



TRLabs Connected Media Research Program

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Table of Contents

1	Introduction	2
2	Connected Media Research at TR Labs	3
2.1	Vision	3
2.1.1	Use Case.....	4
2.2	Background.....	4
2.3	Opportunity.....	5
2.4	Challenges	6
3	Research Program.....	7
3.1	Roadmap.....	7
3.2	Strategy.....	7
3.3	Research Themes.....	7
3.3.1	Intelligent Networks	7
3.3.1.1	Network Architectures	8
3.3.1.2	Network Planning	8
3.3.1.3	Fault Tolerant Networks	8
3.3.1.4	Content Delivery Networks	8
3.3.1.5	Distributed Computing and Storage	9
3.3.2	Personalized Services.....	9
3.3.2.1	Service Oriented Architectures.....	9
3.3.2.2	Session Based Connectivity	9
3.3.2.3	Social Networking.....	10
3.3.2.4	Location Based Services	10
3.3.3	Wireless Systems.....	10
3.3.3.1	Wireless Infrastructure-Based Systems.....	11
3.3.3.2	Wireless Sensor Networks.....	11
3.3.3.3	Wireless Ad-Hoc Networks	11
3.3.3.4	Channel Coding, Modulation, and Spatial Diversity	11
3.3.3.5	RF Devices and Amplifiers.....	12
4	Resources and Competencies	12
A.1	Focus Group Members	14
A.2	Focus Area Researchers	14
A.3	Projects	16

1 Introduction

TRLabs is seeking to become the worldwide leader in the creation, integration, and commercialization of ICT technology for the benefit of its industry members. Recognizing that the world is evolving and embracing ICT technologies that facilitate distributed personalized health care, social networking (e.g. [Second Life](#), [myspace](#), [YouTube](#)), broadband, mobility, and information spaces (e.g. Wikis, blogs), TRLabs has established the following three industry-relevant research focus areas:

1. Connected Media
2. eHome
3. eHealth

As illustrated in Figure 1, these focus areas build upon a broad base of technical knowledge resident within TRLabs. Each focus area aims to investigate and develop applications and proof-of-concept systems that integrate the underpinning technologies. In addition, on-going exploration of new innovative emerging technologies will spawn new focus areas over time.

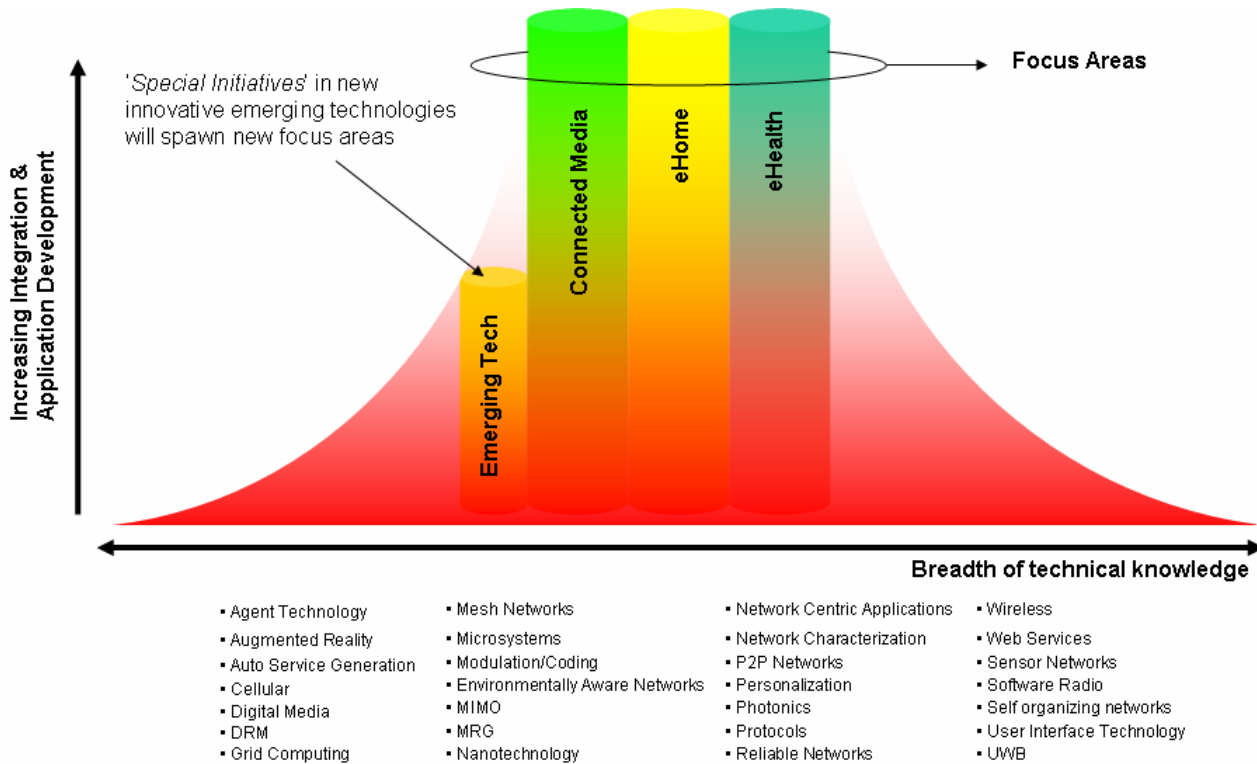


Figure 1. TRLabs Research Focus Areas

Recognizing that communication networks are evolving from '*delivery vehicles*', to '*providers of ICT resources*', the Connected Media Focus Area at TRLabs looks at how to make networks seamless, ubiquitous and cognitive. Research themes within this focus area include intelligent networks, personalized services, and wireless systems.

As networks evolve from "*delivery vehicles*" to "*providers of ICT resources*", the world will change. The home will become 'smart', the working environment will depend upon and exploit the tools and technologies associated with Enterprise/Web 2.0, and entertainment and healthcare will become personalized and distributed. Recognizing this evolution, the eHome Focus Area aims to develop both enabling technologies and integrated applications for the 'Smart Home' and workplace of the future. Research themes in this focus area include home automation and security, DRM, trans-coding, personalized 'infotainment', broadband connectivity, information spaces, and distributed computing.

"e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. ... a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology." ⁱ

2 Connected Media Research at TRLabs

2.1 Vision

This research plan outlines the research vision and current research program of TRLabs Connected Media Focus Area. This document will be reviewed and updated on a regular basis to ensure the program remains relevant. The Connected Media research program has been focused on issues related to intelligent networks, personalized services, and wireless systems. The potential scope for research in this area encompasses a vast and varied set of technologies and applications. Our primary research objectives will be to provide technologies and solutions to increase the efficiency, effectiveness, ubiquity, and overall value of services and applications to the end user.

ⁱ What is e-health? J Med Internet Res 2001;3(2):e20, by Gunther Eysenbach

2.1.1 Use Case

(The year is 2020; the location is Calgary.)ⁱⁱ:

John is old. He's sitting by the window looking out into his garden. He ponders how to handle those new arrivals in his neighbourhood, the "killer snails" someone inadvertently brought back after vacationing in South East Asia. Disgusting creatures they are, and poisonous too. And they thrive in the local summer climate. Better search for help in the worldwide digital library. Yep! Relief there is! Somebody in Port Arthur developed a snail sensor, delivered as smart dust. Better order a handful. Pretty expensive stuff, \$500 a kilogram, but 250 grams will do for the whole garden. The associated monitoring will automatically be taken care of by the home information coordination system. In a few years some wise guy will probably equip the dust with bio-engineered snail-killer in a "clean-garden" package for old folks, but for now John must resort to the tried and true method of stepping on the critters once the home information coordination system has identified their location, giving him some pleasure that would otherwise have been lost.

John's thoughts wander to his grandchildren currently on an adventure traversing a pass in the mountains. The mountains are dangerous; the weather changes fast; there are steep cliffs and deep gullies. The remaining glaciers can behave unpredictably and have crevasses. GPS handheld locators have already been in use for many years; recently this technology has been augmented such that John can follow the progress of his grandchildren across the glacier with immediate video and audio, as well as location information displayed as a path drawn on an interactive map displayed on John's TV. Of course, should some unfortunate incident occur, the local air rescue is scrambled immediately and directed to their exact location, with the paramedics appropriately advised of the required treatment beforehand. John does not worry as he follows their progress.

John's son developed a love for the mountains while working in the oil business. John's son is able to manage his work while on this expedition via ubiquitous integrated project planning system. This system reminds him of milestones and deliverables, of meetings and travels – without him having to transfer such information from the system he has in the office to the GPS system he is currently carrying. The integration is also intelligent. For example, before a meeting the system searches and provides appropriate profile information enabling John to keep his business running, even when on a mountain expedition.

2.2 Background

TRLabs' Connected Media Research Program investigates how to evolve communications networks so that they provide seamless anywhere/anytime access while dynamically and intelligently adapting their operation to provide optimal services to end users. Networks are no longer simply providing a communications channel but

ⁱⁱ Paraphrase from EC Consultation on Future European Union Research Policy: Strategy for ICT in Europe

rather are providing a comprehensive set of ICT resources including communications, content, applications, computing, and storage. A service to a user may consist of an ad-hoc composition of real-time media and stored data, combined and filtered using on-line computing resources, and then delivered to the user.

Connected Media networks lead to highly “personalized traffic”, with personalization of content creating most of the new traffic and many new commercial opportunities. New services and capabilities are emerging including user generated content (YouTube), peer to peer networks (Kazaa, BitTorrent), social networks (Facebook, MySpace, Second Life), wikis (Wikipedia), blogs, etc.

Applications, devices, and network elements need to adapt to provide optimal performance within the network as well as provide seamless services to end users, regardless of how or when the users access the network. The network should facilitate connections in as simple a manner as possible for the user, hiding the complexity of the operations and processes required. For example, the network should hide:

- optimizing the communications path
- allocating computing elements
- dynamically sizing media depending on display devices
- security
- fault tolerance
- automatically handing off between different devices as the user moves

2.3 Opportunity

For an indication of the level of interest and activity related to Connected Media, consider the following:

- As of June 13, 2007, social network Second Life listed the total number of "residents" as 7,228,051, with the number of residents logged-in in the last 7 days as 477,275
- Massive Multiplayer Online Role-Playing Game (MMORPG) World of Warcraft announces it reached 7 million subscribers in September 2006
- Acquisition of Skype by eBay for \$2.6 billion in September 2005
- Acquisition of YouTube by Google for \$1.65 billion in October 2006
- Facebook claimed 106 million accounts in September 2006 with 230,000 new registrations per day
- On-line encyclopedia Wikipedia, started in January 2001, now has 75,000 active contributors working on some 5,300,000 articles in more than 100 languages with currently 1,834,392 articles in English

The Internet is now a reality in every way, for communications, commerce, and connected media. The delivery chain consists of Consumers (Wireline and Mobile), Carriers, Content Delivery Networks, Data Centers, and IP Service Creators. Opportunities exist at all levels of the delivery chain including convergence of wireline, wireless, and broadband; integrating various existing services and components to create new value-added services; developing new distribution models for content and advertising; and much greater personalization of content and services to the end user.

2.4 Challenges

Many of the strengths of the Internet also magnify the challenges. There is little barrier to entry for new services and companies, and fragmentation of the market is therefore very much a reality. New services can be launched and accessed by customers literally the same day, creating potentially new high traffic patterns impacting the overall quality of service (QoS) to the customer as communication links get congested.

In addition to QoS challenges, the plethora of local and long distance service providers a user can now choose from has made delivering seamless end-to-end services a challenge. The explosion of interfaces and inter-connections a service must traverse is making their introduction ever more complex and use more difficult. How to simplify the introduction and use of new services with guaranteed QoS, is a challenge TRILabs Connected Media Research Plan will address.

Another challenge for Connected Media is how to develop and introduce new services which can take advantage of the network while not causing unforeseen bottlenecks and compatibility issues. It becomes more difficult to provide seamless services accessible anytime from any device when those devices have different screen sizes, resolutions, computing horsepower, and network connection rates.

TRILabs Connected Media Focus Area is also challenged with foreseeing disruptive technologies that could severely impact current products and services. Examples include VoIP services cannibalizing traditional phone service, downloadable music cannibalizing music CD sales, Personal Video Recorders changing the viewing habits of consumers from broadcast television to delayed viewing (with no commercials), and new WiMax installations potentially taking away customers from existing broadband service providers. New business models will need to be developed as the current distinction between communication service providers, IP service creators, and the actual content creators, fades resulting in some parties not being adequately compensated for their work (e.g., proliferation of copyrighted video and movies on services such as YouTube).

3 Research Program

3.1 Roadmap

To be completed - Interactive roadmap incorporating a 'flashplayer' layered on top of a 'wiki'.

3.2 Strategy

Given the large scope of the Connected Media focus area, TRILabs will develop expertise in various fields within this focus area by funding and coordinating related projects carried out by its academic research partners (i.e., affiliated professors and students). TRILabs research staff will leverage the results of related projects to develop integrated Connected Media solutions, applications, and proof-of-concept demonstrations. Details of the individual projects supported by TRILabs, as well as the integrated solutions and applications TRILabs thereby develops, change at a rate greater than that of the Research Program; therefore, such information is outside the scope of this document. However, the fields within which TRILabs is cultivating expertise, known as "Research Themes" within the Connected Media Focus Area, are relatively static and identified next.

3.3 Research Themes

The research themes within the Connected Media Focus are based on the common technology infrastructure required to deliver the services and applications of interest to users while supporting demands for ever increased convergence and user convenience. The research themes include:

- Intelligent Networks
- Personalized Services
- Wireless Systems

3.3.1 Intelligent Networks

The Intelligent Networks research theme looks at the continuing evolution of the broadband network to better support new and future services and higher and more flexible bandwidth requirements. That evolution includes improving the efficiency, capacity, and fault tolerance of the network as well as extending the intelligence which has typically been in the peripherals of the network into the network itself. The network is no longer just a communications medium; it is evolving to include content, computing, and storage. The areas of research in this theme include:

- Network Architectures
- Network Planning
- Fault Tolerant Networks
- Content Delivery Networks
- Distributed Computing and Storage

3.3.1.1 Network Architectures

The Network Architectures research area looks at some of the core architectural issues to support the development of future networks, including:

- Basic research on new network and switch architectures
- Self organizing and self configuring transport network concepts
- Issues and strategies for transparent and translucent optical networks
- Impact of machine-to-machine and sensor network traffic

3.3.1.2 Network Planning

The Network Planning research area looks at methods and tools to aid in the planning of complex communication networks, including:

- Optical network design and optimization
- Theory and methods for network planning and operations in the face of demand uncertainty
- Network Design and Network Planning tool development

3.3.1.3 Fault Tolerant Networks

The Fault Tolerant Networks research area looks specifically at mechanisms to provide ultra-high reliability and fault tolerance, including:

- Multiple quality of protection service concepts and design methods
- Basic theory and algorithms for design, operation, and reconfiguration of span and path-protecting p-cycle networks
- Pre-cross-connected protection architectures
- Demand-wise shared protection architecture

3.3.1.4 Content Delivery Networks

Content Delivery Networks go beyond simple delivery by having network elements intelligently cooperate when delivering content to the end users. Elements in this research area include:

- Peer-to-peer distribution architectures
- IPTV delivery architectures
- Network protocol modelling and design

3.3.1.5 *Distributed Computing and Storage*

The network is no longer just a communications medium but now must also provide increasing computational and storage capabilities. Elements in this research area include:

- Distributed and grid computing architectures and methodologies
- Utility computing
- Storage area networks

3.3.2 *Personalized Services*

The Personalized Services research theme looks at how to deliver personalized, dynamic, and adaptive services to the end user. Rather than the simple delivery of relatively static content from a single information source to a user at a fixed location, services now need to support dynamically merging content from multiple sources in real-time such that multiple users can simultaneously view and manipulate that content on different devices with different display and computing capabilities. Furthermore, these users may be mobile, switching devices and/or locations during a session. The areas of research in this theme include:

- Service Oriented Architectures
- Session Based Connectivity
- Social Networking
- Location Based Services

3.3.2.1 *Service Oriented Architectures*

Service Oriented Architecture (SOA) is a design & integration paradigm that is based on the notion of well defined, loosely coupled services. Within SOA, services are viewed as computational elements that expose functionality in a platform-independent manner and can be described, published, discovered, orchestrated and consumed across language, platform and organizational borders. A Service-Oriented Architecture (SOA) is a conceptual framework that identifies service-consumers, service-providers and a registry through which providers publish services and consumer discover them. Elements in this research area include:

- Load characteristics of SOA applications and their impact on the network
- Good design practices for Web 2.0 clients
- Service Management

3.3.2.2 *Session Based Connectivity*

Session Based Connectivity delivers a service over a connection, or a virtual connection, using a service that maintains state information between 'calls'. This allows the 'call' to be seamlessly delivered to a nomadic user whose location and device may vary during a single session by dynamically switching connections (e.g.,

automatically switching between a cellular network and an 802.11 wireless LAN) and continuing a service when a connection is momentarily dropped. Elements in this research area include:

- Session based frameworks
- Cellular/WLAN convergence
- Mobile media management and delivery

3.3.2.3 Social Networking

Social Networking focuses on building and verifying on-line social networks for people who share interests and activities, or who are interested in exploring the interests and activities of others. Currently, most social network services are primarily web based and enable users to interact via chat rooms, messaging, email, video, file sharing, blogging, discussion groups, etc. Elements in this research area include:

- Social network architectures and their impact on network infrastructure
- Real-time social networks, including tele-presence/video conferencing

3.3.2.4 Location Based Services

Location Based Services enhance other services by identifying the location of a user or device. Typical value-added services include resource tracking, finding someone or something, and proximity based notification and actuation. Elements in this research area include:

- Location Based Services frameworks
- In-room and in-building positioning systems
- Location tracking applications

3.3.3 Wireless Systems

The Wireless Systems research theme looks at various aspects of wireless communications as an important access medium for users of Connected Media. Great strides have been made in the capacity and cost effectiveness of wireless systems but there are still many opportunities for significant gains in throughput, robustness, diversity, multi-user support, mobility, etc. Areas of research in this theme include:

- Wireless Infrastructure-Based Systems
- Wireless Sensor Networks
- Wireless Ad-Hoc Networks
- Channel Coding, Modulation, and Spatial Diversity
- RF Devices and Amplifiers

3.3.3.1 Wireless Infrastructure-Based Systems

This research area looks at the long-term evolution of infrastructure-based wireless systems designed to serve mobile/nomadic users beyond their current 3rd generation. Most important of these wireless systems are cellular, WiMax, and the evolution and convergence of these wireless systems. Elements in this research area include:

- Multi-user MIMO
- Multicarrier transmission
- Link adaptation and hybrid ARQ
- Network coordination, scheduling and radio resource allocation

3.3.3.2 Wireless Sensor Networks

Wireless Sensor Networks consist of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations. Wireless sensor networks are now used in many application areas, including environment and habitat monitoring, healthcare, home automation, and traffic control. Elements in this research area include:

- Efficient protocols for Wireless Sensor Networks
- Security mechanisms for low-power sensors in wireless environments
- RF power harvesting

3.3.3.3 Wireless Ad-Hoc Networks

In a wireless ad-hoc network, each node forwards data for other nodes, and the determination which nodes forward data is made dynamically based on network connectivity information. Minimal configuration and quick deployment make ad-hoc networks suitable for emergency situations like natural or human-induced disasters, military conflicts, emergency medical situations, etc. Elements in this research area include:

- Efficient routing protocols for delivering real-time traffic in ad-hoc networks
- Node and resource discovery and configuration
- Security and intrusion detection in ad-hoc networks

3.3.3.4 Channel Coding, Modulation, and Spatial Diversity

This research area looks at the core technologies and techniques required to improve the throughput and robustness of wireless systems. Elements in this research area include:

- Channel coding including block, convolutional, turbo and LDPC codes
- Modulation techniques including higher-order modulation, iterative decoding, detection, and synchronization

- Spatial diversity including MIMO and cooperative communications

3.3.3.5 RF Devices and Amplifiers

This research area looks at the optimization and integration of specific hardware aspects supporting the enhancement of wireless systems. Elements in this research area include:

- Integration and miniaturization of analog RF components using RF IC and RF MEMS
- Power amplifier linearization

4 Resources and Competencies

Underpinning TRLabs research program is its partnership agreements with the University of Alberta, University of Calgary, University of Saskatchewan, University of Regina, and University of Manitoba. These partnership agreements endow TRLabs with the manpower and expertise to pursue research in not only TRLabs' Connected Media Focus Area, but also in TRLabs' eHome and eHealth Focus Areas.

In addition to TRLabs' relationship with the Universities, TRLabs is building partnership agreements with the local technical colleges in Alberta, Saskatchewan and Manitoba to help TRLabs develop and build proof-of-concept systems. These partnership agreements expand the role of the local technical colleges to '*Prototype Development Centres*', or PDCs. With the support of an industry member, TRLabs may work with a PDC (i.e. partner with a local technical college) to transform a piece of theoretical work into a proof-of-concept system that demonstrates the feasibility and/or application of a specific technology.

Through these partnership agreements, TRLabs has developed expertise in numerous technologies since its inception in 1986. Some of that expertise is identified below:

- Grid/Distributed Computing
- Reliable Networks Design
- Wireless Networks and Components Design
- Network Modeling and Simulation
- Cellular Systems
- Web Services

. In addition to the expertise highlighted above, TRLabs has access to the following resources when pursuing industry relevant research and development:

- TRnet
- The Canadian Light Source
- TRLabs Integrated Meeting System
- MINT Lab

TRnet is an independent, wide-area networking laboratory spanning Edmonton, Calgary, Saskatoon, Regina and Winnipeg that offers unprecedented opportunities for research and development. By creating a “crash and burn” test network that mirrors a real network, TRnet will significantly enhance the research and development of new networking concepts and services, as well as reduce the time and risk associated with introducing those technologies.

The Canadian Light Source is Canada’s national synchrotron research facility. Using powerful magnets and radio frequency waves, the synchrotron accelerates electrons to nearly the speed of light, producing intense light beams for probing matter with unprecedented precision. Within CLS, TRLabs supports development of the SyLMAND beam line, a facility that provides the ability to manufacture micro and nano-scale MEMS devices using X-Ray Lithography.

TRLabs Integrated Meeting System consists of high quality video conferencing and computing facilities within each of TRLabs five labs that support both ongoing collaboration between researchers and industry members, as well as providing experimentation and prototyping facilities for Connected Media projects. TRLabs Integrated Meeting System is also connected to the three high-speed research networks in the Prairie provinces (Netera, SRnet, and MRnet), establishing an expanded platform for experimentation and prototyping of network based applications and services.

The Master of Science in Internetworking (MINT) program at the University of Alberta was created to meet industry needs for an accredited graduate degree program in Internetworking. A lab consisting of a Metro OC-12 Ring interconnecting various edge devices (e.g. DSLAMs, Routers, Servers, Phones, Bridges, Ethernet Switches etc.) was built for this program. Among many other uses, TRLabs can access this lab to investigate the design, performance and management of ubiquitous cognitive networks.

These resources, along with TRLabs’ expertise, are used by TRLabs to develop integrated solutions, applications, and proof-of-concept demonstrations relevant to the various research themes associated with the Connected Media Focus Area identified in this document.

Appendix

A.1 Focus Group Members

Name	Title	Affiliation
To be determined		SaskTel
To be determined		Telus
To be determined		PMC-Sierra
To be determined		Vecima Networks
To be determined		Linear Systems
To be determined		Access Communications

A.2 Focus Area Researchers

Name	Affiliation	Research Interests
Chang N. Zhang, Ph.D (CS)	<ul style="list-style-type: none"> • Professor, Department of Computer Science, University of Regina 	<ul style="list-style-type: none"> • Cryptography and Network Security • High Performance Computing and Fault Tolerance • Multimedia Access Control
Ekram Hossain, Ph.D. (EE)	<ul style="list-style-type: none"> • Department of Electrical and Computer Engineering, University of Manitoba 	<ul style="list-style-type: none"> • Wireless Networking protocols • Cognitive wireless systems • Wireless communications services and applications • Computer Communication Networks • Multimedia communications
Guenther Ruhe, Ph.D. (EE)	<ul style="list-style-type: none"> • Industrial Research Chair in Software Engineering, University of Calgary 	<ul style="list-style-type: none"> • IT project planning • IT resource optimization • Software engineering decision support
Sven Achenbach, Ph.D. (EE)	<ul style="list-style-type: none"> • Canada Research Chair in Micro and Nano Device Fabrication • Associate Professor of Electrical Engineering, University of Saskatchewan 	<ul style="list-style-type: none"> • Micro- and nano fabrication • Process technology • Deep X-ray lithography • Wireless applications • Biomedical sensors

Geoffrey Messier, Ph.D. (EE)	<ul style="list-style-type: none"> Assistant Professor, Electrical & Computer Engineering, University of Calgary 	<ul style="list-style-type: none"> Wireless Communications Systems Sensor Networks Radio Channel Propagation Measurements
Ha Nguyen, Ph.D. (EE)	<ul style="list-style-type: none"> Professor, Electrical and Computer Engineering, University of Saskatchewan 	<ul style="list-style-type: none"> Diversity techniques for wireless communications Spread spectrum and multicarrier systems Information theory and coding
David M. Klymyshyn, Ph.D. (EE)	<ul style="list-style-type: none"> Associate Professor of Electrical and Computer Engineering, University of Saskatchewan Principal Investigator, SyLMAND - Synchrotron Laboratory for Micro and Nano Devices 	<ul style="list-style-type: none"> Wireless Communications RF and Microwave Devices and Circuits RF MEMS and Microsystems
Parimala Thulasiraman, Ph.D. (CS)	<ul style="list-style-type: none"> Associate Professor, Computer Science, University of Manitoba 	<ul style="list-style-type: none"> High Performance Computing Algorithm design for Mobile Ad hoc Networks Autonomous Computing
Igor Filanovsky, Ph.D. (EE)	<ul style="list-style-type: none"> Professor Emeritus, Electrical and Computer Engineering, University of Alberta 	<ul style="list-style-type: none"> Wireless Communications
Eric Salt, Ph.D. (EE)	<ul style="list-style-type: none"> Electrical and Computer Engineering, University of Saskatchewan 	<ul style="list-style-type: none"> Wired and wireless communication DSP algorithms for implementation in FPGAs
Witold Kinsner, Ph.D. (EE)	<ul style="list-style-type: none"> Professor and Associate Head, Department of Electrical and Computer Engineering, University of Manitoba 	<ul style="list-style-type: none"> Wireless communications and networking Mobile computing Signal and data compression for multimedia Quality metrics Cognitive informatics
Carson K Leung, PhD (CS)	<ul style="list-style-type: none"> Assistant Professor, Computer Science, University of Manitoba 	<ul style="list-style-type: none"> Databases Data mining and analysis / knowledge discovery Data warehousing
Ivan Fair, Ph.D. (EE)	<ul style="list-style-type: none"> Professor, Department of Electrical and Computer Engineering, University of Alberta 	<ul style="list-style-type: none"> Coding for reliability of digital communication systems Wireless communications
John Doucette, Ph.D. (EE)	<ul style="list-style-type: none"> Assistant Professor, Engineering Management, Department of Mechanical Engineering, University of Alberta 	<ul style="list-style-type: none"> Network restoration and protection Network design Reliability and availability Operation research and optimization

A.3 Projects

Project	Title	Research Theme	Contact
2003WC007	Advanced Transmitter and Receiver Processing for Adaptive MIMO and Multi-Carrier Packet Data Access Systems	Wireless Systems	Witold Krzymien
2004WC005	Scheduling Algorithms for High Throughput Multiple Antenna Wireless Packet Data Systems	Wireless Systems	Witold Krzymien
2005CS001	MIMO/MISO Relays for Improved Cellular Coverage and Capacity	Wireless Systems	Witold Krzymien
2005CS004	Designs of MIMO Coded Modulation Systems with Iterative Decoding	Wireless Systems	Ha Nguyen
2001NA010	Application of MELP (Mixed Excitation Linear Predictive) Vocoder to Content Based Voice Response System	Personalized Services	Kunio Takaya
2003NM001	Advanced Secure Multimedia Content Access Technologies Based on MPEG 7	Personalized Services	Chang Zhang
2003NM003	Real-Time Semantic Visualization of Agents	Personalized Services	Luigi Benedicenti
2003NM005	Interactive Modeling in an Augmented Reality Environment	Personalized Services	Xue Dong Yang
2003NM006	Improving Network Quality of Service in Groupware	Personalized Services	Carl Gutwin
2004DM002	Reducing Overload in Multiuser Online Applications	Personalized Services	Carl Gutwin
2004DM004	Quantitative Measurement of Visual Quality	Personalized Services	Xue Dong Yang
2004DM006	Multi-step Planning for Animated Characters	Personalized Services	Howard Hamilton
2005DM002	Mobile Media Centre	Personalized Services	Craig Gelowitz
2005DM005	Mobile Telephone Extension for TEEMA	Personalized Services	Luigi Benedicenti
2005DM007	Agent-Based Scheduling Systems	Personalized Services	Raman Paranjape
2005DM008	A Light Weight Secure Protocol for Wireless Multimedia Multicast	Wireless Systems	Chang Zhang

2005DM009	Data Fusion for Object Localization in a Dynamic Environment	Personalized Services	Raman Paranjape
2002DN009	Scalability Measurement and Performance Debugging for Managed Distributed Computing Systems	Intelligent Networks	Mahes Maheswaran
2002DN012b	Design and Implementation of Galaxy: QoS over BE Middleware	Intelligent Networks	Paul Card
2004NA005	Distributed Simulation for Hardware/Software Codesign	Intelligent Networks	Dwight Makaroff
2004NA006	Studies on Design of System on Chip and Hardware Security using SystemC	Intelligent Networks	Chang Zhang
2002DN001	High Speed Adaptive Packet Filter-on-Chip	Intelligent Networks	Doug Cornelsen
2004DN008	Modeling Architectural Alternatives for Service Layer Intelligence	Intelligent Networks	Jeff Diamond
2004DN009	Cache and Proxy Planning for Video on Demand	Intelligent Networks	Jeff Diamond
2004NA001	Security Proximity Wireless Access	Wireless Systems	Jack Hanson
2004NA002	Distributed HW/SW Firewall	Intelligent Networks	Ron Bolton
2004NA011	Routing SOAP Requests	Personalized Services	Ralph Deters
2005NP003	SOAP Cache for Mobile Devices	Personalized Services	Ralph Deters
2004NS009	Extension of Network Survivability Principles for Disaster Recover and the Security of "Critical Infrastructure"	Intelligent Networks	Wayne Grover
2005NS001	Design and Analysis of Failure Independent Path Protecting p-Cycles	Intelligent Networks	Wayne Grover
2005NS002	Node-Failure Restoration using p-Cycles	Intelligent Networks	Wayne Grover
2003PR003	AAPN Project Collaboration	Intelligent Networks	Chris Haugen
2004PR001	Passive Microphotonic Devices on Silicon	Intelligent Networks	Ray DeCorby
2004PR003	Long-Period Gratings in Integrated Optics	Intelligent Networks	Jim McMullin

2004PR006	Integrated Acousto-optic Devices	Intelligent Networks	Ray DeCorby
2004PR007	Silicon Nanocluster Glasses for Photonics	Intelligent Networks	Ray DeCorby
2006TC001	Assessment of Architectural Alternatives for Service Layer Intelligence	Personalized Services	Jeff Diamond
2006TC002	Hybrid Switch Architecture	Intelligent Networks	Carl McCrosky
2006TC003	Acoustic Devices for Wireless and Biosensor Applications	Wireless Systems	David Klymyshyn
2006TC004	RF Filtering using High Aspect Ratio Structures	Wireless Systems	David Klymyshyn
2006TC005	Managing Service-Oriented Systems	Personalized Services	Ralph Deters
2006TC007	Real-time Software Trans-coding of MPEG 2 to High Profile MPEG 4 AVC	Personalized Services	Ken Ferens
2002NA006	Microwave MEMS Circuits	Wireless Systems	David Klymyshyn
2002WC007	RF System on a Chip	Wireless Systems	Jim Haslett
2003WC001	RF and IF Digitization in Radio Receivers	Wireless Systems	Jim Haslett
2003WC003	CMOS Integrated RF Tunable Filter	Wireless Systems	Jim Haslett
2004WC007	RF MEMS Tunable Inductor	Wireless Systems	Michal Okoniewski
2005WH001	Tunable Microwave Filters	Wireless Systems	Michal Okoniewski
2005WH002	Low Noise Amplifier for Radio Astronomy	Wireless Systems	Jim Haslett
2005WH003	RF MEMS Varactors	Wireless Systems	Michal Okoniewski
2005WP002	Protocol Architectures for High-Performance and Scalable Wireless Backbone for IEEE 802.11-Based Mesh Networking	Intelligent Networks	Ekram Hossain
2005WP008	Wireless Interfacing for an Excavator	Wireless Systems	Jeff Diamond

2003HT001	Low Power Ad-Hoc Circuit Design	Wireless Systems	Jim Haslett
2003NA002	Particle Filter for In-Mine Positioning	Personalized Services	Brian Daku
2003NA004	An Ultra Wideband Transceiver for Short-Range Wireless	Wireless Systems	Anh Dinh
2003WC010	Self-Phasing Antenna Systems	Wireless Systems	Bob Davies
2004HT019b	Receiver Design for Space-Frequency Coded OFDM Systems in Doubly Dispersive Fading Channels	Wireless Systems	Abu Sesay
2004NA007	Performance of a Localization Algorithm for a Short-Time Duration Radiating Source	Wireless Systems	Brian Daku
2004WC002	Wireless Ad Hoc Self Organizing Sensor Networks	Wireless Systems	Jim Haslett
2005WS001	UWB Receiver Design and Implementation	Wireless Systems	John Nielsen
2005WS002	Filter Banks for Ultra-Wideband Receivers	Wireless Systems	Grant McGibney
2005WS003	Low Power Designs for Personal Area and Sensor Networks	Wireless Systems	Geoffrey Messier
2005WS004	OFDM Based Downlink Multicell Multiple Access	Wireless Systems	Abu Sesay
2005WS005	SIM-Based Wireless LAN Authentication	Wireless Systems	Abraham Fapojuwo
2005WS011	Acquisition of Ultra-Wideband Signals in the Indoor Wireless Channels	Wireless Systems	John Nielsen
2005WS012	Dynamic Channel Estimation and Capacity Measurement for Wireless MIMO Systems	Wireless Systems	John Nielsen
2005WS013	Acoustic Localization on Surfaces	Personalized Services	Grant McGibney