

More than 50 percent of ITTC's expenditures were from funding received through federal grants. Another approximately 30 percent came from industry-related projects. Ten percent came from State funding sources, with the remaining 10 percent originating from the "other" category, which includes other universities and foreign sources.

"ITTC has been a major part of KU's growth in research funding. Its faculty successfully compete at the highest levels for support for their innovative ideas," **Chancellor Robert Hemenway** says. "ITTC is a major reason why KU can legitimately set a goal of becoming one of the top 25 public research universities in the country."

Fiscal year 2002 was the second straight year the Center has increased its expenditures. In FY 2001, ITTC spent a little more than $6 million after dipping below the $6 million mark in FY 2000. Before the setback in 2000, the Center had grown annually from a little under $1 million in 1992, peaking in FY 1999 at just under $6.5 million. ■

Investigators Aid NASA Lab in Exploration of Mars

When NASA scientists analyze data from the Mars Smart Lander (MSL) mission, to be launched in either 2007 or 2009, they may use technology developed at ITTC.

It is expected that information obtained from this mission will lead to new and dramatic knowledge of Mars, letting scientists view and study subsurfaces from much earlier periods of geological time.

ITTC researchers **Muhammad Dawood** and **Prasad Gogineni** are developing a procedure to help scientists better understand what exists below Mars' surface. Their algorithm will interpret information recorded from ground-penetrating radar used on the mission. ITTC will perform the work under a two-year subcontract with NASA's Jet Propulsion Laboratory.

Mounted on top of a rover, the radar will launch waves into the ground on Mars. The powerful signals from the surface of the ground mask the impressions from subsurface layers, whose reflections are much weaker. ITTC researchers must find a way to preserve the faint subsurface echoes while removing the stronger ground reflections. Researchers must then link subsurface reflections to what might have caused them.

Creating this algorithm that will identify subsurface images is extremely involved and is further complicated by the lack of knowledge about the composition of Mars' surface or subsurface, Dawood says.

After Earth, Mars has been the most explored planet in the solar system. Scientists from three countries—the United States, Russia, and Japan—have sent 30 missions to Mars during the last 40 years. Many of these missions have focused, and continue to focus, on questions about the planet's past and/or present water supply.

While water, in its liquid state, cannot exist on the surface of Mars today because of the planet's cold temperatures and thin atmosphere, scientists wonder about the existence of water in Mars' past. Images taken from the Viking orbiters show landscape features, such as deep channels, that appear to have been formed by running water. Scientists have made other observations from satellite images that suggest flowing water once existed on the planet's surface. ■

NSF Grants Fund Two New Research Projects, *continued from page 1*

While several extensive QoS mechanisms for packet networks have been defined, they have not been widely deployed. It is not known how much network capacity could be saved by their use.

It has been difficult to justify the costs of deploying these complex systems without an understanding of how they affect network capacity and user satisfaction. Frost and Duncan will aid in the understanding of QoS by creating a measurement that users can easily interpret.

ITTC's second newly funded NSF project uses resources no one thought existed, to produce a radical new way of building radio systems. ITTC researchers **Joseph Evans** and **Gary Minden** are looking for "empty pockets" within the radio frequency (RF) spectrum. While wireless communication devices such as cellular telephones and radio and television broadcasts use RF, pockets of unused frequencies still exist in the spectrum. Evans and Minden will locate these pockets and use them to create a system with better bandwidth/power characteristics. They will transmit information on the set of frequencies located in these unused areas. Their radio, called Hyper-Orthogonal Frequency Domain Multiplexing (H-OFDM), will have a longer range than existing approaches, while staying within FCC regulations.

Conventional ultra-wideband systems must use very low-power transmissions so as not to disturb other media using the same frequencies. However, this limits the system's range, typically to one mile. ITTC's radio will provide greater range, as it uses higher power at frequencies located in the empty spectrum to transmit its information. The flexibility of the new system will allow the radios to easily comply with both FCC and international rules governing spectrum use.

Joseph Evans holds a radio developed at ITTC. The radio will serve as a prototype in creating the new Hyper Orthogonal Frequency Domain Multiplexing (H-OFDM) system. Evans and Gary Minden have begun looking at the RF spectrum for "empty pockets." They will use these pockets to create a system with more power.

The researchers' project will allow them to develop a working H-OFDM system based on software radio techniques. The applications for this communication system are endless, says Evans, director of ITTC's Networking and Distributed Systems Laboratory. Since H-OFDM radios carefully avoid interfering with each other and other radios, many more homes and businesses can have their own networks. Researchers think that eventually, intelligent H-OFDM radios should be able to handle the data, voice, and video communications for home or business.

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

Achievements and Acclaim

Winter Food Drive Gives Back to Community

In **ITTC's First Annual Winter Food Drive,** faculty, staff, and students filled five boxes with nonperishable items that were taken to the Lawrence Interdenominational Nutrition Kitchen (LINK). Thanks to all who donated for your generosity and support. ■

Saiedian Receives Development Certification

Professor **Hossein Saiedian** earned designation as a Certified Software Development Professional by the Institute of Electrical and Electronic Engineers-Computer Society. He is one of only 206 people to receive certification so far. The process requires more than 9,000 hours of software engineering experience in at least six different knowledge areas. ■

Alexander Publishes Systems-Design Article

An article by Associate Professor **Perry Alexander** appeared in the December 9 issue of *Electronic Design*. The article, "Designing at the Systems Level: Evolution or Revolution," can be found online at planetee.com. ■

ITTC Students Graduate in Winter Ceremony

ITTC employs more than 130 students. The following earned their degrees in December.

Master of Science, Electrical Engineering: **Arun-Prasad Chimata, Vijaya Chandran Ramasami, Matthew Schlesener, Logeshwaran Vijayan, Pradeep Kumar Kondamuri, Guruvayurappan,** and **Qiang Zhang.**

Master of Science, Computer Engineering: **Sreenivas Sunil Penumarthy, Karthik Balasubramanian, Ravi Kiran Vemuri, Sujit Rupert Baliga,** and **Sankaranarayanan Vidyaraman.**

Master of Science, Computer Science: **Sivaprasath Murugeshan, Mahesh Akarapu, Stephen Ganje, Sandhya Rallapalli,** and **Danico Lee.**

Bachelor of Science, Electrical Engineering: **James Kreycik.**

Bachelor of Science, Computer Engineering: **Jacob Woltersdorf.**

Bachelor of Science, Computer Science: **Michael Frisbie.** ■

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ITTC Sponsors Dinner for International Conference

ITTC hosted an evening for members of the International Organization for Standardization (ISO) forum this past fall. Representatives from 21 countries filled the Apollo Room, listening to presentations by Director **Victor Frost** and e-Learning Design Laboratory Co-Directors **John Gauch** and **Ed Meyen**. The more than 60 delegates also received tours of ITTC and dinner in the lobby of Nichols Hall.

Gauch and Meyen spoke on the 16-year collaborative relationship between ITTC and KU's Center for Research on Learning that led to the joint creation of the e-Learning Lab in 2001. They stressed the importance of applying their research and design to e-learning environments while keeping content at the forefront.

"Hosting the ISO dinner was a great opportunity for faculty involved in e-learning at ITTC and KU to meet people from around the globe with similar interests. It was a great learning experience for me, and also a chance for the ITTC e-Learning Design Lab to show off the technology we have developed over the last five years," Gauch says.

More than 60 conference members spent the week researching ways to promote information sharing and reusable knowledge management systems to support e-learning. The forum focused on the use of databases, the Internet, intranets, and Web technologies to store and share information that is relevant to governments, businesses, and education.

ITTC Chief Technologist Gary Minden, center with name tag, leads a group of ISO members on a tour of ITTC. The Center hosted a dinner for ISO last fall.

"Such standards are essential to the future of e-learning at all levels in education," Meyen says. "It makes the sharing of resources and collaboration in development more feasible and cost effective."

The Center established relationships that could facilitate its interactions with those who attended. ■