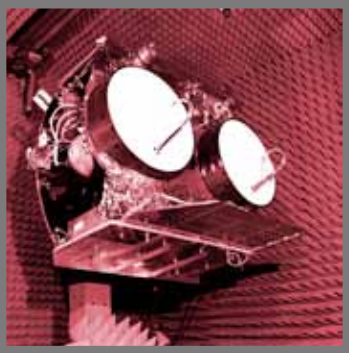
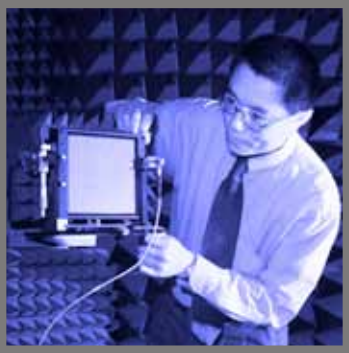
COMMUNICATIONS RESEARCH CENTRE CANADA

Communications Research Centre Canada
An Agency of Industry Canada

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

HIGHLIGHTS





2008-2009

Canada

CRC

About the cover: This cover collection of photos is just a sample of the many images documenting CRC's 40-year history (1969-2009). For more photos, visit www.crc.gc.ca.

CRC at a Glance

- **Research staff:** 239, plus 34 students
- **IP licencing and contracting-in revenue:** $3.6 million
- **Number of active IP licences worldwide:** 508
  (17 new licences in 08-09), including
  - **Number of active IP licences in Canada:** 194
    (8 new licences in 08-09)
- **Collaborative and contracting-in agreements:** 113
  (33 new agreements in 08-09)
- **Patents:** 24 new patent applications, 10 new patents issued, 210 active patents and applications protecting 90 inventions
- **Scientific publications and conference papers:** 224

Advisory Council Members 2008-2009
- Tom Hope, Chair of the CRC Advisory Council
  Executive Vice-President, Toll Cross Investments Inc.
- Veena Rawat, President, Communications Research Centre Canada
- Helen McDonald, Assistant Deputy Minister, Spectrum, Information Technologies and Telecommunications Sector, Industry Canada
- Robert Walker, Assistant Deputy Minister, Science and Technology, Department of National Defence
- Pierre Coulombe, President, National Research Council Canada
- Steve MacLean, President, Canadian Space Agency
- Guy Bujold, President and CEO, CANARIE Inc.
- Dino DiPerna, Vice-President, Optical Networks R&D, Nortel Networks
- Carol Darling, Senior Vice President, Engineering and Technical Services, Canwest Broadcasting
- Paul Flaherty, President and CEO, Northwestel Inc.
- Ibrahim Gedeon, Chief Technology Officer, TELUS Corp.
- Dan Goldberg, President and CEO, Telesat

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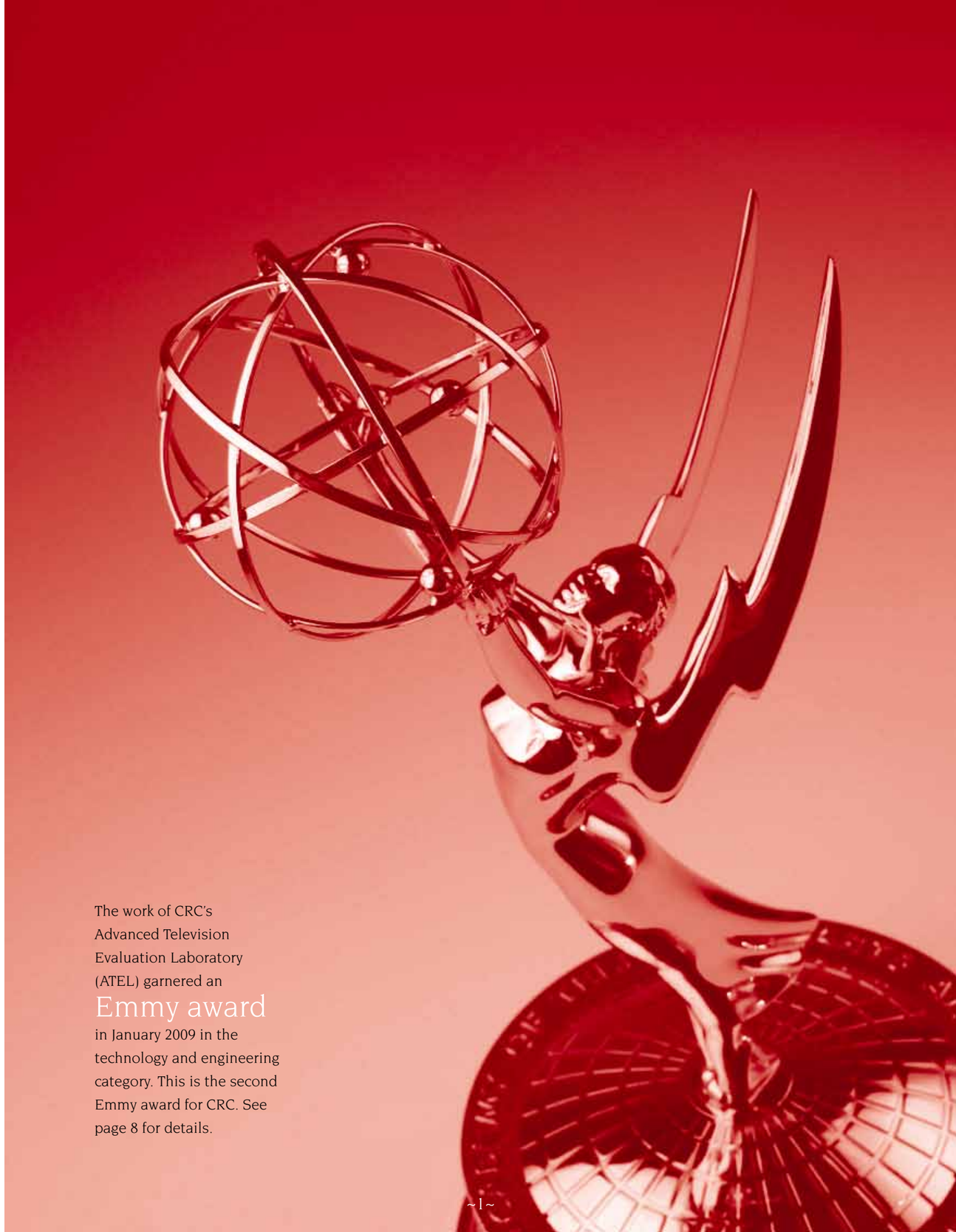


The work of CRC's Advanced Television Evaluation Laboratory (ATEL) garnered an **Emmy award** in January 2009 in the technology and engineering category. This is the second Emmy award for CRC. See page 8 for details.

Message from the Advisory Council Chairman

It certainly has been an exciting year for Canada's ICT sector. From the sale of a telecom research pioneer (Nortel) to the seemingly unstoppable trajectory of the world's fastest-growing company (Research in Motion), there is little doubt that ICT, and wireless in particular, continue to be formidable forces on the Canadian industrial landscape.

Underpinning Canada's global reputation as an ICT leader is its strength in research, which continues to account for the majority of industrial research conducted in the country. As the federal government's centre of excellence for telecommunications R&D, the Communications Research Centre plays a critical role in building on those strengths and demonstrating the growing importance of ICT in everything from manufacturing and aerospace to safety and health care.

Ensuring that CRC's research is relevant to the ongoing challenges facing Canadian industry and Canadian society is the responsibility of CRC's Advisory Council. Comprised of representatives from industry, academia and government, the Advisory Council draws on its experience to advise the CRC on its strategic direction and the relevance of its research.

It has been a tremendous year for the CRC. It was heartening to see the Science, Technology and Innovation Council (STIC) identify CRC as among Canada's innovation leaders, "helping keep Canada at the forefront of communications technology." It was also rewarding to see that CRC's priorities are aligned with the ICT sub-priorities identified last year by STIC: new media, wireless networks and services, broadband networks, and telecom equipment.

That the CRC is on the right track was reinforced by an internal review that members of the Advisory Council participated in over the past year. The review confirmed that CRC's research program and its strategic priorities are aligned with the priorities of its major clients, and it delivers valuable outcomes to Canada's ICT sector, particularly through the exploitation and commercialization of its intellectual property.

The Advisory Council was proud to see CRC's accomplishments receive two highly prestigious awards: an Emmy (the second so far) for its contributions to standardizing the digital television system that is replacing North America's current analog system, and a Federal Partners in Technology Transfer award for a search and rescue technology that saves lives and generates millions in revenue for Canadian companies.

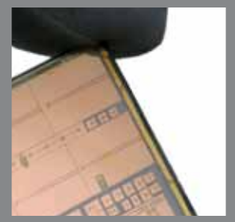
As Chair, I would like to thank all the members of the Advisory Council who volunteer their precious time in helping the CRC remain focussed and invaluable to the ICT sector. The Advisory Council looks forward, with the inclusion of some new members, to continuing to work with CRC's management in this role.

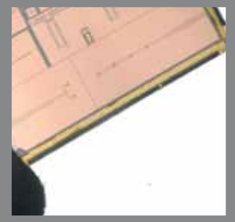
Over the last year, as over the last 40 years, the CRC has shown its significance in contributing to a culture of innovation in Canada. The organization has been at the forefront of many firsts including satellite communications, search and rescue satellite-aided tracking, fiber optics and software defined radio. A complete list of these accomplishments appears on page 12 of this report.

I trust you will enjoy this latest chapter.

Tom Hope

Tom Hope, P. Eng.
Chair, CRC Advisory Council





Message from the President

It has been a very busy and rewarding year at the Communications Research Centre – one that continued to highlight CRC's strategic role in advancing ICT research to address government priorities, and extending the benefits of this research to Canadians.

At an operations level, CRC's research program and its governance were the focus of an internal review. Overall, the results were positive and we are implementing the recommendations, including those which will strengthen CRC's linkages and engagement with clients.

On the research front, among other recognitions, CRC's contributions were acknowledged with an Emmy for advancing an international standard for digital television, and with an award for excellence in technology transfer for developing satcom technologies that have saved thousands of lives worldwide. Both awards demonstrate the relevance of CRC research in addressing issues of importance to Canada. Canadians should take pride in the publicly funded research that led to this recognition.

Overall, 2008-09 was CRC's best year for technology transfer since the high tech boom of 2001-02. We generated near-record earnings of $3.6 million, in part because of a decision to make CRC's technologies more valuable to industry by bundling several patents into a single package. We will continue to identify which programs and technologies have the most commercialization potential, and to exploit these opportunities.

CRC recognizes the importance of extending the benefits of ICT to even more sectors of society, including energy conservation, electrical power and smart grids, education and health care. Over the past year, for example, CRC worked with a number of partners on projects to exploit the potential of broadband network technologies, from linking advanced resources to medical students and healthcare professionals at diverse locations, to continuing to connect remote locations for tele-education applications.

Some research highlights from 2008-09 included enhancement of CRC's radio spectrum monitoring technologies to ensure secure communications for emergency personnel at the 2010 Olympic and Paralympic Winter Games in Vancouver, and the 2010 G8 Summit in Huntsville, Ontario; contribution to the design and validation of technical specifications for a new generation of NATO tactical communications standards, as part of a 12-nation collaboration to ensure communications interoperability for future coalition deployments; and participation in the development of a system for enabling bandwidth-on-demand across diverse broadband networks as part of the EU FP6 Phosphorus integrated project.

CRC was very active on the international scene through collaborations with India, Taiwan, Mexico, Finland, the European Union, and the United States, among others. Work ranged from studying the complexities of microelectronics, to assisting international partners in deploying CRC technology.

While it's satisfying to look back, it is equally rewarding to look forward as CRC celebrates two important events: its 40th anniversary and the commemoration of the Alouette 1 satellite program as an event of national historic significance. CRC's strong research team – past and present – made, and continues to make, success look easy. Thanks to all for another great year.

Rawat

Veena Rawat
President

Vision and Mission

The vision of the Communications Research Centre (CRC) is to provide national leadership in collaborative research and development on innovative communications, broadcasting and information technologies for a strong Canadian knowledge-based economy.

CRC's mission is:

- To be the federal government's centre of excellence for communications R&D, ensuring an independent source of advice for public policy purposes;
- To support government operations led by major clients in selected areas of ICT application such as national defence, public safety and space-based communications;
- To identify and close the innovation gaps in Canada's communications sector by engaging in industry partnerships, building technical intelligence, supporting small and medium-sized high technology enterprises, and working with other research organizations across Canada.

Serving as the federal government's centre of excellence for communications R&D, ensuring an independent source of advice for public policy purposes

There are growing demands on radio spectrum, each producing unique technical and public policy challenges. CRC research focuses on efficient, flexible and interference-free use of spectrum, while propagation and other research facilitates opening new, higher bands to meet demands.

CRC's FM-IBOC module in CRC-COVLAB software has been updated and validated using empirical data gathered during FM-IBOC laboratory tests. In addition, through a partnership with NPR Labs in the U.S., CRC researchers obtained field measurement data for a number of FM-IBOC stations in that country. This has enabled further refinements to CRC's software, thereby enhancing the reliability of its coverage predictions. Such tools are key in spectrum management practices and facilitate bilateral discussions on border-area issues.

When the **Canadian Radio-television and Telecommunications Commission (CRTC)** invited comments on Canadian broadcasting in new media, CRC responded with a submission describing new broadcasting technologies. CRC detailed how mobile TV broadcasting, standard definition television programs multiplexing, and distributed transmitter networks for regional coverage have the potential to provide Canadians with more services and a better overall experience. Furthermore, with the conversion to digital broadcasting systems in 2011, CRC contended that there remains a place for over-the-air terrestrial broadcasting. CRC is also working to adapt CRC-COVLAB to meet the CRTC's needs.

CRC is exploring **propagation issues related to V-band** (40 to 75 GHz) telecommunications, the next frequency band above Ka band allocated to satellite communications. This research is being conducted on behalf of Industry Canada's Spectrum Engineering branch, particularly for intersystem interference assessment purposes, and the CSA under the STAR (Satellite Telecommunications Applied Research) program.

A one-day workshop on **software defined radio** (SDR) and **cognitive radio** (CR) introduced potential users to these two major enhancements to radio signal processing.

- **SDR** embeds functions such as filtering, coding, and modulation in a software system that can be altered independently of any hardware platform. The resulting radio can be updated and upgraded even after it is on the market, offering major benefits to manufacturers, operators and consumers. By improving interoperability, SDR can reduce the number of radios that users need in the field. Other areas that rely heavily on signal processing and embedded computer systems are looking closely at the concepts developed as part of SDR.
- **CR** represents protocols that optimize a wireless communications device's use of the radio-frequency spectrum, while minimizing its interference with other devices. This makes it possible to adapt a device to current spectrum conditions in real time, giving regulators, licensees and the public more flexible, efficient and comprehensive access to spectrum. CR identifies any nearby spectrum use, then changes the frequency, adjusts output power, or alters transmission parameters and characteristics. CR also assigns priority use to the spectrum owner, while allowing others to share unused portions of the spectrum.

On the international standards front, 2008-09 saw the completion of the IEEE 802.16*h letter ballot standardization process. It resulted in the inclusion of* MILTON*-derived cognitive radio sensing approaches in the* IEEE 802.16 (WiMAX) *standard. Microwave-Light Organized Network* (MILTON) *technology was developed by* CRC *between* 2002 *and* 2004.

Supporting government operations led by major clients in selected areas of ICT application

CRC supports a number of members of the federal family, including the Canadian Space Agency (CSA), Public Safety Canada, and the Department of National Defence (DND) as well as its R&D arm, Defence Research and Development Canada (DRDC).

Photo: J. Lang, PCSP/NRCan

CRC's Chris Iles servicing a telecommunications network connecting Devon Island, Nunavut to the south. Devon Island's Haughton Crater, a site somewhat similar to the surface of Mars, is the home of the Haughton-Mars Project, an international interdisciplinary field research project involving **CSA**, *NASA and others. The Polar Continental Shelf Program of Natural Resources Canada provides logistical support to such northern research, including the telecommunications connections enabled by Chris.*

Among CRC's other initiatives with **CSA** is the 2010 CASSIOPE satellite mission. CASSIOPE will be equipped with an Enhanced Polar Outflow Probe (e-POP) to help scientists understand the impact of solar variability on the space environment, and the Cascade communications payload to exchange extremely large data files via satellite. The principal investigator for e-POP's radio receiver instrument, and the program manager for the Cascade project are CRC experts.

CRC provided a valuable study to **Public Safety Canada** on the deployment of a satellite restoration link in support of the National Public Alerting System, to be used as a request for proposals for the development of a restoration component of an all-Canada Emergency Alert System (EAS). The component allows for the continued operation of the EAS in the event of a primary (Internet) infrastructure failure. Work was also completed with television and radio broadcasters, as well as satellite and cable operators, on overall implementation and performance constraints associated with EAS deployment.

Military operations require reliable, strategic and tactical long-range communications, even in the most difficult environments and terrains. With **DND**, CRC has been studying the use of aerostats to enhance wireless communications. An aerostat can greatly improve line-of-sight coverage of a base station radio to end users on the ground. Among the wireless technologies studied: an 802.16-based broadband wireless fixed WiMAX system, with a WiMAX base station and omni-directional antenna integrated into the aerostat payload. Researchers on the ground tested up to 10 subscriber units that communicated with each other via the base station on the elevated aerostat. The results: increased range and throughputs among subscribers, plus improved coverage.

With **DRDC**, CRC has been developing technologies for next-generation tactical communications systems. The work has focussed on signal processing techniques for robust spectral-efficient radio waveforms, and on adaptive narrowband medium access control schemes for the provision of Internet protocol-based voice and data services. The technologies were transferred to industry for use in a proof-of-concept prototype aimed at demonstrating the feasibility of enhancing the Canadian Army's current tactical radios to meet operational requirements for increased information sharing.

Field trials were a key activity in advancing the SASNet system in 2008-09. SASNet aims to define and demonstrate an intelligent sensor system for military operation in complex terrains for future **Canadian Army** requirements. Recent advances in computing and communication have produced a significant shift in sensor network research and have led to small multi-functional wireless sensors that integrate sensing, data processing and communicating components.

Sensor networks represent a significant improvement over traditional sensors, since the sensors collaborate in performing sensing tasks, and improve detection and tracking performance through multiple observations, geometric diversity, extended detection range and faster response time. The sensors form an ad hoc network to deliver aggregate information from geographically diverse areas. The ad hoc features of a sensor network are essential in providing interconnection between the sensors and devices in areas without existing communication infrastructure. The sensors must coordinate to establish a communication network, divide the task of mapping and monitoring the terrain in an energy-efficient manner, adapt their overall sensing accuracy to the available resources, and reorganize upon sensor failure. SASNet will apply recent technological developments in wireless, ad-hoc networks, sensors, fusion, information processing, localization and networking.

In establishing the prototype for a new generation of NATO tactical communication standards, as part of the TACOMS P2K project, CRC researchers developed spin-offs that are having a significant impact on near-term needs of the Canadian Forces: a security gateway to interconnect Canadian Army communications systems, and an interface gateway box to provide interoperability between the Canadian and Netherlands armies. These technologies were field tested under the watchful eye of CRC network systems experts at NATO exercises in Europe.

Canadian clients attest to CRC advantage

"To be able to take advantage of an investment that the Canadian government made, as well as having a group like CRC with its resources available to us, has really springboarded us ahead of our competitors."

Carl Villeneuve,
Software Engineering
Manager of Montreal's Ultra Electronics

"Access to these technologies has made our firm more competitive in global markets and we're firmly committed to continuing this highly productive industry/government partnership."

Mark Briggs, Vice President of Marketing and Operation with Spectrum Signal Processing of Burnaby, B.C.

"CRC not only had the expertise, but also the tools, so we could offer customers a completely integrated solution, which had tremendous added value."

Maxime Dumas, Business Development Manager of Quebec City's Lyrtech

Identifying and closing the innovation gaps in Canada's communications sector

Along with generating knowledge, CRC transfers knowledge. Whether licensing its intellectual property, engaging in industry partnerships, or working with other research organizations, Canadians and the Canadian economy benefit from CRC's effort to close Canada's innovations gaps.

Search and Rescue Satellite Aided Tracking (SARSAT) has not only saved thousands of lives, it has generated over $100 million in sales revenues for Canadian companies. Developed by the CRC in the mid-1970s, SARSAT now involves over 38 countries and is credited with the rescue of more than 25,000 people since activation in 1982. Today, SARSAT is transitioning to MEOSAR, which uses medium earth orbit satellites. In 2008-09, CRC conducted MEOSAR tests using its three antennas to track U.S. GPS satellites and, in the future, European Galileo satellites.

In 2008, SARSAT team members from CRC, CSA, DND, the National Search and Rescue Secretariat, and an industry partner were honoured with a Federal Partners in Technology Transfer award from the Government of Canada.

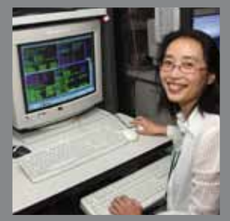
Software defined radio (SDR) is another technology transfer success story on an international scale. CRC continues to supply companies with the tools they need to get a running start in SDR, including a software development kit for the Software Communications Architecture-required code – known as the SCARI software suite – as well as training on its use.

Closing the innovation gaps also involves **collaborations**. In 2008-09, CRC worked with:

- industry on the development of cognitive radio as applied to a new generation of mobile wireless devices;
- academia on the development of adaptive antennas and MIMO technologies;
- the North American Broadcasters Association to evaluate possible interference to digital television reception from broadband over power line transmission.

Overall, CRC earned $3.6 million in technology transfer revenue in 2008-09. With IP revenues of $2.5 million, CRC continues to be the top performing Canadian federal lab in terms of IP revenues normalized to R&D budget. Collaborative and contracting-in R&D generated $1.1 million in 2008-09. CRC received millions more through agreements with other government departments.

Also in 2008-09, CRC launched an internal technology commercialization program. Eleven out of 17 project proposals were selected in late 08-09 and over the next two years, researchers will be working to bring their technology-ready projects to market. Watch for 2D to 3D, video FRC-2, SDR broadcast, spectrum monitoring, tunable filter, SDR waveform, P25 waveform, SDR university, WiFi cognitive, Ku-Ka antennas, and CRC COVLAB.



"A stranger once shook my hand and thanked me for the clarity of the hockey games he watches in HDTV. I was very struck by that."

Ron Renaud, member of CRC's Emmy award-winning team

Our People

Advancing Knowledge
CRC scientists and engineers are not only prolific publishers, their work is frequently cited by international colleagues as researchers continue to advance our understanding and generate applications. For example, one paper on groundbreaking work conducted at CRC in fiber optics has generated over 1000 citations. Also indicative of CRC's worldwide recognition, one of the organization's leading scientists is the editor-in-chief of the *IEEE Transactions on Broadcasting*. CRC experts also served as guest editors on special issues of the publication: one dedicated to quality issues on mobile multimedia broadcasting and another on IPTV for broadcasting applications.

Serving Canadians
The work of CRC's Advanced Television Evaluation Laboratory (ATEL) garnered an Emmy award in January 2009 in the technology and engineering category. ATEL was one of four organizations recognized for its contributions to standardizing the digital television system that is replacing North America's current analog system. ATEL's investigations ensured that high definition television (HDTV) – one of the advances supported by digital television – would offer a significant enough improvement in video quality to merit the adoption of a new standard. Many HDTV systems were proposed and tested before one could finally meet that objective.

Pioneering
IBC is the leading international forum for the electronic media industry. CRC was among the exhibitors at IBC 2008, showcasing its Openmokast technology – the first mobile broadcasting handset based solely on an open source platform. Openmokast is built on a vision of collaboration that could potentially influence the future of broadcasting. IBC 2008 also saw CRC's resident MMB expert assume responsibility for a segment of the European Broadcasting Union Village – a testament to the trust bestowed by the international community.

Training HQPs
CRC boasts a strong contingent of highly qualified people (HQPs) and helps fuel Canada's supply of new HQPs who bring their expertise to all sectors of the Canadian economy. Some 34 students came through CRC's gates in 2008-09, many of them researchers who will continue innovating well into the future. Consider the following:

- the University of Ottawa co-op student who advanced the conversion of 2D video program material to 3D – an achievement that will help make 3DTV a reality.
- the PhD student, also from the University of Ottawa, investigating scalable optical switches. She has already published four journal papers and joined a promising high tech firm as a result of her work in this area.
- the co-op student studying engineering at l'École de technologie supérieure, part of Université du Québec, who was able to tackle any problem presented to him, from fixing a network to designing an analysis tool studying anti-virus systems.

International Collaboration

India

CRC has been working with India's Centre for the Development of Advanced Computing **(CDAC)** for several years. With training and support from CRC experts, CDAC implemented a public safety radio system using CRC's Software Communications Architecture (SCA) technologies. And this is just the beginning, as CDAC looks to train more organizations in India. As a result of CRC's interaction with CDAC, Canadian companies are now entering the Indian market.

CRC's work with India's Centre for Development of Telematics **(CDOT)** has shifted from a WiMAX-based to a WiFi-based cognitive radio system, complemented by CRC-developed Microwave-Light Organized Network (MILTON) technology. With this, partners expect to provide a low cost, rural access solution to bring broadband wireless Internet to remote Indian villages located up to 20 kilometres apart.

Taiwan

In 2008-09, CRC completed one agreement with Taiwan and embarked on another. During a three-year program with National Taiwan University, CRC gained insight into the possibilities and limitations of the following: silicon processes for implementing circuits for millimetre wave applications; application of microwave design techniques used in gallium arsenide to silicon technology; and novel 2D and 3D passive structures to improve performance and reduce circuit area. The research also saw the successful implementation of such communication circuits as low-noise amplifiers and mixers for operation at 60 GHz. The partnership positioned CRC for the next phase of collaboration with National Chiao Tung University on cognitive radio at 60 GHz.

Mexico

CRC is training Mexican specialists in the use of CRC-COVLAB technology, empowering them with a very powerful tool to model and predict broadcast coverage and ensure effective and efficient broadcast services. The training is part of a large block acquisition of CRC-COVLAB technology that saw the Government of Mexico purchase a number of licenses for the software.

Finland

In collaboration with the VTT Technical Research Centre of Finland, CRC engineers are examining how Low Temperature Co-fired Ceramics (LTCC) can be applied to high-frequency wireless components, from antenna modules to transmitters, power amplifiers and filters. While LTCC is used in lower microwave frequency applications, applying it to higher microwave frequencies is complex. Access to state-of-the-art LTCC processes – like those provided by VTT – is very constructive. CRC is gaining insight into the intricacies of using LTCC for high frequency applications: reaching frequencies of 30 GHz, 60 GHz and beyond are objectives of the collaboration with VTT.

European Union (EU)
The Framework Program (FP) is the EU's main instrument for funding research, including research in information and communications technologies (ICT). FP7, the seventh in the series of programs, runs from 2007 to 2013 and boasts a budget of over 50 billion euros. CRC is the national contact point and as such, assists organizations in finding partners. CRC's record of success set in earlier framework programs is continuing with FP7. To date, nine projects with Canadian participants have been approved at a total cost of 74 million euros, 63 percent of which is from the European Commission (EC). Participants fund the rest. Canadian participants include two multi-nationals, an SME, seven universities and a government lab.

Phosphorous – a project funded under FP6 – saw CRC collaborate with a European and global alliance of partners in the development, testing and dissemination of advanced networking solutions. The project, which extended into 2009, addressed some of the key technical challenges enabling on-demand, end-to-end network services across multiple domains. Employing applications and technologies – including CRC's UCLP – across a test bed of network resources and infrastructure – including Canada's own advanced network organization, CANARIE – Phosphorus proved it has the power required for research networking, e-science and grid communities.

Innovating

3DTV

In an effort to help established media bring new broadcast formats into the consumer marketplace, CRC is developing 2D to 3D conversion techniques, including investigating software applications to allow the real-time conversion of 2D DVDs to 3D format, so they can be played on a 3D auto-stereoscopic monitor. In addition, progress was made in multi-view video coding and depth image base rendering.

Sensor Technology

For environmental uses such as detecting seismic activity, and aerospace applications that call for sensors to be embedded in engines, sensor components must withstand high temperatures. CRC-patented fiber Bragg grating based on ultrafast laser technology has opened the door to the use of new, robust materials – including sapphire – which is particularly useful in sensor applications because the photosensitivity mechanism remains stable at up to 2000°C.

Planar Lightwave Circuit (PLC) Technology

CRC is developing a suite of photonic devices based on silica-on-silicon PLC technology. Planar layers of silica are laid down, heated and patterned into device structures that have characteristics similar to optical fibers, making them compatible with fiber infrastructure. Current research is focused on the development of next generation PLCs that can route light and manipulate the bits and packets of information carried on the light beam. This type of all-optical processing is an important step in optical network technology as it could eliminate the need to convert optical signals back to electrical signals to carry out signal processing functions.

Microwave Photonics

As microwave devices migrate to ever higher frequencies and bandwidths, the limitations of current components can lead to design problems. Microwave photonics offers a unique approach for processing microwave signals which not only overcomes these difficulties, but can also add significant functionality to an all-optical, microwave circuit.

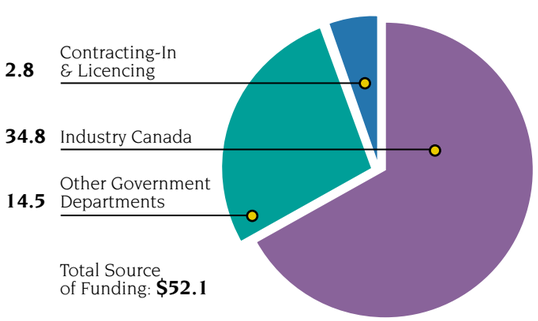
Microwave photonics employs optical components and techniques to emulate functionality currently offered by electronic components. Optical signal generation, conditioning and routing can potentially operate at frequencies up to 100s of GHz. Because of the enormous bandwidth potential, it may even be possible to significantly alter a system's operating frequency and modulation format with no hardware modifications – an enormous advantage for inaccessible platforms like satellite payloads.

Optics is still in its infancy, however. Most components are hand assembled, much like electronic circuits were fabricated decades ago. Just as the electronics industry catapulted forward with the introduction of integrated circuits, so too will optics benefit from the development of a photonic integrated circuit. Integrated multiple optical components on one chip are common, and the fabrication of low-cost, complex optical circuits is drawing near. With advances in silicon optics, these circuits may even be fully integrated with electronics on the same substrate.

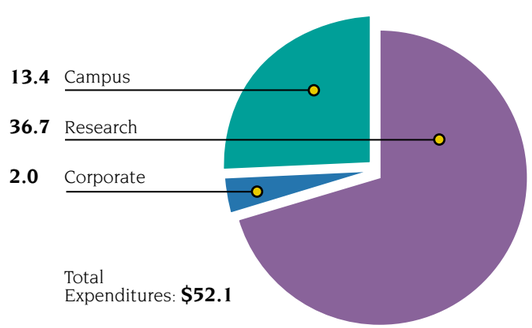
CRC is carrying out R&D on such complex circuits to take advantage of the properties of an optical system: size and weight reduction, large frequency coverage, large electrical bandwidth, low-loss fiber-optic interfaces, and immunity to electromagnetic interference. All of these factors are of utmost importance for space applications.

Finance

CRC Source of Funding
(in millions)
2008-2009



CRC Expenditures
(in millions)
2008-2009



Firsts

Communications Research Centre (CRC) celebrates its 40th anniversary in 2009. What better time to showcase the "firsts" achieved at CRC laboratories. CRC played an integral role in designing, building and/or testing the technologies and/or hardware that led to the following accomplishments at the national or international level.

Alouette, 1962	Canadian satellite – designed, built and tested by Defence Research Telecommunications Establishment, the forerunner of CRC – launched into space, making Canada the third nation in space
Anik-A, 1972	Commercial domestic communications satellite at C-Band
GaAs-FET, 1973	Space-qualified gallium arsenide field effect transistor amplifier
SARSAT, 1976	Proof-of-concept test of a satellite system for search and rescue
Hermes, 1978	Direct-to-home satellite television broadcast; also used for telehealth and tele-education
Telidon, 1978	Public demonstration of Telidon videotex/teletext system, a forerunner of on-demand access to information found through the Internet today
Fiber Bragg Gratings, 1978	Discovery of photosensitivity in optical fiber, leading to the development of fiber Bragg gratings
Broadband Fiber Optics, 1979	Trials of providing telecommunications service to homes over a broadband fiber optic distribution system
Satellite News Gathering, 1981	Mobile, self-contained satellite news gathering terminal, with capacity for one video and two audio signals
Cospas-Sarsat, 1982	Rescue using Cospas-Sarsat satellite system
ARPANET, 1985	International terrestrial connection to ARPANET, predecessor of the global Internet
HDTV, 1987	Demonstrations of high-definition television
SHARP, 1987	Unmanned airplane flight powered by microwaves from a ground station
Over-the-air Broadcast Radio, 1990	Demonstration of digital radio
CRC-COV, 1991	Coverage prediction software to help design single-frequency networks (SFN)
Internet Radio Broadcast, 1993	Commercial radio broadcast over Internet
Spectrum Explorer, 1996	Wide band RF spectrum scanning system with direction finding
Broadband HDTV Demonstration, 1998	Two-way HDTV telemedicine workshop with Japan
Mobile Broadcasting, 1998	Interactive multimedia mobile broadcasting demonstration platform
Haughton-Mars, 1999	Video conference between Canadian Arctic and CRC using a 0.5m Ka-Band suitcase terminal
Mobile Satellite Internet, 2000	Internet access/usage in a moving vehicle at Ka-Band
Software Defined Radio (SDR), 2002	Reference implementation of the Software Communications Architecture (SCA) specification
WiMAX in Aerostat, 2008	Rapid-deploy aerostat to improve communication coverage, tested for Department of National Defence

Canadian First World First North American First Canadian/Japanese First