INSTITUTE FOR COMPUTING, INFORMATION AND COGNITIVE SYSTEMS •I•C•I•C•S•

ICICS FOCUS

THE UNIVERSITY OF BRITISH COLUMBIA

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Coordinating Response to Quell Catastrophe

ICICS and UBC are major players in an expansive research program designed to integrate the disaster response of Canada's vital infrastructure networks.

1: Alejandro Cervantes, 2: Konstantin Beznosov, 3: Juri Jatskevich, 4: Gary Poole, 5: Brian Klinkenberg, 6: Carlos Ventura, 7: Hafiz Abdur Rahman, 8: José Marti, 9: Tamara Munzner, 10: KD Srivastava, 11: Jorge Hollman, 12: Kafui Monu

- **Disaster Response**
- **Infrastructure Interdependency**
- **Interlinking Systems**

Imagine a lovely afternoon stroll back to the office after a leisurely lunch. Suddenly the earth shudders. Everywhere is the sound of breaking glass, metal scraping metal, walls falling. Car alarms drown out screaming. A fallen power line ignites a broken gas main. Electrical, telecommunication and transportation systems all grind to a halt. Hospitals and emergency services are unable to cope as the city succumbs to the chaos of disaster.

This is exactly the kind of scenario that the new Joint Infrastructure Interdependencies Research Program (JIIRP) aims to avoid. Funded by the National Sciences and Engineering Research Council (NSERC) and the Public Safety and Emergency Preparedness Canada, the $2.98-million initiative involves six partner-projects at universities across Canada.

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ICICS Fall 2005 Vol. 16, No. 2

ICICS Director's Corner

It has been an exciting six months. In July 2005 we unveiled the new ICICS/CS addition, the physical culmination of the ICICS vision to create a world-class interdisciplinary, human-centred technology institute. By bringing together more researchers under one roof, the new laboratory, office and classroom space facilitates collaboration, learning and teaching across disciplines.

Our cover story in this issue of Focus features an ICICS team's contribution to a major national initiative to integrate the disaster response of Canada's infrastructure networks. Led by electrical and computer engineer José Marti, the 13-member group will use ICICS's new Interactive Workroom to develop real-time simulation tools for disaster response.

In this issue we also profile four recent ICICS members. New Computer Science head William Aiello, who came to UBC from industry, describes his vision for a burgeoning department in a time of flux.

Computer scientist Giuseppe Carenini's work in computational linguistics, human–computer interaction and information visualization is helping to develop computer systems that support decision making. Electrical and computer engineer Lutz Lampe uses communication theory to test the limits of wireless transmission and to design technologies for bandwidth sharing. Computer scientist Rachel Pottinger's research in metadata management will help solve the problems that companies face when they want to integrate information from an array of databases.

We hope you enjoy this issue of *FOCUS* and we look forward to telling you more about our new facilities and research in upcoming issues.

Rabab Ward, ICICS Director

JIIRP: ***Continued from page 1***

ICICS member and Electrical and Computer Engineering professor José Marti leads the largest of the six projects—Decision Making for Critical Linkages in Infrastructure Networks with funding of $1.1 million. Major industry partners include BC Hydro, BC Transmission Corp., TELUS, the GRVD, and Vancouver Airport Authority.

"Most major infrastructure companies have well-defined internal plans of how to deal with emergencies, but there is not enough development in coordinating these plans," says Marti. In a situation such as an earthquake, tsunami or terrorist attack, the disaster response of all essential services and utilities must be coordinated in real-time to minimize loss of life and damage to communities.

The researchers in Marti's group are world leaders in developing real-time simulation tools for large, extensive systems and complicated events. Along with Prof. Marti, the group includes ICICS members Philippe Kruchten, Konstantin Beznosov, Jeffrey Joyce, Juri Jatskevich, KD Srivastava (Electrical and Computer Engineering); Kelly Booth, Tamara Munzner and Richard Rosenberg (Computer Science); Carson Woo (Commerce); as well as UBC professors Gary Poole (Psychology); earthquake expert Carlos Ventura (Mechanical Engineering); and geographical information systems researcher Brian Klinkenberg (Geography).

Critical Links and Human Decision Making

"The most critical part for us is to understand where and how all of these infrastructures are linked and therefore become interdependent and vulnerable," Marti says. With the world coming to BC's doorstep for the 2010 Olympics, coordinated real-time emergency preparedness of our hydro, telecommunications, transportation, water and other critical infrastructure systems is essential.

The other major challenge is to integrate human decision making with the simulation of events as they are unfolding. In a rapidly-developing disaster situation, there may not be enough time to implement the best decision model. "We need to model decision-making processes in a dynamically changing environment where each decision would have consequences in certain locations at certain times," emphasizes Marti.

Integration after Deregulation

Traditionally, public power companies in Canada have managed every aspect of electric power delivery, from generation to transmission and distribution. With deregulation, each of these areas is managed separately. "While one goal is to promote the development of small, distributed generation as a better economic and environmental alternative to large-scale coal or nuclear power generation, deregulation also increases the challenges of mitigating the risk of blackouts and coordinating the disaster response," says Marti, who also leads the Power Systems Group at UBC.

Adding Insight to the Picture

"Although the power system's control centre is well developed, a lot of information is delivered in a text-based form," says Marti. When a catastrophe occurs, the time it takes to interpret this information is crucial. Powerful computational tools and processing algorithms are not enough. Clear and comprehensive visualization is needed to prioritize the complex hierarchy of decisions involved in managing a catastrophic event.

José Marti can be reached at 604.822.2364 or jrms@ece.ubc.ca

Honing Human–Computer Communication

New ICICS member Giuseppe Carenini combines research in computational linguistics, human–computer interaction and information visualization to develop computer systems that effectively support decision making.

- **Computational Linguistics**
- **Human–Computer Interaction**
- **Information Visualization**

"One of my goals is to improve human–computer communication in the context of decision making."

How do we understand and create language, and why is this of interest to computer scientists? Filtering information, generating evaluative arguments, or influencing and aiding decision making are all tasks that we perform in language. They are also key tasks for computers. However, the language skills we take for granted are difficult to translate into binary code. Computational linguistics is an area of computer science that models how humans interpret and generate language—from building words to ordering and combining them into sentences to express meaning about objects and events in time and space.

Breaking the Bottleneck

"The bottleneck in computer-supported decision making is the ability of computers to convey information to humans and vice versa," says ICICS member Giuseppe Carenini. "If we can enable a computer to communicate using natural language, particularly in combination with graphics, we should be much closer to realizing interactive decision making."

There is a growing interest in this field, as more and more people make decisions by relying on large amount of text-based information available on the Web. Summarization is a key aspect of Carenini's work. It involves taking thousands of documents on a specific topic, such as customer reviews, extracting key information and summarizing it in knowledge-intensive ways that are tailored to user preferences. When buying a digital camera, for example, you would like to know whether—and why—other people liked or disliked any specific feature you were interested in. This could range from brand, price and megapixels to LCD size, camera weight or white balance.

"When we make decisions, we try to simplify the situation so it becomes easier. The value of this technology is to ensure that we consider all the information that is relevant to us, and not just focus on an arbitrary subset of information," says Carenini. Buying a house or vacation package are other examples of major purchases where online tools are increasingly relied upon to provide information used in decision making.

Value Charting User Preference

"The advantage of using language models is that you can tailor them to what people want, or know," Carenini notes. Building user preferences into the system includes modelling human reasoning, preference and inference. "In some ways computational linguistics is a subfield of AI and AI is a subfield of computational linguistics," says Carenini, who is also a member of the LCI group and an associate member of the IMAGER Lab at UBC.

His work also incorporates value charts, which use graphic visualization and interactive techniques to display linear models—a mathematical tool used in decision analysis.

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Building on Success

William Aiello has assumed the position of Head of Computer Science at an exciting time in the department's history—inheriting new facilities, high enrolment and world-renowned faculty.

After sixteen years in industry, ICICS member William Aiello returned to academia nine months ago to take the helm of UBC's Department of Computer Science at a very exciting time. Aiello left his position as director of Network Security at AT&T to head a department of 53 faculty members, 200 graduate students, 900 undergrads, and 35 staff members. He seems to be taking this quantum leap in stride.

"It is quite remarkable that we have increased our enrolment of undergrad students, whereas averages for the rest of North America have decreased by 15 to 20 percent as a result of the dot.com fallout." Aiello credits the department's success to its excellent faculty, strong international reputation, and to the provincial government's Double the Opportunity Initiative (DTO), intended to double the number of CS and ECE graduates in BC. Although Aiello admits that DTO has put considerable pressure on the department in terms of space, teaching and administrative resources, he says "now that the new buildings are complete, it is time to absorb the change and see what we can improve upon."

With a background in physics, applied mathematics (a PhD from MIT) and a career in network and computer security, Aiello is at home in a field that is increasingly complex and interdisciplinary. Computer security cuts across all aspects of computer science and industry. "The software market has been mostly driven by functionality and price without a high priority historically placed on security issues, so if you are now working in security you are practically tripping over problems," he says, "and that keeps the work exciting."

"One of the exciting things about computer science is that it is a discipline that affects every single aspect of modern life: commerce, medicine, engineering, science, government, the arts, you name it."

Computer Science—the New Physics

Post WWII, every scientist or engineer had to have some knowledge of physics. Today, the other essential common discipline is computer science. Every researcher uses computers as a tool in a central way, notes Aiello, but the impacts of computer science run much deeper. Early work in areas such as statistics, coding theory and information theory wasn't concerned with how much computing time would be required to model and compute solutions to problems. "As theory becomes richer and more complex, most disciplines have adopted combinatorial and algorithmic viewpoints that take into account the feasibility of computations," Aiello explains. "So the way in which computer science is affecting the foundations of other disciplines is very exciting,"

Building Space and Community

Incorporating this expansive vision of computer science into research and teaching is one of Aiello's main goals. The interdisciplinary mandate of ICICS has created a research environment that has opened up exciting opportunities for computer scientists to work with researchers across disciplines.

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New ICICS/CS Teaching and Research Addition

On July 19, 2005, the $40-million, seven-storey new addition to the Institute of Computer, Information and Cognitive Systems/Computer Science (ICICS/CS) building opened its doors to students, researchers and the general public. The vision of a multi-disciplinary, human-centered technology institute was first put forward in 1999, with a CFI proposal that took a year and a half to write and involved over 80 faculty members. The ICICS initiative evolved from the Centre for Integrated Computer Systems Research (CICSR), formed in 1986 with 35 faculty members from the core departments: Computer Science, Electrical and Computer Engineering and Mechanical Engineering.

Today, with 138 faculty members and over 700 graduate students from 18 UBC departments, ICICS has blossomed into one of the leading non-health science interdisciplinary research groups in the world, with research support of over $15 million. Over the past five years, ICICS researchers have filed 48 invention disclosures and 18 patents.

On hand for the opening ceremonies were Dr. Eliot Phillipson, President and CEO of the Canada Foundation for Innovation (CFI), Ms. Arlene Paton, the province's Assistant Deputy Minister of Advanced Education, and UBC President Martha Piper.

Funding for the ICICS side of the addition came from an $8.8-million grant from CFI; $8.2 million from the BC Knowledge Development Fund; and a $2.6-million donation from Dr. Stewart and Mrs. Marilyn Blusson. Industry partners Nortel Networks Inc., Partners for the Advancement of Engineering Education (PACE) and others have provided $2.4 million in cash and in-kind support.

The computer science portion of ICICS/CS and the adjoining Hugh Dempster Pavillion were funded by a $17.6-million grant from the provincial government's Double the Opportunity (DTO) program.

High-Tech Labs Support Leading Research

ICICS' specially designed research labs include the Physical Measurement Lab, the Human Measurement Lab, the Interactive Multimedia Lab (IMM-N), the Multimedia User Experience Lab (MUX lab), the Open Media Environment, as well as a sound studio and observation studios. They have state-of-the art equipment, over-height ceilings for mounting cameras, sensors and other devices, and raised flooring to house electrical and communication wiring.

As an example of innovative ICICS infrastructure, the Interactive Multimedia Lab has a 16 ft. x 9 ft. glass screen with a 4 ft. x 3 ft. array of projectors that will be connected to a high-speed switching matrix so that video from various sources can be combined and displayed on the screen in a variety of formats. The screen is so large that a window had to be designed for the side of the building to install it. The room will also have local computers that can render images directly onto the screen. Research in this area will investigate new techniques for managing and presenting large amounts of information in various settings, including face-to-face and online group meetings (see JIIRP article, cover). ICICS is one of the few research institutes in the world that has this technology.

Major research areas, many showcased at the opening, include computer animation, computer vision and robotics, artificial intelligence, physical measurement and motion capture, human measurement, and human–computer interaction.

"ICICS is internationally renowned for innovation and collaboration," says director Rabab Ward. "The interdisciplinary research that ICICS supports is fundamental to attracting some of the best scientists in the world. The new facilities will help us retain them—and train tomorrow's leading researchers."

Unveiled.

David Lowe exhibits UBC technology that enables robots to see and assess their surroundings. The software he developed has been licensed to SONY for the latest version of **AIBO, the robotic dog.**

Graduate student **Dana Sharon,** wears a special **motion sensor suit** to demonstrate technology similar to that used to create the movements of **Gollum** in **Lord of the Rings.**

Michiel van de Panne explains **Motion Doodle,** software that uses motion capture technology to animate drawn characters based on real-life movements.

Sid Fels and **Edgar Flores** demonstrate a **mechanical jaw** that can simulate the human jaw in all six directions. It has applications in dentistry, orthodontics, speech, an communications.

Robert Bridson demonstrates **physics-based animation** that uses ground-breaking software to produce natural, fluid movement. The fruits of his earlier work have been seen in **Star Wars II** and the **Harry Potter** movie series.

Managing Metadata

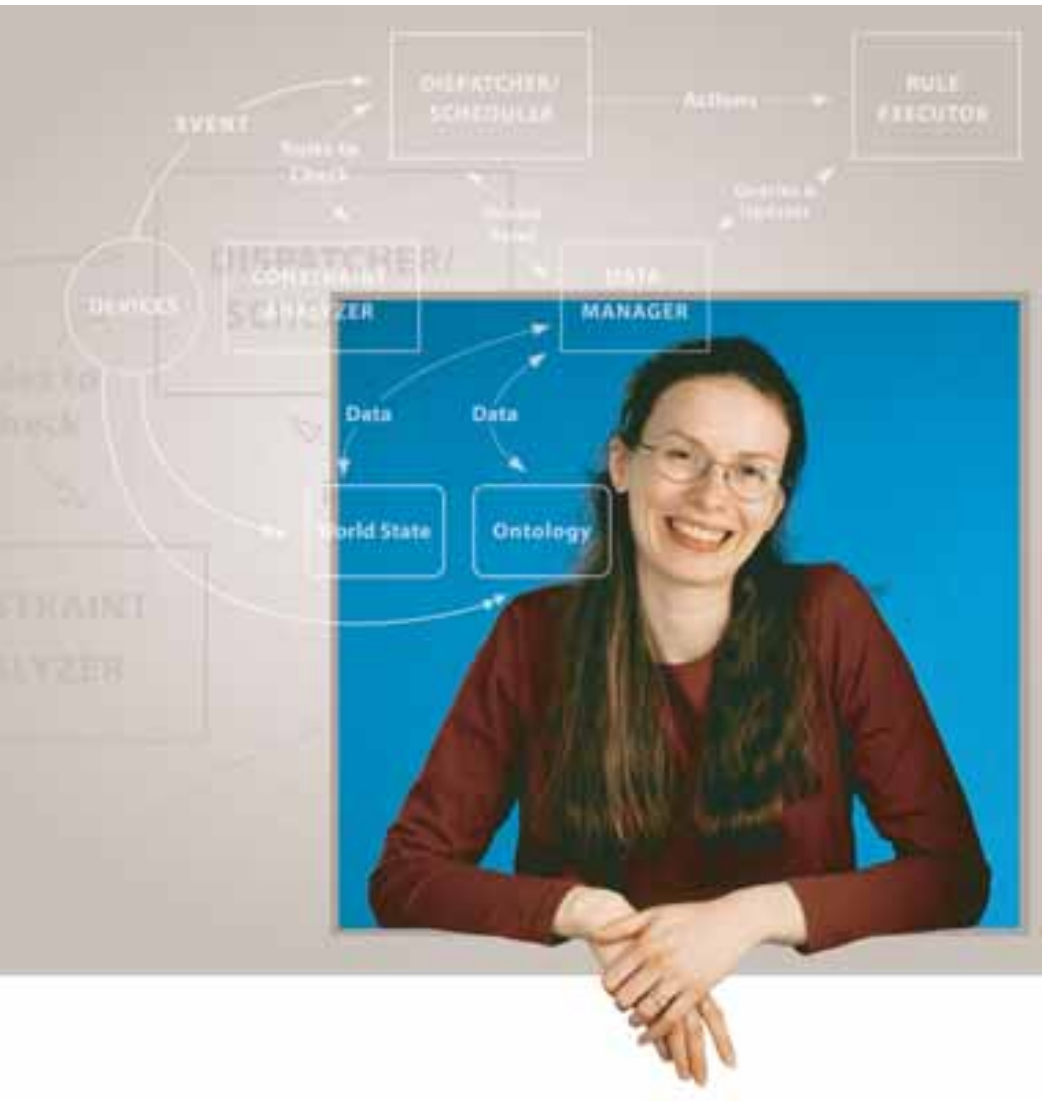
New ICICS member Rachel Pottinger is working to solve common problems that arise when companies and institutions try to work with data from different databases.

- **Metadata Management**
- **Data Integration**
- **Schema Merging**

On average, any one company has over 80 databases. This represents a staggering amount not only of information, but of man-hours dedicated to application design and data entry. The merging of information from one database to another, and the design of generic systems that can be used across an organization, present formidable metadata problems that computer scientist Rachel Pottinger is working to solve.

"One of the interesting things about metadata management is that it is not something a lot of people are working on," admits Pottinger. "But when you start talking to people in other fields about what you are doing, they all understand because they all have metadata problems."

"The question in metadata management is how much can we do that is generic and still solve the problems that are relevant."



Corporate Mergers and Merging Schema

The corporate merger is a good example of a major metadata challenge. The customer databases of two merging banks might be different. In one, each customer's information might be stored by name, where one field is used for both first and last name. In the other, two fields might be used; one for first name and another for last name. The new organization then has the dilemma of trying to figure out what data corresponds with what name, or how to merge data from both databases—without missing or mixing up any fields or records.

Combining differently structured databases or "merging schemas" comes with its own set of problems, however. "You still need to be able to rewrite the queries to ensure that you are able to access all of the data," says Pottinger.

Creating a Common Schema

While corporate mergers might be an obvious example, a more common one is dealing with databases within an organization, such as human resources, payroll, customer service and accounts payable. Universities and other institutions also have "mega" metadata problems. Even within ICICS, each department has different databases.

"Everyone has their own requirements and their own preferred format for information, which means that everyone is building their own case-by-case application, often with the same information in many fields." says Pottinger. "What we would like to do is record the information once, rather than having to do it several different times." Pottinger is working on a system that will be generic enough to use in different data models (relational or XML), yet able to solve application-specific problems.

Continued on page 9

Modulating Peaceful Coexistence

Electrical and computer engineer Lutz Lampe uses communication theory to test the limits of wireless transmission and design technologies for bandwidth sharing.

- **Bandwidth Sharing**
- **Wireless Sensor Networks**
- **Communication Theory**

The holy grail of next-generation wireless systems is an ongoing search to discover how to reliably transmit as many bits per second per Hertz bandwidth with as little power as possible, using relatively simple algorithms that can run increasingly small devices. "We also want to do this in a network, with many users and multiple source and receive points," says ICICS member Lutz Lampe.

He likens his basic research in coding modulation to an insurance system, where all bits of data are interdependent. Transmission of data bit by bit, independently, is prone to data loss. However, the more bits that are dependent upon each other, the more reliable the transmission —up to the point of overload. "A good example is a CD," says Lutz. "If it has one scratch, you won't hear anything, but if it has too many scratches, it won't play." His work involves an intricate balance between pushing the limits of performance and reducing complexity.

Whispering over Wideband

Many current wireless systems operate in relatively narrow (licensed) frequency bands. Recently, the communications industry has been re-examining the use of ultra-wideband (UWB) signalling, in the 3 GHz to 10 GHz range. One advantage of higher bandwidths is that they support much higher data rates. Lampe is collaborating with seven ICICS colleagues, including principal investigator Robert Schober (ECE) on a major UWB project. This research is funded by NSERC, Noika Products Ltd., and Bell Canada and supported by Sierra Wireless, EXI Wireless Systems Inc., and OMNEX Control Systems Inc.

UWB technology would allow high-speed systems to transmit with extremely low power. In fact, since the signal power of UWB devices would fall below the "audible" level of other systems, they could operate across licensed narrowband systems without interference. "In effect, you are speaking with such a low voice that others can't hear you," explains Lampe. His part in the project is evaluating and testing industry proposals against the limits of communication theory, which solves queries such as "what is needed to transmit one bit of data reliably."

Boosting Bandwidth Usage with Spectral Sharing

In related research, Lampe is principal investigator on a Bell Canada funded project to develop coexistence mechanisms that enable efficient bandwidth sharing. The issue of coexistence is not confined to licence-exempt bands, such as the heavily used Industrial, Scientific and Medical (ISM) bands. Licensed bands are extremely underutilized—in the neighbourhood of less than 5 percent. Lampe is working on coding modulation schemes that would allow flexible spectrum management, or "spectral sharing" among currently licensed and licence-exempt bands.

Wireless Sensor Networks

Wireless sensor networks (WSNs) is another area where Lampe's work in coded modulation plays a key part.

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Rediscovering Power Line Communication

Another interesting niche for communications theory research is in power line communication. ECE Prof. Lutz Lampe organized the International Symposium on Power Line Communication held in Vancouver in April, 2005. "There has been a revival of interest in this technology for use in remote areas," says Lampe. Many rural areas still do not have cable or telephone lines, but power lines are no longer a luxury.

"If the line is there, we can use it for communications," he says. "The challenge is that power lines weren't designed to carry a communication signal, so this requires new technology." For example, a hybrid of power line and wireless technology has been successfully applied to provide internet services to remote recreational areas on Vancouver Island.

Carenini: ***Continued from page 3***

"Combining value charts with language models will provide a system that allows the user to visualize preferences and all of the alternatives, while at the same time generating evaluative arguments and pointing out important aspects of the data."

In future work, Carenini hopes to apply the same techniques to historical information, such as summarizing different biographies of the same person, or different historical accounts of the same event. "This would allow us to easily identify core information and perhaps even conflicting information," he explains. Writers of biography and history should take note—and be sure to check your facts.

Giuseppe Carenini can be reached at 604.822.5109 or carenini@cs.ubc.ca

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Aiello: ***Continued from page 4***

And with the new CS and ICICS buildings now complete, the department can only continue to thrive.

"It is great to have new lecture and lab space, but one of the things I like most about these buildings is that they will enhance a sense of community by bringing students together in a communal space," Aiello says. With increases in global competition and the dizzying speed of technological change, undergrad programs must continue to be innovative to maintain enrolment. Programs must provide higher level skills, such as project and team management, as well as good technical basics. "The R&D effort in information technology continues to surpass any other discipline, including pharmaceuticals, so there are still plenty of opportunities in IT and computer science."

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Pottinger: ***Continued from page 7***

Managing New Types of Data

Often data is stored in spreadsheets rather than databases because it is easier to view and share information, and to change schemas (add or delete records or fields). Medical and scientific researchers often store data this way, Pottinger notes. She is interested in fusing databases and spreadsheets in order to gain the sophisticated querying capabilities of databases while retaining the advantages of spreadsheets.

"Many ICICS researchers have very interesting data that they need to combine from many different sources," Pottinger says. She sites José Marti's group who are working on visualizing information for disaster recovery (see JIIRP article, cover). "These are the big problems in real applications that I am interested in helping to solve."

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Lampe: ***Continued from page 8***

Applications for WSNs have spread from military to civilian use, including security surveillance, fire protection, avalanche detection, and environmental and health monitoring. Lampe is working with ICICS and ECE colleagues Victor Leung (PI), Vikram Krishnamurthy and Shahriar Mirabbasi to develop better techniques for collecting, processing, transmitting, and receiving sensor data. They are supported by several industry partners, including Victoria-based Valhalla Systems Inc., Novax Industries Corp., OMNEX Control Systems, Wireless 2000, Lockheed Martin ORINCON Defence, and VeriChip Corp. "Since these networks use hundreds or thousands of low-cost sensors, the key again is energy efficiency and low complexity."

"In wireless communication, more bits per second per Hertz bandwidth translates into more revenue per Hertz."

Lutz Lampe can be reached at 604.822.8261 or lampe@ece.ubc.ca

Passing Notes:

"Multimedia and Mathematics 2005" Workshop
A Banff International Research Station (BIRS) workshop organized by ICICS brought university and industry together to share ideas about the latest advances in multimedia and mathematics.

Six graduate students, 26 faculty members from 24 universities, and 8 researchers from Microsoft, Apple, Hewlett Packard, the TiZ Media Foundation, and NSF made up the 40 participants (29 men, 11 women) from Canada, the UK, Australia, and the US. With a focus on discovering common ground, they explored the mathematical modelling, analysis, and representation of the information in their respective media fields.

Recognition for Lifetime Achievement
James Little, Acting Associate Dean of Science and Computer Science professor, has been recognized for Research Excellence and Service to the Research Community from the Canadian Image Processing and Pattern Recognition Society.

Public Art Project Has ECE Connection
The city of Vancouver has chosen **Sidney Fels** (ECE) and artists Fiona Bowie and Rebecca Belmore to construct a $180,000 piece of electronic public art for the new community centre complex to be built at 1 Kingsway.

Canada Research Chair for Kevin Murphy
Computer Science professor **Kevin Murphy** has been awarded a Canada Research Chair in Machine Learning and Computational Statistics. The funding for his research in artificial intelligence and robotics totals $500,000, plus infrastructure funding of up to $37,515.

Clarence de Silva Elected
Mechanical Engineering professor **Clarence de Silva** has been elected as the Chair of the Dynamic Systems and Control Division of the American Society of Mechanical Engineers (ASME).

Joint Infrastructure Interdependencies Research Program Grant
José Marti (ECE)—leading a team of ICICS members from several departments, including **Philippe Kruchten**, **Konstantin Beznosov**, **Jeffrey Joyce**, **Juri Jatskevich**, and **KD Srivastava** from ECE; **Kellogg Booth**, **Tamara Munzner**, and **Richard Rosenberg** from CS; and **Carson Woo** from Commerce—has received a $1.3-million grant to develop simulation and communication tools for coordinating responses during large-scale emergencies.

ECE Professors Awarded NSERC Grant
José R. Marti and **KD Srivastava,** working with UBC's Industry Liaison Office and Powertech Labs Inc., have been awarded $125,000 for developing a device that detects faults inside a power transformer's tank.

Honours for Izak Benbasat
Izak Benbasat—Chair of UBC's Sauder School of Business Management, Information Systems Division—has been ranked the fifth most productive information systems scholar worldwide in a study published in the Association for Information Systems (CAIS) journal. Benbasat, the only Canadian named to the top ten, holds the Canada Research Chair in Information Technology Management and was recently elected to the Academy of Humanities and Social Sciences of the Royal Society of Canada for his exceptional contributions to scholarship.

Two ECE Professors Receive NSERC Award
Guy Dumont and **Sidney Fels** have received $499,355 from the NSERC/CHRP program for their project to develop a device that will improve the safety of anesthesia. The new device will monitor changes in patient conditions, reducing the number of errors in the operating room.

CFI Grant for Kevin Leyton-Brown
Computer Science professor **Kevin Leyton-Brown** has received a Canada Foundation for Innovation New Opportunities Fund grant for $75,747 to build a 96-node computer cluster. Leyton-Brown aims to improve the practical performance of algorithms for hard computational problems.

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UBC's Institute for Computing, Information and Cognitive Systems (ICICS) is an umbrella organization that promotes collaboration between researchers from the faculties of Applied Science, Arts, Commerce, Dentistry, Education, Forestry, Medicine, Pharmacy, and Science. ICICS supports the collaborative computer-oriented research of more than 135 faculty members and over 700 graduate students in these faculties. ICICS researchers attract approximately $15 million in annual grants and contracts. Their work will have a positive impact on us all in the future.

PUBLICATIONS MAIL AGREEMENT NO. 40049168
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