Communications Research Centre Canada
An Agency of Industry Canada

Centre de recherches sur les communications Canada
Un organisme d'Industrie Canada

CRC HIGHLIGHTS
2006 - 2007

BUILDING NEXT GENERATION COMMUNICATIONS TECHNOLOGIES FOR CANADA

Canada

CRC

For additional copies of this publication,
please contact one of the following:

Communications Research Centre Canada (CRC)
3701 Carling Avenue
Box 11490, Station H
Ottawa, ON K2H 8S2 CANADA
Phone: (613) 991-3313
Fax: (613) 998-5355
E-Mail : info@crc.ca
www.crc.ca

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Fax (toll-free): 1-800-565-7757 (Canada and U.S.)
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E-mail: publications@pwgsc.gc.ca

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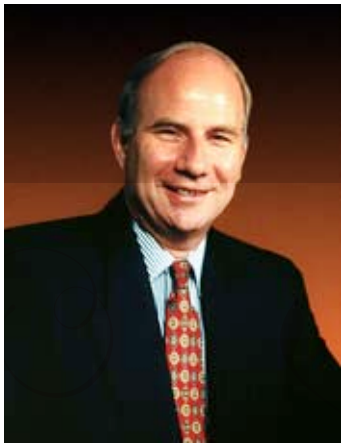
MESSAGE FROM THE CHAIR



Canada has a long history of global leadership in the area of Information and Communications Technologies (ICT), an area which the federal government has emphasized as important in improving the quality of life and standard of living for Canadians.

Recently, the government released the Science and Technology Strategy for the country. Entitled *Mobilizing Science and Technology to Canada's Advantage*, the strategy identifies ICT as one of the top four areas of Canadian S&T strength, echoing the findings published by the Council of Canadian Academies in its 2006 report, *The State of Science and Technology in Canada*.

CRC's Strategic Plan 2007-10 is aligned with the government's priorities. This plan describes the state of telecommunications research in Canada, the emerging challenges in ICT, how CRC's research and development (R&D) programs are responding to these challenges, and measurable outcomes for strengthening ICT innovation and growth in Canada over the next three years.

As the primary federal laboratory for telecommunications research, CRC works closely with partners to advance new communications technologies and provide strategic advice for the development of policy, regulations and standards. Today, CRC is evolving through increasing collaborative and multidisciplinary research. More than ever, CRC is leveraging the expertise of partners in academia, other federal laboratories, the private sector and international organizations to accelerate the commercialization and adoption of new communications, broadcasting and information technologies.

Over the past year, CRC's R&D has made a significant contribution to address the challenges of policy, regulations and standards development for emerging technologies such as cognitive radio, WiMAX, digital broadcasting and Software Defined Radio, to name a few. This report provides details of CRC's accomplishments.

I am proud that CRC has been able to act as a catalyst for collaboration, and thank the many individuals and organizations, including our clients, staff, Board of Directors and Industry Canada, for their shared vision and commitment to Canada's social and economic success.

Alan Winter

MESSAGE FROM THE PRESIDENT

Telecommunications R&D at CRC is a two-way street. Not only does CRC have a long and distinguished history in helping government establish effective, forward-looking and responsive policies, but these policies also guide CRC's future priorities.

Right now, the boundaries between telecommunications and broadcasting are blurring. The Internet is playing a major role in delivering services and, increasingly, consumers want these services from a single device wherever they are.

Developing policies and regulations that reflect these changes requires expert technical advice. As the government's primary research lab for information and communications technology, CRC is in an excellent position to assist government in addressing these challenges. To this end, CRC has established the following main priorities, as outlined in the CRC 2007-2010 Strategic Plan:

- improving R&D efforts related to Industry Canada's medium and short-term problems
- identifying links between research activities and their potential applications
- developing more working relationships with other government departments that are potential users of ICT, and
- increasing cross-Canada marketing efforts for the CRC intellectual property and technology portfolio.

CRC has made significant progress in defining its R&D program and fulfilling its advisory role. You will find repeated examples throughout this year's Highlights report of how CRC's research agenda is contributing to socio-economic priorities of the government for policy and regulation development. For example, satellite communications for rural broadband or sensor networks that improve our military's capabilities are promising technologies that are important for Canadians. CRC provides expert assessments of these technologies and technology trends to help government make more informed policy and regulatory decisions.

Also on the regulatory front, CRC prepared a report in response to the Canadian Radio-television and Telecommunications Commission's *Notice on the Future of Broadcasting*. This wide-ranging review recognized the growing popularity of unregulated platforms, such as the Internet and mobile networks, particularly among younger Canadians. In its report, CRC highlighted other emerging technologies such as mobile television, enhancement to digital television transmission, Internet Protocol Television, wireless broadband networks, satellite broadcasting and more.

As well, when the Telecommunications Policy Review Panel process was underway, CRC consulted closely with Industry Canada during the development of the report, and provided technical data to assist the Panel in its review. CRC executives also made a presentation on "New Broadcasting Technologies" to the Standing Committee on Canadian Heritage for the House of Commons.

We look forward to working with Industry Canada and our partners over the coming years to respond to their needs and accelerate the adoption of ICT for the benefit of all Canadians.

Veena Rawat

ABOUT CRC

Communications Research Centre (CRC) is the Canadian government's primary laboratory for research and development (R&D) in advanced telecommunications. CRC aims to identify and close the innovation gaps in the telecommunications sector; build technical intelligence; assist Canadian telecommunications firms in their efforts to remain globally competitive; and, anticipate major telecommunications trends in support of public policy, regulations and standards.

CRC is the only national laboratory with critical mass and expertise in three major technologies that form the basic transport mechanism for information delivery across Canada: radio, satellite and fibre-optics.

With a staff of more than 275 research engineers and scientists, CRC provides technical advice related to Industry Canada's mandate for spectrum management, communications policy and regulatory decision making. CRC also works with international organizations in the development of standards to facilitate the efficient delivery of telecommunications and broadcasting applications.

CRC assists or partners with several other Canadian departments and agencies on information and communications technologies applications for national defence, public safety and space-based communications. Significant R&D and program delivery is conducted on a cost-recovery basis for Industry Canada, the Department of National Defence (DND) and the Canadian Space Agency (CSA).

CRC contributes to the growth of Canada's ICT sector by engaging in industry partnerships, building technical intelligence, supporting high-technology enterprises and working with other research organizations across Canada and around the world.

The CRC, as custodian of the Shirleys Bay Campus, provides a secure environment for organizations to conduct classified research and operations.

Through the CRC Innovation Centre and Canada Network of Wireless Centres (CWCnet), CRC helps start-up companies develop and test new technologies.

CRC at a Glance

Research Staff
Researchers: 287 (incl. 9 new)
Students: 17

Research Partnerships
Total active collaborative agreements with industry: 33 (10 new)
Total active collaborative agreements with university/government: 45 (7 new)

Contracted R&D IP Licences
Contracting-in agreements: 58 (48 new)
IP licenses: 401 (42 new)
Total revenues: $2.31M

Patents
Active patents: 237
New patent applications: 18
New patents issued: 8

Media
Articles on CRC : 30
Interviews for TV and radio: 7

Visits
Corporate tours: 19
International visitors from: South Korea, India, European Commission, Germany, Switzerland, France, Russia, U.S., Japan, The Netherlands, Singapore, Mexico, Finland, China, Spain, Australia.

Scientific publications, reports, patents and technical demonstrations
Journal papers: 93
Conference presentations: 155
Technical memoranda: 18

STRATEGIC PRIORITIES 2007-2010

With significant input from its major clients and its Board of Directors, CRC has identified six strategic priorities to define the major elements of its research program and associated activities:

Broadband Access - CRC will support the federal government's goal of connecting all Canadians. Research activities focus on delivering cost-effective broadband solutions to rural and remote communities - innovations that could be replicated in other parts of the world.

Radio Spectrum - CRC will provide Industry Canada with a solid technical base for the development of policy and standards for efficient and effective regulation and allocation of radio spectrum. CRC also supports Canada's participation in international spectrum allocation.

Defence Communications - CRC will enable DND to make decisions on procurement and deployment of military communications systems.

Network Security and Public Safety - CRC will provide advice regarding the security of network infrastructure for communications, commerce, defence and other applications. In partnership with other Canadian organizations, CRC is examining the needs and capabilities of technology in this field, including the security of wireless networks. CRC will also develop new technologies for emergency/disaster communications, and search and rescue.

Internet and Convergence - CRC will provide technical insight into future convergence issues (Internet, wireless, optical, broadcasting) to assist government in making informed policy decisions.

Applications - CRC will assist content providers and user communities in connecting together, and evaluating new tools and applications for social benefit.

Broadband Access

CRC's Commitment

R&D to bring broadband access to rural and remote areas in Canada

Strategic Priority

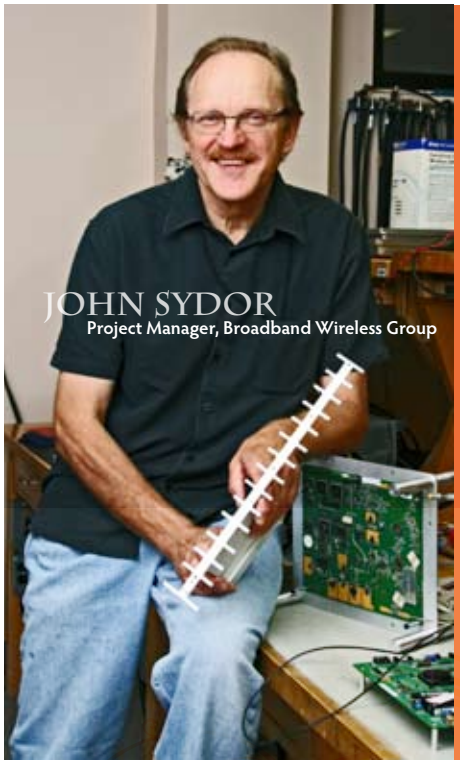
CRC will support the federal government's goal of connecting all Canadians. Research activities focus on delivering cost-effective broadband solutions to rural and remote communities - innovations that could be replicated in other parts of the world.

From WiFi to WiMAX

Canada is a major international player in the development of technology that brings wireless broadband to the mass market. WiMAX and WiFi, based on the Institute of Electrical and Electronics Engineers (IEEE) standards, have attracted commercial interest among many Canadian companies, from chip and equipment manufacturers to broadband service providers. CRC conducts collaborative research internationally and with Canadian companies and universities to augment these technologies with cognitive radio capabilities that increase the use of the radio frequency (RF) spectrum.

What is Cognitive Radio?

Cognitive radio includes smart radios and other new wireless devices that can sense the RF spectrum and react to avoid transmission bottlenecks, for instance by switching instantly to nearby unused frequencies. CRC is investigating how small changes to the protocols inside WiFi and WiMAX standards can result in significant performance gains and improve the use of valuable spectrum.



"CRC is developing WiMAX cognitive radio Internet technology that can be used in small communities in Canada. Our engineering team is working with the IEEE and collaborating with Wavesat Inc. of Montréal to have a low-cost terminal ready for the fall of 2008. There is considerable interest in this last-mile technology in Canada, India and elsewhere in the world."

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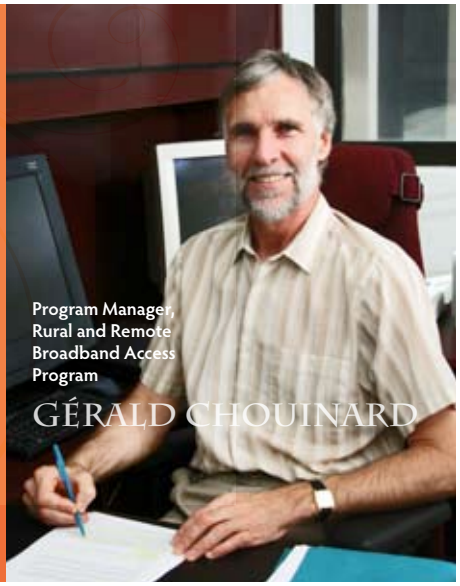
John Sydor and CRC's Broadband Wireless Group are working with partners on new approaches to reduce power requirements for handheld terminals while increasing downlink data capacity – two major barriers to the implementation of video-intensive applications with these devices.

Tapping the TV spectrum

In order to extend connection to all Canadians, a more cost-effective way of bringing broadband Internet to rural Canada is needed. CRC is working with the IEEE on a cognitive radio standard that would see wireless broadband services delivered over unused TV channels in sparsely populated areas. As co-chair of the international IEEE 802.22 working group, CRC has assisted the working group on issues related to technology, systems and interference. An international standardization of such technology will allow volume production of the equipment, which will result in lower per-unit costs.

"The 802.22 standard offers exciting possibilities for creating wireless regional area networks of up to 30 kilometres in radius in non-line-of-sight propagation conditions in rural and remote areas. So far, the group is on track to deliver an approved 802.22 standard to industry in 2008. That could see low-cost equipment arriving in rural areas of Canada by early 2009. Many countries in the world will benefit from this new standard."



CRC has been a major participant in the IEEE 802.22 working group, from attending meetings and weekly teleconference calls to providing some 30 technical contributions. CRC's contributions are well received internationally. Not only is it viewed as a "neutral" player in standards setting, CRC is widely recognized for its expertise in relevant technologies, overall systems aspects and frequency band utilization.

Other Highlights

- CRC's Broadband Applications and Demonstration Laboratory (BADLAB) participated in several interactive multimedia events and demonstrations, including tele-education and tele-haptics involving remote and rural communities, and a dance performance broadcast in real-time from Seoul, South Korea.
- The National Arts Centre continues to use the CRC BADLAB to coach music students, via videoconferencing, in St. John's, Newfoundland and Labrador, Kangiqsualujjuaq, Quebec and Nunavut (MusicGrid and VirtualClassroom).
- CRC participated in the REACH project (Remote Assertive Community Healthcare) by providing satellite linkage between a Toronto clinic and patient station.
- The installation of CRC's experimental Mobile Multimedia Broadcasting (MMB) system in Montréal enables CRC and Radio-Canada to begin experimentation and demonstrations of emerging technologies, based on the Digital Audio Broadcasting (DAB) Eureka 147 standard.
- CRC implemented and tested highly integrated wireless modules (TxRx units) for broadband applications that can support a communication link over a distance of approximately 100 metres and at data rates of 700 Mbps.

Expanding broadband in the North

CRC collaborated with the Canadian Space Agency to expand broadband Internet in northern communities. Ka-band ground terminals linked to the Anik F2 satellite were installed in multiple communities in Yukon, Northwest Territories and Nunavut as part of CRC's Satellite Multimedia Applications Research and Trials (SMART) Program, which demonstrates broadband satellite communications services and applications, and provides technical support to other government entities.

Radio Spectrum

CRC's Commitment

To support the efficient and effective use of radio spectrum

Strategic Priority

CRC will provide Industry Canada with a solid technical base for the development of policy and standards for efficient and effective regulation and allocation of radio spectrum. CRC also supports Canada's participation in international spectrum allocation.

Spectrum Management

CRC designs better "traffic cop" for spectrum monitoring

Since 1993, Industry Canada had used a cost-effective, user-friendly and flexible technology, developed by CRC in collaboration with Defence R&D Canada and Industry Canada's Spectrum Engineering Branch, to assess the use and quality of radio spectrum across the country. Now, CRC researchers have designed a high-performance Spectrum Explorer® that is smaller, lighter and less expensive than previous systems.

Helping licensees develop CRC technology

Transforming technologies developed in-house into commercial successes is an ongoing priority at CRC. For example, CRC supports Spectrum Explorer® licensees Telemus Inc. of Ottawa, Ontario and Aerosystems International Inc. of Saint-Laurent, Quebec in their product development. CRC also assists other government departments in using the Spectrum Explorer® suite of technologies to meet their requirements.

JOHN LODGE
Research Program Manager,
Communications Signal Processing

"A Spectrum Explorer® system can draw a complete picture of the radio spectrum within seconds, which can then be updated on an ongoing basis. Recent improvements are prompting a significant increase in the number of units used by Industry Canada's radio inspectors and are expected to stimulate sales by our licensees. The technology offers next-generation solutions for other users, including service providers, law enforcement agencies and military organizations."

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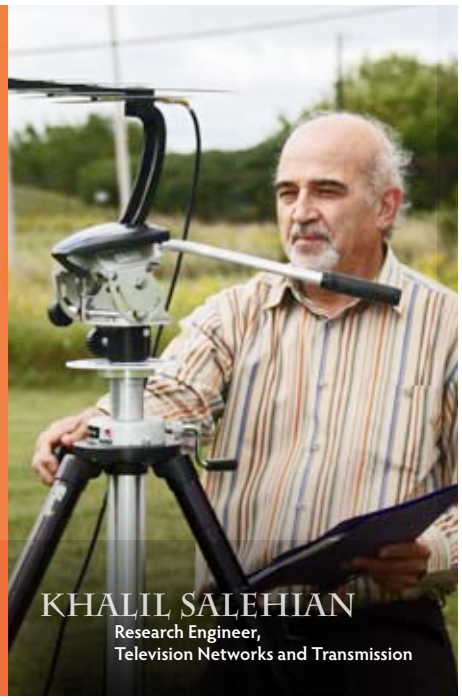
A high-performance Spectrum Explorer® was successfully implemented and demonstrated over the past year using only a moderate-cost spectrum analyzer and a laptop computer. This provides Industry Canada with an economical, portable and calibrated equipment set with extended frequency coverage. It also has the potential to increase licensing for CRC technologies internationally.

Clearing the way for DTV

Digital television (DTV) transmission systems open the possibility of sharing the core DTV-UHF spectrum with other licensed or unlicensed services. CRC is conducting two major studies for Industry Canada to ensure a smooth introduction of these new technologies. One study is measuring the impact that new unlicensed devices using the television spectrum will have on DTV, while the other is examining new technologies using the TV spectrum and efficient video coding for DTV and multimedia services.

"CRC is conducting extensive studies and tests to investigate the interference effects of new emerging technologies such as IEEE 802.22 Wireless Regional Area Network (WRAN) and IEEE 802.16 WiMAX on DTV reception, and to devise appropriate sharing criteria for their possible deployment in the TV bands. The results of such studies will be provided to Industry Canada for the development of necessary rules for the use of DTV-UHF spectrum by these new services."



CRC is a major contributor to Canadian and international standards. Over the past year, a number of groups at CRC prepared engineering studies for Industry Canada on spectrum issues related to a major update of Canada's spectrum licensing system, and on FM-IBOC technology assessment.

Improving HDTV transmissions

CRC is currently testing a proposed improvement to the ATSC transmission standard used for HDTV in North America. The change will make it possible to receive DTV and new services on handheld and mobile devices, and improve reception at fixed locations.

Other Highlights

- CRC's coverage prediction and analysis software (CRC-COVLAB) was used to conduct interference analyses for the anticipated FM-IBOC service roll-out in the U.S., close to the Canadian border.
- Radio-Canada adopted an enhanced version of CRC-COVLAB as its main broadcasting analysis tool to ensure quality transmissions across the country.
- CRC, the University of Calgary and COM DEV Canada continued development on the ePOP (enhanced Polar Outflow Probe) radio receive instrument, which will be aboard the Cassiope satellite, scheduled for launch in 2008.
- CRC data on cloud attenuation modeling and facing will form part of a larger report for the European Space Agency on radiowave propagation for satellite communications and navigation in tropical and sub-tropical areas.
- CRC conducted a study of the impact of new broadcasting and telecommunications technologies (e.g. Digital Video Broadcasting Handheld (DVB-H), MediaFLO and WiMAX) on television broadcasting services in Canada.

Defence Communications

CRC's Commitment

To support Canada's national defence

Strategic Priority

CRC will enable DND to make decisions on procurement and deployment of military communications systems.

Autonomous wireless sensor networks to aid military

As battlefields become more complex, it is critical that military personnel have access to timely, accurate and relevant information at the tactical level. CRC is assisting in this task through its investigation of new aerial and ground sensor networks for search and rescue, surveillance and monitoring over civilian populated zones.

Improving surveillance and situational awareness

CRC is a global leader in the area of mobile ad hoc and sensor wireless communication technologies. As part of the SASNet project, CRC is providing advanced technologies that allow autonomous sensor networks to perform integrated surveillance tasks and provide improved situational awareness. The opportunities to move these technologies to the field are excellent, providing a leap-ahead capability to the Canadian Army's tactical information collection.

"Software developed for RUNES (Reconfigurable Ubiquitous Network Embedded Systems) could help provide Canada's land-based forces with improved surveillance capabilities, as part of the Department of National Defence's SASNet (Self-healing Autonomous Sensor Network) project. CRC's technical contributions to RUNES will also help accelerate commercial deployment of this critical new technology to other sectors, including border control, rescue and emergency."

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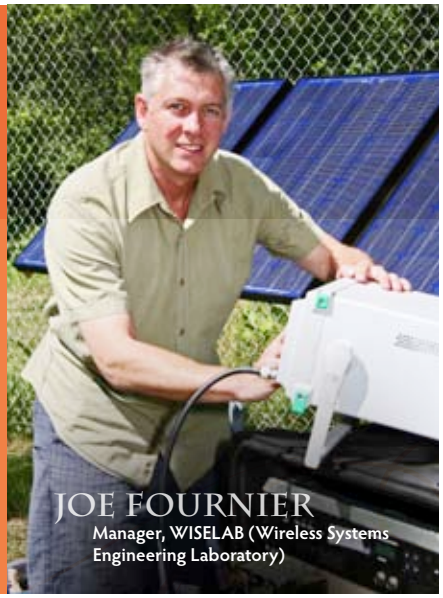
CRC is collaborating with the European Union to create an autonomous self-healing wireless communication system (RUNES) that will enable network-embedded systems to interoperate and adapt as their environments change. For example, if a system component is damaged during a fire in a tunnel, other components could compensate so emergency response efforts can continue.

Moving advanced communications from vehicles to soldiers

When Canada's Land Forces need to evaluate new wireless communications technologies to fill specific secure broadband wireless needs, they turn to CRC's Wireless Applications and Systems Research group. Over the past year, CRC investigated the potential application of Joint Tactical Radio Systems Soldier Radio Waveform, 802.16 WiMAX Broadband Wireless Communications Systems, and wireless communications within vehicles.

"We are conducting extensive studies and evaluations on these technologies in order to identify performance characteristics and functionalities, and thereby ascertain their suitability to various military environments and applications. One of the goals of these evaluations is to put advanced communication capabilities into the hands of soldiers, rather than into vehicles, thereby moving towards a network-centric future."



Joe Fournier and his team from the WISELAB conducted their first evaluation and demonstration of advanced broadband secure military radio capabilities at CRC in collaboration with ITT Industries and Oerlikon Contraves Inc. About 50 people from various groups of DND and DRDC attended a live demonstration.

Other Highlights

- CRC's demonstration of a Policy-Based Traffic Management System prototype is advancing efforts to improve the management of communication resources in maritime environments.
- Field trials are planned of CRC-developed antenna prototypes for a Multiple Input Multiple Output (MIMO) system, to be mounted on light-armoured vehicles.
- DND's Land Forces Trials and Evaluation Unit (LFTEV) has commissioned CRC to study ways to reduce the technological risks associated with the design and acquisition of a wireless digital video system. CRC identified key technologies and design parameters that will meet their requirements.

Linking Canadian and allied forces

CRC continued developing next-generation mobile wireless communications to meet current and future military requirements (High Capacity Tactical Communications Network). This included providing technical support to the Canadian Army in field trials of a network interface device to interconnect their Tactical Network with alliance partners in Afghanistan and elsewhere.

Network Security and Public Safety

CRC's Commitment

To enhance Canada's safety and security

Strategic Priority

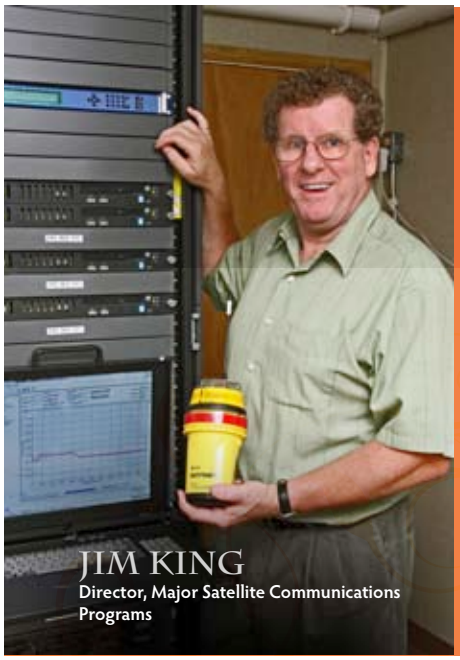
CRC will provide advice regarding the security of network infrastructure for communications, commerce, defence and other applications. In partnership with other Canadian organizations, CRC is examining the needs and capabilities of technology in this field, including the security of wireless networks. CRC will also develop new technologies for emergency/disaster communications, and search and rescue.

The ultimate search and rescue system

Soon, search and rescue authorities will be able to locate nearly anyone in distress. CRC is contributing to a next generation satellite system that will provide search and rescue authorities with the ultimate distress alert and locating service. The MEOSAR system will radically reduce search and rescue response times by providing near-instantaneous distress alerts from virtually anywhere on the planet, including Canada's far North.

MEOSAR's Benefits

The Medium-Earth Orbit Search-and-Rescue (MEOSAR) system will be like moving from a slow, dial-up Internet connection to a high-speed always-on connection. The many benefits include continuous global coverage, more reliable reception of beacon signals by multiple signal paths, near-instantaneous detection and location of beacons, and the ability to track moving beacons on a life raft or on an aircraft even before it crashes.



JIM KING
Director, Major Satellite Communications Programs

"CRC is recognized as a world leader in search and rescue via satellite. With the MEOSAR project, we have provided significant technical support at the international level for this new constellation of search and rescue satellites. We've demonstrated the system's capabilities from CRC facilities to foreign delegations from Australia, Brazil, the U.K., France, the U.S., South Korea and Turkey. This has provided excellent visibility to CRC and Canadian companies involved in MEOSAR."

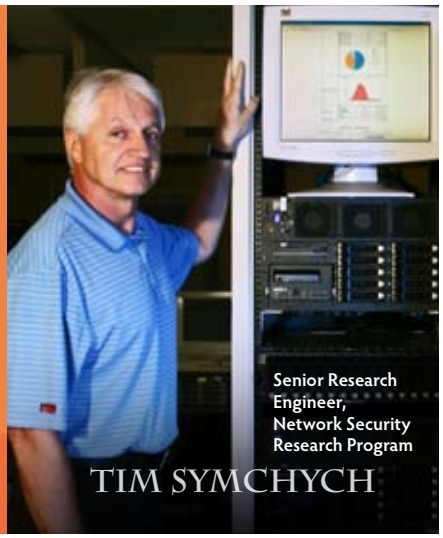
▲

Jim King's team in the Major Satellite Communications Program worked with EMS Satcom in Ottawa and the Canadian Space Agency to develop a prototype ground station for MEOSAR, which allows distress beacons to be detected and located quickly. Preliminary trials have demonstrated great potential.

Safeguarding Canada's network infrastructure

Network security and reliability are issues of national concern and an ongoing priority of Industry Canada. CRC's Network Security team is working on several research fronts to minimize this risk, including detection of next generation of attacks, detection of disguised malicious activities, next generation of network management systems and tools, and development of advanced test strategies and facilities.

"A secure network infrastructure and supporting network services is a fundamental tenet of reliable and robust communications systems. CRC is committed to a Network Security Research Program that identifies and develops the essential security components for the next generation of wireless and wired networks. The applied research activities and prototype products contribute to the technology base that is used by both government and the private sector to better protect critical information communications technologies."



CRC is developing better algorithms and techniques to detect emerging threats on network infrastructures, applications and services. Rather than using signature-like features, which do not meet current requirements, CRC has prepared a proof-of-concept for a new approach that can find new and similar attacks. This work shows the first signs of being able to predict that certain activities seen over the network can be directly linked to attacks.

Other Highlights

- CRC identified future research in cyber security, in collaboration with Public Safety Canada, DRDC, National Research Council (NRC), Communications Security Establishment and Industry Canada.
- Industry Canada and other public and private sector organizations benefited from CRC's significant capability in virtualized network security testing.
- The U.S. President's National Security Telecommunications Advisory Task Force held an R&D Exchange Workshop in Ottawa in which CRC participated and helped organize.
- CRC developed and demonstrated a Policy-Based Network Management prototype system for secure management of networks in partnership with DRDC.

A new way to test network security products

In a separate project led by CRC, researchers developed a way of testing commercial intrusion detection systems by using the product's own library of known attacks. This approach is radically different from current testing techniques, which depend on using programs that exploit vulnerabilities in systems, since not all exploit programs are available to researchers or product vendors. This new technique will likely be used to augment the testing strategies within the Industry Canada, Spectrum Information Technologies and Telecommunications (SITT) Protocol Analysis Lab.

Internet and Convergence

CRC's Commitment

To accelerate development and adoption of new Internet technologies

Strategic Priority

CRC will provide technical insight into future convergence issues (Internet, wireless, optical, broadcasting) to assist government in making informed policy decisions.

Making television mobile

CRC is paving the way for a new generation of digital television (DTV) services that give broadcasters the option of using part of their channel capacity to offer TV programs and other data services to portable or mobile devices, including laptops and cell phones. Developed jointly by Samsung Electronics and Rohde & Schwarz, the Advanced-VSB (A-VSB) system is an enhancement to the current 8-VSB transmission system. The goal of A-VSB is to improve reception of 8-VSB in fixed, mobile or portable modes of operation.

Enhancing digital audio

CRC test results led to the selection of a new international Digital Audio Broadcasting (DAB) standard known as DAB+, using much more efficient audio coding techniques.

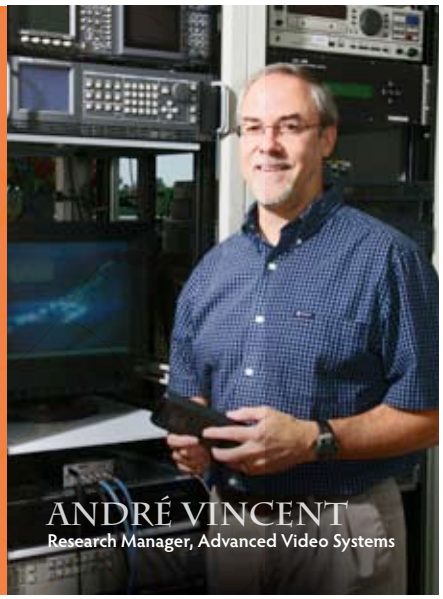
" Preparing for the A-VSB testing has been a big priority for CRC's Television Networks and Transmission group over the past year. Rohde & Schwarz collaborated with CRC to establish a Single Frequency Network in Ottawa in order to set the means to test Samsung's A-VSB in a number of conditions such as fixed, indoor, downtown, portable and mobile reception. Samsung proposes A-VSB as a standard to the Advanced Television Systems Committee (ATSC) and CRC provides an unbiased environment to perform all the necessary tests."

CRC is building a new DTV distributed transmission network. The new facility will make research possible in new areas such as advanced-VSB, single frequency networks, and portable and mobile television transmission.

Helping set global standards for IPTV

The CRC is one of the world-class research organizations contributing to global efforts to establish standards for Internet Protocol Television (IPTV). CRC is supporting the International Telecommunication Union, and the Institute of Electrical and Electronics Engineers (IEEE) in their efforts to ensure equipment interoperability and quality of service (QoS) for IPTV.

"CRC is working to bring quality of service guarantees to IPTV, as is the case with conventional television. Our group is investigating QoS issues related to IPTV. We also presented several tutorials on IPTV, namely at the International Broadcasting Convention in 2006 and have been invited back for 2007."



CRC's Advanced Video Systems group is developing a test bed to analyze how delay, compression bit rate, transmission errors and other issues are affecting picture quality. The resulting research will be of direct benefit to telecommunications equipment manufacturers and broadcasters worldwide.

Other Highlights

- Environment Canada is testing CRC's User Controlled Lightpath Provisioning (UCLP) system software (Version 2) in a new articulated private network connecting EC sites across Canada.
- CRC has become an affiliated partner in the OptIPuter, a U.S. National Science Foundation project that interconnects distributed storage, computing and visualization resources using optical networks.
- CRC successfully tested new error correction codes to enhance the error robustness of mobile broadcasting applications over the ATSC DTV system.

CRTC review on Future of Broadcasting

In response to the CRTC Notice on the Future of Broadcasting, CRC prepared a report that included a description of emerging broadcasting technologies, their potential impact on policies and regulations, as well as future broadcasting technologies CRC is exploring.

Applications

CRC's Commitment

To put technology to work for Canadians' health

Strategic Priority

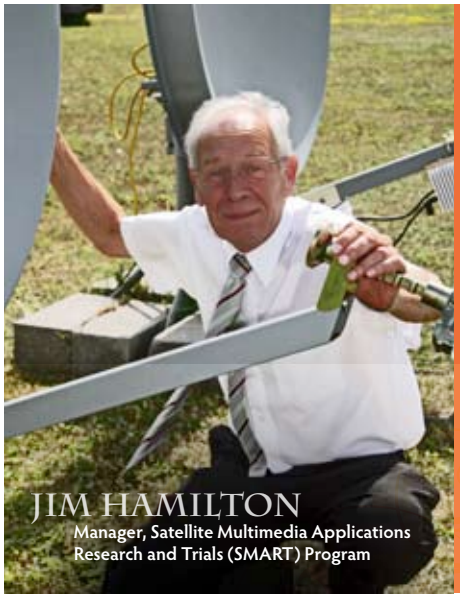
CRC will assist content providers and user communities in connecting together, and evaluating new tools and applications for social benefit.

Tele-health: Bringing healthcare to the home

CRC is working with public and private sector partners to develop a cost-effective and commercially viable medical home care solution for North Americans, regardless of where they live. The Remote Assertive Community Homecare (REACH) project can use either satellite or terrestrial broadband technology to connect patients requiring daily supervision with care providers from Assertive Community Treatment (ACT) programs. The technology allows ACT staff to supervise the taking of medication and monitoring of the patient's health remotely, enabling them to manage a greater case load and improve the overall quality of care.

Promoting e-health

A new partnership between CRC, NRC, the Centre for Global E-Health and Innovation, the Canadian Obesity Network and the Canadian Pediatric Society will focus on developing broadband visualization tools and networks to support youth and citizen engagement on the enhancement of e-health services. The first session included a virtual town hall session on "diet and body image" involving more than 600 students from across Canada.



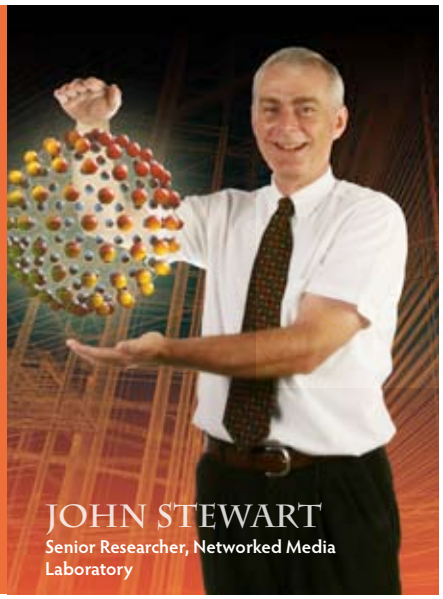
"Our test results from the field trial with London Health Sciences confirmed that the technology can reduce the cost of ACT teams by more than 20%, while improving the quality of care available to patients. We were so encouraged by the success that we're now focusing on adding new features to the product to increase opportunities for its commercial success."

CRC's SMART team demonstrates new satellite communications services in applications in collaboration with national and international partners to provide Canadians, wherever they are, with services like tele-education, tele-medicine and tele-government. In 2006, CRC demonstrated the REACH project at the Canadian Psychiatric Association Meeting in London, Ontario and at the International Telecommunication Union's conference in Hong Kong.

A new way to interact with computers

CRC is working on key technologies that will allow the development of human-network interfaces that are less intrusive than keyboards and computer screens. In the future, new interface devices will be deployed across peer-to-peer computer networks so that the user interface is distributed throughout people's personal environments. This deployment will require the integration of advanced computer graphics, real-time network protocols and custom sensing devices.

"Building on our past success in creating technology for shared three-dimensional virtual reality, we are now working to reduce or remove the human interface boundaries. Our goals are to replace the computer keyboard and mouse with more intuitive devices, and to further refine the use of sound for navigation and the feeling of presence."



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CRC's advanced virtual reality FreeWRL browser is gaining broad acceptance in both industry and academia. The FreeWRL code is downloaded from the web an average of 4,000 times every month.

Other Highlights

- CRC is developing wireless sensors for biomedical and environmental applications as part of a new three-year agreement with the National Taiwan University.
- An international standard was established based on CRC's Audio Loudness meters. The technology has been distributed to several regional broadcast organizations around the world to solve the problem of loudness experienced by consumers when switching between television channels.
- CRC completed a three-year project with the University of Ottawa and National Research Council on Virtual Navigation in Image-Based Representations of Real World Environments (NAVIRE).

Bringing virtual design to architecture

CRC, in partnership with Carleton University's Immersive Media Studio and the National Research Council, completed the CANARIE-funded EUCALYPTUS project – a new web-services technology that enables architects, designers, and engineering and construction teams working in different cities to collaborate online to design buildings or entire neighbourhoods. The project, which could lead to new applications in architectural design, gaming, emergency response and the performance arts, recently won the ORION Discovery Award.

Core Science

CRC's Commitment

To maintain Canada's leadership in science and technology

About 25% of CRC's research effort is spent on core research activities aimed at building intellectual capacity required to address client requirements. Some of the facilities and expertise associated with these core competencies are unique in Canada and even in North America.

CRC focuses most of its scientific research efforts and funding on five main core competencies:

Wireless systems (terrestrial and satellite communications)
Communications networks
Radio fundamentals (propagation)
Broadcasting and interactive multimedia
Photonics (optical communications)

2006-07 Highlights

New Facilities and Upgraded Capacity

- Higher frequency wireless research (up to 100 GHz) will be supported by the new Research in Advanced Antenna Technologies Laboratory (RAATLab), as well as installation of a sophisticated beacon/radiometer receiver operating at 20 GHz.
- Improved photonics capability with the opening of CRC's new 20,000 square-foot Photonics Lab, which includes offices for staff and guest workers.
- Better in-lab digital broadcasting testing for receivers and other broadcasting equipment with the acquisition of new modulators, channel simulator and development of software for sampling off-air DTV signals.
- New multimedia broadcasting test bed is being developed to support testing of IP-based multimedia and video streaming applications, mobile TV and IPTV services.
- Building critical mass in wireless R&D through CRC's continued leadership of six publicly funded wireless centres across the country (Canada Network of Wireless Centres).
- Enhancing the performance of mobile communication systems using CRC-developed software to evaluate and improve line-of-sight operations for urban environments as part of the European Commission's Wireless World Initiative New Radio (WINNER) program, in collaboration with Carleton University.
- Advancing optical communications through CRC's new collaboration with NASA Langley to develop a fibre Bragg grating-based fibre laser source.

- Partnering with industry to implement a Single Frequency Network (SFN) infrastructure in Ottawa to test advanced vestigial side band (VSB) for Rohde & Schwarz.
- Selecting a new European standard following CRC testing of three candidate systems for the WorldDMB Task Force on Audio Coding for digital radio broadcasting.
- Building more advanced research networks using CRC's all-optical network (AON) test bed to improve performance of a new hybrid reconfigurable optical add/drop multiplexer (ROADM) architecture.

Demonstrations

- Training surgeons at a distance: CRC, University of Ottawa, University of Alberta, CANARIE and a private sector company demonstrated how eye surgeons in different locations can be trained using haptics and high-speed networks.
- Testing next-generation optics: CRC demonstrated a lower-voltage and better performing semiconductor electro-optic switch; novel optical components for optical switching, filtering and sensor applications; and a simple, fast and economic method to fabricate low-cost polymer photonic devices.
- Developing prototypes: CRC successfully tested a beam steering mechanism prototype, based on CRC's patented antenna steering technology.
- Converting 2D to 3D: CRC has successfully demonstrated a novel technique that converts two-dimensional images and video to 3D as a step towards making 3D-TV a reality.

New Technologies

- Broadband system: CRC has developed an innovative calibration technique related to next-generation broadband systems.
- New codec: CRC is working on a Spike-based Audio Codec, which partially mimics the behaviour of the human auditory system.
- New processes: CRC developed a component fabrication and a set of assembly processes to fabricate and test 77 GHz high Q-factor resonators, which are used in collision avoidance radar, wireless sensing and security applications.
- Free download: An eight-state Turbo code design and simulation tool is available on CRC's Web site to highlight the performance of CRC's patented techniques.
- New software: CRC has developed software for the Global System for Mobile Communications (GSM) synchronization, demodulation and decoding of the forward and reverse channels.
- Spectrum: CRC worked on a direct Ka-band transmitter calibration technique.

COLLABORATIONS

Leveraging Canada's strengths through partnerships

CRC collaborates with public and private sector partners in Canada and internationally to guide public policy and to strengthen the competitiveness of Canadian companies.

CRC and Canadian Partners

Federal: Partners include, amongst others, Industry Canada, Canadian Space Agency, Defence Research and Development Canada, the Canadian Broadcasting Corporation, CANARIE, Environment Canada, Canadian Radio-television and Telecommunications Commission, Communications Security Establishment, Okanagan Research & Innovation Centre.

Academic: Partners include, amongst others, University of Ottawa, Carleton University, Université de Sherbrooke, University of Manitoba, University of Calgary, Université du Québec en Outaouais, Queen's University, Université Laval, University of Waterloo, École de technologie supérieure, Simon Fraser University.

Private Sector

CRC collaborates with 33 companies across Canada to accelerate technology development and commercialization.

Through its participation in the Canada Network of Wireless Centres (CWCnet) and the CRC Innovation Centre, CRC also supports small- and medium-sized companies to bring wireless communications technology to the marketplace.

CRC and International Partners

CRC brings Canadian expertise in advanced communications to the global stage, while leveraging the critical mass of other countries to the benefit of Canada. Through its international partnerships, CRC is helping to close the innovation gaps in Canada's communications sector and identify marketing opportunities for Canadian business.

As a neutral third party with a strong expertise in spectrum matters, CRC is often called upon by international organizations and major equipment manufacturers in the development of new wireless standards.

Partner Highlights

India: India's Centre for Development of Telematics (C-DOT) is working with CRC and a Montréal company to develop a WiMAX cognitive radio Internet technology that can bring broadband wireless to small communities in Canada, India and elsewhere in the world.

South Korea: CRC concluded a two-year collaborative research agreement with Electronics and Telecommunications Research Institute (ETRI) on voice-enabled broadcast applications. Under this collaboration, CRC has contributed to the development of a draft specification that will be the basis of a formal WorldDAB technical committee standardization process for Internet access in vehicles.

Europe: CRC is working with European partners on several fronts.

- European Commission's Wireless World Initiative New Radio (WINNER) consortium: CRC and Carleton University develop ray-tracing simulation software.
- European Union PHOSPHOROUS project: CRC, Nortel and CANARIE test a new generation of scientific applications that couple scientific instruments, data and high-end computing resources on a global scale.
- European Union-led autonomous self-healing wireless communication system: CRC is collaborating on a system that will enable networked embedded systems to interoperate and adapt as their environments change.
- International Telecommunication Union (ITU): CRC contributes to the radio propagation, video quality and several other ITU programs.
- European Space Agency (ESA): CRC participates in ESA programs related to tele-medicine via satellites and search and rescue.

United States: CRC has become one of the first Canadian partners of the U.S. National Science Foundation's OptIPuter computer science research project – one of the first initiatives under the Canada-California Strategic Innovation Partnership.

CRC continues to work with the U.S. on Search and Rescue via Satellite (SARSAT) for the development of the next generation MEOSAR.

Other international partners: Australia, Brazil, China, Finland, France, Germany, Israel, Japan, Mexico, Russia, Singapore, Spain, Switzerland and The Netherlands.

Other Partner Highlights

- CRC was one of the organizers and a major participant in the 33rd APEC (Asia-Pacific Economic Cooperation) Telecommunications and Information Working Group meeting, held in Calgary in April 2006. Activities included technology demonstrations, virtual presentations and the Grid Showcase.
- The ITU Telecom World 2006 in Hong Kong featured presentations and demonstrations by CRC.

TECHNOLOGY TRANSFER AND COMMERCIALIZATION

CRC's Commitment

To commercialize promising public research

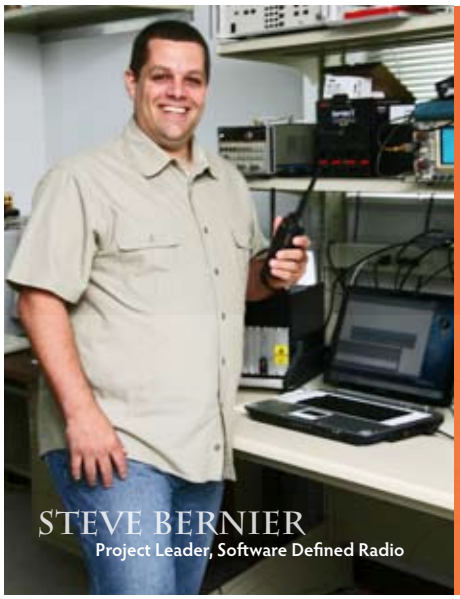
CRC's billion dollar impact

More than 100 companies can be traced to CRC. From that number, 60 spin-off companies generated $1.61 billion in sales in 2005, according to a comprehensive 2006 study of the CRC's economic impact by Doyletech Corporation. Other highlights of the report include:

- CRC clients generated $33.7 million in licensing and contracting revenue over a 15-year period, and
- CRC's 961 licensing and sponsored research agreements generated $520 million, and created 2,602 person years of employment between 1990 and 2005.

Moving Software Defined Radio into the mainstream

Following eight years of research and development, CRC launched a new development toolkit for Software Defined Radio (SDR) in November 2006 that will speed its adoption in civilian markets, including space, avionics, automobile, public safety and consumer electronics. SDR can accommodate any communications protocol and frequency band simply by downloading the appropriate software on the selected radio hardware. For example, it enables ambulance workers, police, firefighters and other emergency personnel to quickly reconfigure their radios to a communications protocol in order to connect during a crisis.



"Our SCARI Software Suite 2007 minimizes learning curves and greatly simplifies the complete SDR development life cycle. Developers will no longer have to redesign their components from a blank canvas, as components can now be assembled from a library of much smaller artifacts by simple drag-and-drop functionality."

The SCARI Software Suite 2007, composed of a core framework and a series of development tools, has been adopted by major radio manufacturers and research centres around the world and is also available, all integrated, on key commercial off-the-shelf (COTS) platform providers, including Spectrum Signal Processing, ISR Technologies, Lyrtech and Pentek.

2006-07 Impact

Intellectual Property (IP) Agreements

- Total number of IP agreements executed: 87
- The IP Portfolio consists of 496 active agreements

Collaborative and Contracting-in Agreements

- Total number of agreements executed: 82
- The collaborative and contracting-in portfolio consists of 142 active agreements

Patent Portfolio

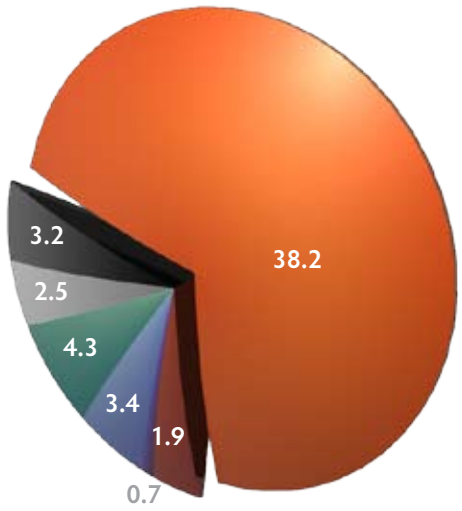
- New patent applications filed: 18
- New patents issued: 8
- Patent portfolio consists of 237 active patents and applications (98 inventions)

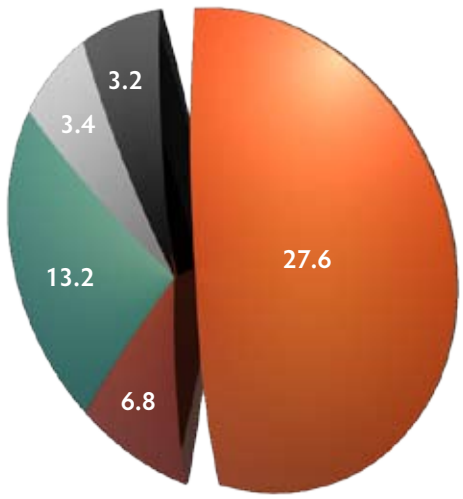
CRC-COVLAB signs another customer

CBC Radio-Canada has adopted CRC's coverage prediction and analysis software to ensure quality broadcasting transmissions across the country. Since 1993, CRC has sold approximately 60 licences of CRC-COVLAB and related software in Canada, the United States, Mexico, Brazil, Australia, Switzerland, Taiwan and South Korea, generating over $733,000 in revenue.

To date, 48 companies from Canada and around the world are paying royalty and licensing revenue to CRC related to the CRC and the United Technologies Corporation fibre Bragg grating and Toshiba/CRC fibre coupler patent portfolios. A new U.S. patent was issued to CRC in April 2006 for its Bragg Grating and Method of Producing a Bragg Grating Using an Ultrafast Laser, and several companies have expressed interest in licensing the technology. Other patents are pending.

FINANCES





Revenue 06-07 (in Millions)

- Industry Canada - Operations, Capital Assets, & Spectrum Research
- O&M Funding from IC Corporate Reserve
- Additional Capital Funding
- DND - Research
- Cost-recoverable Tenant Services
- Contracting-in & Licensing
- Revenue Reported under Other Government Departments (OGD) - CSA & DND

TOTAL $54.2M

Expense 06-07 (in Millions)

- Direct Research
- Research Support & Administration
- Site Operations & Other Expenses
- Photonics Lab Construction Costs and Loan Repayment on Previous Construction Project
- Expenses Reported under Other Government Departments (OGD) - CSA & DND

TOTAL $54.2M