

TRLabs eHealth Research Program

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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.

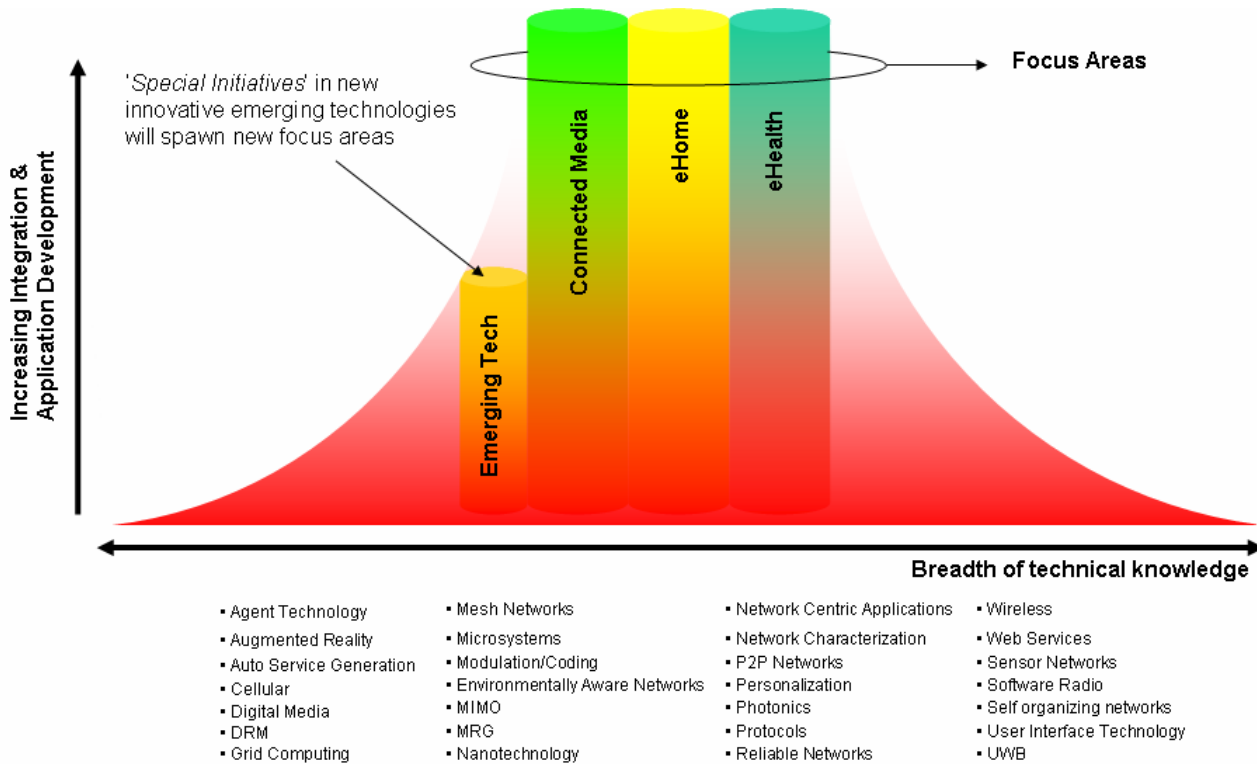


Figure 1. TRLabs Research Focus Areas

Recognizing that communication networks are evolving from ‘*delivery vehicles*’, to ‘*providers of ICT resources*’, the Connected Media Focus Area at TRILabs looks at how to make networks seamless, ubiquitous and cognitive. Research themes within this focus area include ubiquitous cognitive networks, social networking, and personalized mobile web-based services.

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 Broadband (BB) Home 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 TRILabs eHealth research program is described in greater detail next.

2. eHealth Research at TRILabs

2.1 Vision

The eHealth research program is focused on issues related to medical networks, health informatics, and medical imaging. The potential scope for research in this area encompasses a vast and varied set of technologies and applications that leverage TRILabs ICT expertise. Our primary research objectives will be to provide technologies and solutions to increase the efficiency, effectiveness, delivery and safety of

1. Distributed personalized health care, and
2. Intelligent tools that assist in healthcare delivery.

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

2.1.1 Use Case

A Million Little Hospitals

The year is 2030.

At 95 years of age with a chronic heart condition, the last thing I would want to do is be stuck in a hospital bed in the midst of a showdown with the food. Gladly that was the life that was.

The boomers drove demand for quality of care that reflected their mobile lifestyles, longevity, and the health system's ever improving ability to address chronic conditions outside the hospital bed. Health care providers instituted a new health care model, an economic necessity as the population aged and required proportionately greater access to the health care system. The new health care model is a distributed, personalized health care system that empowers the individual with information, access and mobility. The 'Big H' hospital – a heavily hierarchical system that required centralized access to a small number of large facilities with medical decision making in the hands of a small number of people, has been replaced by a 'flat', decentralized system of health care that allows a home, your devices, or even your car to be able to function as a medical monitoring and communication system – and makes the individual an active participant in the health system. The notion of 'A Million Little Hospitals' thrives.

The Bio-Intelligence Age – Too Much Information?

We've entered the bio-intelligence age with its micro, adaptable, embedded and intelligent systems and devices. The biological, physical and information worlds have merged and there's a bio-everything: biosensors; biomaterials; bio-computation; and bio-informatics among others. Systems and devices have become smaller, embedded, programmable, flexible and transparent. Mobile agents anticipate patient needs and customize movement of, and interaction with, data..

Bones' Star Trek gadgets have arrived. Biomonitoring information is gathered from everything from smart band-aids to heart pads to wireless thermometers. Biosensors are resident in everything from toothbrushes to the toilet bowl to smart T-shirts. Advances have allowed for routine, diagnostic pinprick blood testing. Nanotech has heralded the 'smart dust' era – where sensors mixed into my orange juice can be swallowed and transmit information on everything from vein blockages to disease conditions. These numerous non-invasive or embedded bio-sensors detect function and biochemical data about health status; reminds me of the old shoot 'em up video games with the red health status monitor.

So there's a mountain of health data now... reminds me of the explosion of information when the film camera transitioned to the digital age.

The beating heart of the Million Little Hospitals model is how data is managed, and who owns it.

In my basement is the managed residential gateway that delivers multimedia services around my home. Updated and managed by my telecom provider, information security and maintenance of privacy of information is the backbone that permits my health records to be stored at home, and be accessed and updated as required by myself or medical professionals. My medical information is owned by me – and can be accessed regardless of whether I'm at home or on vacation. This gives me the peace of mind of knowing diagnosis and treatment of any condition I might encounter can be made faster with ready access to my medical history.

Yesterday's written records have transitioned onto an electronic platform. There's the usual notation and text, but the nature and breadth of data has exploded – and generated a revolution in health care prevention, early treatment, and effective treatment of chronic conditions. My health biography includes 2D and 3D imagery. The 'fourth' dimension is the real-time and over-time monitoring of myriad conditions. This has proved really helpful for now epidemic conditions like skin cancer and melanoma – where imaging over time and network intelligence combine to flag warning signs.

A graphic user interface places all of this information on a 3D CT Scan of my body. Well – 4D if you plug monitoring or image information into it. Reminds me of those body layer overlays there used to be in the old encyclopedias. I don't like the function that animates the aging effect on my body using temporal CT Scans – but others like having fun with it.

Enter my virtual doctor and health system.

No line-ups. No waiting weeks for an appointment. Triage and examination is by and large a long-distance date with the health system these days. Real-time bio-monitoring will automatically alert my doctor if something is amiss and the dialogue with my doctor will begin via e-mail and collaborative online interaction. Or if it's an emergency, the doctor can summon the cavalry to rescue me. The big difference vis a vis a few years ago is that I'm in control of health management rather than the physician. Funny how the feeling of ownership of your health drives a complete paradigm shift that has one eating bran, fruits and vegetables and all those other too good for you foods. The health system is not a crutch. Responsibility for my health lies with me.

My HomeBody software on my interactive wall at home is a collaborative tool designed to interact with my doctor on all routine matters. Medical tests, X-ray and CT images – they can all be displayed and manipulated for purposes of conducting an online conversation with my doctor or other medical personnel. Touch and voice commands make interaction much easier than it used to be. Speech recognition and tracking of eye movement makes much of the interaction hands free.

A more complex version of the HomeBody software – MediBody - is now the nucleus of medical education and diagnosis collaboration. The world's doors have been opened for information, diagnosis, and education.

Doctors can collaborate real-time over any distance on tough diagnostic challenges using 'live' data and imagery. Students can perform virtual operations that feel real.

Robotics advances have allowed many types of operations to be conducted with greater precision using remote surgeons – a real boon to the emergence of a 'rurban' and 'rural' population decentralization trend enabled by network access and a myriad of intelligent applications and services.

The second line of 'defense' for my health needs is my virtual family. I have an application at home that looks something like the Brady Bunch intro – a screen division that allows me to see my global family at home in real-time. There's a central camera in the kitchen so people know there's privacy boundaries, but the real advantage to me is that this system sends real-time bio information to selected family members. Sensors around my house note my movement. The system is intelligent – so if certain movement parameters or bio patterns are broken, the wireless network notifies family members immediately, gives them remote access and maneuverability to a full set of cameras in my home to investigate, and can transmit information to medical professionals if required.

Society was collectively asked to be more personally accountable for health – and we are. Monitoring, connectivity, and on-line access to the medical profession have certainly helped with wellness and prevention, early treatment, and effective treatment of chronic conditions. So what's the result. Well – 100 year olds are still commonly living independently at home. The retirement age is now 80 because we're healthier in our longevity. And I have confidence in life and adventure with the security of connectivity.

It's fair to say that we've made communications over networks "as good as being there" as was touted when networks transitioned from connectivity to value in the early part of this century. Today's networks are about quality of experience.

But there's more to it than that. What people don't see are advances in the network backbone that were required to distribute real-time data with accessibility both within and external to the health system, to centralize databases, and to allow databases to be accessed remotely while maintaining privacy controls. Distributed networking and storage, and much faster wireless and wireline network speeds have been the enabler for the information explosion and real-time experience that is today's new reality. Wireless advances in the form of speed, devices, security, and applications have been central to achieving mobile eHealth.

Health care has decentralized to the home, but also within the health system itself. Networks have become more intelligent, allowing for customization of a home network and its connectivity to the health system. The result – a much more individualized form of health care that broke the long-standing perception of an impersonal system.

We live in a new 'virtual' reality that empowers the individual. We're people at the end of the day, and the network is our tool. The change from late stage diagnosis – an expensive cure - towards early detection or even prediction of disease - cheap cure or intervention - has improved the quality of the health of the individual, and the public purse is thankful for the revolution. We old-timers living at home have a saying these days – 'home is where the heart monitor is.'

2.2 Background

eHealth is an emerging field that can be broadly defined as the application of information and communications technology (ICT) to the health care sector. Health care is a \$130 billion (2004) industry in Canada. With today's per capita health expenditures held constant, health expenditure in Canada can be expected to increase by 30% over the next 30 years due to the aging of Canada's population alone (Health Canada). Several major initiatives have been started to control the growth of healthcare costs. These include "Wellness" or illness-avoidance programs, largely achieved through public education and lifestyle change, as well as integrating ICT technologies into clinical processes, to both speed up and improve the quality of those processes. The Health environment is among the most demanding of all sectors; ICT solutions developed in this sector require robustness relevant to many industries, thereby highly leveraging the return of eHealth R&D investments.

In this context, the health care industry also needs to be viewed as a source of wealth creation rather than a cost challenge with cost containment as the driving force. Canada has the attributes to transform itself from a net importer of health related technologies to a world leader in health product and services exports. Canada has the market scale to create and grow a self sustaining eHealth industry, and with the US as neighbours, the potential to export health products and services to a market more than 10 times Canada's size.

The health industry has lagged other comparable industries in embracing Information Technology (IT) and consequently is on a steep learning curve as pressures grow to make the system more effective. Historically, health institutions and professionals have spent little on IT; however TRILabs (and others) believe that investments in IT will improve the efficiency, responsiveness, and capability of our healthcare system.

The World Health Organization (WHO) recently (April 2005)^[1] published a strategy paper entitled "*eHealth*". The following excerpts from this paper capture the WHO's perspective on eHealth:

Today, eHealth – understood in this context to mean the use of information and communication technologies locally and at a distance – presents a unique opportunity for the development of public health. The strengthening of health systems through eHealth may contribute to the enjoyment of fundamental human rights by improving equity, solidarity, quality of life and quality of care.

Extremely rapid changes are occurring because of the advances in information and communication technologies. eHealth may be expressed in terms of digitalized products, systems, and services for health. These technologies hold great promise for both low- and high-income countries, and some are already

realizing the benefits. These benefits apply not only to health-care delivery, but also to public health governance, finance, education, research, and health-related economic activities.

eHealth should have an impact on health systems by making health services more efficient and improving access to care, especially in remote areas, for people with disabilities and for the elderly. It should benefit health-care providers, professionals, and final users through higher quality of care and health promotion. It should also affect the cost of care by reducing redundancy and duplication of examinations and making possible economies of scale.

2.3 Opportunity

The demographics of the baby boomer generation will exert significant pressure on the health care system over the next several years, and the current system without significant innovation will not be able to satisfy the demands placed upon it. This creates both opportunities and challenges when applying information and communication technologies to help relieve some of the pressure placed upon our health care system. Currently, in clinical settings, many hours are devoted to the processing of paperwork associated with patient admitting, clinical charts, report management, etc. Much of this work is duplicated across various disciplines within the health care sector, with the same information being obtained from a patient numerous times in different settings. An integrated electronic health record would help reduce duplication and incongruity, as well as reduce the time associated with gathering patient information.

Often there are significant delays between the collection of information and the availability of that information to a health care team. For example, no automatic process for disseminating test results, or informing medical practitioners if a patient fails to show up for a scheduled test, currently exists. This creates an opportunity to improve the efficiency of health care delivery with integrated information systems and comprehensive workflow management systems.

The vision of healthcare in the next ten years must include ubiquitous access to information, with the availability of anything, anywhere, anytime, and in any form necessary or convenient. The network and access devices must be context, location, and environmentally aware, and integrate information emanating from numerous sensors identifying the status and location of patients, equipment, and health care providers. This of course introduces significant challenges in security, as ubiquitous access requires ubiquitous security and traceability. It also requires very high levels (better than four nines, i.e. 99.99% - 99.999%) of availability, given that lives, and the operation of critical clinical functions, may be compromised if systems fail.

The design of information and communication systems in health care settings must take into account the differing requirements of all potential users in various disciplines. Nurses, for example will want to minimize the number and size of devices they carry. First responders and home care workers, on the other hand, must be linked to information resources and hospitals, creating the need for reliable mobile wide area wireless networks.

2.4 Challenges

The opportunities outlined in Section 2.3 present a number of challenges. Clinicians need to accept solutions offered by integrating ICT into the health care system and can only be achieved if they are involved in creating them from the outset. Practitioners of information technology, systems engineering, and other disciplines, must have a common language and understanding with clinicians and health care providers.

Transitioning to a new way of doing things is slow and difficult, and challenged by the scarcity of time available to busy practitioners in an overloaded system. There is a large gap between the visions and the possibilities identified in this document, and the reality of the day-to-day operations and provisioning of healthcare currently. Furthermore, integrating ICT technologies into Canada's health care system risks initially increasing the inefficiencies of an already overloaded system. Doctors would like to know if ICT system improvements will relieve some of the pressure placed upon them and enable them to complete their work more efficiently. Clinicians stand to lose a significant investment in time and energy from pilot programs that never get implemented and are suspicious of support systems that monitor their work.

Exploiting the opportunities and addressing the challenges associated with the adoption of ICT technologies by the healthcare sector requires analyzing user requirements, workflow process, system designs, middleware requirements, and integrated solutions. The skills necessary for this analysis exist within the information and communication technology industry, and TRILabs can contribute in a number of these endeavours by leveraging its relationships with the health sector, academia, and industry.

3. Research Program

3.1 Strategy

Given the large scope of the eHealth focus area, TRILabs will develop expertise in various fields within this focus area by funding and coordinating related eHealth investigations (i.e. 'projects'), carried out by its academic research partners (i.e. affiliated professors and students), of interest to TRILabs industry members. TRILabs research staff will leverage the results of related projects to develop integrated eHealth 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 overall eHealth 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 eHealth Focus Area, are relatively static and described in the following section. Three major research themes within the eHealth Focus Area are being fostered: Clinical Networks, eHealth Management and Medical Informatics. Briefly, the Clinical Networks theme investigates network infrastructure technologies that support health applications and solutions. The eHealth Management theme investigates the applications and solutions that move data in support

of health care processes and workflows. And the Medical Informatics theme focuses on data analysis and processing that assists health care delivery.

3.3 Research Themes

3.3.1 Clinical Networks

This research theme investigates the design and performance of both wired and wireless networks in a clinical health care setting. This requires modelling and analyzing the current use, as well as the projected future use, of such networks, taking into consideration how the use patterns of such networks will shift over time. Clinical networks will have critical applications running over them that will significantly alter the way in which networks can be designed when compared to traditional “best effort” IP-based networks.

Research at TRILabs in this theme has thus far focused on radiology networks. X-ray files account for a large portion of the data created in the healthcare system currently. TRILabs has conducted research into modeling, simulating, and analyzing the performance of hospital radiology networks. This work will expand to include other departments that will add significant traffic to inter-hospital networks (e.g. pathology).

3.3.2 eHealth Management

eHealth Management is an emerging field located at the intersection of medical informatics, public health and business^[2]. The eHealth Management research theme within TRILabs incorporates the following topics^[3]:

3.3.2.1 Electronic Medical Record / Electronic Health Record (EMR / EHR)

“EMR / EHR is a patient's medical record in an electronic format, accessible by computers on a network for the primary purpose of providing health care and health-related services. Information in an EHR includes documents relating to the past, present or future physical and mental health and condition of a patient, medical test reports or multimedia images, and financial and demographic information. In addition, ordering of medical tests, treatments, medications, and clinical guidelines used for the patient's care, are accessible within the EHR. EHR data can be captured or transmitted, received or updated, stored or retrieved, securely and in real-time by users at the point of care or distant locations”^[4].

EMR / EHR is a complex system with several source components providing cross-related information. For example, lab, pathology, radiology and ADT systems may be integrated in a common front end interface to provide information and build the patient EMR / EHR. TRILabs has previously participated in EMR / EHR infrastructure projects in conjunction with St. Boniface General Hospital Research Centre to research and develop patient location systems, security platforms and network architectures. New projects that integrate and build EMR / EHR applications are under development.

3.3.2.2 Telemedicine

Telemedicine refers to the use of ICT to provide clinical care to patients at a distance. This includes patient monitoring and the provisioning of services directly to patients. In addition, the Telemedicine research theme includes investigating how to best give healthcare workers access to information, as well as how to communicate and share this information in a secure environment.

The Telemedicine research theme compliments on-going research within the eHome Focus Area. Current research within the eHome Focus Area into service discovery and composition will enable the development of home care applications that monitor a patient's health.

TRLabs is also currently involved in research applying expertise in signal processing to automatically pre-screen long streams of data collected from medical monitoring devices. This research will enable presenting busy physicians with the most salient features of such a stream quickly.

3.3.2.3 Evidence Based Medicine

"Evidence-Based Medicine is the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research"^[5]

Evidence-Based Medicine may be integrated into the clinical decision process at various stages. For example, when a clinician diagnoses a patient, when a clinician places a medical order, or when a clinician is searching for suitable treatment information. In each of these cases evidence-based medicine can enhance the outcome by enabling the clinician to make a more knowledgeable decision. Previously, TRLabs participated in a Winnipeg Health Region project that evaluated the effectiveness of evidence based medicine. New projects in this theme are under development.

3.3.2.4 Citizen-oriented Information Provision

Citizen-oriented Information technologies provide a patient and healthy individuals with medical information on selected topics. TRLabs will investigate this topic further aiming to increase the value proposition of eHealth Management.

3.3.2.5 Specialist-oriented Information Provision

Specialist-oriented Information technologies support medical personnel by providing them with specialized information (e.g. overview of latest medical journals, best practice guidelines, epidemiological

tracking, etc.). TR Labs will investigate this topic further aiming to increase the value proposition of eHealth Management.

3.3.2.6 Virtual Healthcare Teams

ICT technologies can support the creation of Virtual Healthcare Teams by facilitating the collaboration of geographically dispersed health care professionals and the sharing of patient information amongst those professionals. TR Labs will investigate this topic further aiming to increase the value proposition of eHealth Management.

3.3.3 Medical Informatics

Medical Informatics is an interdisciplinary field that incorporates aspects of medicine, mathematics, biology, computer science and engineering. Medical Informatics studies, invents, and implements structures and algorithms to improve the communication, understanding and management of medical information^[6]. Medical Informatics is also known as Biomedical Informatics in the US and Health Informatics in Europe. Research in Medical Informatics impacts the basic sciences, clinical services, and/or the healthcare organization^[7].

Medical Informatics may be subdivided according to the health area in which it is applied (vertical approach), or it may be subdivided according to the medical service in which it is applied, thus crossing multiple health areas (horizontal approach). For example, Medical Informatics may be subdivided into Radiology-Informatics for radiology, Neuro-Informatics for neurosciences, Pathology-Informatics for pathology, etc. (vertical approach). Alternatively, Medical Informatics may be subdivided into Medical Imaging, Systems Biology, Visualization and Modeling, etc. giving rise to applications that cross health care boundaries (horizontal approach). TR Labs research related to Medical Informatics follows the horizontal approach. Consequently TR Labs subdivides its Medical Informatics research into Medical Imaging, Visualization and Modeling, and Systems Biology, as described next.

3.3.3.1 Medical Imaging

Within Medical Imaging, TR Labs is investigating:

- Medical imaging software technology that supports novel methods for image reconstruction, detection, simulation, processing and analysis.
- Computer aided diagnosis technology that supports database reconstruction, feature extraction, and classifier design and evaluation.
- Imaging informatics technology that supports image acquisition, management, storage, and distribution. For example, TR Labs has investigated models for secure data access, analyzed the

performance of patient location systems, and investigated how to maintain privacy when mining data and building health surveillance systems.

Relationships with healthcare organizations such as the Winnipeg Regional Health Authority, St. Boniface Research Centre, and the Saskatoon Health Region, will identify specific projects supported by TRILabs in this area.

3.3.3.2 Visualization and Modeling

Within Visualization and Modeling, TRILabs is investigating:

- The use of images to guide therapeutic procedures
- Novel methods for visualization and modeling
- The derivation of patient-specific models from images
- Imaging computing architectures
- Computer aided procedures
- Virtual reality systems for medicine

TRILabs has investigated image construction using PET (Positron Emission Tomography) data and conducted several visualization and modeling demonstration projects using mobile agents and distributed visualization technologies. This work is particularly valuable to health care education. Industry Canada (Medical Imaging Technology Roadmap, Working Group 4, Final Report) noted that there is a great need to develop effective training based on high-fidelity virtual reality simulation models for medical students at all levels up to and including practising clinicians. Among the benefits would be more systematic feedback to students, reduced reliance on animals and cadavers, ease of training for rarely practised procedures and techniques, and the ability to evaluate completely new techniques.

3.3.3.3 Systems Biology

Within Systems Biology, TRILabs is investigating developing applied technology that supports the visualization and modeling of the physiology, function and structure of biological systems. Systems Biology visualization and modeling enhances the understanding of health and disease mechanisms at all levels, from systems to cells. In addition, the associated mathematical and computational analysis of anatomic structures and functions enhances the understanding of variations in health and disease.

3.4 Roadmap

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

4. Resources and Competencies

Underpinning TRILabs 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 TRILabs with the manpower and expertise to pursue research in not only the eHealth Focus Area, but also in TRILabs eHome and Connected Media Focus Areas.

In addition to TRILabs' relationship with the Universities, TRILabs is building partnership agreements with the local technical colleges in Alberta, Saskatchewan and Manitoba to help TRILabs 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, TRILabs 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, TRILabs has developed expertise in numerous technologies since its inception in 1986. Some of that expertise is identified below:

- Grid/Distributed Computing
- Medical Information Security
- Photonics and Biosensors
- Reliable Networks Design
- Wireless Networks and Components Design
- Home Technology
- Visualization
- Groupware
- Network Modeling and Simulation

TRILabs has significant visualization expertise. A recent project on distributed 3D rendering, the Distributed Visualization System (DVS), furthered TRILabs relationship with the medical community.

TRILabs also has significant expertise in software agents. Software agent technology facilitates optimizing processes by automatically initiating actions currently burdening medical practitioners. For example, software agent technology could automatically inform physicians and patients in a timely fashion of test results and/or inform physicians when patients fail to appear for a scheduled examination or test.

TRILabs also carries out wireless network research (e.g. wireless ad-hoc networks, self-organizing low power wireless networks) creating the expertise necessary to research and develop biomedical RF devices and networks. This expertise led to the development of a health monitoring device called the "smart band-aid".

Furthermore, TRILabs expertise in photonics is relevant to developing bio-photonic sensors and monitoring devices; TRILabs research in operations is valuable in analyzing public health policy; and finally, ongoing work in

network optimization and modeling is relevant to designing high performance, reliable and secure medical networks.

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

- TRnet
- The Canadian Light Source
- The eHome technology integration/application development lab
- MINT Lab

TRnet is an independent, wide-area networking laboratory spanning Edmonton, Calgary, Saskatoon, Regina and Winnipeg. TRnet is a “crash and burn” test network that mirrors a real network. It facilitates 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 the field of medicine, the Canadian Light Source enables users to design new drugs and medical treatments.

The eHome technology integration and application development lab will enable research and development of eHealth technologies and applications within the home that facilitate the delivery of distributed personalized health care.

The Master of Science in Internetworking (MINT) program at the UofA 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, through the University of Alberta, TR Labs can use this lab to investigate the design, performance and management of regional health networks, as well as the delivery and performance of distributed eHealth services.

These resources are used by TR Labs to develop integrated eHealth solutions, applications, and proof-of-concept demonstrations relevant to the various research themes associated with the eHealth Focus Area described in this document.

5. References

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- 5 Centre for Evidence-Based Medicine definition available at <http://www.cebm.net/glossary.asp>. Last accessed September 6th, 2006
- 6 Cambridge Health Institute website available at www.genomicglossaries.com. Last accessed July 25th, 2006
- 7 Vanderbilt University website available at www.mc.vanderbilt.edu/dbmi. Last accessed July 25th, 2006.

Appendix

A.1 Focus Group Members

Name	Title	Affiliation
Ahmed Adboh	Scientific Founder and President,	Teleforms Inc.
Brian Eckhardt	VP eHealth	InfoMagnetics Technologies Corp.
Mark Fedorak	President & CEO	Xanatec Technologies, Inc.
Alan Graves	Director, Access Network Strategies	Nortel
Brad Goble, MBA	CEO & Managing Partner,	TDV Global
Todd Herron	CEO	CliniTrust
Dr. Penny Jennett	Director	EHealth Industry Project
Marshall Ring	VP Strategic Business Development	Biomedical Commercialization Canada Inc.
Dave Schroeder	Director of R&D/ MMDD	SaskTel
Vlatka Tustonic	Business Development Officer	Saskatoon Health Region
Rod Pohl	Director, Information Technology	Brandon Regional Health Authority
Chuck LaFleche	Chief Business Development Officer	Momentum Healthware

A.2 Focus Area Researchers

Name	Affiliation	Research Interests
Sergio Camorlinga, PhD (CS)	<ul style="list-style-type: none"> • R&D Manager, TRILabs • Adjunct Professor, Computer Science, U. of Manitoba • Lecturer, Radiology Faculty of Medicine, U. of Manitoba 	<ul style="list-style-type: none"> • Medical imaging • Clinical networks • Imaging Informatics in Medicine
Jeff Diamond, PhD (Ops. Res.)	<ul style="list-style-type: none"> • Research Manager, TRILabs 	<ul style="list-style-type: none"> • Network modeling and optimization
John Doucette, Ph.D. (EE)	<ul style="list-style-type: none"> • Assistant Professor, Mechanical Engineering (Industrial engineering), U. of Alberta 	<ul style="list-style-type: none"> • Network planning and optimization • Network reliability and survivability
Rasit Eskicioglu, Ph.D. (CS)	<ul style="list-style-type: none"> • Associate Professor, Computer Science, U. of Manitoba 	<ul style="list-style-type: none"> • Systems software
Ken Ferens, PhD (ECE)	<ul style="list-style-type: none"> • Assistant Professor, Elec. and Comp. Eng., U. of Manitoba 	<ul style="list-style-type: none"> • Wavelets, fractals, compression • Artificial neural networks • Internetworking

Eleni Giannouli, MD, FRCPC	<ul style="list-style-type: none"> Assistant Professor, Internal Medicine, Faculty of Medicine, U. of Manitoba 	<ul style="list-style-type: none"> Internal medicine (respiratory)
Richard Gordon, PhD (Chemical Physics)	<ul style="list-style-type: none"> Professor, Department of Radiology, University of Manitoba Adjunct Professor, Departments of Computer Science and Electrical & Computer Engineering Scientist, Manitoba Institute of Child Health 	<ul style="list-style-type: none"> Imaging Nanotech Statistical mechanics
Dean Jin, Ph.D. (CS)	<ul style="list-style-type: none"> Assistant Professor, Computer Science, U. of Manitoba 	<ul style="list-style-type: none"> Software engineering Systems integration
Zahra Kazem-Moussavi, PhD(EE)	<ul style="list-style-type: none"> Associate Professor, Elec. and Comp. Eng., U. of Manitoba 	<ul style="list-style-type: none"> Biomedical engineering
Carson Leung, PhD (CS)	<ul style="list-style-type: none"> Assistant Professor, Computer Science, U. of Manitoba 	<ul style="list-style-type: none"> Data mining and analysis Image databases
Yanni Ellen Liu, PhD (CS)	<ul style="list-style-type: none"> Assistant Professor, Elec. and Comp. Eng., U. of Manitoba 	<ul style="list-style-type: none"> Resource management in computer networks and systems
Ekram Hossain, PhD (EE)	<ul style="list-style-type: none"> Assistant Professor, Elec. and Comp. Eng., U. of Manitoba 	<ul style="list-style-type: none"> Wireless communications and networking Mobile computing High-speed networking
Mirek Pawlak, PhD (EE)	<ul style="list-style-type: none"> Professor, Elec. And Comp. Eng., U. of Manitoba 	<ul style="list-style-type: none"> Statistical signal and image processing
Martin Reed, MD	<ul style="list-style-type: none"> Professor Radiology, Section Head, Child Radiology, Health Sciences Centre, U. of Manitoba 	<ul style="list-style-type: none"> Pediatric radiology
Attahiru Alfa, PhD (Ops. Res.)	<ul style="list-style-type: none"> Professor & Centara Chair in Telecomm., Elec. and Comp. Eng., U. of Manitoba 	<ul style="list-style-type: none"> Queuing systems Network flow problems
Raman Paranjape, PhD (EE)	<ul style="list-style-type: none"> Professor, Electronic Sys. Eng., U. of Regina 	<ul style="list-style-type: none"> Mobile Agent Systems – medical data retrieval Biomedical signal and image processing
Luigi Benedicenti, PhD	<ul style="list-style-type: none"> Associate Professor, Software Systems Engineering, U. of Regina 	<ul style="list-style-type: none"> Software engineering and Software Product Lines Mobile agents and their application in emergent behaviour Augmented reality New Media Technology and Scientific Visualization Distributed Computing

A.3 Projects

A.3.1 New Projects

Projects	Title	Research Theme	Contact
2007EH001	Sleep Apnea Detection System Program (Task #1 – Sleep Apnea Signal Analysis) (Azadeh Yadollahi)	Medical Informatics	Dr. Zahra Moussavi/ Dr. Sergio Camorlinga
2007EH002	Sleep Apnea Detection System Program (Task #3 – Self Calibration & Flow Estimation) (Saiful Huq)	Medical Informatics	Dr. Zahra Moussavi/ Dr. Sergio Camorlinga
2007EH003	Sleep Apnea Detection System Program (Task #5 – Signal Compression & Data Transmission) (Manju Ramnathan)	eHealth Services	Dr. Zahra Moussavi/Dr. Sergio Camorlinga
2007EH004	Integrated Wellness Visualization System for Caregivers	Medical Informatics	Dr. Luigi Benedicenti
2007EH005	CAD for Pediatric Brain Trauma and Progression	Medical Informatics	Dr. Sergio Camorlinga / Dr. Martin Reed /Dr. Carson Leung
2007EH006	A Diabetic-Patient Agent Model	Medical Informatics	Dr. Raman Paranjape
2007EH007	Home Care Monitor System Project	eHealth Services	Dr. Sergio Camorlinga / Dr. Dean Jin
2007EH008	Cognitive Radio for Biomedical Devices	Clinical Networks	Dr. Ekram Hossein

A.3.2 Proposed Projects

Projects	Title	Research Theme	Contact
PP2007EH009	CAD for Pediatric Bone Fractures, Osteoporosis and its Progression	Medical Informatics	Dr. Sergio Camorlinga / Dr. Martin Reed
PP2007EH010	Virtual Environment Interface for Upper Limb Prosthesis Training	Medical Informatics	Dr. Anh Dinh

A.3.3 On-going Projects

Projects	Title	Research Theme	Contact
2003DN002	Tel-Medicine: 4D Screening and Digital Image Reconstruction, Starting with PET Imaging via Density Estimation (Barbara Pawlak)	Medical Informatics	Dr. Richard Gordon
2003DN020	Archive Planning for a Distributed PACS System (Peng Zhou)	Medical Information	Dr. Michel Toulouse/Dr. Ellen Liu
2004DN003	Traffic Model for Hospital Point-of-Care Networks (Haitham Abu Ghazaleh))	Clinical Networks	Dr. Attahiru Alfa / Dr. Jeff Diamond
2005EH005	WiMax for Telemedicine and Mobile Health Services (Dusit Niyato)	eHealth Services	Dr. Ekram Hossein
2006EH002	Service Availability of a Provincial eHealth Network on the Alberta SuperNet (Jude Akpoh/Ye Tang/Brody Todd)	Clinical Networks	Dr. John Doucette
2006EH003	Agent-based Hospital Bed Allocation Model and Simulation (Sara Goreishi Nejad)	eHealth Services	Dr. Raman Paranjape
2006EH004	Intra-Facility eHealth Network Availability and Optimization (Brody Todd/Ahmed Kasem)	Clinical Networks	Dr. John Doucette

A.3.4 Completed Projects

Projects	Title	Research Theme	Contact
2003NM004	Agent-Based Health Record System (Ben Tse)		Dr. Raman Paranjape
2004DN002	Web-based Remote Respiratory and Swallowing Sound Monitoring (Mohammad Aboofazeli)	eHealth Services	Dr. Zahra Moussavi
2005DN001	Efficient Data Mining for Anomaly Detection in a Distributed Federation of Health Surveillance Databases with Privacy Constraints (Quamrul Kahn/Tariqul Hoque) (Subscribed Research Project)	Medical Informatics	Dr. Carson Leung / Dr. Jeff Diamond
2005EH002	Performance Study of Regional Hospital Networks - Phase I (Kelly Sudol)	Clinical Networks	Dr. Sergio Camorlinga

A.3.5 Cancelled / Reallocated Projects

Projects	Title	Research Theme	Contact
2005EH003	Performance Study of Regional Hospital Networks (Michelle Card)	Clinical Networks	Dr. E Liu / Dr.Camorlinga
2005EH004	A Telemedicine System for a "Wireless" Hospital	eHealth Services	Dr. Zahra Moussavi/Dr. Ekram Hossain
2006EH001	A Network Architecture for In-Hospital Wireless Patient Monitoring	eHealth Services	Dr E Hossein / Dr Z Moussavi