Communications Research Centre Canada

Radio Science Branch

Profile

performance
management network

Communications Research Centre Canada

Radio Science Branch

Profile

Submitted by:

performance management network

November 16, 2000

Table of Contents

1.0 Profile

1.1 Introduction

This report is intended to provide a summary description or profile of the Radio Science Branch of the Communications Research Centre Canada (CRC). The report begins with an overview of CRC, and continues with a description of the Branch in terms of the major categories of the performance framework approach. These include:

- Branch research groups and their objectives;
- The resources available to the Branch;
- The clients, collaborators and other stakeholders who interact with the Branch;
- The results and impacts of Branch activities, outputs and interactions with other groups.

1.2 Communications Research Centre Canada (CRC) Overview

CRC is the Canadian Government's primary communications research organization. It was originally formed in 1969 as a civilian research centre under the Department of Communications, having evolved from previous military communications objectives. In 1993, CRC was made part of Industry Canada, the federal government's major industrial and economic development agency. The corporate goals of CRC are:

- to be at the forefront of communications science and technology, in order to offer insight to the government for the formulation of industrial strategies, regulations and policies in the public interest;

- to be recognized nationally and internationally as a leading centre of excellence in communications technology R&D addressing Canadian needs and a primary source of independent technical and scientific advice;

- to be a catalyst and central player in a web of industrial and institutional partnerships to ensure Canada maintains its world leadership position in the development and application of communication technologies; and,

- to make sustained and measurable contributions to the growth of an entrepreneurial, innovative communications industry in Canada.

Recently, the CRC Board of Directors has recommended that CRC focus on achieving excellence in long term communications R&D in broadband wireless and photonics, as the organization's contribution to Canada's competitiveness in the global economy.

At the present time, CRC has five research branches. In addition to the Radio Science Branch, which will be described in more detail below, these include:

- Broadcast Technologies Branch, which focuses on R&D and testing related to advanced video and digital television (DTV), digital radio broadcasting (DRB) and datacasting services to be carried over terrestrial off-air channels, satellite, cable, multipoint distribution systems and local multipoint communications systems.

- Satellite Communications, which conducts leading edge R&D to support the evolution of future satellite communications and manages the implementation of the satellite communications component of the current Long Term Space Plan on behalf of the Canadian Space Agency;

- Terrestrial Wireless Systems, which develops concepts and technologies for fixed, mobile and personal wireless communications systems; and,

- Broadband Network Technologies focuses on issues associated with implementation of a broadband network for Canada's Information Highway. These include operability between wireline and wireless services, network

standards and security and the convergence of communications, broadcast and computer technologies.

CRC also has an Innovation Centre where small firms involved in various aspects of communications are incubated and provided with space and access to facilities and advice in their early development stage.

The CRC annual budget for 1999-2000 totals $60.3 million, with $27.1 million coming from A base funding, $19.2 million from the Long Term Space Plan, $6.4 million from the Department of National Defence, and the remaining $7.6 million from Industry Canada Spectrum Engineering, contracts and other revenue generating services.

2.0 Radio Science Branch

2.1 Description

The mission of the Radio Science Branch is:

> *to study and quantify the physical limits to the reliability, quality and performance of radio systems, in order to increase the existing body of knowledge on radio phenomena, and provide scientific and technical information and advice to government and industry to help them plan, select and implement the best wireless systems, networks and services for Canada.*

The research of the Branch provides foundation knowledge to support CRC's research in terrestrial wireless, satellite communications, and broadcast technology. In support of this mission, the Branch conducts research programs related to radiowave propagation, electromagnetic compatibility and advanced antennas. These research programs are described in greater detail below.

2.2 Radiowave Propagation

The objectives of this research program are:

- to study and model radiowave propagation for terrestrial and earth-space telecommunications systems in frequency bands from 1 MHz to 100 GHz,
- to evaluate the influence of radio propagation phenomena on systems and technology, and techniques to mitigate negative effects; and,
- to disseminate information and provide advice to Industry Canada, the Department of National Defence and other governmental and non-governmental

organizations in support of improved spectrum management and design of terrestrial and satellite communications systems.

Facilities include:

- an Earth-Space Propagation Measurement Facility, now configured to measure 20.2/27.5 GHz satellite beacon signal level, radiometric sky noise at 12/20 GHz and meteorological quantities,
- a Terrestrial Fixed Propagation Measurement Site to measure vertical profiles of atmospheric refractive index and related environmental factors; and,
- a Radio Channel Characterization Laboratory to measure complex CW signal /channel impulse response from 30 MHz to 60 GHz.

Research is focused on finding technical solutions to the increased demand for radio communication. This demand has led to two initiatives, exploration of methods to increase the efficiency in use of the radio spectrum and the extension of communications into the 20 - 100 GHz range. In addition, new digital wireless services such as digital broadcasting require propagation knowledge at lower frequencies in more detail and in different forms than analogue systems. The new knowledge obtained about propagation phenomena supports the development of radioclimatological models and engineering tools to support improved design capabilities for future systems. As well, the knowledge is available to support Industry Canada's radiowave spectrum management and development of regulatory frameworks.

2.3 *Electromagnetic Compatibility*

Objectives of this research program are:

- to characterize the electromagnetic environment; and
- to determine its impact on electronic and electrical devices and systems.

Since the electromagnetic fields radiated by an ever increasing number and variety of wireless devices have the potential to cause interference and malfunctions, there is a need to understand and characterize the electromagnetic environment to assess compatibility. The main clients of this research program are: Industry Canada, National Defence, Health Canada, other federal departments and agencies and Canadian industry.

Facilities include:

- an Electromagnetic Compatibility Laboratory, which is equipped to carry out noise measurements up to 1 GHz and near field measurements up to 2 GHz;
- specialized tools (2 multi-component phantom heads) to measure radiation fields in and around humans; and
- access to facilities for the characterization of large antennas.

The government, through Spectrum Engineering, has created an Environmental Task Group to study electromagnetic interference effects. Specific projects with both public and private sector partners include studying the operational environment of large antennas, determining the potential for interference of digital TV signals on various medical devices, and examining the coupling of external fields to enclosed printed circuit boards. The work includes the development of radio frequency (RF) field measurement tools and techniques that are required with the advent of new wireless devices. These tools have been developed and used extensively in industrial collaborations and contracts. The Group is also working with DND to study the electromagnetic hardness of various

electrical and electronic systems and to examine the use of high power microwaves to neutralize landmines.

2.4 *Advanced Antenna Technology*

The objectives of the Advanced Antenna Technology research program are to:

- investigate and develop state-of-the-art hardware and software applicable to low profile structures and active and passive antenna arrays at microwave and millimeter frequencies; and

- develop antennas with improved performance, or increased functionality, to meet the challenging requirements of emerging wireless communication systems.

The group has an Antenna Measurement Facility which includes:

- a far field measurement system for frequencies of 1 - 50 GHz;

- a near field measurement system for frequencies up to 65 GHz; and

- a roof top far field measurement facility and a quasi-optical test bench (under development).

The group has numerous projects involving other CRC Branches, universities, other government departments and industry. The results of the group's work are provided to Industry Canada Spectrum Engineering, National Defence and other government departments and agencies to support the development of new wireless communications systems and regulations, and to Canadian industry for commercial exploitation.

3.0 Resources

In 2000-2001, the Radio Science Branch has a total budget of $3.3 million, to support about 37 full-time equivalent staff, with a salary budget of $2.3 million, and $1 million in operating funding. Table 1 below, provides a breakdown of the sources of funding and utilization of resources, based on the 2000-2001 Operational Plan. A-base funding provides almost 80% of operational resources. External funding sources include DND, Spectrum Engineering, CIDA and industry. DND is the largest single source of external funding, providing almost $300K in salary and non salary funds, and Spectrum Engineering provides $85K in direct project specific funding. Of the 37.3 full-time equivalent personnel, 32.3 are provided from A-base funding and the other 5 from contract revenues, grants and special funds.

Table 1: Branch Resources

	FTEs*		O&M FUNDING ($000s)					
	A-Base	Other***	A-Base	Spectrum	IP	Cont. In	Other	Total
VPRS**	4		68				66	134
RVEP	15	0	270	40	6	22	10	348
REMC	6.3	1	126	35		46	6	213
RAAT	7	4	140	10		30	142	322
TOTAL	32.3	5	604	85	6	98	224	1 017

* Salary budget is $2.3 million

** Includes VP and Branch administration and support

*** Includes project paid employees

4.0 Outputs

The immediate outputs of the activities of the Radio Science Branch include new knowledge, new and improved test procedures, new and improved products and processes, research and test results, and technical advice and assistance. As well, the Branch produces trained individuals through co-op, post doctoral fellowships and guest worker postings. Examples and indicators of each of these types of output are described below.

4.1 New Knowledge

New knowledge is produced in the form of scientific and technical papers, reports and presentations at conferences and seminars.

4.2 New and Improved Policies, Regulations and Test Procedures

Contributions to new policies, regulations and test procedures are usually produced through participation in the International Telecommunication Union, Radiocommunication Sector (ITU-R). For example, the Radiowave Propagation Group has recently contributed to the revised procedures for applying propagation information to design various satellite telecommunications systems.

4.3 New and Improved Products and Processes

Although not a primary output, new products and processes are produced in the course of undertaking research and development. An example would be the development of an L band antenna for use with a new commercial receiver. Another example would be the software program CRC Predict, which calculates VHF/UHF signal strength in the

presence of various natural and man made obstructions. These products and processes can be patented and licensed for manufacture or use.

4.4 Research and Test Results

These outputs arise from research and testing performed for example as input to technical discussions with Spectrum Management, or as part of contract research. These outputs are often important intermediate outputs used to produce further outputs or results.

4.5 Technical Advice and Assistance

R&D activities undertaken increase the knowledge and expertise of Branch staff. This expertise is provided in the form of technical advice and assistance to the full range of partners, collaborators and clients of the branch, including other CRC Branches. An example would be the technical advice and assistance provided to Spectrum Management directly or through participation in international technical bodies on behalf of Canada, such as the ITU-R.

4.6 Highly Trained Personnel

As a result of their involvement on Branch R&D projects, undergraduate and graduate students and other guest workers acquire new knowledge and expertise. This new capability and expertise is made available to the organizations they are working with following their stay at the Branch.

5.0 Reach (Partners, Collaborators and Clients)

Radio Science Branch has an estimated 40 - 60 active partners, collaborators and clients from the university, government and private sectors. Some of these have a longstanding intensive relationship, others have a very short term minimal one, such as provision of several days of advice or services. The various types of relationships and partnerships are categorized below.

5.1 Canadian Public Sector (Policy/Regulatory/Security)

The most important clients of the Radio Science Branch are the Spectrum Management and Spectrum Engineering Groups at Industry Canada. This Branch, like other CRC groups, provides technical support to policy and regulatory decision makers in the areas of wireless communication activities. Another important group in this category is international regulatory agencies such as the ITU-R. Department of National Defence and the Canadian Securities Establishment are other important public sector clients of the Branch. Finally, the Radio Science Branch collaborates with other CRC Branches

5.2 Universities

Canadian and international universities collaborate with the Branch groups on many research projects of common interest. For example, The University of Manitoba and the Advanced Antenna Group have a joint project funded by an NSERC Strategic Grant. Local universities (Carleton, Ottawa) are involved as well as several in other provinces and other countries (U.S. and U.K.).

5.3 International Agencies

Radio Science Branch also does collaborative and funded work with other national and international organizations in areas where the branch can provide testing and research. For example, the Radiowave Propagation Group is a member of the NASA Propagation Experimenters Group, collecting and analyzing propagation data from various sites. The Branch is also assisting in training engineers from India to develop antennas for terrestrial and satellite communications, with funding from CIDA.

5.4 Telecommunications Manufacturing and Services Industries

Radio Science Branch has provided product development and testing, and technical assistance to a number of individual Canadian and foreign firms. Depending on circumstances these projects can be collaborative or fee-for-service. In addition, Canadian firms have licenced products developed by the Branch for commercial exploitation. An example is CRC Predict, which has been licenced to a local firm for use in a software product developed to predict terrain effects on radio propagation.

6.0 *Intended Results and Impacts*

The intended results and impacts of the activities and outputs of the Radio Science Branch are achieved through influence on the partners, collaborators and clients of the branch, and the wider communications community. The specific results vary considerably, depending on the particular beneficiary group. In addition, impacts occur sequentially, with direct outcomes usually occurring either during or immediately following the interaction, and longer term impacts flowing later from the direct outcomes. These longer term impacts often occur among a wider group of beneficiaries than those identified under direct outcomes. The following sections present typical intended early results and longer term impacts for each of the groups identified in section 5 of this report.

6.1 *Canadian Public Sector (Policy / Regulation / Security)*

The development and dissemination of new knowledge and provision of technical advice to government agencies responsible for setting communications policy and regulations (such as Industry Canada's Spectrum Management and the CRTC) is intended to result in improved decision making which is fully informed concerning technical issues. Longer term impacts include improved management of the electromagnetic spectrum, in particular those bands reserved for radio and television use.

Participation on international technical committees is intended in the short term to provide intelligence to Canadian policy and regulatory agencies on international developments and priorities, and to contribute to improved international regulations and guidelines. Longer term impacts include assisting Canada in remaining abreast of international developments, influencing development in areas of importance and interest to Canada, and keeping Canadian policies and regulations well positioned vis a vis the international environment.

Radio Science Branch support to the military is intended to result in better communications and other electronic systems for Canadian and allied military forces. For example, the Branch has been involved in testing the susceptibility of military equipment to strong electromagnetic fields to ensure the availability of equipment to perform in battlefield situations. The Branch has also studied the use of intense microwave fields for detecting and neutralizing landmines.

The results and impacts of working with other CRC Branches are to provide more extensive and integrated services and capabilities to meet client needs.

6.2 *Universities*

The intended result of collaborations with Canadian and international university researchers is to extend and complement the Branch's research capabilities, to increase the quality and amount of radio science research being done which is relevant to Canadian needs, and transfer knowledge from academia to the Branch and vice versa. Additional benefits to Canada include training of highly qualified personnel. Longer term impacts include building improved relationships with the university research community, increasing university-industrial linkages and increasing the supply of researchers in this field. Collaborations with university and other research groups are also intended to provide strategic intelligence as to the important new directions for communications research to meet future Canadian public and private sector needs and support decision making within the Branch on strategic research directions.

6.3 *International Agencies*

Collaborative and contract research with the agencies of other governments is intended to generate and gather additional information, provide additional experience in the application of various technologies and systems and improve the ability of the Branch to

provide relevant advice to Canadian public and private sector organizations, and international organizations, like the ITU-R. An additional impact is improvement in the visibility and credibility of CRC internationally.

6.4 *Telecommunications Manufacturing and Services Industry*

The intended results of working with individual firms is to support the transfer of technology, the development and introduction of new and improved products, processes and systems, and help establish and maintain Canadian industry as an active presence in the international wireless arena. Longer term impacts include increased technical know how, improved decision making, and increased sales, reduced costs and similar measures associated with increased competitiveness and economic success for the firms being assisted.

7.0 Radio Science Branch Performance Framework

Table 2 on the next page summarizes the major components of the Radio Science Branch discussed in the previous sections using the performance framework approach. It describes the Branch in terms of resources (the activities performed and outputs created by the use of financial and human resources), reach (the clients, collaborators, partners and stakeholders which the Branch influences), and results (immediate and longer term results and impacts which occur because of the Branch).

Table 2: Radio Science Branch Performance Framework

Mission Statement:	To study and quantify the physical limits to the reliability, quality and performance of radio communications.
Resources:	37.3 full time equivalent employees, $3.3 million in total funding (2.6 million A base, $700K external)

HOW?	WHO?	WHAT do we want?	WHY?
Resources	Reach	Results	
Activities / outputs	Users / clients / co-deliverers / beneficiaries	direct outcomes	ultimate impacts
Research, Development and Testing ▸ radiowave propagation ▸ electromagnetic compatibility ▸ advanced antennas Development and Operation of Test Facilities Publications / Test Results Advice / Assistance Management ▸ contracts ▸ projects ▸ staff	Federal Government: ▸ Spectrum Management ▸ DND ▸ CSA ▸ CIDA Universities ▸ Canadian ▸ Other International Regulatory Agencies ▸ ITU-R International Agencies ▸ NASA, NATO Telecommunications Firms ▸ Technical service providers ▸ Manufacturers, systems integrators ▸ Wireless service providers	Technically aware policy and regulatory decision making Improved use of technology by government agencies Canadian influence in international standards development Awareness, use of Canadian capability Increased awareness of propagation, electromagnetic noise and interference, and antenna information, technology and applications, international developments by government and industry New and improved products, processes and systems	Best use of spectrum Technically effective, efficient public communications policy, regulations Improved government decision making in use of communications technology Canadian influence in international regulatory system Canadian policies and regulations aligned with international requirements Increased competitiveness of Canadian broadcast and telecommunications manufacturers More informed, appropriate decisions by public and private sector wireless communications stakeholders

DATE DUE
DATE DE RETOUR

CARR McLEAN 38-296