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 2004/05

Canada

CRC

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MESSAGE FROM THE CHAIR | As a trade based economy, Canada must continue to invest significantly in research. Research and development is key to continuing the success of our industries as they develop new and improved technologies, products and services for use around the world. Within that context, government labs play a very important role in bridging the gap between long-term university research and more development-focused activities traditionally undertaken by the private sector. | The technologies being developed at CRC, and in the ICT sector as a whole, are predominantly enabling technologies. Enabling technologies have an impact on all other sectors by allowing them to become more efficient and innovative themselves through the use of technology. This makes the ICT sector one of the most important sectors for improving productivity and the future of the Canadian economy. Over the past year, CRC has once again demonstrated its tremendous value to government and industry by making significant progress in areas such as health, environment and mining through collaboration with other agencies and government departments on enabling technologies. | The unique combination of expertise at CRC is what makes the organization so essential. As a government leader in commercialization, CRC has demonstrated the ability to take ideas and turn them into successful technologies and applications. But CRC also plays a very important role in sharing that expertise with its partners, which include government departments, academia, the private sector and international organizations. | Collaboration is the key to CRC's success. As you will see in this document, CRC continues its success in working with partners to the benefit of all. | I am proud to have been involved with CRC for many years. I would like to thank Industry Canada and CRC's clients, staff and Board of Directors for their commitment, and I look forward to working together to help ensure continued innovation into the future. | **Dr. Alan E. Winter**

MESSAGE FROM THE PRESIDENT | After another busy year, we can now look back and see that CRC continues to strengthen its leadership in communications research. That leadership has become a hallmark of CRC and is something for which we can take great pride. | As part of the commercialization agenda, we have, over the course of the past year, agreed to dozens of new licenses for technologies developed by CRC staff and signed many collaborative agreements with organizations here in Canada, and around the world. Technologies like Software Defined Radio, which is designed to address the interoperability challenges for public safety radio users, and the MILTON system, which provides broadband access to more rural areas, are out in the world, showing what CRC can offer. | In addition, essential work is being done everyday, and success can be seen in other projects as well, ranging from our research on mobile ad hoc networks (MANET) to the work on exploring the possibilities of three-dimensional television images (3D TV). | On campus, construction has begun on the new, state-of-the-art photonics lab, which will allow CRC to continue efforts in this important field of research. Construction has also been completed on the new RAATLab (Research in Advanced Antenna Technologies Laboratory). | Important corporate activities have also helped to support the efforts of our researchers. The launch of CRC's new R&D newsletter, *Eye on Technology*, has been met with tremendous positive feedback. CRC's participation in the government's efforts on the integration of science and technology across departments and the commercialization pilot project continue to strengthen our role as the government's primary lab for communications R&D. | This year, network security and public safety has continued to be an important area of research for CRC. | We work very closely with the Department of National Defence, as well as our other partners, to develop technologies that will help address some of the major communications challenges faced in these areas. | But to recognize all of the wonderful achievements this year, it is important that we realize that it is the people that truly make CRC what it is. CRC has an extremely strong Board of Directors who are extraordinary in helping to guide the organization into the future. As well, the quality of the people at CRC is reflected by the tremendous number of CRC staff members who were recognized this year, both by their peers and by international organizations, for their work. | At a research facility like CRC, you can only go as far as your staff can take you. With the quality of the people at CRC, I know the sky is the limit. | **Veena Rewat**

> “From Alouette…to ARPANET,… CRC has helped Canada lead the way in communications”

THE COMMUNICATIONS RESEARCH CENTRE CANADA

Located on the Shirleys Bay campus in Ottawa, the Communications Research Centre Canada (CRC) is the government's primary laboratory for advanced telecommunications R&D. With research expertise built up over more than 50 years, CRC has an extensive track record of success in the field.

CRC has been involved in some of the most significant developments in communications in Canada. From the Alouette satellite, which made Canada the third nation in space, to the first Canadian link to the ARPANET, which was the predecessor to the Internet, CRC has helped Canada lead the way in communications. | Today, CRC has been divided into four main research branches, looking at broadband network technologies, terrestrial wireless technologies, satellite communications and radio propagation, and broadcast technologies. Each of these branches conducts research activities that are looking ahead – beyond today's "technology horizon" and into the future. | The results of the research activities at CRC are far reaching. The technologies being developed as a result of CRC research have been licensed to organizations and companies around the world, being included in products that are used every day. | But CRC's impact goes even further. The expertise and knowledge developed as a result of that research is applied to other areas as well. CRC provides program management for major satellite communication projects and it creates partnerships with Canadian and international organizations. It also acts as an independent source of technical advice for telecommunication policy and regulatory decisions made by the government.

Technology Transfer & Commercialization | The commercialization of technology is at the heart of the government's plan for Canada. Taking the R&D being carried out in Canadian labs and universities and bringing them to market has been identified as one of the key ways that Canada can continue to grow its economy. But it's more than just the economy that benefits from commercialization. Without it, the potential benefits of new Canadian technologies, benefits to communities and all Canadians, will never be realized.

CRC is a leader in technology transfer and commercialization for the government. With over 330 licenses and 230 patents, CRC has over 90 distinct technologies available for use by the private sector. The revenues brought in by these technologies are used to help continue the research at CRC, contributing to even more developments in the future.

Working with Partners in Canada and Around the World | One of CRC's key advantages is the links it has established with Canadian and international partners. Over the years, CRC has worked with dozens of academic institutions, private sector companies, and government departments and agencies from around the world. CRC has extremely close ties with many Canadian government departments, often partnering with them on important research areas of mutual interest and conducting research on their behalf. CRC researchers contribute to many international standards organizations, and regularly participate in international tests and trials to develop those standards.

Through collaborative agreements, CRC also participates in many joint R&D projects with organizations from around the world, working to further develop important technologies that will benefit everyone.

CRC Innovation Centre | The foundation of Canada's economy is the success of small- and medium-sized enterprises (SMEs). Through the CRC Innovation Centre, SMEs in the information and communication technologies sector have a partner they can count on to help them succeed.

The Innovation Centre helps out start-up companies, as well as some more established ones, by providing work space and access to CRC experts, helping them develop and test their technologies. This close link to one of the largest concentrations of top technology researchers in Canada means that these companies have a unique opportunity to benefit from CRC's accumulated knowledge and expertise.

Supporting Research Activities | CRC offers many corporate services to support its R&D activities and to promote the results of these activities. In addition to functions such as human resource management and finance related activities, researchers have access to services such as the model shop, creative and visual services, communications services and the technology transfer office.

CRC also acts as the landlord for the Shirleys Bay campus, with a number of other departments and agencies taking advantage of the concentration of expertise and services located on site. As such, CRC is responsible for ensuring the maintenance of the campus as well as the health and safety of staff working on site.

STRATEGIC PRIORITIES

CRC has identified six strategic priorities for future research. These six priorities will help CRC focus its R&D efforts on areas that are of strategic importance to telecommunications in Canada, will allow CRC to continue to support policy decisions being made in the future and help to address specific challenges faced by various clients. | **Those six strategic priorities are:**

BROADBAND ACCESS | Broadband access activities are aimed at carrying out research that will help deliver cost-effective solutions for access to broadband services in rural and remote communities in Canada. In order to focus activities for this priority, CRC also established the Rural and Remote Broadband Access (RRBA) program in 2002.

RADIO SPECTRUM | Industry Canada is mandated to regulate the radio spectrum and therefore, must have a solid technical base to make proper decisions and policies. Research in this area contributes to advice on spectrum policy and regulation development, reallocation and/or new or more efficient use of allocated spectrum, and utilization of new frequency bands.

DEFENCE COMMUNICATIONS | National Defence (DND) is one of CRC's major clients and research tasks are done on a cost recovery basis. Most of the activities are closely tied to CRC's expertise and to DND's requirements for communications R&D, creating a mutually beneficial relationship. DND's present interests include interoperability of communications networks, quality of service, network security and high-capacity wireless systems.

NETWORK SECURITY + PUBLIC SAFETY | Communications, commerce, defence and other applications require secure network infrastructure. CRC continues to conduct research in the area of network security and communication systems for public safety, in partnership with other Canadian organizations. In particular, security of wireless networks is one area increasing concern.

INTERNET + CONVERGENCE | Although the Internet can be considered to be a mature technology' having been in existence for over 20 years, it is important for Canada to be on top of, and even contribute to, new world developments and improvements. As technology evolves and bandwidth is more readily available to consumers at reasonable cost, it also becomes important to understand and predict convergence trends between the various competing and complementary information delivery systems. CRC can provide a valuable look forward on these trends so that the government can be better informed when considering policy decisions.

APPLICATIONS | One of the key drivers for acceptance and use of broadband technology is the availability of applications requiring a high quality of service. CRC is well positioned to use its access to various national and international communications networks to conduct demonstrations of novel broadband applications, such as e-learning, e-health and others, with a particular focus on those with a high degree of social or industrial benefit.

THIS YEAR'S ACTIVITIES

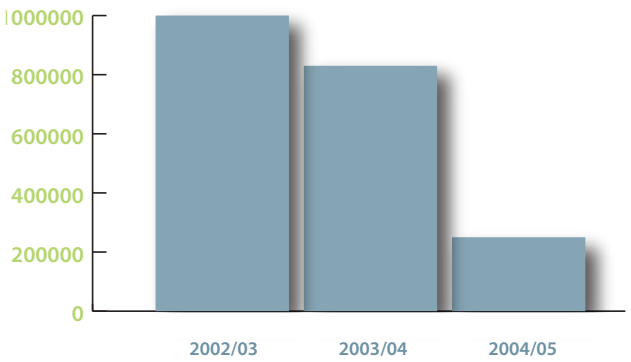
R&D activities have been carried out in all four of CRC's research branches in support of the six key research priorities. Broken up by priority area, here are just some of the key accomplishments and initiatives from the past year.

BROADBAND ACCESS AND THE RRBA PROGRAM |

Within CRC's mandate to explore broadband technologies, CRC established the Rural and Remote Broadband Access (RRBA) Program in 2002. This program is aimed at developing cost-effective technologies to help the government's goal of bringing broadband services to Canada's rural and remote areas. Within the scope of the program, support was given to projects at CRC that would help deliver on this mandate.

Projects that have received support as part of the RRBA program will be marked with a

Funding for the RRBA program over the past three years



BROADBAND ACTIVITIES

- The joint CSA/CRC/industry Payload Flight Demonstration Program for Anik-F2 was completed with successful in-orbit tests in December 2004. The focus has now shifted to preparing for trials of the experimental on-board processor and providing technical support and guidance to Industry Canada's National Satellite Initiative. This will also involve work to benefit from the Ka-band capacity credit that is being provided to the government for use in Northern Canada.

- Research and development continues on Ka-band broadband ground station technologies for mobile enterprise services. A prototype terminal incorporating a number of CRC's new technologies is under development.

- CRC has demonstrated a new form of silica waveguides containing fluid-filled microchannels. These microchannels could be used for a broad range of new functions for photonic devices, including as an internal sensor, or as a chip cooling mechanism using microfluidics.

- Research continued on real-time techniques for propagation fade compensation in an open-loop satellite link through frequency scaling of attenuation.

- Work moved forward on the Microwave-Light Organized Network (MILTON) technology, which is designed to deliver wireless broadband access in less populated areas. A successful on-going field trial of the technology was conducted in the Ottawa area with the installation of a hub in September 2004.

SETTING THE STANDARD FOR RURAL AND REMOTE ACCESS

Through the RRBA program, CRC actively participated in the formation of the new IEEE 802.22 Working Group. This group is working on international air-interface standards for Wireless Regional Area Networks (WRAN), which are aimed at extending broadband access to the less densely populated rural areas.

- Research on the development of a digital television (DTV) based, interactive multimedia broadcasting system continued this year. Extensive tests were conducted on the transmission of IP data over DTV channels and a DTV to Wi-Fi bridge was also demonstrated.

RADIO SPECTRUM

- Potential improvement to coverage provided by the DTV Single Frequency Network (SFN) built in Ottawa by CRC with support from Canadian DTV (CDTV) was confirmed by field tests. The results of the tests showed that such a network could improve coverage and reduce the amount of spectrum required when compared to a conventional stand-alone transmitter.

- CRC's participation in the three-year Coalition Command Control and Communications Demonstration Environment (CC3DE) Project Agreement through The Technical Cooperation Program (TTCP) has led to concepts for robust distributed management and security for coalition networks. CRC has developed a prototype system that demonstrates the capability of an automated, policy driven method for controlling management traffic across national and coalition boundaries and over bandwidth constrained communication links.

- In order to better understand the issue and to provide advice to Industry Canada on future regulations, the evaluation of the Interference Potential of PLC (Power Line Communications) Systems in the Frequency Range 1-80 MHz has begun with modelling and simulation work.

- Preliminary results of a study on digital multimedia broadcasting (DMB) and large-area coverage have shown the coverage improvements that could be expected if the system could operate in the VHF (195 MHz) band. This is done to investigate the possibility of using un-used TV channels for non-broadcasting services in remote and rural areas.

- Working with the University of Ottawa, CRC studied the potential of interference from 5 GHz Radio Local Area Networks (RLANs) on weather radar systems. This research will be used to provide input into the International Telecommunication Union (ITU) to help develop new international standards.

- The impact of applying reduced satellite spacing, as proposed by some satellite service providers in the United States, on the quality of service for Canadian broadcast systems is being investigated.

- Adaptive radio research is underway to explore wireless systems that exploit unused frequency spectrum in time and space, and dynamically adapt to the varied environments and changing conditions.

- CRC is studying and has characterized Ultra Wideband (UWB) Emissions and has carried out measurements of path loss with a UWB source in order to further the understanding of these issues and to support the development of future regulations by Industry Canada.

DEFENCE COMMUNICATIONS

- CRC participated in two interoperability field trials for the Canadian Army under the NATO TACOMS Post-2000. These exercises took place in Europe, with teams from the Netherlands, France, Norway, the UK, Sweden and Canada. The results from this activity are having a significant impact on the acceptance of a new generation of NATO standards and on plans for multi-national NATO Army deployments.

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- To support Defence R&D Canada's (DRDC) Software Based Radio activities, CRC has begun a new study to investigate the feasibility and design of a multi-band antenna feed horn and the related waveguide hardware as a retrofit to Canadian Navy ship-born satellite antennas.

- In work targeted at reliable communications for military operations in complex terrain, low complexity MIMO signal processing algorithms have been developed which illustrate the gains available using asynchronous transmissions.

- The development of the military version of the Spectrum Explorer was pursued by adding new signal processing algorithms for detecting and identifying additional classes of signals. Demonstrations and field trials were performed with the Canadian Forces and other friendly forces to better address the requirements of the Canadian Forces and its closest allies.

- Under DRDC's Technology Demonstration Program, CRC is carrying out a project to demonstrate advanced technologies aimed at enhancing the capabilities of the Canadian Forces' tactical communication system. Work is focused on the development and implementation of a high-data-rate software radio modem, and of a mobile ad-hoc network architecture suitable for tactical systems.

- In Partnership with DRDC Valcartier, a new project by CRC looking at military sensor networks is studying recent advances of small, low-cost, low-power, multifunctional wireless sensor nodes for communications over short distances.

NETWORK SECURITY + PUBLIC SAFETY

- CRC is participating in the development of enhancements to the international satellite system for search and rescue (Cospas-Sarsat) and is setting up antennas to receive SAR signals from future navigation satellites (GPS, Glonass and Galileo).

- CRC is working closely in the area of network security with Industry Canada and other Government departments/agencies such Defence R&D Canada, the Canadian Security Establishment, National Research Council, RCMP and Public Safety Emergency Preparedness Canada. Prototype tools for network monitoring are currently being tested on the CRC in-house network and are also being considered for technology transfer.

- Multiband - multi-protocol radio prototypes are being developed, based on the Software Defined Radio technology to address interoperability issues in public safety and emergency situations.

- Research was conducted exploring advanced signal detection techniques to enhance wireless LAN security through the application of RF fingerprinting. RF Fingerprinting will help to protect against hackers by screening out unauthorized users on wireless LANs.

- At the inaugural meeting of the Broadcasters' Public Alerting Working Group in September 2004, CRC, in conjunction with e-Radio, presented a demonstration on the use of Radio Data Service (FM-RDS) for Public Alerting. An experimental FM station was set up at CRC for the occasion.

- Work has continued on mobile ad hoc networks as a way for multiple organizations to communicate during emergency response and security operations. Techniques to prevent unauthorized users from joining a mobile ad-hoc network and to prevent wormhole attacks have been implemented for testing and evaluation.

INTERNET + CONVERGENCE

- A two-way high definition (HD) videoconference was established between CRC and the National Institute of Information and Communications Technology (NICT) of Japan. Several demonstrations using this technology were also done at international conferences during January in Hawaii (PTC 2005) and Bangkok (APAN).

- Considerable efforts were invested in the development and demonstration of a special application called Broadcast File Download, which illustrates digital audio broadcasting's (DAB's) potential to effectively deliver data files to mobile users.

- A new version of FreeWRL was released to the Open-Source community and used to demonstrate shared virtual reality between CRC and Hawaii at the Conference of the Pacific Telecommunications Council.

- Emerging technology for digital video broadcasting on handheld devices (DVB-H) is being evaluated and compared to DAB/DMB for multimedia services to mobile and portable receivers.

APPLICATIONS

- The Broadband Applications and Demonstration Laboratory (BADLAB) was used to host and facilitate various interactive multi-media events and demonstrations, such as the Virtual Classroom initiative, via broadband networks involving CA*net 4 and satellite links to remote and rural communities.

- CRC partnered with several organizations, including Telesat, to fulfill a contract with the European Space Agency to demonstrate telehealth and telesurgery applications via satellite in Canada.

- In collaboration with Defence R&D Canada and several private sector partners, CRC designed and implemented a high capacity wireless system to support the demonstration of the remote surveillance and control of an unmanned air vehicle (UAV). The demonstration involved a UAV flying in Ottawa being monitored from a control station at CeBIT 2005 in Hanover, Germany.

- By partnering with Canada Health Infoway and others to plan and implement telehealth services in Northern Canada, satellite ground equipment developed by Canadian industry is now being installed. Initial demonstrations of these new services to potential users are planned in 2005.

- The WISELab successfully supported the 2004 Atlantic Littoral ISR (Intelligence, Surveillance and Reconnaissance) Experiment (ALIX) in Gagetown, NB (CFB Gagetown) by using its broadband wireless network, providing interconnection among the various battlefield elements.

OTHER ACTIVITIES

COMMERCIALIZATION

This year, CRC signed over 90 licensing agreements, collaborative arrangements and contracting-in agreements. CRC research also generated eight new patents and 35 new patent filings for 17 distinct technologies. With that, CRC remains one of the top government labs for technology transfer and for the percentage of R&D budget generated through licensing. **Some examples of this year's technology transfer activities are:**

- CRC has licensed its "SCARI Software Suite" for Software Defined Radio development to eight Canadian and foreign companies over the past fiscal year, and new licensing

opportunities continue to develop. CRC's Advanced Radio Systems research team has also been in demand for providing courses, tutorials and technical support on SCA implementation and radio development.

- CRC's Forward Error Correction (FEC) technologies have been licensed extensively both nationally and internationally. In the last fiscal year, two new patents were issued, and a new patent application was filed. FEC technologies are currently licensed to 49 Canadian and foreign companies, two of which obtained licenses during the last fiscal year.

- CRC recently signed a collaborative R&D agreement with India's Center for Development of Telematics (CDOT), to further develop the Microwave-Light Organized Network (MILTON) technology. CDOT will also assist in the commercialization of this technology in India. This could mean significant IP revenues for CRC in India's rapidly growing telecommunications market. CRC and C-DOT are also working with Wavesat, a Canadian company, on incorporating WiMAX technology into the MILTON system.

- On top of existing licenses with companies such as Dolby, Phillips and Panasonic, this year the CRC-SEAQ (System for the Evaluation of Audio Quality) software was licensed to 10 entities. These licenses are with companies including Canadian organizations like Ottawa-based Gennum and the University of Montreal, as well as foreign entities such as NASA and France Telecom.

COLLABORATION + PARTNERSHIPS

Every year, CRC continues to build on its strength, its ability to make connections with organizations and researchers across Canada and around the world. Once again this year, CRC has continued to develop new partnerships, and to strengthen existing ones.

CANADIAN COLLABORATION

- CRC supported trials of a new Real-time Emergency Management System by Satellite (REMSAT) being developed by Telesat, and is participating in the development of additional, enhanced features in 2005.

- CRC continues to provide technical and program management support of the CASCADE payload and the Enhanced Polar Outflow Probe (ePOP) payload on behalf of the Canadian Space Agency.

- The analysis of digital television transmission measurements done in Montreal was completed and shared with the CBC. The CBC will use these results to help in the launch of its HDTV service in Montreal.

- As a founding partner, CRC continues to be the lead on the Canada Network of Wireless Centres (CWCnet), a program designed to support the testing of new wireless technologies by small- and medium-sized enterprises (SMEs) at R&D sites across the country.

- Collaboration with the University of Ottawa and NRC has continued under an NSERC strategic grant on "Virtual Navigation in Image-Based Representations of Real World Environments". The purpose of the project is to develop technologies to allow a person to virtually walk through a remote environment, based on a large collection of actual images of that site.

- CRC also provided scientific leadership in Canada and around the world through more than 250 publications

this year. A list of these publications is available on the CRC Library's website at: http://www.crc.ca/publications-library.

INTERNATIONAL COLLABORATION

- CRC collaborated with ONERA (France), Politecnico di Milano (Italy), and CETUC (Brazil) under a European Space Agency contract to investigate earth-space propagation fundamentals and impairment prediction modeling for tropical climates.

- A collaboration agreement with the National Science Council (NSC) of Taiwan on the design of monolithic microwave integrated circuits (MMICs) in the 60 GHz range continued this year. This is the second year of a three-year agreement with NSC.

- CRC began collaborating on three major European Union 6th framework projects – B3G/4G, Public safety communications systems and intrusion/detection/security in wireless networks. The framework is the EU's primary vehicle for funding R&D activities.

- The User-Controlled Lightpath Provisioning (UCLP) System developed jointly with the University of Ottawa under a contract awarded by CANARIE from their Directed Research Program was successfully deployed on CA*net 4. The UCLP System software was further enhanced under collaboration with the Technical University of Catalonia (UPC) in Spain and then used to carry out a live demonstration from the BADLAB in June 2004 to the EU delegation on e-Infrastructure.

- A series of audio subjective tests were completed to gather data to validate a new multichannel loudness meter developed at CRC. This loudness meter will be submitted to the ITU-R as a candidate technology for an international standard to be used by broadcasters around the world.

- CRC continued collaboration with European research labs in the area of signal processing, through participation in the EU COST-273 program – 'Towards Mobile Broadband Multimedia Networks'.

- CRC signed a Memorandum of Cooperation (MOC) with the Hong Kong Wireless Technology Industry Association, which operates the Hong Kong Wireless Development Centre. This MOC allows CRC and WTIA to cooperate so that SMEs in Canada and Hong Kong can test out applications on wireless platforms in each other's territories (at a reasonable cost) and gain access to each other's markets.

Corporate Activities

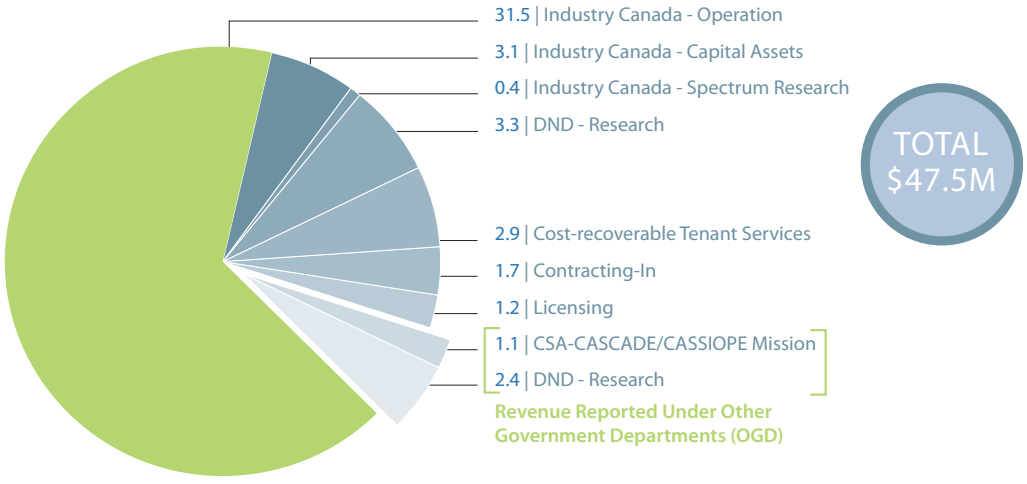
- Several multi-year projects have been instituted to upgrade the aging infrastructure at Shirleys Bay, including the campus electrical distribution system, the storm and sanitary sewer systems and the water distribution system. At the same time, programs are being put in place to train staff in safety related areas including fall arrest, working in confined spaces, hazardous spill cleanup, asbestos abatement and mould cleanup. These multi-year projects and training programs will make the Campus a safer place for its employees and visitors alike.

- CRC developed and launched the International Society Technologies (IST) R&D Network as part of its activities as the National Contact Point for the EU's IST Program. The system is aimed at sharing information with Canadian organizations interested in collaborative opportunities with European organizations. To date, over 200 Canadian organizations have signed up for the network through the web site at www.crc.ca/ist.

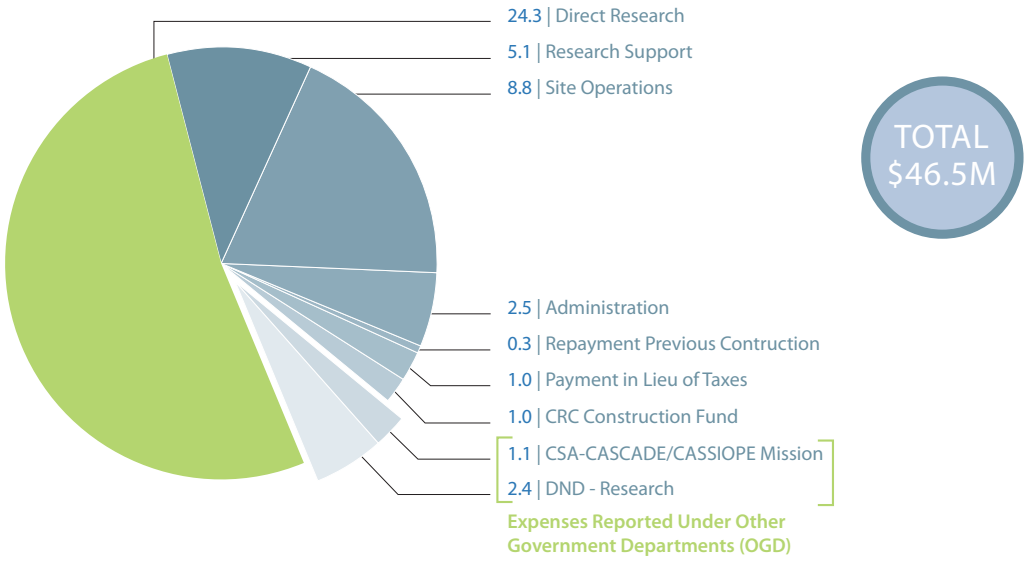
- This year brought the launch of CRC's new external newsletter *Eye on Technology*. This web-based newsletter is produced three times a year and provides readers with information about research activities at CRC. Following the first issue of Eye on Technology, released in March 2005, more than 100 new readers subscribed to the newsletter through the CRC web site.

FINANCES

2004-05 CRC REVENUE



2004-05 CRC EXPENSES



Notes:

(1) CRC receives funding from a number of government and non-government sources. In 2004-05, Industry Canada provided close to 75% 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 tenancy on the CRC campus. Revenue from the private sector is generated through the licensing of intellectual property and contracted R&D.

(2) Construction of the Laboratory for Photonic Components & Systems Research will be completed in 2006-07. The $1.09M from Industry Canada funds unutilized in 2004-05 will be expended in 2005-06 for the Photonics Laboratory construction. Construction of the RAATLab was completed this year.

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