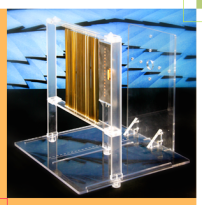
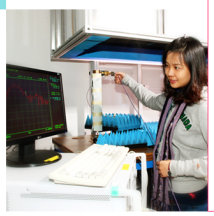
Communications Research Centre Canada
An Agency of Industry Canada

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



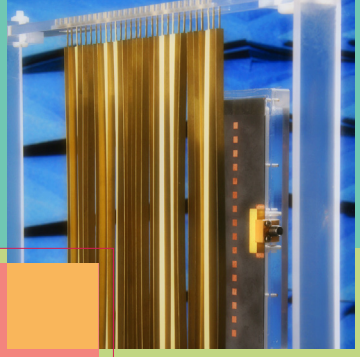


Communications Research Centre Canada

Highlights 2009-2010

Canada

CRC



Fresnel zone plate antenna

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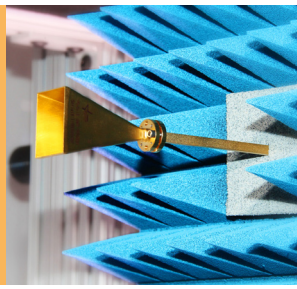

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CRC research at a glance

Research staff: **244**, plus **37** students
IP licencing and contracting-in revenue: **$2.8 million**
Number of active IP licences worldwide: **526** (**18** new licences in 2009-2010), including
- Number of active IP licences in Canada: **197** (**3** new licences in 2009-2010)

Collaborative and contracting-in agreements: **113** (**43** new agreements in 2009-2010)
Patents: **19** new patent applications, **11** new patents issued, **215** active patents and applications protecting **91** inventions
Scientific publications and conference papers: **232**

The Communications Research Centre Canada (CRC) is part of Industry Canada's Spectrum, Information Technologies and Telecommunications sector (SITT).The CRC conducts research and development that provides insight into future advanced telecommunications and information and communications technologies (ICTs). This helps Industry Canada develop telecommunications policies and regulations, other government departments improve decision making related to ICTs, and Canadian companies close the innovation gap through technology transfer.

Message from the President

Information and communications technologies (ICTs) represent one of the most powerful tools for enabling innovation. They are also an area where Canada excels internationally which is why the federal government's Science & Technology Strategy and its pending Digital Economy Strategy highlight the importance of ICT to building a stronger and more competitive Canadian economy.

As Canada's largest public sector ICT research and commercialization institution, CRC plays a key role in accelerating the adoption of ICTs, including wireless networks and services, broadband networks and digital media, across a growing number of diverse sectors.

A read through this year's annual report provides a window into how CRC's collaborations with its government clients and industry partners are overcoming barriers to the implementation of new technologies.

In 2009-2010, CRC was proud to enhance its spectrum monitoring technology for deployment at the Olympic and Paralympic Winter Games in Vancouver to ensure interference-free use of spectrum by emergency services and others.

This past year also saw our cognitive radio team invited to Singapore as one of the 10 cognitive radio technologies demonstrated.

On the environmental front, a solar powered node has been established at CRC as part of the GreenStar Network – a project that aims to reduce greenhouse gas emissions from ICTs. In the area of healthcare, CRC's participation in a virtual healthcare network is resulting in better training for medical students.

CRC continued to work with industry partners in 2009-2010 to transfer promising technologies, including software defined radio. Its ability to download the software needed to process different signals is redefining wireless communication, and CRC has been at the forefront from its inception to its ongoing transfer to industry.

Another technology – the world's largest satellite-based mobile asset tracking systems – earned CRC and its industry partner an award from Federal Partners in Technology Transfer.

It's particularly heartening to report that, for the first time since the high tech boom of the late 1990s, ICT start-ups filled the CRC's Innovation Centre. CRC will continue to support these emerging companies in identifying new products and global markets for innovative Canadian technologies.

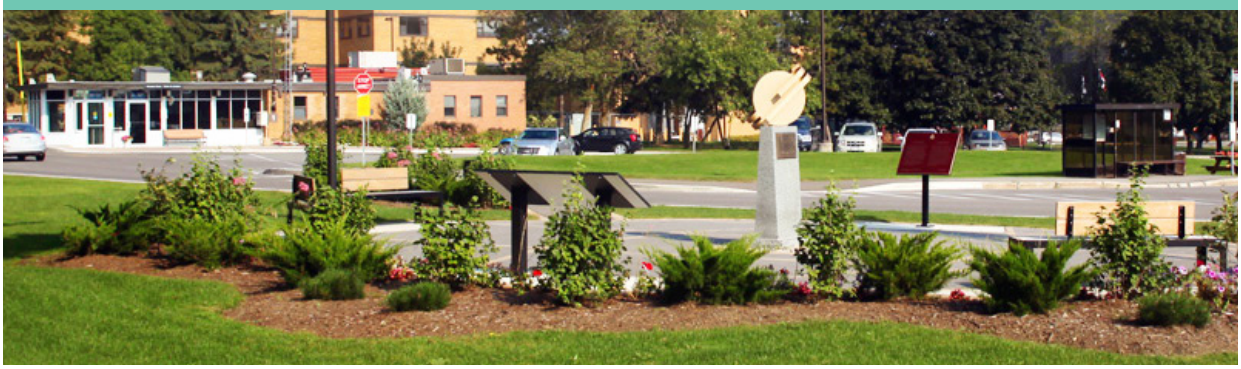
Responding to the needs of our clients and partners is a priority for CRC and this requires an adept understanding of the rapid technology changes happening world-wide. Towards this end, CRC is refocusing its Advisory Council to provide more targeted advice from government clients, industry and academia on the latest trends and opportunities in our key technical areas: satellite, wireless, broadcasting and networks.

Thank you to the Advisory Council members and our interim chairman Tom Hope for their commitment and advice over the past year.

Thank you as well to our government clients, industry partners and staff. You have demonstrated time and again the power of ICTs to cut across sectors to improve Canada's innovative capacity. There is still much work ahead, and through continued collaboration and excellent research, we will succeed in ensuring Canada's leadership in the digital economy.

Veena Rawat

Alouette 1 made us proud in 1962 and again in 2010 with its commemoration as an event of national historic significance. Working for the Defence Research Telecommunications Establishment, the Alouette pioneers endeavoured to make Canada's first satellite a reality. Their determination triumphed again this spring when the Historic Sites and Monuments Board of Canada placed a plaque at CRC, ensuring future generations will know of this remarkable contribution to science and engineering.



The OR21 Spectrum Explorer® unit during antenna trials

Enabling Industry Canada

CRC R&D in advanced telecommunications provides insight that informs Industry Canada policy direction, regulatory decisions and program delivery. Commercialization of CRC R&D by Canadian companies and CRC support of international standards development help fuel the country's economy through the increased adoption of ICTs.

Strengthening cyber security: Cyber security is a major concern of industries and governments alike. Building on earlier work that tracks computer attacks, the CRC is focusing on the more complex and rampant problem of malware – malicious software designed to infiltrate a computer system without the owner's consent. The CRC is using its Automatic Experimentation System (AES) tool to simulate a real network made up of virtual computers and virtual connections – a virtual "sandbox" in which malware can unleash its attack for the benefit of research.

Equipping the regulator to monitor Olympic airwaves: The CRC supports Industry Canada in ensuring both the effective and efficient use of radio frequency spectrum, and emergency telecommunications services. Industry Canada's Vancouver regional office used Spectrum Explorer® – CRC's suite of radio frequency spectrum monitoring and surveillance technologies – to provide spectrum management and interference mitigation at the 2010 Olympic and Paralympic Winter Games in Vancouver.

Spectrum management staff operate the mobile version of Spectrum Explorer® in Whistler, B.C.
Photo courtesy of Industry Canada Pacific Region

Preparing Canada for DTV in 2011: The CRC carried out tests to study over-the-air DTV reception. Using Quebec City as its test site (the technical configuration in the region is ideal, with adjacent analogue and digital channels that transmit from the same location), it was found that small "DTV-ready" antennas sold to consumers of over-the-air television are not very efficient at VHF frequencies.

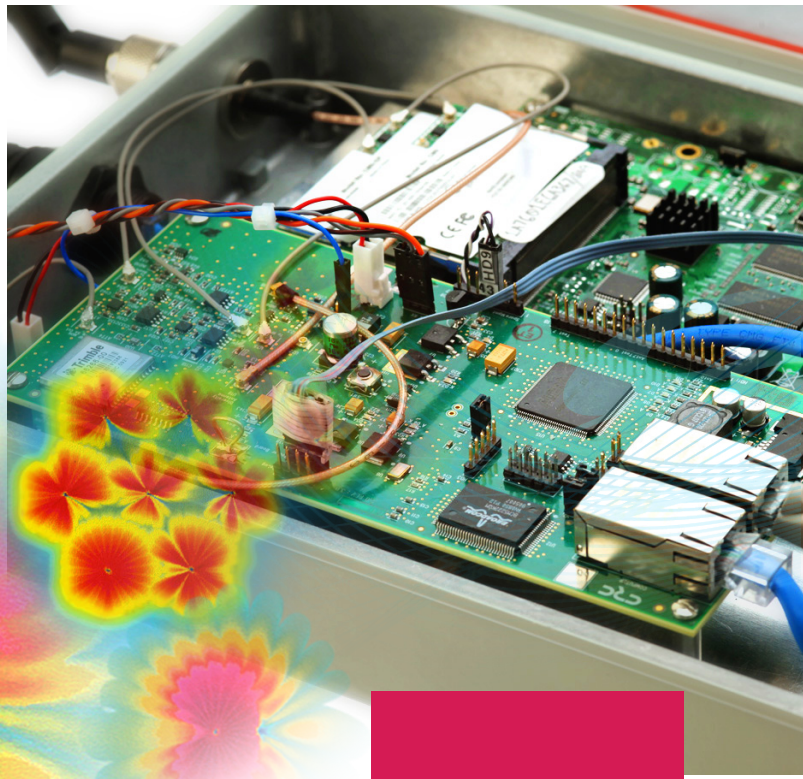
Testing HDTV over WiMAX networks: Worldwide Interoperability for Microwave Access (WiMAX) technologies are at the forefront of both fixed and mobile broadband wireless access. In 2009-2010, CRC researchers conducted field tests to evaluate the performance of HDTV video transmission over WiMAX networks. The CRC set up a WiMAX test network and managed the broadcast of the video clips. A frame-by-frame analysis determined that fixed WiMAX – the focus of this initial phase of the study – performs well in carrying high bandwidth, low latency applications.

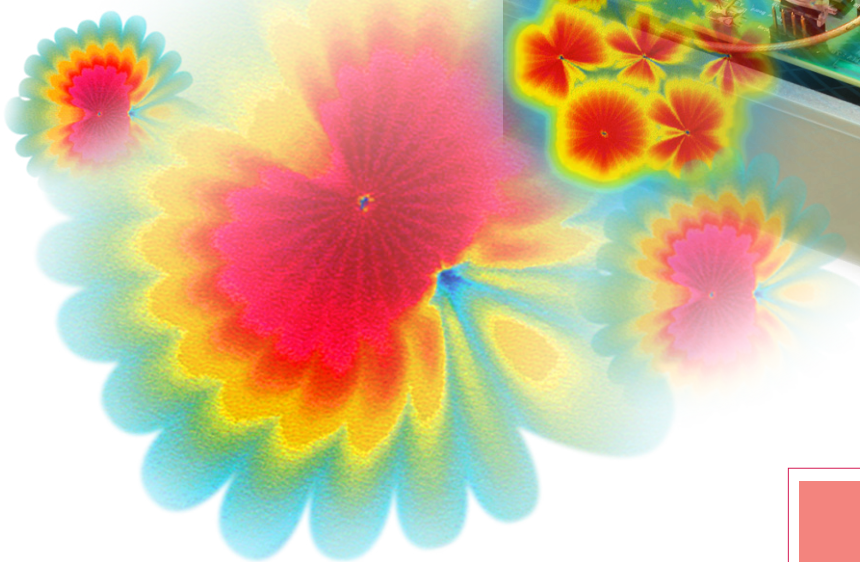
In another study, researchers investigated the performance of HDTV over an Internet protocol television (IPTV) network, and demonstrated how the quality of the signal could be assured.

WISELAB personnel install WiMAX test antennas

Ensuring efficient spectrum use in the evolution to mobile broadcasting: Before broadcasters can begin transmitting programs to handheld devices, technical specifications need to be tested to ensure unobstructed delivery for consumers on the move. In 2009, the Advanced Television Systems Committee (ATSC) approved ATSC-M/H, the North American standard for mobile digital television (DTV). CRC researchers conducted subjective tests to determine the most efficient data rate for ATSC H/M. This will result in data rates that minimize bandwidth requirements while still providing appropriate video quality.

Introducing the world's first Wi-Fi based cognitive radio networking platform: CRC researchers developed the world's first Wi-Fi based cognitive radio-development platform. Called CORAL, this wireless test bed will also enable researchers to investigate issues that are important to future cellular and wireless access systems. CRC researchers were invited to demonstrate the patented technology at IEEE DySPAN 2010. This Institute of Electrical and Electronics Engineers event is the world's premier conference dedicated to dynamic spectrum access networks.





Simulation of autonomous 5 GHz MILTON Rosette cells adapting to each other's presence using cognitive radio sensing and identification of interference

Increasingly, companies and organizations are accessing computing resources virtually over the Internet as a way to save resources, increase efficiencies and reduce greenhouse gas emissions. This utility-like capability is particularly relevant for advanced research, given the robust computer resources required to enable innovation. CRC's Infrastructure as a Service (IaaS) framework facilitates virtual computing. In 2009-2010, the CRC continued to work with its partners to advance the software associated with its IaaS framework: user-controlled lightpaths (UCLP) and its commercial version, ARGIA. The software is now used in several projects funded by CANARIE, Canada's Advanced Research and Innovation Network. They include:

Demonstrating a virtual healthcare network: The Heath Services Virtual Organization, spearheaded by the Northern Ontario School of Medicine and McGill University, is a virtual network that links medical resources – including databases, experts and surgical mannequins – to students and healthcare professionals at widely dispersed locations. Using ARGIA software, which creates and manages lightpaths or dedicated links, the CRC looks after the network infrastructure by assembling the pieces to form a virtual network.

Studying sustainable methods to fuel ICT: A solar powered node has been established at CRC as part of the GreenStar Network, a project led by École de technologie supérieure that brings together Canadian industry, universities and government agencies. Partners, each with their own test bed fueled by an alternative energy source, are studying efforts to reduce greenhouse gas emissions from ICTs. The IaaS software will be used to implement a "follow-the wind/follow-the sun" architecture that supports the live migration of virtual machines, thereby optimizing the use of available green energy. Partners' research will help inform standard development in this domain.

Research team members with solar panels and GreenStar Network equipment (insert)

Enabling Other Government Departments

Supporting the Canadian Space Agency (CSA) Polar Communications and Weather (PCW) mission: The CRC is one of several federal partners involved in the PCW mission, which will provide continuous communications services and weather observation of Northern regions. The CRC is monitoring industry activities, making recommendations and performing independent studies.

Improving satellite communications: Radio frequency (RF) photonic technology is particularly useful in satcom applications, providing greater bandwidth and RF transmission options, while reducing electromagnetic interference, size, weight and power requirements. In 2009-2010 the CRC designed and fabricated an integrated optical phase shifter for satcom applications.

Equipping the Mars Rover with wireless communications capabilities: The CRC is involved in the CSA's Mars Rover program, one of five initiatives intended to position Canada and Canadian expertise in a future international mission to Mars. In 2009-2010, the CRC wireless team established a multi-year contract with the CSA to design the wireless communication systems for the Mars Rover, which will search for water erosion and subsurface water with the help of a retractable sky camera to see around obstacles.

Helping developing countries adopt telemedicine: The CRC is helping developing countries adopt telemedicine through its participation as co-chair of a UN action team.

The CRC is a longstanding strategic partner with the Canadian Space Agency. In space science, a CRC researcher is the principal investigator for the Radio Receiver Instrument on the Enhanced Polar Outflow Probe aboard the CASSIOPE satellite, scheduled for launch in 2011. In space technologies, the CRC provides satellite communication (satcom) know-how, search and rescue satellite-aided tracking (SARSAT) expertise, global navigation satellite system support, and application development assistance.

CASSIOPE satellite antenna calibration

Mars

Medium Earth orbit search and rescue (MEOSAR) capabilities will soon improve search and rescue satellite-aided tracking (SARSAT). While Canada's contribution is coordinated by the National Search and Rescue Secretariat, much of the R&D is carried out by the CRC. From satellite technology and emergency locator beacons, to radios enabling communication among rescue crews, CRC R&D is facilitating many facets of SARSAT.

Providing expertise to future SARSAT systems: Recently, the U.S. approved in principle the use of a transponder conceived by the CRC, CSA and an industry partner in an earlier phase of MEOSAR development. The first MEOSAR transponders could fly aboard future GPS satellites as early as 2017.

The CRC concluded two, three-year research projects for the National Search and Rescue Secretariat in 2009-2010:

- The MEOSAR study provided researchers with access to satellite signals from the current U.S. Distress Alerting Satellite System or DASS. The CRC linked ground stations from Canada and abroad to produce more timely and accurate readings of beacon positioning.

  Phase two will include demonstration and evaluation planning for the MEOSAR system, and the development of next generation beacons. The latter will expand on work completed for the SARBACAN (Search and Rescue Beacon development with Canada) project, funded in part by the CSA. The CRC has served as a work package leader and technical authority on SARBACAN since 2009.

- In the rapid deployment terminal assignment, researchers used CRC software defined radio (SDR) technology to develop and demonstrate a prototype "gateway" that enables interoperability between different types of terrestrial radios used by rescue crews. The technology also features a satellite backhaul to enable communication with potentially distant locations, such as a command centre. Some of the prototype software components are ripe for commercialization.

Improving communications between NATO nations:
In 2009-2010, a NATO working group selected the CRC's proposed radio protocol for the basis of a new radio communications interoperability standard. CRC researchers contributed to the design and specification of the NATO standard for tactical VHF/UHF radio networks that will enable interoperability between nations and provide higher performance.

Assisting the Canadian army abroad: CRC experts provided planning and technical support to the Canadian army at NATO exercises in Sweden and the Netherlands, where NATO interoperability standards were tested and interoperability solutions were demonstrated.

Investigating future satcom needs: The CRC is assisting the Canadian Forces (land, sea, air) in defining their satellite communication needs for the next 15 years by conducting system analysis and design, defining trends and developing implementation plans for engineering test facilities where new systems can be field trialed.

Improving surveillance through wireless sensor networks:
As part of DND's SASNet project to define and demonstrate a self-healing autonomous sensor network, the CRC provided a scalable system solution – from deployment to command control centre – where sensor networks were integrated into a multi-level architecture. Such sensor networks also hold huge potential in a broad range of civilian and public safety deployments and conditions. And developments in mobile systems offer additional advantages: allowing for dynamic access capable of sensing a wide spectrum range and adaptively selecting the optimal frequency band.

Support through-wall radar research: The CRC provided assistance to Defence Research and Development Canada by designing and fabricating the antenna and antenna array housing for the Through-Wall Synthetic Aperture Radar demonstrator project, which is investigating the possibility of through-wall radar surveillance. In addition, CRC produced microelectronic components essential to the project.

Model shop personnel prepare the Through-Wall antenna array housing

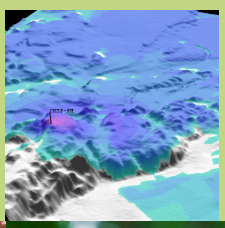
Robust wireless communications and robust reliable networks are vital to Defence Research and Development Canada (DRDC). Along with providing DRDC with expertise in these areas, the CRC manages DRDC's Defence Communications R&D Program (DCP). Beyond the DCP, the Canadian military sought CRC expertise to enhance communications interoperability among nations, as part of its contribution to NATO.

Others

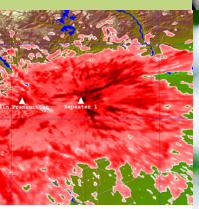
Investigating smart grids and renewable energy: CRC began investigating "smart grids" in 2009-2010 in cooperation with Natural Resources Canada (NRCan). The goal is to create a smart grid that incorporates ICTs into the electrical system to seamlessly shift between traditional and renewable forms of energy when renewable forms are available. The project involves measuring wind and solar sources, modeling the system and developing the switching software. Once operational, NRCan intends to pilot test the technology in select Northern communities.

Helping emergency services in Toronto: When Toronto Emergency Management Services (EMS) upgraded their radio communications system, they turned to CRC-COVLAB to determine antenna positions needed to provide ubiquitous coverage within their jurisdiction. Using measurements taken in Toronto, CRC experts analyzed this field data and provided EMS system planners with the best parameters to use in CRC-COVLAB. Equipped with software training by CRC experts, local operators used the simulation software to predict radio frequency coverage, enabling system planners to advance to implementation, and allowing police officers, fire fighters and paramedics to transition to an upgraded system.

Supporting public safety and emergency preparedness: Forming a public alerting system involves an "extended family" of government organizations. As part of its investigation into a national public alerting system, Public Safety Canada explored ways to ensure communication in the event of primary system failure. The CRC assisted in the design of a satellite interface that would act as a back-up for the main alerting system. Given the immediacy of the need for a solution, partners opted to pursue an option with a broadcast network.



Displays of coverage produced by CRC-COVLAB



Empowering Industry Through Technology Transfer

The CRC offers a number of technology transfer opportunities, including R&D collaborations, specialized engineering consulting services, unique R&D facilities and test beds, prototype development, intellectual property (IP) licensing, and an Innovation Centre for start-ups and other small- and medium-size enterprises.

The CRC pursued multiple industrial and academic collaborations and contracting-in agreements in 2009-2010. They included:

- performing high-power wireless system analysis;
- investigating the radio behaviour of advanced handsets;
- evaluating and optimizing 28 GHz and 38 GHz radios;
- providing technical advice on integrating the audio loudness meter;
- developing tunable planar lightwave circuits for ultrafast optical signal characterization;
- licensing the use of a prototype system for automated malware experimentation;
- performing fibre Bragg grating prototype development.

Milestone:

CRC and an industry partner received a technology transfer award from the Federal Partners in Technology Transfer in 2009 for successfully developing, transferring and commercializing an omni-directional antenna that led to the creation of one of the world's largest satellite-based mobile asset tracking systems.

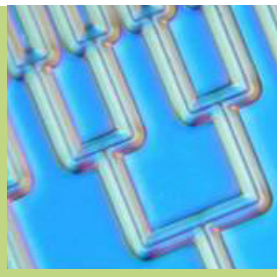
Advanced Antenna team members celebrate with their industry partner at the Federal Partners in Technology Transfer awards

Milestone: ICT start-ups filled the CRC's Innovation Centre for the first time since the high tech boom of the late 1990s.

Ongoing technology transfer success stories include:

Software Communications Architecture (SCA): SCA forms the basis of software defined radio (SDR). After first influencing the direction of SCA standards adopted by the U.S. military, the CRC went on to develop SDR technology, including an SCA software development kit. The resulting SCARI++ software suite empowers customers to quickly develop SCA-compliant applications. It is now licensed by manufacturers and developers worldwide.

Broadcast technologies: Several CRC-developed broadcast technologies are on the cusp of commercialization, including technology enabling television's evolution toward 3D. The CRC has developed a real-time 2D-to-3D video conversion tool that began generating interest in 2009-2010. Interest has also been growing at international broadcast conferences for CRC's software defined broadcasting equipment, open broadcast platforms and loudness meter.



Silica microchannels on a chip, as seen through an optical microscope

Engaging in Collaborations

Collaboration is critical to capitalize on expertise. Harmonization, economies of scale and interoperability – all enabled by international standards – are essential to a global marketplace. The CRC is active in standardization efforts of NATO, the International Telecommunication Union (ITU), Institute of Electrical and Electronics Engineers (IEEE), Video Quality Experts Group and Advanced Television Systems Committee (ATSC).

Advancing international standards: The CRC's success in audio loudness metering began in 2006, when the ITU adopted the CRC-developed meter as the international standard to measure loudness in broadcast productions. The ITU agreed on a reference level for loudness in 2009. The CRC continues to advance the adoption of this voluntary standard through its work at both the ITU and the ATSC.

Innovating with academia: The CRC collaborated with McGill University to demonstrate pulse train generation at 40 GHz in CRC-fabricated planar lightwave circuits (PLCs). In a separate initiative, novel long-period gratings were demonstrated in silica PLCs in collaboration with Institut national de la recherche scientifique.

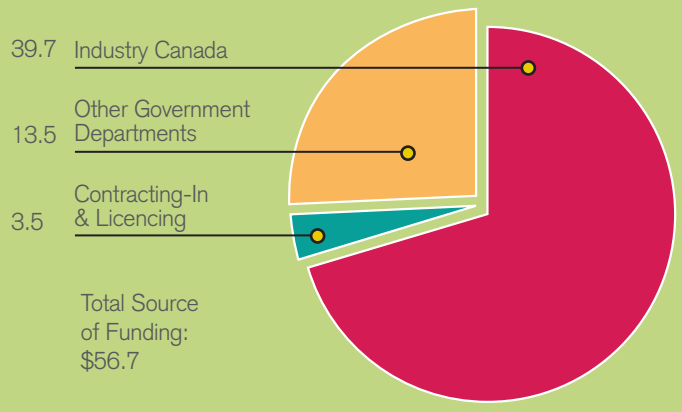
Educating: Along with the many Canadian students and postdoctoral fellows the CRC nurtures, the organization also hosted four Taiwanese researchers from National Chiao Tung University and the National Chip Implementation Centre (CIC). One CRC researcher spent three months at CIC. This multi-year collaboration involves 60 GHz circuits and structures, designed and fabricated in Taiwan, then tested and characterized at the CRC.

Chairing international committees: The Wireless Innovation Forum is dedicated to driving innovation in software defined radio, cognitive radio and dynamic spectrum access technologies. CRC representatives chair several committees and working groups of the Forum.

CRC has collaborative agreements with several foreign organizations including: the European Broadcasting Union; Camara Nacional de La Industria de Radio y Television, the Mexican Association of Broadcasters; the Electronics and Telecommunications Research Institute in the Republic of Korea; Japan's National Institute of Information and Communications Technology; the EU Cooperation in Science and Technology (COST) Actions 2100 and IC0802; and Eindhoven University of Technology in The Netherlands.

Finance

CRC Source of Funding
(in millions)
2009-2010



CRC Expenditures
(in millions)
2009-2010