NEW DIRECTIONS

a blueprint for the '90s

Strategic Plan
1993

Communications Research Centre
Centre de recherches sur les communications

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Industry Canada Industrie Canada

MOBILITY IN A GLOBAL NETWORK

(WIRELESS COMMUNICATIONS: THE FIBRE OF THE FUTURE)

The world is witnessing an explosion in electronic communications. New forms of voice, image and data communications have become commonplace. Through radio and television broadcasting, billions of people around the globe now have access to virtually instant information and a vast array of entertainment originating from anywhere in the world. The competitiveness of business depends increasingly on the use of informatics and a modern and versatile communications infrastructure. It is not a surprise that telecommunications and information technologies are the fastest growing sectors of the economy and a significant contributor to the wealth of the nation. The Communications Research Centre and its sister laboratory, the Canadian Workplace Automation Research Centre, are actively participating in this growth, with CRC emphasizing R&D in the communications aspects while CWARC specializes more in informatics applications. This document sets out the strategic plan for CRC.

Society is becoming increasingly mobile. In business and at home, and even while traveling, users are demanding access to a wide range of sophisticated services which rely on telecommunications systems. The traditional separation between the "carriers", wireless communications and broadcasting is disappearing as global networks emerge. Through its R&D contributions and strengths in systems and microelectronics technologies for the wireless delivery of satellite, radio and broadcast communications, CRC has played and continues to play a major role in shaping the development of the Canadian communications infrastructure.

CRC is well positioned to provide leadership in Canada towards the realization of the mobile and wireless world of the 21st century, and we are determined to meet the challenges of this rapidly changing environment. In this strategic plan we are embarking on new directions for the laboratory. We have given CRC a new vision and values which are reflected in a clear mission, a modified organizational structure, new operating principles and enhanced authorities. We will continue to develop and expand our core competencies, and we will use all our resources effectively and creatively. We are committed to close client relationships with other sectors of the Department of Communications. We will seek enhanced client relationships with other departments and will develop and expand partnership arrangements with industries, universities, regional and provincial research centres and provincial governments in order to enhance the mutual transfer of knowledge and technology. In these times of restraint we will establish partnership arrangements to pool our resources to expand the national industrial capability and

contribute to increased national productivity. In these ways, CRC will assist and support the Canadian communications sector in establishing a seamless global network which will both incorporate and rely strongly on wireless and mobile communications.

A particular challenge for CRC is to affirm a mandate as the centre of excellence for communications research for the entire federal government. CRC is traditionally viewed as an organization meeting the needs of DOC*, and to a lesser extent, those of some other federal departments such as the Department of National Defence. A major interdependence on CRC for their communications research needs by other federal departments will be essential if CRC is to move forward. Such an interdependence is a new culture which must be nurtured and developed.

Similarly, through alliances and partnerships with industrial manufacturers and service providers, we expect that existing interdependencies will grow and be strengthened, to the benefit of all.

Canada is challenged in an unprecedented manner to undergo major structural change in order to maintain its status and standard of living. This change will transform us from a resource-based to a knowledge-based society within which we must create sustained social and economic development, and a strong manufacturing base. To succeed, and to maintain Canada's leadership role in telecommunications, there must be a high level of commitment to science and technology and to continuous learning and innovation. The Communications Research Centre, well equipped with great experience in communications sciences and technologies, is part of the solution.

I am proud to present CRC's 1993 strategic plan, which will guide us in new directions as we approach the 21st century.

Jacques Lyrette
President
Communications Research Centre

* When this document was first published, CRC was part of the Department of Communications. It has been part of Industry Canada since June '93.

R&D in the Government of Canada

"The departmental S&T establishments perform roles that are critical to the efficient functioning of modern societies and reflect their complexity and the heterogeneity of situations. A large proportion of these activities are undertaken to support policy advice, develop testing methodologies and support industry in process and product approval. Other intramural S&T activities produce unique, large and sophisticated data bases, our public knowledge infrastructure, that inform both government and business decisions. And, a few establishments operate in formal or informal partnerships with industry to provide strategic technological advances for medium and long term time horizons or operate major facilities required by both government and industry. Finally, some establishments are simply service organizations which provide engineering support to private sector firms or other government departments and agencies.

By expanding knowledge, science becomes a tool for fulfilling government responsibilities and achieving government objectives; it provides information for timely and effective policy and regulatory decisions and establishes the public knowledge infrastructure which is critical to many business and economic development activities. As the quality of science improves, so does the reliability of information and the probability that the choices made are the best ones. It is incorrect to postulate that government is simply a funder of S&T. It is an important user, and the significance and impact of its regulatory and decision-making roles as well as the public goods nature of a substantial portion of its output mean that government S&T must be as good as that anywhere else – in industry, in universities and in private organizations."

NABST: Revitalizing Science and Technology in the Government of Canada, November 1990
Pierre Lortie, Chairman

Contents

Mandate, Mission and Vision

Two primary goals of the Department of Communications are to ensure that:

- Canada's communications systems evolve in an orderly manner, at the forefront of global developments, to serve all Canadians at affordable costs; and
- Canadians have the freedom to choose from a wide selection of Canadian cultural products and information services among the broad international choice being carried through our communications systems.

CRC's mandate is to conduct communications and related research and development to serve the national need, with or on behalf of the Department of Communications, other Federal Government departments and agencies, provincial governments, academia, and the private sector.

Through this mandate, CRC strives to:

- develop and promote the use of communications technologies, systems, and services;
- support the efficient use and management of the radio frequency spectrum;
- contribute to the development of national and international standards in communications technologies, systems, and services;
- provide communications research and development services, advice, and facilities;
- transfer technology to Canadian industry for exploitation;
- contribute technical expertise in support of government policy initiatives; and
- facilitate and participate in international research and development agreements.

Accordingly, CRC's mission is:

"To conduct scientific research and innovative engineering which contribute to the orderly development and accessibility of communications technologies, systems, and services for the benefit of all Canadians".

with a corresponding vision, shared by all employees:

"Leadership and excellence in communications research".

CRC's Values and Principles

Service
To meet communications research needs both within and outside the federal government is our highest goal.

Excellence
To achieve the highest standards of excellence in our R&D programs to ensure that we will remain a leader in the communications research community.

Our Environment
To provide a challenging environment in which superior performance and innovative initiatives are encouraged and rewarded, professional development opportunities are provided, and participative leadership is fostered.

Creativity
To encourage exploratory R&D to ensure an ongoing source of new ideas and skills, as well as to provide the creative environment necessary to attract and retain the best researchers .

Intellectual Capital
To maintain our intellectual capital by emphasizing the medium to long- term R&D needed to address public and private sector needs.

Collaboration
To collaborate with others so as to maximize synergy with the R&D performed by universities, industry, and other research organizations.

Technology Transfer
To promote the marketing, diffusion and exploitation of our knowledge and technologies through technology transfers, licensing, training, scientific exchanges, and standards activities.

Publications
To disseminate our research results widely through appropriate media, symposia, workshops, and library services.

Ethics
To adhere to professional standards and codes of ethics.

Management
To manage our activities effectively with due regard for economy, efficiency, and the achievement of objectives, through teamwork and shared values.

Success Criteria

To gauge the quality and effectiveness of the research work carried out at CRC, a number of success criteria have been defined against which results can be measured:

Development of New and Enhanced Services
What new and enhanced services are available to the Canadian public as a result of CRC innovations?

Spectrum Conservation and Utilization
How has CRC contributed to spectrum conservation and improved utilization?

Technological Advances
What have been the contributions of CRC to technological advances?

Overall Client Satisfaction
Has CRC provided its clients with value for money and met their needs? Has it retained existing clients and attracted new ones?

Enhancement of Scientific/Engineering Knowledge Base
How many papers/reports have been published, is the quality of CRC papers world-class, has it contributed to a better understanding of selected areas of work? Has CRC trained young scientists through active participation in research projects?

Standards
How has CRC contributed to the establishment of new standards to promote the rational introduction of new technologies and services?

Transfer of Technology
How much revenue has been generated from technology licences, how has CRC contributed to job creation/preservation in industry, did it create/enhance domestic industrial capabilities, has it helped make industry more competitive?

Introduction

This Strategic Plan for the Communications Research Centre sets out both challenges and exciting opportunities. It describes the environment in which CRC operates, and outlines a series of "New Directions" which will take CRC on an entrepreneurial course in close relationships with its partners towards the development of a global communications network and services of the future.

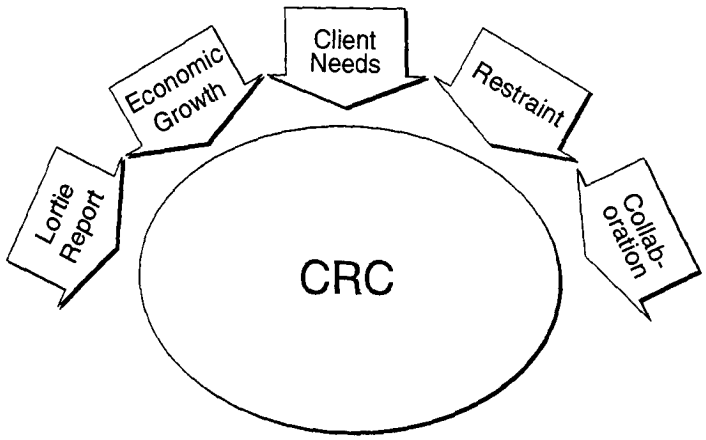
But a strategic plan is built upon more than that. There are important questions which must be posed and answered. The first of these is "what business are we in?" CRC is in the business of R&D in wireless and broadcast communications, including proof-of-concept development and demonstration. We cannot and should not try to be all things to all clients – strategic choices must be made, and a clear focus on R&D priorities must be defined and maintained.

The second question is "who are the clients"? The broad task of CRC is to serve government and the people of Canada. It does this in three ways: first, by supporting policy processes in government through objective and expert advice, it nurtures the introduction and exploitation of new technologies and services; second, it supports industry through the transfer of knowledge and technology, and by direct assistance; and third, by introducing new technologies to all sectors of the Canadian economy, CRC helps to make them more efficient and effective.

The final broad question is "how does the CRC support its clients"? Most importantly, CRC maintains a vision and understanding of the future – the new services that will become available and the technologies that will make them possible. We maintain this vision by keeping a close watch on strategic developments both nationally and internationally, and use it to identify and understand client needs. Through alliances with other government departments, private companies and research networks we ensure critical mass and empower others, and maintain and build on its core competencies.

This document is intended to position CRC for the future. In it, we first give a brief analysis of the environment and external forces which both constrain our actions and provide challenging opportunities. We then identify five new directions which form our response to the challenges of the environment. For each of the new directions, we describe strategic goals and the initiatives that will be used to attain them.

The Environment



CRC is challenged by a number of environmental factors within which we must define bold new directions for the remainder of the decade. There are, however, important opportunities: to exploit the new authorities of the research institute status; to create new alliances and clients; to ensure the development of existing and future core competencies; to develop new management practices; and to enhance the resource base. The management team and staff of CRC are committed to meeting these challenges and opportunities, and in doing so to define new directions which will constitute a blueprint for the nineties.

Of the various external and internal forces acting on CRC, five have been selected as the most important in determining the future directions and priorities. These are:

Response to the Lortie Recommendations

Late in 1990, the Federal Science and Technology Expenditures Committee of the National Advisory Board on Science and Technology presented its report "Revitalizing Science and Technology in the Government of Canada" (the Lortie Report) to the Prime Minister. This report identified a number of impediments to effective R&D and presented a number of recommendations for restructuring R&D in government. On April 1, 1992, as part of a five-year trial based on these recommendations, the Communications Research Centre received increased authorities and developed a renewed mandate, mission and vision. Responding to

this environment is a challenge for both CRC and the Department. This strategic plan is an important part of CRC's response.

Economic Growth

All sectors of the Canadian economy depend on the national communications infrastructure for their survival. In the future, the availability of a wide range of services designed to obtain, manage and and transport information will be extremely important as Canadian businesses compete on international markets. These services will place huge demands on the country's communications infrastructure as the global network becomes a reality. CRC will refocus its research program to ensure that it contributes effectively to understanding and developing the global network.

Response to Client Needs

The Lortie report recommends that client needs be carefully identified and that clients be served through contractual relationships. In addition to serving the needs of the DOC, CRC intends to become the federal focus for communications research, and at the same time to strengthen its relationships with other governments, with industry and with universities.

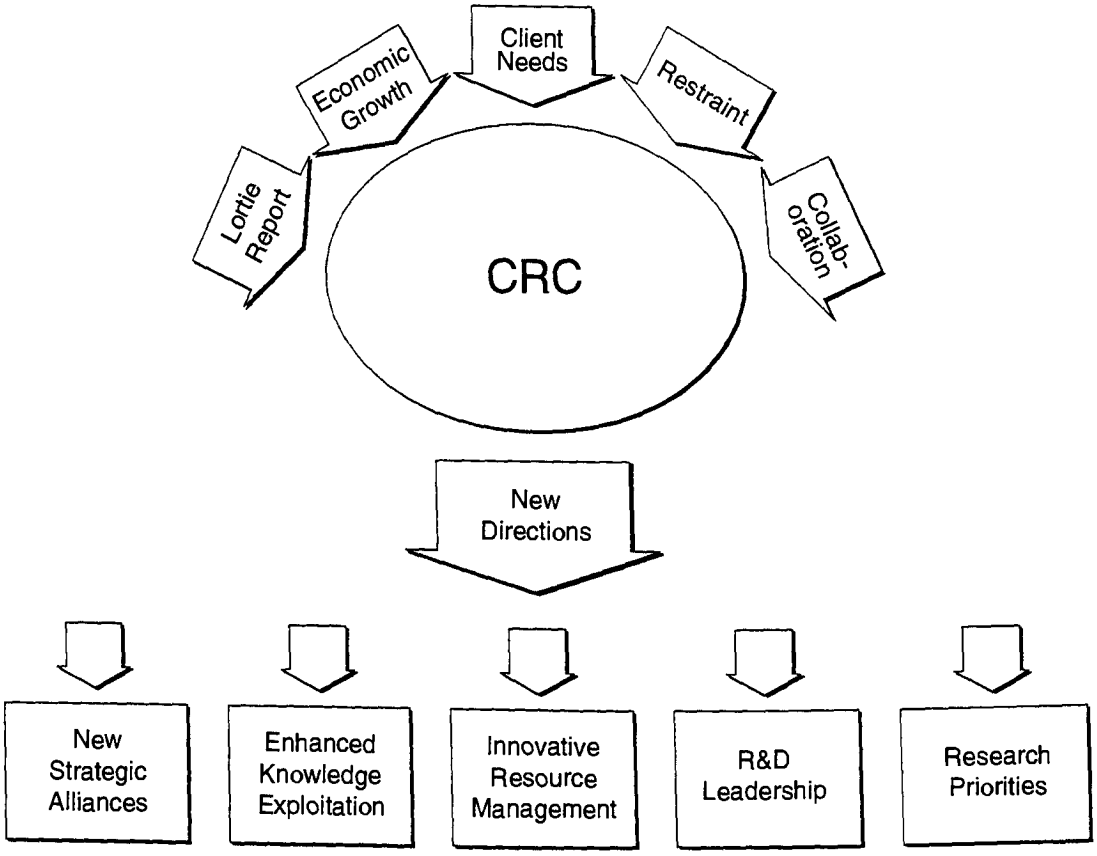
Government Restraint

In a time of economic difficulties and severe government restraint, it will be necessary to manage resources with imagination and to develop partnerships where resources can be pooled in order to ensure the continuing viability of the organization.

Increased Collaboration

Due to the increasing scarcity of resources and a weakened economy, more and more organizations are recognizing the need for and urgency of increased collaboration and sharing of ideas, expertise and resources. Success and the health of organizations will depend strongly on their capacity to forge new partnerships and alliances and to receive benefits from others. These partnerships must be within and between government organizations, and with academia and the private sector.

New Directions



The forces described above have led to the selection of five New Directions for the Communications Research Centre. They were chosen not only because they build on CRC's core competencies, but also because they address particular issues which must be resolved in order that CRC continue to make significant contributions to the continued improvement of the quality of life in Canada.

These five New Directions are discussed individually below.

New Strategic Alliances

CRC currently has a number of alliances and agreements within DOC, with other departments, with universities and with industry. We will pursue expanded client relationships and partnerships in all of these areas. We intend to develop new strategic alliances with four primary classes of clients:

The Department of Communications as a Client

Within DOC, the branches responsible for spectrum management and regulation have traditionally been important clients of CRC, and these relationships have been greatly strengthened through the initiatives of DOC in dedicating spectrum research funds to a broad range of R&D activities which are relevant to spectrum issues. CRC believes that its expertise should more strongly influence telecommunications and broadcast policy and regulatory decisions. Strong, responsive relationships must be developed with DOC's policy branches and with other parts of DOC in order to provide better service to the department.

Over the next five years, CRC expects to develop the following formal agreements:

- The Government Telecommunications Agency provides, on a cost recoverable basis, telecommunications services to most federal departments and agencies. Through its Architect program, it is planning the future networks of the federal government. CRC wishes to negotiate an agreement with GTA to provide R&D activities in new network services.
- To establish closer relations with the Broadcasting, Telecommunications Policy and Telematics and New Media Branches. The considerable support currently provided to CCIR and CCITT activities will continue.
- With the Communications Development and Planning Branch, CRC will collaborate on infrastructure and applications development.

Other Government and Public Institutions

CRC relies strongly on a major strategic agreement with the Department of National Defence. Approximately twenty percent of CRC's research personnel work on DND programs. CRC will work to establish similar alliances:

- DOC maintains the federal lead for R&D in satellite communications, and CRC is presently negotiating with the Canadian Space Agency for a significant, cost recoverable R&D program which will avoid duplication of federal capabilities and facilities, and which will be similar to the existing agreement with DND.
- Industry, Science and Technology Canada has a wide variety of programs aimed at industry development. CRC wishes to be considered an instrument to deliver the policies and mandate of ISTC, and we intend to negotiate a major support agreement with ISTC.
- The federal regional development agencies are performing an important role in the economic development of the country, and we will strive to enter into new partnership agreements with them.
- The provincial governments are strongly encouraging the introduction of new information technologies, and CRC will aggressively pursue opportunities to work together.
- There has always been a strong association between CRC and Canada's universities. Although in many cases this has been a contractual relationship, in others graduate students carry out their thesis work at CRC. Some of our staff are adjunct professors. Our contracts assist in producing centres of expertise in such diverse fields as radiowave propagation and modulation and coding techniques. Through these associations, we have contributred extensively to the knowledge base of the country. As discussed later, we will enhance this pool of knowledge through a series of CRC Scholarships.

CRC intends to provide increased levels of support to a number of other federal departments, such as Transport, and Fisheries and Oceans. As opportunities arise and resources permit, formal agreements will be developed with these departments. As well, we will continue to support and participate in the work of other laboratories and research networks such as TRLabs, NWCRF, CCMC, OCRI and TRIO.

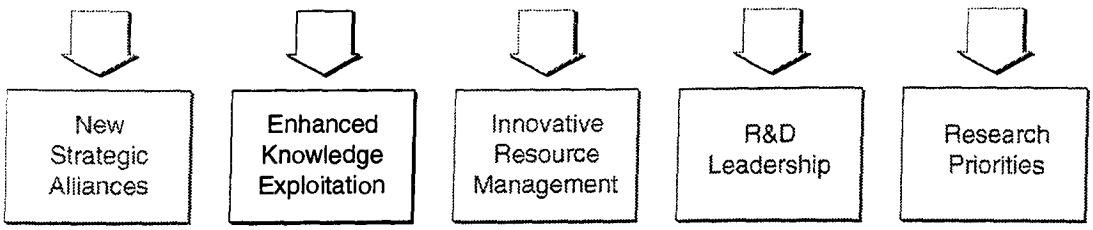
Industry - Service Providers

Private sector service providers develop the communications infrastructure of the country, providing new and enhanced services and new economic opportunities. CRC currently works with several industrial organizations and associations in order to share costs and pool R&D resources. Over the next five years we will pursue partnership agreements on a cost shared basis with at least five service providers.

Industry - Manufacturers

Since its inception CRC has provided scientific and technical assistance to industry throughout Canada through the licensing and transfer of technology and knowledge. This activity will be enhanced through various means described below, and with greater emphasis on cost sharing.

Enhanced Knowledge Exploitation



CRC will exploit its knowledge base and intellectual property in new ways using its expanded set of authorities:

Patents and Licences

Traditional ways of exploiting the knowledge base of CRC have been primarily through the direct provision of advice, and through patenting and licensing. Using its new authority for revenue retention, CRC's intellectual property will be actively marketed and business development cases prepared. The goal is to increase the revenues received from licences and royalties from the current $200K per year to $500K per year within five years.

Training

CRC's skill sets are well suited to the provision of highly specialized training courses, both for internal use and on a fee basis. The goal is to provide three training courses per year within five years.

As resources permit (financed perhaps by training courses), CRC will encourage Canada's future scientists to commit to a career in telecommunications research through a series of CRC Scholarships. The first of these, a scholarship honouring the Canadian radio pioneer Reginald Fessenden, will soon be awarded. Such scholarships will enhance our strong relations with academia.

Technology Commercialization

Although CRC has an exceptional record in this area, there has been no deliberate strategy to nurture spin-off companies, such as ensuring that specialized knowledge and facilities remain accessible to a new company. The goal is to demonstrate that within five years, at least one company has been created through CRC support. In this initiative, we will seek the cooperation and collaboration of ISTC.

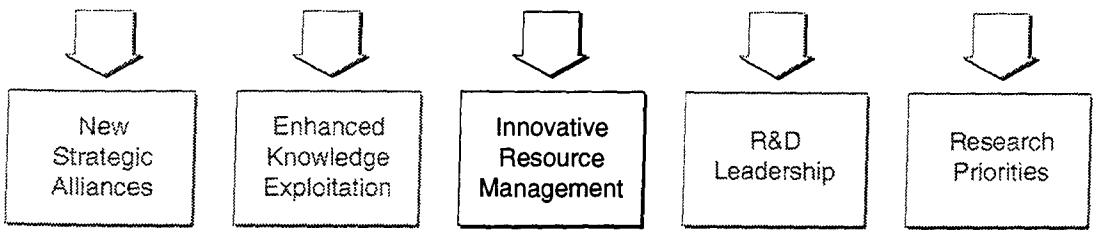
Exchange Program

CRC now has the authority to create an exchange program patterned after the model developed by the Canadian Workplace Automation Research Centre. The goal is to initiate a program that will see a minimum of twenty-five and a maximum of fifty industry and university staff on exchange at CRC within a five year period. Again, the cooperation and collaboration of ISTC will be sought to meet this goal.

Contracting-In

In certain areas, where CRC possesses specialized knowledge and facilities, contracts from outside organizations will be accepted. This work will be carefully planned and monitored to ensure that the laboratory is not in competition with either industry or universities.

Innovative Resource Management



To prosper in this period of severe government restraint, it will be essential to manage existing resources creatively. Although there are difficult resource issues at CRC in relation to site operation and maintenance, there are also significant resource strengths which can be drawn on: physical, financial and human. CRC will exploit these assets in creative ways. This involves a new vision for the CRC campus, with active industry development support on site.

Site Exploitation

A new vision for the CRC campus will be developed, which will encourage sharing of facilities and knowledge in order to support and encourage startup companies.

For example, CRC could could act as an incubator in the exploitation of innovations and the creation of new companies by offering on a cost-recoverable basis and for a limited period office and laboratory space, secondment of key personnel, or research services. The credibility of CRC would help business marketing for the company. Once the company became viable, it would move to another location while CRC would retain appropriate royalties or licensing rights.

It would also be possible to offer similar arrangements to established companies who have a need for particular knowledge or facilities. In such cases, the resulting intellectual property would provide royalties, or support might be provided simply on a fee-for-service basis.

Expanding the Financial Base

Initiatives in expanding our strategic alliances and contracting-in to exploit both our unique knowledge base and our specialized equipment and facilities will diversify and expand the financial resource base at CRC. In addition, areas will be identified where resources may be conserved or exploited more productively.

Through such initiatives and new sources of revenue, the goal is to expand the financial resource base by fifty percent over the next five years.

Human Resources

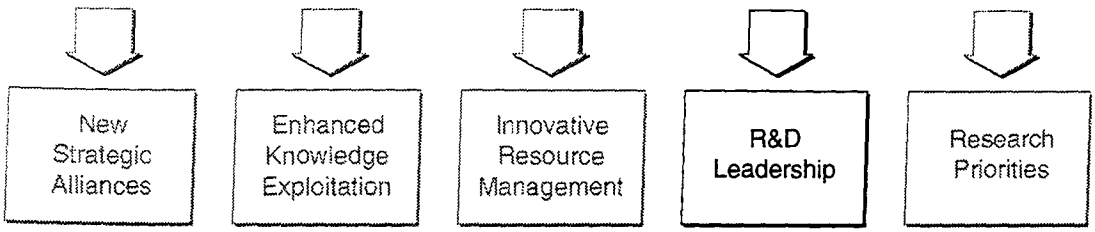
There are four goals in human resource management at CRC. The first is to continuously improve and strengthen our core competencies through diversity of work experiences and formalized training programs. The second is to renew our dedication to excellence in recruiting - we can afford to hire only the very best. The third is to create a strong management succession plan. Finally, we intend to obtain sufficient flexibility in our salary budgets that within five years, ten to twenty percent of the research staff will be under an exchange program. This will be accomplished either by obtaining increased resources through alliances and other initiatives, or by shrinking the existing staff level through attrition or other means. All options will be addressed.

Site Costs and Managing Smarter

The site at Shirley Bay is much like a small town. The escalating cost of maintaining the site is a serious problem principally because DOC has been unable to obtain inflation protection for site costs as is provided to the Department of Public Works. There has been a serious and increasing effect on building maintenance and site infrastructure (roads, sewers, etc.).

The resolution of this problem will not be easily achieved. Some economies should be possible through conservation measures and changed management practices. A review of all site costs has been started. If the exchange/incubator programs are successful, there may be income that could support site costs, either directly or by spreading the costs over a larger clientele. CRC cannot solve this problem on its own.

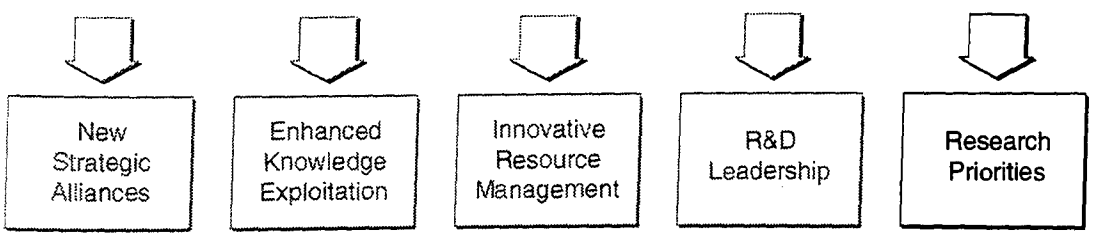
Leadership in Telecommunications R&D



There is a need for leadership in communications R&D at the national level in Canada. There is significant overlap in the communications research programs of federal and provincial networks of centres of excellence, universities, CRC and various companies. Overlap may be beneficial, but should result from deliberate decisions. Both academia and the private sector have suggested that CRC assume a leadership role to help ensure complementarity of research activities where this is appropriate.

Leadership in communications R&D at the national level is a shared responsibility, and CRC is prepared to work with others to provide necessary leadership through the coordination of the research programs at a national level ~~of~~ in the areas of broadcast, satellite and radio communications, and microelectronics.

Research Priorities



At the beginning of this plan, the President's foreword introduces a vision of the developing global network. Along with concepts of services such as interactive multimedia communications and personal global "telephone" numbers, the vision supposes a renewed importance of wireless communications in providing the essential ingredient of mobility in the global network. Other characteristics we might postulate for the network include: bandwidth-on-demand where the

bandwidth necessary for a particular application will be provided automatically at low cost; a distributed and stored intelligence in the network that will be aware of an individual's preferences; multi-national ownerships and transparency of national boundaries; dramatically improved interfaces between the network and the user; and so on.

In the Introduction, CRC's business was defined as R&D in wireless and broadcast communications, including proof-of-concept development and demonstration, and much of the remainder of this document has dealt with clients – the need for strong client relations, strategic alliances and how to better serve them.

A framework has now been built for the selection of research priorities. Internally, we have carried out an evaluation of existing activities, new trends and opportunities, and client feedback. Clearly, our priorities and directions for the near future must be built on our existing core competencies, augmented by new competencies that must be developed to satisfy new priorities. A three-tiered approach has been selected – a first level containing those priorities that directly support our core business in wireless communications, a second level which is more global and provides enabling and supporting expertise to the first, and a final level which provides proof-of-concept and demonstrations of new technologies and systems.

The first level consists of CRC's four principal research areas:

1. Satellite Communications Systems

Satellite communications plays a key role in augmenting terrestrial systems to provide telecommunications and broadcasting services to all of Canada including remote areas. The government, through the DOC, establishes satcom policy and plans spectrum and orbit utilization to ensure that such services are provided in the most cost effective manner.

CRC's prime goals are to stimulate utilization of the next frequency band at 20/30 GHz for personal communications and advanced business services and to participate and encourage industry participation in the implementation of LEO (low-earth orbit) personal communications systems. We have a strong competency in all major aspects of satellite communications R&D.

2. Broadcast Technologies

During this decade, there will be a dramatic increase in new television and radio broadcast services which will allow the consumer to select and interact with entertainment and information programs. Digital technologies will increase broadcast systems performance and reduce spectrum requirements. These new broadcast services will require new policies and strategies, spectrum allocation rules and regulations which will stimulate industry and protect consumer interests.

CRC's research into broadcasting technologies will span the range from enhanced, present-day TV to HDTV, as well as covering interactive broadcast service concepts, network configurations and interconnection, and innovative service applications. CRC has strong competencies in several major areas of broadcast technologies.

3. Radio Networks and Architectures

Common network services of today, electronic mail and file transfer, will soon include integrated applications such as multimedia information retrieval, desktop video conferencing and entertainment services. Interoperability of different networks will become essential. There will be a need to protect user privacy, information and resources, and technical standards will become increasingly important.

Research will focus on network security, network architectures using distributed intelligence to ensure robustness, and radio, satellite and optical access to extend network services to rural and remote areas. CRC is joining the CANARIE consortium, and will work closely with ISTC in furthering CANARIE's objectives. CRC has a competency in rhis area which was developed on behalf of DND. We will form a new group and build on and complement the work being done for DND.

4. Defence Communications

CRC was originally a laboratory of the Department of National Defence, and since the formation of DOC we have maintained a special relationship with DND. Under an MOU between departments, DND pays the salaries and the research costs of a significant program in communications R&D ranging from propagation studies through modulation and coding techniques to military satellite

communications. Currently the salaries of approximately twenty percent of CRC's scientific and technical staff are recovered under this agreement. The program is undergoing a complete review to ensure that it is responsive to DND's new priorities.

The second tier of research priorities comprises areas of knowledge and expertise which support and enable the above:

1. Radio Science

Radio science is the study and quantification of physical limits to the reliability and performance of radio communications systems – propagation effects, radio noise and interference and electromagnetic compatibility. It provides a scientific basis for the development of spectrum policy, and CRC is the only organization in Canada that conducts a comprehensive program to study these effects.

New services such as digital broadcasting and digital mobile communications demand radio propagation knowledge of a type never before anticipated. Priority research areas include propagation studies and model development for emerging services in mobile radio, for digital broadcasting and microcellular communications, at 60 GHz for indoor communications and at Ka-band frequencies for mobile satellite. A new program to examine the effects of electromagnetic radiation on health is planned in collaboration with the Department of Health and Welfare.

2. Microelectronic and Optical Technologies

Microelectronic technologies permit a high degree of integration of microwave, optical, digital and antenna functions within a small area. They are enabling technologies which can provide important solutions for efficient and novel spectrum management techniques, and usage such as wider bandwidth circuitry for portable communications terminals. CRC also uses its unique facilities and expertise to stimulate an industrial capability in several key communications-related areas of microelectronics as a valuable spin-off from its core program.

R&D priority is on the miniaturization of circuits which impact the four principal research areas of the first tier program. Examples include small integrated antennas operating at millimetre-wave frequencies for wideband satellite

communications, chips which converge microwave, optical and digital signals for interface applications, and photonic components for processing information in the all-optical domain.

The third and final tier included in the research priorities contains one item:

1. Proof-of-Concept Demonstrations

Most new technology, system or service application ideas only become meaningful and credible when the idea becomes tangible, and it is usually not possible to interest a potential client in exploiting new technology or services without a proof-of-concept demonstration. Thus the development of prototypes, testing and demonstration become essential ingredients in successful technology transfer to stimulate markets, meet user needs and ensure commercial exploitation. These are found in all telecommunications R&D laboratories in both the public and private sectors.

New targeted areas for demonstration and applications are to develop and demonstrate test beds for robust and high speed computer network architectures; network privacy and security; government applications for mobile satellite; satellite technologies and applications in the 20-30 GHz bands; hybrid microcircuits incorporating photonics and digital and analog circuits; new satellite system concepts for Canada; and new health and educational services/applications.