



About Communications Research Centre Canada >>>>>>

>>>>>> Communications Research Centre Canada (CRC), an agency of Industry Canada, is the leading federal laboratory for research and development (R&D) in advanced telecommunications.

It is a mission-focused laboratory that prides itself on excellence in gathering technical intelligence and providing independent advice to help shape public policy. CRC builds partnerships to bridge innovation gaps in Canada's telecommunications sector, and assists small and medium-sized enterprises through technology transfer.

By being a national leader in collaborative R&D on leading-edge telecommunications and information technologies, CRC supports Canada's drive to increase its innovation capacity and to become the world's most connected nation.

CRC continues to assess the major telecommunications trends, and taps into its technical expertise to recommend concepts that can work within political and economic realities. It does so by working together with the public, private and academic sectors at home and abroad. CRC is supported by a board of directors that includes representatives from government, academia and industry.

CRC's critical mass of researchers and facilities is dedicated to R&D on the technologies that form the basic communications across Canada: *radio, satellite, broadcasting* and *fibre optics*. CRC's R&D focus is to understand how these technologies can mesh to create affordable, quality communications networks — ones that serve all Canadians, regardless of where they live in a country characterized by its huge size, widely dispersed population and variety of climatic conditions.

CRC has established an integrated approach to R&D among its diverse research groups to develop innovative and affordable technological solutions for bringing broadband services to all regions of Canada, especially under-served rural and remote areas. All Canadians deserve to have equal access to education and healthcare, as well as connections to global business opportunities. On behalf of all Canadians, CRC is working to reach that goal.

Message from the Chair >>>>>>



Communications Research Centre Canada (CRC) is a Canadian innovation leader. CRC transfers its leading-edge innovations and expertise to industry, and helps accelerate the commercialization of new telecommunications technologies that benefit Canadians and others around the world.

As a federal laboratory, CRC provides a long-term communications technology foundation to its major government clients: Industry Canada, National Defence and the Canadian Space Agency. CRC's expertise helps shape national and international public policy, regulations and standards, and influences the future applications of new technologies.

CRC brings early focus and direction to emerging communications technologies, and helps lead collaborative academic research and industrial development. CRC's experts are encouraged to think outside established paradigms, and to push the boundaries of communications technologies and systems to deliver the most value to all Canadians. For example, in 2002–2003, CRC's widely experienced research groups joined forces to find technical solutions for delivering broadband services to Canada's rural and remote areas, so that all Canadians can have equal access to education, healthcare, and business opportunities.

In October 2002, CRC and its federal partners held an open house to celebrate the 50th anniversary of the Shirleys Bay Campus. More than 1800 visitors attended to learn more about CRC and its partners, their innovations and their impact on Canadians. Through the years, CRC has helped spin off more than 60 companies. Its technology transfer activities have made it the number one federal laboratory in North America for technology transfer, based on figures presented at the 2003 conference of the Association of University Technology Transfer Managers in Orlando, Florida. This success is due to talented researchers and staff working together with clients and partners in the innovation process to move communications technology from the laboratory to the market.

I would like to thank CRC's staff for their commitment; CRC's clients and partners for their support; and my colleagues on the Board of Directors for a strong strategic focus for the future.

Dr. Alan E. Winter

Message from the President >>>>>>



CRC had a unique and exciting year, marked by a golden jubilee to celebrate 50 years of innovation at the Shirleys Bay Campus and a legal victory that has become yet another milestone in CRC's impressive history.

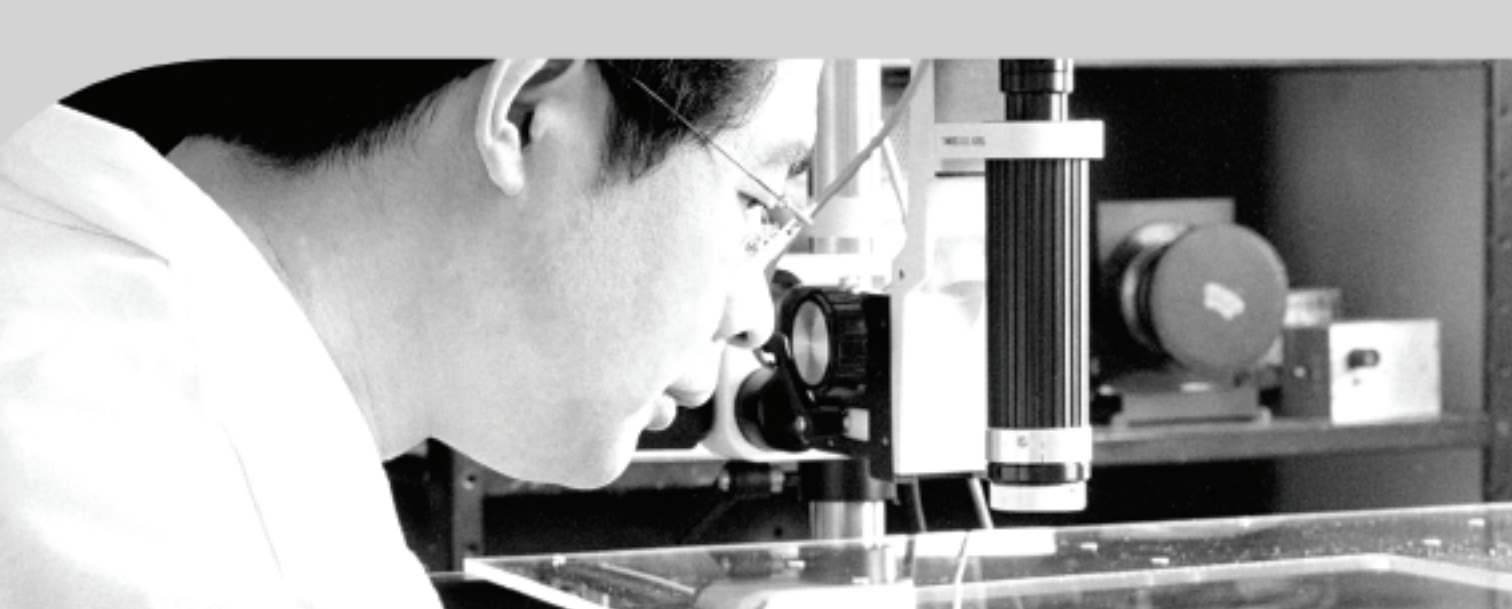
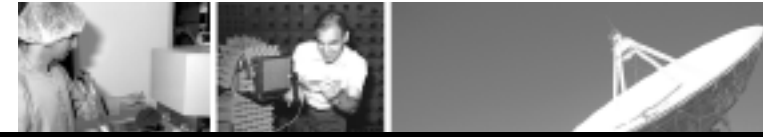
The 50th anniversary open house proved that if you want to be considered an innovation leader, you have to show people what you're doing. In the following report, you will read about how CRC is creating knowledge and technologies for the benefit of all Canadians. You will see how CRC's work is helping shape public telecommunications policies, standards and regulations. You will also learn how CRC has helped the Government of Canada protect its intellectual property through a legal victory that sent a strong message to international business that Canada is serious about protecting its innovation capacity. As with much of CRC's activities, this legal victory relied on strong partnerships, which CRC has become a master at developing.

Partnerships form the core of CRC's work. As a federal laboratory, CRC works closely with academic, industry and government partners such as Industry Canada, National Defence and the Canadian Space Agency. This is so that CRC can develop its world-class expertise in a way that supports the needs of its clients, as well as Canada's goals for equitable broadband connectivity and increased innovation.

CRC's collaborative approach to research and development has led to an impressive portfolio of technologies. The ability to protect and transfer these technologies to industry has made CRC a federal government champion for innovation.

With the changing conditions in the industrial telecommunications landscape, the role that CRC plays in evolving communications in Canada has grown and will continue to grow in importance. The future looks bright.

J.G. (Gerry) Turcotte



Technologies for Rural and Remote Broadband Access

In April 2002, CRC launched the Rural and Remote Broadband Access Program to research and develop cost-effective technologies for bringing broadband services to Canada's rural and remote areas.

A steering committee comprising CRC research managers, and representatives from Industry Canada, universities and private industry, reviewed 25 project proposals from CRC's various research groups. The committee selected 14 projects, which were awarded a total of one million dollars in seed funding for 2002-2003. The projects addressed wired, wireless and satellite solutions, enabling technologies, and applications. All projects reported successful first-year results, and planning has begun for some field trials of the technologies. Proposals for the projects' continuation for the second year will be reviewed, along with new project proposals.

Terrestrial Wireless Systems

- > CRC is combining wireless and fibre optic technologies to support the distribution of broadband multimedia traffic to and from subscribers. This innovative approach allows for the reduction of the complexity and costs associated with delivering broadband Internet service. The project has garnered international attention, and is featured as a cover story in the April 2003 issue of *RF Design* magazine.
- > Researchers are developing technology and software for upcoming field trials under the Microwave Light Organized Network (MILTON) Project. MILTON is an experimental wireless access network that will likely be one of the world's first "cognitive" radio networks based on IEEE 802.16a technology. The network is designed to provide broadband wireless access to rural communities and remote areas using licence-exempt five gigahertz bands.
- > CRC hosted a forum that brought together all publicly funded Canadian wireless centres. The goal is to create a national alliance that would offer stronger support to Canada's wireless industry. CRC also helped formalize wireless and photonics clusters in Ottawa to pool expertise and help accelerate the rate of innovation and commercialization.

Satellite Systems

- > CRC successfully integrated a Dynamic Bandwidth Allocation scheme with a link enhancement protocol, which aims to optimize the use of satellite links and improve application response times.
- > Researchers developed prototypes of a direct satellite transmitter and portable terminal that operate in the Ka frequency band. These prototypes demonstrate the potential for having small, portable broadband communications capabilities that would operate in the new commercial Ka-band.

- > CRC, National Defence and other national and international partners celebrated the 20th anniversary of Cospas-Sarsat, a satellite-aided search-and-rescue system that has helped save more than 14 000 lives around the world. CRC continues to contribute expertise to optimize the system. It also continues to receive licensing royalties for its chip technology contained in the emergency beacons that are sold worldwide.
- > CRC's international recognition as Canada's centre of excellence for satellite communications led to invitations to publish articles on the topic in the prestigious *Online Journal of Space Communications* and *Space Japan Review*. Both articles are available online.

Broadcasting

- > CRC developed a dataport that will allow people travelling by public transportation to receive digital radio and multimedia services via their wireless local area network devices.
- > At the 2002 Software Defined Radio (SDR) Forum in San Diego, CRC was the first to demonstrate an advanced decoding technique for Digital Radio Broadcasting using SDR technology. The technique will increase digital radio reception at high vehicle speeds and will eliminate the need for a new transmission standard.
- > CRC researched and developed several techniques for enhancing digital television coverage. These include using multiple transmitters on the same channel: on-channel repeaters and synchronized transmitters. For the latter, CRC developed a unique method for identifying and synchronizing the transmitters by adjusting transmission parameters.



Some Faces Behind the Innovations >>>>>>>

Behind every great innovation is a great innovator. CRC researchers continue to be recognized for excellence in their fields, and for contributions to innovative communications research and development.

Photonics

- > CRC is designing new laboratories for research and development of passive and active components for optical networks, such as planar lightwave circuits based on dielectric and polymer materials. The new laboratories will also be used for laser manufacturing of optical components such as fibre Bragg gratings. Companies that manufacture Bragg grating components under CRC licence will benefit from new grating technologies, which will be produced with ultra-fast lasers that can be used in extreme environments.
- > Creators of optical networks will save costs thanks to innovative photonic components made with polymer materials, manufactured using CRC's new laser techniques.

Network Systems

- > Network security research focused on integrating monitoring and analysis tools with intrusion detection systems.
- > In partnership with the National Research Council Canada, CRC is co-managing a federal GigaPOP, an on-ramp for federal organizations to the CA*net4 collaborative research and innovation network.

Application Demonstrations

- > CRC and its partners successfully concluded LearnCanada, a program funded by CANARIE Inc. that used interactive broadband technology to link teachers across Canada for professional development activities.
- > CANARIE Inc. also approved funding for MusicGrid, an international virtual classroom program involving

partners such as the National Arts Centre. The program will allow music students and instructors around the world to collaborate via broadband videoconferencing.

- > Students in a northern Inuit community took weekly violin lessons with an instructor near Ottawa, thanks to multimedia satellite trials conducted by CRC and partners such as Telesat.
- > CRC and its partners hosted a virtual classroom session with Canadian astronaut Steve MacLean and six schools across Canada, which were linked by broadband technology.
- > CRC and the Canadian Microelectronics Corporation (CMC) successfully demonstrated wafer probing and device testing under remote control. CMC engineers in Kingston used broadband network technology to control a wafer prober and other test instruments to carry out measurements at CRC's microelectronics laboratory in Ottawa.
- > CRC gained international visibility from its shared virtual reality system prototype and Web3D Consortium software development kit, designed to enable high-speed virtual interactions for applications such as distance learning and business.
- > CRC helped set up and test a broadband wireless link for a new Web telescope housed on site. With its goal to support public education, SMARTscope will allow users to control a telescope via the Internet and to view real-time images of the night sky.



> **Athena Buckthought** is an example of the top-ranking new talent that CRC is attracting. Athena is a PhD student from Carleton University in Ottawa and is working with CRC's three-dimensional television research group. She received the Donald O. Hebb Award from the Canadian Society for Brain, Behaviour and Cognitive Science, for the best research project by a student at a Canadian university or research institute.

> **Dr. Gilbert Soulodre** received the prestigious Fellowship Award from the Audio Engineering Society for his significant role in the development of procedures and international standards for the subjective testing of audio systems.

> **Dr. Yiyang Wu** received an Innovator Award from the Federal Partners in Technology Transfer. The award recognizes his leading-edge contributions to the research and development of digital television technology, and for assisting in its successful commercialization.

Government Clients >>>>>>>

As a federal laboratory, CRC delivers valuable technical expertise to its government clients, which include Industry Canada, National Defence and the Canadian Space Agency.

Industry Canada counts on CRC's expertise to make sound public policy decisions relating to communications issues such as spectrum management. Industry Canada is also looking to CRC for innovative solutions for delivering cost-effective broadband services to under-served rural and remote areas.

National Defence seeks CRC's expertise for its depth of experience and R&D excellence in the development of military communications systems and technologies.

The Canadian Space Agency relies on CRC to manage and contribute to the satellite communications component of the Canadian Space Plan.

Here are the highlights of CRC's service delivery to its main government clients during 2002–2003:

Industry Canada

- > Hickling Arthurs Low, an independent consulting firm, released a report on the use of technology advice at Industry Canada. The report credited CRC for contributing to Industry Canada's capacity to make sound public policy decisions and regulations. The contribution cited, as an example, was CRC's research and development of Digital Radio Broadcasting technology, which led to the establishment of national and international standards and regulations.
- > CRC's study on mutual non-interference conditions helped support a new Industry Canada policy, which involves using part of the UHF television spectrum for emergency communications services.

- > CRC carried out research on emerging Ultra Wide Band (UWB) technology. Studies were conducted on device interference, waveform characterization and antennas. The definition of technical parameters and specifications will help Industry Canada develop related national standards and spectrum policies. CRC also provided input on the topic to the International Telecommunication Union, which sets international standards.
- > CRC's spectrum monitoring technology, Spectrum Explorer, is being incorporated into Industry Canada's Integrated Spectrum Observation Centre, and an increasing number of Spectrum Explorer units are being deployed across Canada. CRC worked closely with Industry Canada's regional offices to test emitter localization capability in Montréal, and to develop Safety Code 6 measurement capability in Toronto.
- > CRC's new techniques involving Dynamic Frequency Selection for radio local area networks were presented to the International Telecommunication Union. The techniques allow sharing between radio location and wireless access systems, including radio local area networks in the five gigahertz range.

National Defence

- > CRC created a software radio test bed to test and demonstrate high-data-rate VHF modem technologies for tactical radios.
- > CRC provided technical support to the Canadian Forces Experimentation Centre to demonstrate broadband military communications networks, including an interface with uninhabited airborne vehicle (UAV) technology.

- > Researchers at CRC developed a prototype of a sub-network relaying system for the Canadian Forces. The system will allow coalition naval ships to exchange information over HF/VHF/UHF line-of-sight wireless links.
- > CRC supported NATO in its development of a standard for narrowband voice communications, which will improve performance and interoperability in coalition operations.
- > CRC is part of a multinational project involving the development and demonstration of a common technical architecture for interoperable, secure military networks.
- > CRC developed an innovative antenna architecture that will save space and minimize mechanical steering on Canadian naval ships.
- > CRC completed an adaptive fade mitigation study for National Defence's advanced EHF satellite system. Researchers also developed solutions that enhance the system's networking performance.
- > CRC continues to provide signal surveillance algorithms and software for Defence Research and Development Canada's MiDAS Project, which is attracting a lot of interest from the Canadian and U.S. militaries.

Canadian Space Agency

- > CRC continues to provide technical and program management of the Canadian Space Agency's Payload Flight Demonstration Program. The Canadian Ka-band multimedia payloads for the new Anik F2 satellite were delivered to Boeing, and the scientific payload instruments for the enhanced Polar Outflow Probe (ePOP) satellite are being designed.

Transfer of Technology and Knowledge >>>>>>>

CRC has a successful record of transferring technologies and expertise to industry and universities. This transfer helps build an innovative, knowledge-based economy.

Results from the 2001–2002 fiscal year, released in 2003, position CRC as the top federal laboratory performer for technology transfer in North America, when intellectual property revenues are based on laboratory researcher per capita. Record intellectual property revenues of four million dollars meant that CRC earned almost 25 percent of all Canadian federal intellectual property revenues, while spending only about two percent of the federal R&D budget.

As of March 31, 2003, CRC had:

- > 418 active intellectual property agreements
- > 68 active contracting-in agreements
- > 214 active patents and applications covering 89 inventions available for licensing (16 new patent applications were filed, and 14 patents awarded, in 2002–2003)

Industrial Development

The CRC Innovation Centre

Since 1994, the CRC Innovation Centre has been helping small and medium-sized companies incubate while they conduct their research and development, and prepare to launch their businesses. On a fee-for-service basis, the Centre offers Canadian companies office space and access to unique test beds, facilities, expertise and technologies.



Patent Success Story

CRC became the first government laboratory in Canadian history to fight and win a patent interference case before the United States Patent and Trademark Office. CRC and United Technologies Corporation squared off against two large multinational telecommunications companies. At issue was a critical patent in a production process that has proven revolutionary in the optical industry. The patent is for a phase mask technology used for the cost-effective manufacturing of fibre Bragg gratings. CRC's victory sets an important precedent for the federal government in the protection of its intellectual property rights. For more on this story, visit www.crc.ca/success_stories.





More than 30 companies have passed through the doors of the Innovation Centre in the last nine years. In 2002–2003, the Centre welcomed:

- > Nimcat Networks, sponsored by CRC's Informatics group. The company is developing Voice-over-IP telephony solutions for small and medium-sized businesses.
- > Toronto company OnWebOS™, which is using CRC's Broadband Applications and Demonstration Laboratory to access the CA*net4 research and innovation network. This is so that the company can test video and audio over-IP technology needed for a widely available eLearning, eBusiness and virtual presence platform.

Spotwave Wireless and IP Unwired graduated from the Innovation Centre. Spotwave worked with CRC's wireless and antenna experts to develop products that make cell phones work almost anywhere, while IP Unwired worked with CRC's radio communications group to develop technologies for the military. Both companies are doing well in their markets.

Technology Transfer Activities

- > CRC licensed its patented video frame-rate conversion software, CRC-FRC, to Miranda Inc. The Montréal company builds equipment for the film and video production

industry. Based on the strength of the CRC software, Miranda transferred the licence to its spin-off company, Alolith, which will concentrate on developing and commercializing algorithm-based software products that incorporate the CRC software as one of the core modules.

- > CRC-Predict technology was a key factor in Ottawa-based Marconi Wireless securing a worldwide product development mandate for its deciBel Planner. This software for radio signal analysis contains the CRC-Predict code.
- > More than 6000 users from companies, universities and research laboratories in Canada and around the world downloaded the free software code for Software Defined Radio, developed by CRC and Defence Research and Development Canada with support from the Software Defined Radio Forum. CRC's expertise in Software Defined Radio technology continues to be sought worldwide.
- > In the field of electromagnetic scanning, CRC entered into a collaboration agreement and option licence with EMSCAN Corporation of Calgary. The company is tapping CRC's expertise in electromagnetic measurement technology for its new radiation test equipment.
- > CRC's Forward Error Correcting codes were licensed to Advantech Advanced Microwave Technologies of Montréal, and Soma Networks of Toronto, to help the companies enhance the performance of their wireless communications systems.
- > CRC worked with a small Canadian company, Avendo Wireless Inc., to design multi-element antenna arrays. These helped the company demonstrate its leading-edge, high-capacity, MIMO wireless system. The success of the demonstration helped the company secure investment funding.
- > CRC licensed the fibre Bragg gratings portfolio that it markets under a cross-licence agreement with United Technologies Corporation to two Montréal-area start-ups. Avensys and LxSix Photonics signed agreements that will allow them to manufacture Bragg gratings. Avensys plans to use the optical components for environmental sensors, while LxSix has filed a patent for a highly automated manufacturing process for the gratings.
- > CRC continued its active review of patents for potential licensing to marketing partner British Technologies Group International Inc.

University Collaborations

- > CRC is collaborating with Carleton University on a MIMO system, a key technology for next-generation broadband wireless systems.
- > CANARIE Inc. has approved funding for CRC and researchers from the University of Ottawa for a project on dynamic end-to-end light-path provisioning.

> A graduate student from the University of Manitoba worked with CRC researchers on techniques to improve the efficiency of holographic antenna feeds.

> CRC presented two university radio science students with the annual Reginald A. Fessenden scholarship awards, funded by the Natural Sciences and Engineering Research Council of Canada.

> CRC's work with the University of Québec and IMAX Corporation on video signal processing resulted in a video frame-rate conversion algorithm that was patented and licensed to companies.

> The University of Ottawa and Carleton University worked with CRC on advanced broadband transmission technologies.

International Collaborations

> CRC became a partner in the Information Society Technologies Europe-Canada project, whose goal is to foster R&D co-operation between European and Canadian organizations. This will be done through events and applications demonstrations in areas such as e-learning, e-culture, e-content, e-work and e-commerce.

> In collaboration with the Hong Kong Academic and Research Network (HARNET) and CANARIE Inc., CRC held live, interactive virtual classroom sessions between students in Canada and Hong Kong during the ITU Telecom Asia Exhibition. This was the first international use of HARNET. The demonstrations supported the marketing efforts of CRC and its fellow Canadian exhibitors, and contributed to branding Canada as a global high-technology leader.

> As part of a collaborative project with the National Science Council of Taiwan, CRC submitted innovative designs of monolithic microwave integrated circuits (MMICs) to OMMIC, a member of the Philips group of companies. The designs resulted in the successful fabrication of the circuits.

> CRC concluded four collaborative research projects with India's Centre for the Development of Telematics (C-DOT). The projects focused on wireless technologies and were funded by the Canadian International Development Agency.

> CRC is collaborating with the Electronics and Telecommunications Research Institute in South Korea on three-dimensional and digital television transmission technologies. Since South Korea has the same digital television standard as Canada, the collaboration allows CRC to use South Korea's equipment and expertise to carry out research and development for Canadian industry.

> CRC shared its expertise with the Video Quality Experts Group, an international body that proposes recommendations to the International Telecommunication Union, which sets international telecommunications technology standards.

Revenue and Expenses (\$ millions) >>>>>>

REVENUE

Industry Canada	35.7
Tenant and Support Services	3.1
Private Sector	5.2
Department of National Defence	5.6
Canadian Space Plan	22.5
Spectrum Research (Industry Canada)	0.6
TOTAL REVENUE	72.7

EXPENSES

Research Program:	
CRC Research Program	24.7
Research performed for National Defence	5.6
Spectrum Research	0.6
Research Support	4.7
Canadian Space Plan:	
Contracts	22.0
CRC Research	0.5
Sub-Total Canadian Space Plan	22.5
TOTAL RESEARCH PROGRAM	58.1
Tenant and Support Services	3.1
CRC Administration	2.5
CRC Site Services	9.0
TOTAL EXPENSES	72.7

CRC receives funding from a number of government and non-government sources. In 2002-2003, Industry Canada provided 49 percent of CRC's funding. Other government funding was provided by the Canadian Space Agency and the Department of National Defence to carry out R&D, and to cover costs related to their residence on the Shirleys Bay Campus. Revenue from the private sector is generated through the licensing of intellectual property and contracted R&D.

Board of Directors >>>>>>

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