Communications Research Centre Canada
An Agency of Industry Canada

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

CRC Strategic Research Plan 2004-2007

Canada

CRC

EXECUTIVE SUMMARY

The Communications Research Centre Canada (CRC), an agency of Industry Canada (IC), is one of the country's leading laboratories for research and development (R&D) in advanced telecommunications. CRC's vision is one of national leadership in R&D on telecommunications and information technologies. Through our unique expertise and collaborative ways of doing business, CRC is responding to the federal government's goal to increase Canada's innovation capacity and to make information and communications technologies available to all Canadians.

Working within Industry Canada's mandate to help make Canadians more productive and competitive in a knowledge-based economy, CRC's Strategic Research Plan identifies two overarching goals aimed at turning research into opportunities and outcomes that matter to Canadians.

Goal 1: Innovation Leadership

Develop core competencies in the telecommunications field to maintain a high degree of expertise and knowledge needed to respond to and drive advancements in science and engineering for the well-being of Canadians.

Goal 2: Client Support

Carry out R&D for clients requiring expertise in communications technologies and provide technical advice. CRC will continue to provide advice on radio frequency (RF) spectrum use and communications technologies to its parent department, Industry Canada. CRC will also continue to support its federal government clients, National Defence (DND), the Canadian Space Agency (CSA) and others, as well as academia and industry.

In addition, CRC will generate new opportunities for joint research activities that effectively combine resources and knowledge to meet Industry Canada's core strategic objectives: innovation, connectedness, marketplace, investment and trade.

Strategic Priorities

CRC developed six strategic priorities to help meet these goals:

Broadband Access: CRC's Rural and Remote Broadband Access (RRBA) Program will continue to help fill the R&D gap not addressed by industry by finding cost-effective technologies and solutions that will enable and facilitate the deployment of broadband access in Canada's rural and remote areas.

Radio Spectrum: In support of Industry Canada's mandate to regulate radio spectrum, CRC will continue to conduct research and provide technical advice for spectrum allocation and the development of policy and related technical standards.

Internet and Convergence: CRC will focus on predicting and understanding trends and underlying technologies for the convergence of the Internet and other telecommunications and broadcasting technologies. This will allow the Canadian government to make more informed policy and regulatory decisions for the eventual provision of fully integrated services to Canadians.

Network Security and Public Safety: CRC will expand its research in network security in support of a growing need for a secure national network infrastructure and to overcome emerging challenges, such as wireless network security. R&D will also be conducted to rationalize the use of RF spectrum and related communication technologies to improve public safety.

Defence Communications: CRC will continue to provide scientific and technical (S&T) advice to DND in order to enhance the capabilities of the Canadian Forces through advanced communications technologies.

Applications: CRC will continue to provide access to various national and international communications networks used to demonstrate novel broadband applications with potential social and industrial benefits.

In an effort to meet client needs, CRC must also address challenges such as succession planning and campus infrastructure planning – two key elements in building its level of expertise and maintaining its research capacity.

Focused on the Future

Working with our partners, CRC will address these goals and contribute its unique expertise to devise solutions for future telecommunications challenges.

Throughout the years, CRC has focused on research that makes a difference to Canadians. The upcoming years will be no different.

Introduction

Because of Canada's geography, connectivity has always been a great challenge. The challenge was first addressed with birch bark canoes; followed by steel rails, asphalt roads, and runways and airways. By the middle of the last century, a connectivity other than transportation became important – telecommunications.

Government policies of the 1960s recognized this and called for national broadcast coverage and telephone dial tone (at least one telephone in every community greater than 500!). These challenges and those since have been met with remarkable progress in telecommunications technology and applications.

With the relatively recent dawn of the information society, the telecommunications infrastructure is now sometimes referred to as the foundation that supports a knowledge-based economy. Recognizing this, it is now Canada's goal to become the most connected nation in the world and to offer the possibility of broadband access to every community in Canada by mid-decade. This is a goal for which the crossbar rises steadily, requirements increase, and applications become more demanding. However, geographic challenges remain the same and barriers will continue to reappear as ubiquitous access to a more advanced infrastructure becomes highly beneficial.

Since the CRC's last Strategic Plan in 2001, the telecommunications industry has suffered a severe financial downturn worldwide for a variety of reasons. This and other recent events have resulted in both opportunities and challenges for a research organization such as CRC and therefore, the Board of Directors suggested in June 2003 that an updated plan be developed to reflect these new realities and to set a course for the next several years. In particular, the Board emphasized that clear understandable goals should be articulated so that progress against objectives can be easily tracked. This plan has been written with this focus in mind and roughly has a three-year time horizon.

CRC's Mission

As a federal government research laboratory, it is imperative that the R&D activities of the CRC are aligned with the mandate of its parent department, Industry Canada. CRC must also adhere to the principles stated in The Council of Science and Technology Advisors' report, Building Excellence in Science and Technology (BEST), which identifies four major roles that government laboratories must fulfill. These are[1]:

- support for decision making, policy development and regulations
- development and management of standards
- support for public health, safety, environmental and/or defence needs
- enabling economic and social development

In fulfilling these expectations, CRC's primary 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.

Complementary to this primary mission, CRC will also help 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
- working with other research organizations across Canada

CRC's unique position in Canada's communications research infrastructure derives from the fact that it is the only national laboratory with a critical mass of staff, programs, facilities and expertise in the three major technologies that form the basic transport mechanism for information delivery across Canada: radio, satellite and fibre optics. This enables CRC to conduct research activities not only in these areas independently, but also to investigate and understand how they can better operate together to form an efficient seamless communications network.

Industry Canada's Strategic Objectives

Industry Canada has identified five strategic objectives for achieving sustainable economic growth and building a world-leading innovative economy[2]. As an agency of Industry Canada, CRC aligns its research objectives with the following:

Innovation	Improving Canada's innovation performance
Connectedness	Making Canada the most connected country in the world
Marketplace	Building a fair, efficient and competitive marketplace
Investment	Improving Canada's position as a preferred location for domestic and foreign investment
Trade	Working with Canadians to increase Canada's share of global trade

CRC mainly supports the Innovation, Connectedness and Marketplace objectives, and all have been the subject of a great deal of activity during the past two years. In particular, after extensive cross-Canada consultations, Industry Canada (with its partner Department, Human Resources Development Canada) has articulated a number of targets to ensure Canada becomes one of the most innovative countries in the world during the next decade. CRC also supports trade and investment initiatives within the Information and Communications Technology (ICT) sector. This support includes provision of technical advice and expertise for trade and investment missions.

Innovation is not only the generation of new ideas but also the commercialization of research findings in a timely manner and the adoption of new processes and technologies. CRC, with its ability to 'de-risk' new technologies, can play a valuable role in the innovation chain, positioned somewhere between the basic but perhaps unproven research performed in universities and the requirement by industries to get new ideas to the marketplace quickly.

Connectedness, a key part of an economy based on innovation, provides the required infrastructure and ensures that all Canadians have the means to participate in the creation and sharing of knowledge. One of the major innovation targets is the goal that high-speed broadband access is widely available to Canadian communities by 2005. Industry Canada has made a commitment to invest significant funds to achieve this target.

A fair, efficient and competitive *Marketplace* requires regulations, policies and standards that instill confidence and inspire investment. New standards and regulations arise from technological advances in sectors, such as telecommunications and information technology, where Canada must actively participate and defend its interests as a member of a world community. CRC plays an important role in this area by providing scientific advice to Industry Canada and by taking part in international technical committees.

CRC's Strategic Goals

Based on its mission, the objectives of Industry Canada, and the environment in which the lab exists, CRC has identified two main goals to guide its research through the upcoming years.

Goal 1: Innovation Leadership

CRC will continue to develop its core competencies in the telecommunications field to maintain a high degree of expertise and knowledge needed to respond to and drive advancements in science and engineering for the well-being of Canadians.

[1] Recommendations on the federal roles in performing science and technology as presented in the report, "Building Excellence in Science and Technology (BEST)," by the Council of Science and Technology Advisors, December 1999.

[2] Industry Canada – Making a Difference – Our Priorities for 2002-2003

Core Competencies

In order for CRC to continue to perform its mission and achieve its strategic goals, a significant portion of its effort must be devoted to longer term R&D. It is through longer-term R&D that CRC maintains and increases its reputation as the federal government's centre of expertise in communications technology, and generates new intellectual property (IP). It is fundamental that CRC continues to be recognized by its peers, nationally and internationally, for its excellence in research. As one measure of success, CRC ranks among the top federal laboratories in North America for IP revenues resulting from licensing and technology transfer.

At its foremost, CRC is a wireless laboratory and, on the recommendation of its Board of Directors, will endeavor to devote some 80 per cent of its base R&D resources to this communications area. CRC has established and maintains a very unique Canadian R&D capability in a number of wireless communications disciplines, including satellite communications, radio propagation, wireless access and digital broadcast technology. Complementing this is a strong research program in optical communications based on photonics technologies.

CRC's core expertise, as well as its major ongoing and future investments in staff and facilities, can be grouped into the following main areas:

- wireless systems
- communications networks
- radio fundamentals
- interactive multimedia
- photonics

CRC believes that these five areas provide a strong base of expertise to undertake leading-edge R&D activities to meet its clients' needs and to support the federal government's mission to ensure delivery of high-quality communications services to all Canadians, regardless of location.

Wireless systems R&D involves the investigation of hardware components, technologies, and systems for reliable, robust and high capacity fixed, mobile, personal and broadcast communications, as well as technologies and subsystems for existing and emerging satellite networks. CRC is Canada's leading laboratory for satellite communications and broadcasting research.

Communications networks R&D involves the study and development of advanced network protocols with emphasis on interconnectivity and interoperability among various wired and wireless systems, the efficiency and reliability of communications over wireless links, and standards. CRC will continue to expand its R&D activity related to network security and infrastructure, aspects of critical interest to CRC's major client, DND.

Radio fundamentals research involves the study of radiowave propagation phenomena and their influence on wireless communications, as well as electromagnetic compatibility and the effects of fields on communications, electronic and electrical equipment. This area also involves investigation of antenna theories and techniques to improve the performance of existing and next generation wireless systems and the development of techniques and tools for spectrum surveillance.

Interactive multimedia R&D involves investigation of technologies related to the convergence of communications, computer and broadcast networks as they merge into a single web of communication links and services. It also deals with technologies to format information content to adapt to network constraints and meet varying end-user requirements. The activity includes the conduct of applications trials and demonstrations that show the full potential of multimedia-based communications for the end-user community.

Photonics R&D involves investigation into all-optical solutions for the cost-effective delivery of broadband services to the individual, component technologies required to achieve interoperability between wireless and fiber-optic networks, and optical/wireless subsystem components.

Investment in these areas is key to maintaining excellence, generating intellectual property for technology transfer, establishing new partnerships and collaboration across Canada, and enhancing CRC's national presence. In particular, this provides much of the technology base for all client-related activities.

Goal 2: Client Support

CRC's client base includes federal government departments and agencies, Canadian industries and academic institutions that have an interest in a variety of technologies and issues related to telecommunications. In many cases, these stakeholders interact with each other through consortia, working groups and other alliances to exchange information and work together on specific topics. The Canadian broadcasting industry, in particular, has no domestic research capability other than CRC with whom to interact and obtain valuable insight and technical information. CRC is an active participant in many such consortia and continues to be instrumental in forming new alliances in Canada.

A very important and critical part of CRC's R&D work is performed on a cost-recovery basis on behalf of three major clients: Industry Canada, DND and the Canadian Space Agency. In addition, work is done in partnership with other federal departments and agencies. Since the majority of CRC's budget comes from government clients, it is important that these relationships are nurtured and that the organization remains in a position to respond to their future requirements. To diminish the risk of losing a major client, CRC must maintain an ongoing dialogue with its major stakeholders on several fronts (technical, operational and political) as well as a proper investment in those areas that are anticipated hot topics.

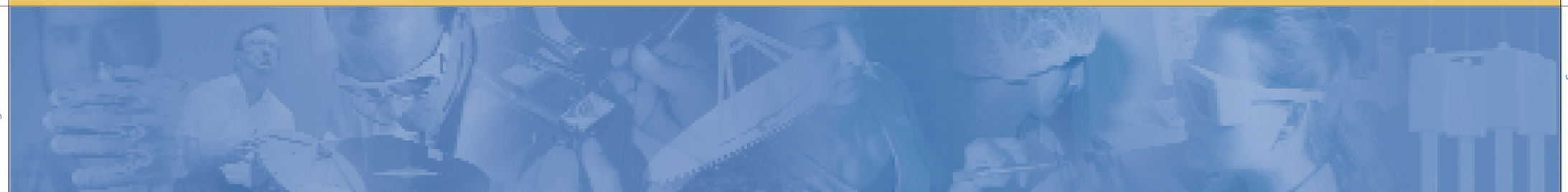
Opportunities also exist to build relationships with new government clients and focused efforts will be made to do so. In particular, the government will be looking at these future horizontal relationships as a way to increase the return on its research dollar investment.

Support to Industry Canada

The CRC provides S&T advice, often on an as-needed basis, to the Spectrum Regulatory and Policy Branches and, in particular, to the Spectrum Engineering Branch, the Information Highway Advisory Branch (especially through the BRAND Program – Broadband for Rural and Northern Development), Technology Partnerships Canada, CANARIE's program and other branches of Industry Canada that have responsibility for communications policy and regulatory decision making. A key to CRC's support is the ongoing Spectrum Research Program for which Industry Canada provides seed funding. Carrying out this program draws on the underlying expertise and knowledge that CRC gains through internally funded, longer-term research endeavors. The R&D covered by the program includes topics related to terrestrial wireless, fixed and mobile satellite services, broadcasting services, electromagnetic compatibility, and telecommunications standards. CRC also acts as the main focal point for all international S&T initiatives in the ICT Sector. The priorities for R&D under this program are jointly determined by CRC and Industry Canada.

Support to the Department of National Defence

The Defence Communications R&D Program is an ongoing cost-recoverable program in which CRC conducts R&D on behalf of Defence R&D Canada (DRDC) under the terms of the Memorandum of Understanding between DND and Industry Canada. CRC receives some 25 per cent of its R&D resources from this arrangement. The overall mission of the program is to provide improved operational capability in the Canadian Forces (CF), and to maintain scientific knowledge and expertise in wireless communications to assist DND and the CF in decision-making. The program is formulated each year under DRDC's business planning process in collaboration with DND and CF clients. The current



program includes projects spanning communication layers from physical, through network to application, and addresses growing military requirements in network-centric operations for communications interoperability, increased information flow, and effective mobile communications in complex environments. The R&D is complementary to the CRC research program and, as such, the synergism benefits both CRC and DND.

Support to the Canadian Space Agency

Recognized as the federal government's centre of expertise in satellite communications, CRC has a long-standing partnership with the Canadian Space Agency (CSA). Along with its A-base supported R&D program in satellite communications, CRC assists the CSA in fulfilling the objectives of the Satellite Communications Program within the Canadian Space Plan. This assistance helps to maintain or increase Canadian industry's share of the worldwide market for satellite communications and to ensure that Canadians have access to the world's most advanced satellite communications technologies. For major domestic satellite communications programs funded by CSA, CRC performs the important functions of program management and scientific authority on a cost-recovery basis.

Support to Other Government Departments

As the federal government's primary telecommunications research laboratory, CRC is in a good position to assist or partner with other departments and agencies on communications issues. For example, CRC is working with the National Research Council on e-learning applications over broadband networks, and both organizations are together cultivating productive relationships with Library and Archives Canada and the National Arts Centre to get culturally-rich content online. CRC is also working with a federal community of interest on technologies related to network security. It should be possible to increase the number of interdepartmental collaborations, particularly as these organizations attempt greater use of broadband technologies to deliver content and services to their respective clients.

Strategic Priorities

Through discussions with Industry Canada, various other clients, board members and CRC management, six major strategic priorities have been developed to define major elements of CRC's research program and associated activities to help CRC meet its goals. CRC believes that these six priorities will ensure that the organization will continue to conduct world-class R&D in areas of importance to telecommunications in Canada, provide a window on the future for policy decision-making and help to address specific challenges faced by various clients.

It should be noted that CRC will not address all of these issues alone, but will continue to foster working relationships and partnerships with numerous organizations across Canada. In most of these partnerships, CRC offers significant expertise in its core strength areas while the other parties either bring complementary scientific expertise or valuable insight into the application and use of a particular technology.

Broadband Access

The objective of this activity is to carry out scientific and engineering research to develop cost-effective solutions for access to broadband services in rural and remote communities in Canada. Its scope ties very well into Industry Canada's major objectives of *Connectedness* and *Innovation* as well as the recently funded BRAND Program.

Radio Spectrum

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

Defence Communications

DND is one of CRC's major clients and research tasks are done on a cost-recoverable basis. Most of the activities are closely tied to CRC's own technology interests, 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

As communications, commerce, defence and other applications become more dependent on the national network infrastructure, the requirement for security and redundancy increases in priority. CRC already has modest research activity in this area but due to its growing importance, some additional tasks will be undertaken in partnership with other Canadian organizations. In particular, security of wireless networks is one of the emerging challenges.

Internet and 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. For example, if high-quality video can be transmitted from anywhere in the world over the Internet onto a large computer screen, what is the potential impact on the Canadian broadcasting industry and its regulations? 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 high-quality applications. CRC is well positioned to use its access to various national and international communications networks to conduct high-quality demonstrations of novel broadband applications, with a particular focus on those with a high degree of social or industrial benefit.

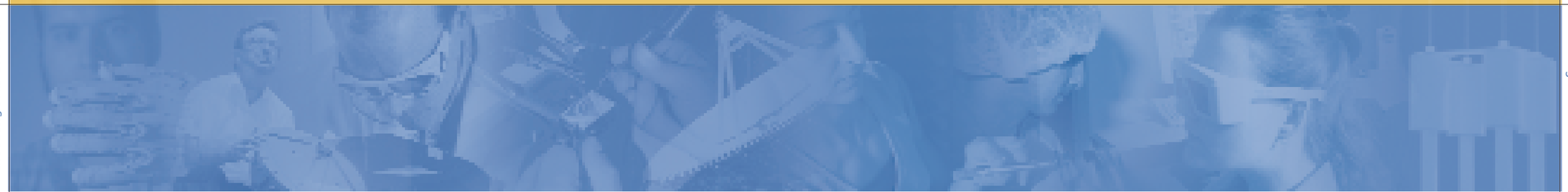
The interrelation between these six priorities and two strategic goals is depicted in the diagram in Appendix A. These priorities are further described in the form of tables in Appendix B. Each priority is detailed in terms of the specific programs and projects that CRC will undertake, their impact, performance measures, linkages and approximate resources. More specific performance measures will be developed on a yearly basis and will be included in operational plans.

Operational Considerations

Human Resources

From the perspective of human resources management, there will be a number of key issues that must be addressed if CRC's strategic direction is to become successful and productive. Foremost, there is a need to clarify CRC's size/growth guidelines to ensure that there is a proper balance of experienced and junior staff with the required skill sets. The current phenomenon of an aging CRC population combined with normal attrition will also influence the development of these guidelines. It is also imperative to examine the capacity of CRC's corporate support organizations to handle any staffing challenges. Solutions include mechanisms for career and succession planning, encouragement of staff and management training, and a flexible culture for employees to maintain a healthy work/life balance.

More broadly, CRC will review the current organization structure to ensure that it supports the direction of its business objectives. Moreover, CRC will need to ensure that there will be a sufficient managerial complement and sound management practices in place to ensure the integration of new recruits into the organization.



In embarking on these initiatives, CRC will continue to ensure that its core human resource practices continue to be in tune with new government policies on hiring, diversity, ethics and values, and that CRC management is fully apprised of the impact that these reforms may have on the ongoing conduct of business.

Finally, CRC will continue to foster relationships with Canadian universities with a view to encouraging graduate student placement in our laboratories to work on projects of mutual interest. CRC already has a number of adjunct professors attached to various universities on staff which should facilitate this effort and also offers the opportunity for professors to spend sabbatical time within the various groups. Student placements are beneficial to both parties and have the positive effect of increasing the resources that can be applied to a given task at moderate cost.

Fixed Assets and Campus Infrastructure

CRC is not only responsible for managing its own assets, but is also the landlord of the Shirleys Bay Campus, a 700-hectare site with a number of other government tenants. As such, CRC is responsible for maintaining much of the infrastructure, some of which dates back to the early 1950s. Although the tenants contribute to this financially, the size and age of the campus makes this task an annual budgetary challenge. However, CRC does find that having a large area of land is critical for research work involving satellite and radio antennas. Furthermore, the campus as a whole has grown to over 1,000 employees and has become a major research centre in its own right, particularly for agencies that require some degree of physical security. CRC will therefore continue to try and address the issue of funding and maintaining this important infrastructure with Industry Canada and Treasury Board.

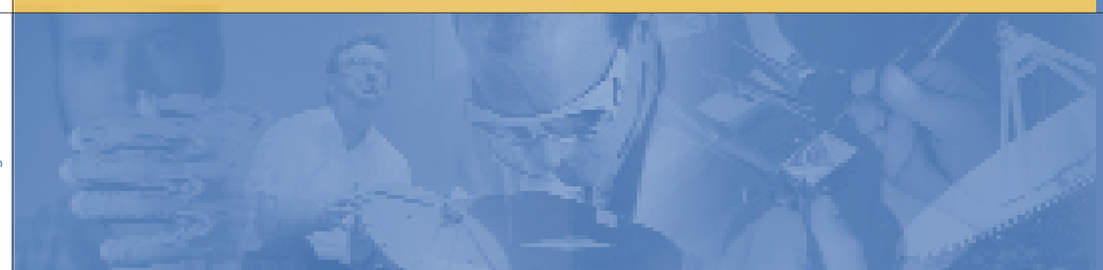
CRC is also in the process of undertaking some additional construction to add new laboratory and office space for its research program. In particular, a new antenna laboratory and an expanded facility for photonics research are currently in progress. Any vacated space will then be modified and used for other programs. Although these projects have encountered some problems and are somewhat behind schedule for a variety of reasons, they are considered important for CRC's future growth and will provide critical space and new capabilities. Therefore, all avenues will be explored to ensure their successful completion.

Finally, a research organization such as CRC requires an internal communications network that is robust, fast and secure. It must operate within the constraints of government regulations but at the same time, be somewhat independent so that new protocols, hardware and services can be tested in a working environment. CRC will continue to review its network infrastructure to determine the best balance between researcher requirements and those applications that need to interact with Industry Canada and other government central agencies.

Conclusion

The telecommunications and information technology sector has always been an exciting and productive area for Canada and this remains as true today as 50 years ago when communications research at Shirleys Bay first started. Although the industrial side has experienced several up and down cycles during this period, the sector nevertheless continues to grow worldwide and market opportunities exist for products that are both timely and add efficiency or new applications for infrastructure operators.

The federal government, for its part, has articulated a number of major objectives for Canada for the next decade, and among these is to become or remain a world leader in research, connectivity and innovation. At the same time, there are a number of operational and policy issues that Canada and other nations face as communication networks become more complex, vulnerable and open to the rest of the world. The leadership opportunities for a laboratory such as CRC are obvious. This plan outlines some of the future directions that CRC, together with its partners, will take to meet the many challenges that are facing us in the future.

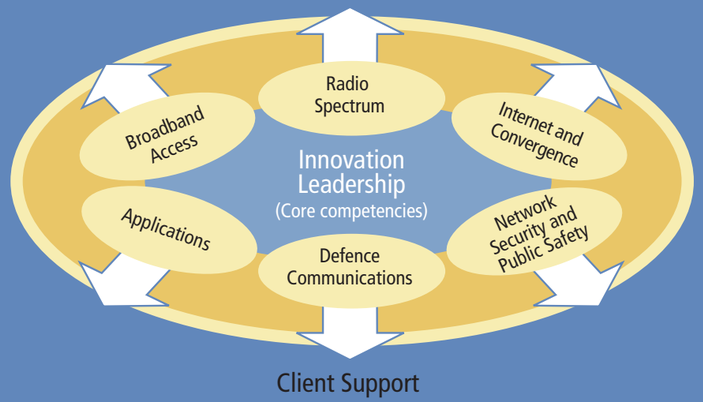


Appendix A

Representation of CRC's Strategic Goals and Priorities

The following figure graphically represents the two strategic goals that were identified in developing the CRC Strategic Plan; namely Innovation Leadership and Client Support. The six strategic priorities described in the plan and detailed in the tables in Appendix B are indicated by the arrows that tap into the core competencies of the CRC to deliver to the various clients of the organization. The core competencies have to be maintained on a long-term basis to be able to feed the various R&D programs underlying these priorities. The concept represented in this chart will be used to develop annual operational plans where performance measures will be defined more precisely.

In the reverse direction, the requests and perceived needs of the clients will result in adjustments to the strategic priorities and these adjustments will, in turn, guide the development of the core competencies so that these competencies continuously evolve to always be relevant.



Appendix B

BROADBAND ACCESS

STRATEGIC PRIORITY	PROGRAMS/PROJECTS	IMPACT ON CANADIANS	PERFORMANCE MEASURES	INDUSTRY CANADA ALIGNMENT	LINKAGES AND PARTNERS	RESOURCES
R&D on innovative and efficient solutions enabling broadband access everywhere in Canada.	R&D programs consisting of sets of coordinated projects on basic research, development of technologies, test beds and subsystems, and field trials and demonstrations of systems concepts and applications. **A**- The Rural and Remote Broadband Access (RRBA) program was initiated in April 2002 and will last until 2007. Under this program, R&D projects are submitted by CRC research managers and evaluated by a program Steering Committee (see note 1) for funding. These R&D projects are then coordinated through this program. The types of projects which focus on Broadband Access are: • MILTON • satcom ground terminals and systems • radio propagation • antennas • signal processing and equipment design • broadband access using digital broadcast technologies • adaptation of TCP/IP and quality of service • optoelectronics and photonics • integrated electronics • internet applications • user preference evaluations, etc. **B**- The Satellite Multimedia Application Research and Trials (SMART) program demonstrates satellite communications services and applications. Together with national and international public and private-sector partners, CRC demonstrates: • tele-health • tele-learning • tele-justice • other applications CRC and its partners are now focusing on demonstrating more advanced broadband multimedia applications that will be commercially feasible with the next generation of Ka-band satellites.	Cost effective high-speed broadband access for all Canadians wherever they live would give them an opportunity to connect to key services and global business opportunities as well as actively contribute to the Canadian Innovation Agenda. Transfer of technologies and IP to Canadian industry for the development of new products and services. The development of new products and services for domestic and international markets should create more job opportunities for Canadians. Benefit to public organizations through development and validation of new technologies capable of delivering their services to a broader audience and at lower cost (tele-health, tele-education, e-government, etc.).	**A** – BRAND and other IC broadband access programs are provided with the necessary technical advice. Broadband systems are successfully demonstrated. Broadband systems field trials are conducted conclusively. A rigorous performance assessment process has been put in place as part of the RRBA program (see note 1). **B** – Successful satellite demonstrations are carried out with active participation from many partners. National and international standardization supported. Patents. Technology and IP transferred to Canadian companies. Revenue to CRC from IP and contracts. Research publications and conference contributions.	Supports IC Connectedness and Innovation objectives as well as social and economic development policy objectives. Supports IC broadband programs (e.g. BRAND). Provides input to IC spectrum policy and regulations. Provides technical input to national and international standards setting for wide applicability of the technology and the ensuing lower cost equipment achieved through volume production. Contribute to the Canadian Innovation Agenda.	Government: • Industry Canada • Infrastructure Canada Industry: • Equipment manufacturers • Service providers Universities Communities: • Municipalities needing technical information International: • ITU-R/T/D, IEEE, etc. Research organizations	CRC's A-Base: RRBA program first year (FY 02/03): $1,065K seed funding supplemented by $3.3M in salary and O&M RRBA program second year: $830K seed funding supplemented by $2.43M in salary and O&M SMART program: $860K per year Contract and IP revenue In-kind resources from partners

Note 1: A Steering Committee has been formed under the Rural and Remote Broadband Access (RRBA) R&D program involving CRC research managers and representatives from IC, universities and industry. This Steering Committee carries out evaluation of the R&D project proposals at the beginning of each fiscal year (FY) and develops comments on preferred evolution of these projects. It prioritizes these proposals for eventual decisions on funding. This committee also evaluates the results of these R&D projects at the end of each FY with respect to relevance to the RRBA program and whether the projects met their milestones and achieved the objectives stated at the beginning of the FY. The Steering Committee generates guidance regarding the continuation of these projects.

RADIO SPECTRUM

STRATEGIC PRIORITY	PROGRAMS/PROJECTS	IMPACT ON CANADIANS	PERFORMANCE MEASURES	INDUSTRY CANADA ALIGNMENT	LINKAGES AND PARTNERS	RESOURCES
R&D to use currently assigned spectrum more efficiently, characterize unassigned spectrum and develop technologies for using it. R&D on innovative concepts, systems and technologies to use, share and/or reallocate the spectrum in a more efficient manner and to better monitor its usage.	A research program consisting of a set of coordinated projects on basic research, development of technologies and subsystems, and demonstration of system concepts to enhance the use, sharing and monitoring of the RF spectrum. The projects include: • radio propagation • channel characterization and modeling for current and new services • interference characterization and mitigation techniques • spectrum monitoring and policing techniques • electromagnetic compatibility requirements • spectrum sharing techniques among various services • impact of Ultra Wideband Systems on spectrum use • increase efficiency of spectrum use through: - advanced modulation and source coding - advanced antenna, circuit and component technologies - Software Defined Radio (SDR), MIMO and innovative network topologies Test beds are developed/maintained to perform engineering testing when required.	More efficient use of existing spectrum and new spectrum will allow meeting the increasing demand for wireless services for an increasingly mobile Canadian population. Technical expertise strengthens Canadian positions in international fora dealing with spectrum allocation in order to meet Canadian wireless services requirements. Transfer of information and technology to Canadian industry will enable them to develop competitive and innovative products and services for the domestic and international markets and thus create wealth and new job opportunities for Canadians.	Timely development of technical bases in support of spectrum sharing studies to be carried by IC. Contributions to national and international standards and regulatory fora such as CITEL, TIA and the ITU-R for new technologies and applications. Client feedback on the deliverables resulting from the various spectrum R&D projects. Development of guidelines for system characterization for new spectrum allocations. Development of advanced system concepts, modulation, source coding and compression techniques applied to specific services or better use of the RF spectrum (e.g. SDR to emergency and/or military communications systems, etc.) New patents granted and licensed to industry. Information and technology transferred to industry for the development of new products and services. Research publications and conference contributions.	Supports spectrum allocation planning, new policy and regulations development. Supports the department's Connectedness agenda through more efficient use of the spectrum. Supports government's broadband access initiative (BRAND). Supports Canada's positions in regional and international regulatory and standards setting fora such as CITEL and ITU-R.	Government: • Industry Canada • Department of National Defence Industry: • Various Canadian security organizations • Equipment manufacturers • Wireless telecommunications service providers Universities and colleges National and international private and public R&D organizations Regional and international organizations (e.g. CITEL, ITU-R, etc.)	CRC A-Base IC Spectrum Research Program Contract and IP Revenue In-kind contributions from partners

DEFENCE COMMUNICATIONS

STRATEGIC PRIORITY	PROGRAMS/PROJECTS	IMPACT ON CANADIANS	PERFORMANCE MEASURES	INDUSTRY CANADA ALIGNMENT	LINKAGES AND PARTNERS	RESOURCES
R&D on techniques, technologies, and systems in defence communications to enhance operational capabilities of the Department of National Defence (DND) and the Canadian Forces (CF).	The Defence Communications R&D Program, conducted on behalf of Defence R&D Canada (DRDC), formulated under DRDC's business planning process in collaboration with client groups, targeted at R&D in wireless communications technologies to enable the CF's goals for transformation to a network-centric force. Characteristics are: high mobility, increased information flow, seamless interoperability in coalition operations, and operation in complex environments (e.g. urban). R&D projects include: • network architectures and protocols for interoperability of heterogeneous systems • ad hoc mobile radio networks for future land and naval systems • network management techniques for protection of networks • signal processing techniques for high data rate communications • adaptive/smart use of radio spectrum to meet demand for more bandwidth • integration of voice and data over wireless • demonstration (HCTCN TD) of technologies to enhance capability of the CF tactical communications system • antennas, microelectronics and software radio techniques for efficient lower-cost systems • high-resolution signal surveillance technologies and EW communications analysis Other projects for National Defence clients, including broadband wireless for UAV trials and network optimization for military satellite communications.	Maximizes benefit of CRC's core competencies in support of DND and the CF objectives. Through S&T advice, enhances the ability of the CF to make informed decisions on defence technologies. Contributes to the success of military operations through new capabilities provided by advanced communications technologies. Contributes to the growth of a Canadian defence industrial capability by transferring technology to industry and conducting collaborative projects.	Advice provided to DND and the CF in decision-making and planning of future systems (e.g. for NATO TACOM 2000). High data rate tactical communications technologies demonstrated that enhance or provide new capabilities for CF operations. Demonstration of military quality-of-service driven network architectures for secure interoperable communications. Influence on new NATO standards for military VHF/UHF communications. Collaboration with Canadian industry and technologies transferred to industry. Collaboration with allied defence organizations, leveraging R&D investment.	Supports DND objectives for a highly-mobile, knowledge-centric, technologically-prepared CF. Supports Industry Canada's strategic objectives on Innovation, Connectedness, Investment and Trade. Supports Canadian positions in international standards organizations (NATO, ITU, IEEE, etc.). Contributes to a more capable and efficient communications infrastructure within government.	Government: • Industry Canada • National Defence • DRDC • Canadian Forces Experimentation Centre • Communications Security Establishment • OCIPEP Industry: • Canadian defence companies Universities National and international research organizations (e.g. TTCP, NATO, US and other allied military research labs)	Defence Communications Program, funded by Defence R&D Canada through DND/IC MOU Other DND clients CRC facilities and collaboration Contract and IP revenues In-kind contribution from partners $4-5M

NETWORK SECURITY AND PUBLIC SAFETY

STRATEGIC PRIORITY	PROGRAMS/PROJECTS	IMPACT ON CANADIANS	PERFORMANCE MEASURES	INDUSTRY CANADA ALIGNMENT	LINKAGES AND PARTNERS	RESOURCES
R&D on technologies, techniques and systems to improve communication networks security, interoperability and reliability in Canada.	1. Integrate the CRC network-monitoring tool with a variety of intrusion detection systems to provide an ongoing overview of a network state, particularly if the network is under attack from external sources. 2. Assess network security using IPsec and VPN technologies. 3. Initiate a project on security in mobile ad hoc networks. 4. Demonstrate implementations of SDR architecture (SCA) to improve interoperability of public safety communication systems. 5. Increase coordination with the Industry Canada/SITT Protocol Analysis Laboratory.	The issue of network security and survivability is one of growing concern for all Canadians, but in particular for government, business and law enforcement agencies. CRC can add its expertise in network systems of various kinds to work with partners on this very important problem. A key impact will be the assessment of the vulnerabilities of networks using several different tools and security protocols, and the sharing of information with other key players in this field. A second impact will be new technologies to improve interoperability and systems for emergency/disaster communications.	1. Comparative assessment of intrusion detection systems through field trials on CRC and CSE operational networks. 2. Comparative assessment of network vulnerabilities using IPsec and VPN. 3. A field trial with NewMIC on the distribution of secret keys within ad hoc networks and new approaches to make distribution and authentication mechanisms more robust when the ad hoc network is not connected to the Internet. 4. Development and demonstration of a reprogrammable radio using the SCA as the deployment software. 5. Joint activities with the Protocol Analysis Laboratory.	This work supports an overall government desire to ensure that communications networks are secure and not vulnerable to attacks, and that Canadians can have confidence when using these networks to conduct their daily business. The work also supports Industry Canada's role in emergency/disaster preparedness.	Government: • Industry Canada • DND • Canadian Security Establishment • Infrastructure Canada • OCIPEP • RCMP NATO NewMIC (Vancouver)	$500K annual approx.

INTERNET AND CONVERGENCE

STRATEGIC PRIORITY	PROGRAMS/PROJECTS	IMPACT ON CANADIANS	PERFORMANCE MEASURES	INDUSTRY CANADA ALIGNMENT	LINKAGES AND PARTNERS	RESOURCES
R&D on enabling technologies and techniques for the convergence of telecommunications systems (Internet, cellular, wireless LANs, radio and television broadcast, cable and satellite distribution) to efficiently deliver a mixture of services for which these systems were not designed initially. R&D on technologies and techniques to deliver advanced applications over the Internet.	R&D programs and projects on basic research, development of technologies, subsystems, test beds, field trials, demonstrations of system concepts and applications. **A** - Convergence of systems Projects include, but are not limited to: TCP/IP mobile communications, interconnection of wireless and wired networks, Voice over IP, systems of systems (e.g., combination of Wi-Fi, cellular and satellite communication networks), broadcasting over the Internet, networks management, bandwidth on demand, etc. **B** - Applications over the Internet 1. Develop software to enable users of optical networks to set up end-to-end connections with guaranteed bandwidth. 2. Develop efficient algorithms for switching and connection management in optical networks. 3. Evaluate multimedia software tools and the IPv6 protocol for collaboration between multiple sites. 4. Develop techniques for HD video conferencing and multicasting over broadband networks Field trials and demonstrations may be carried out to prove feasibility of the R&D results as well as to give visibility to the results of the R&D work.	Increase and facilitate access to telecommunication services for all Canadians through the use of transparent multi-purpose user terminals. Increase of use of electronic communication means: e-business, e-government, e-commerce, e-vote, etc. As the availability of network bandwidth increases for the end user, it becomes important to manage this properly so that a wide variety of traffic patterns can be carried. A key impact will be new techniques to enable a user to dynamically configure the network for a particular application. A second impact is further development of the tools and protocols necessary to make these applications possible. Job creation through transfer of technologies to Canadian industry for the development of new products for domestic and international markets.	**A** - Input to IC for improvement to existing and development of new policy and regulations. Feasibility of access to same or complementary information or services through different delivery systems proven and demonstrated. **B** - 1. Successful test of user-enabled connections over CA*net 4. 2. Demonstration of improved QoS and failure recovery on the NCIT*net test network. 3. Adoption by users in new applications such as e-learning. 4. HD video transmission demonstrated using newly available consumer hardware. Revenues from IP licenses and contracts, patents. Research publications and conference contributions.	IC and CRTC Telecom and Broadcasting Policy. Supports IC Broadband programs and its Connectedness, Innovation and Marketplace agendas. Supports Government Online agenda The work supports the government's role in linking Canadians electronically by developing some of the tools that will be required in future networks, and by helping to ensure that Canada remains a key world player in new Internet developments. The work will also provide some technical insight into future convergence issues for policy discussions.	Government: • Industry Canada • CRTC • Other departments • CANARIE Inc. Industry: • Telecommunications service providers • Equipment manufacturers Universities: • University of Ottawa • Carleton University • Universidad Politécnica de Madrid International: • ITU, CITEL, IEEE, etc. Research organizations: • NRC, • NCIT/NCIT*net	CRC A-Base Contract and IP revenue In-kind contribution from partners $350K CRC annual approx. $192K external for project #1 (all partners) $100K external for project # 2 (university only)

APPLICATIONS

STRATEGIC PRIORITY	PROGRAMS/PROJECTS	IMPACT ON CANADIANS	PERFORMANCE MEASURES	INDUSTRY CANADA ALIGNMENT	LINKAGES AND PARTNERS	RESOURCES
Development and demonstration of broadband user applications.	1. An ongoing in-house program to develop or improve e-learning applications using existing and new software to maximize the user experience of the broadband communications medium (VirtualClassroom Program). 2. A leadership role in a CANARIE-funded program with national and international participants to establish a broadband music education community (MusicGrid Program). 3. An ongoing project to investigate shared virtual reality systems for inter-site collaboration. 4. A series of events to connect the National Library with a selection of community and school libraries across Canada using CA*net 4 (L-Grid Program). 5. Planning activities for a program to connect CA*net 4, Canadian Arctic communities and other circumpolar countries to enable collaboration in areas such as governance of the North and education (ArcticGrid Program).	One of the key drivers for acceptance and use of broadband technology is the availability of high-quality applications. A key impact of this strategic priority will be to demonstrate the value of using broadband communications and interactive software tools to communities of interest such as educators, and to improve these tools after user feedback. A second but equally important impact is to enable content-rich organizations located mainly in urban communities (such as the NAC and the National Library) to connect to and interact with locations across Canada. Finally, this type of research lends itself very well to establishing mutually beneficial collaborations with other countries.	1. The main performance indicator for the VirtualClassroom program is the continuing formation of teams of research scientists and educators to develop and evaluate advanced applications to support the creation of a broadband-enabled learning environment. Examples are the recently completed and successful LearnCanada Program, and the ongoing MusicGrid program (#2 below). 2. Full integration of videoconference and video server applications into the music programs of the various partner sites by mid-2004. 3. Successful completion with user feedback of a field trial of the prototype CRC shared virtual reality collaboration system, including human factors, system performance and QoS (mid-2004). 4. The National Library will have the tools and expertise to conduct these events independently by mid-2004. 5. The first national/international meeting will be held in Canada to establish the ArcticGrid by the end of 2004.	As Canadian communities become more and more connected through initiatives seed-funded by Industry Canada, it will be increasingly important to have applications available for people to use in order to take advantage of the broadband infrastructure. CRC is well positioned to assist both content provider and user communities in connecting together and evaluating new tools and applications, particularly those with a high degree of social benefit. CRC's role in training organizations unfamiliar with these tools and how to connect is particularly valuable.	• Industry Canada • National Research Council • Library and Archives Canada • National Arts Centre • Heritage Canada • Department of Indian and Northern Affairs • CANARIE Inc. • Ottawa-Carleton District School Board • Memorial University, Nfld • Algonquin College • University of Ottawa • Carleton University • Avalon East School District (Nfld) • University of the Arctic • Lewisporte-Gander District School Board (Nfld) • La Commission Scolaire au Coeur-des-Vallées, Québec • Kangiqsualujjuaq, Quebec • Iqaluit, Nunavut • NewMIC, BC • Manhattan School of Music, NYC • Sibelius Academy, Finland • Other international organizations	VirtualClassroom: $120K annual MusicGrid Program: $1.4M (all partners) Shared virtual reality: $250K annual

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