Planning Report for the Review of the Radio Science Branch of the Communications Research Centre Canada

performance management network

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Submitted by:

performance management network

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Table of Contents

1.0 Introduction

The Communications Research Centre Canada (CRC) has decided to undertake a formal review of the various organizational units which make up CRC. CRC has 5 Research Branches, each of which focuses on a specific area within communications. In 1999, a review of the Broadcast Technologies Research Branch was completed, and a summary of the results presented to the President and the Management Board. Based on the results of this review, CRC management has decided to continue the practice, and has selected the Radio Science Branch for the next review study. This review will follow a similar methodological approach as the previous study. It will also incorporate a number of lessons learned, including involving Branch management more fully in the study. In keeping with this approach, a seminar was held September 22, 2000, attended by the review consultant and the President, in which the Branch Vice President and the three Branch Research Program Managers gave detailed presentations of the work of the Branch to provide context to the review.

This Planning Report is intended to provide an outline of the approach to be taken in undertaking the review. It begins with a summary description of CRC and the Branch (Section 2), and follows with a discussion of the issues to be examined (Section 3), and the methodological approaches to be used in conducting the review (Section 4). The report concludes with the planned schedule for undertaking the review (Section 5).

2.0 *Description of Communications Research Centre Canada (CRC) and the Radio Science Branch*

The following is a summary description of CRC and the Radio Science Branch. A more complete version can be found in **Annex A** which contains a **Profile of the Radio Science Branch.**

2.1 *Communications Research Centre Canada (CRC)*

CRC was originally formed in 1969 as a civilian research centre under the Department of Communications, building on former military communications facilities and expertise. CRC has become the Canadian government's primary communications research organization. In 1993, as a result of a major government reorganization, 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.

CRC has five Research Branches. In addition to Radio Science Branch, which will be described in more detail below, these include Satellite Communications, Broadcast Technologies, Terrestrial Wireless Systems and Broadband Network Technologies. CRC also has an Innovation Centre which supports the development of emerging firms and the transfer of technology to Canadian industry. In 1999-2000, CRC had an annual budget of $60.3 million.

2.2 Radio Science Branch

2.2.1 Objectives, Activities and Outputs

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. The Branch also provides technology development and testing, and advice to government (Industry Canada's Spectrum Engineering, DND and CSA) and private industry related to satellite and terrestrial wireless communications systems. 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.

Radiowave Propagation Research has several objectives: 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 to disseminate information and provide advice to Industry Canada, the Department of National Defence and other governmental and non-governmental organizations to support improved spectrum management and design of terrestrial and satellite communications systems.

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. 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 spectrum management and development of regulatory frameworks.

Electromagnetic Compatibility research objectives are to characterize the electromagnetic environment and determine its impact on electronic and electrical devices and systems. The government, through Spectrum Engineering, has created an Environmental Task Group, to which the group belongs, to study these effects. Specific projects include working with both public and private sector organizations to study 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 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.

Advanced Antenna Technology objectives are to investigate and develop state-of-the-art hardware and software technologies applicable to low-profile structures and active and passive antenna arrays at the microwave and millimeter wave frequencies, and develop

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

The research, development, testing, and advisory activities carried out by these three research groups result in a number of outputs which are listed below:

- new knowledge;
- new and improved standards and test procedures;
- research and test results;
- technical advice and assistance;
- new and improved products and services; and,
- trained highly qualified personnel.

2.2.2 Resources

In 2000-2001, the Radio Science Branch has a total budget of $3.3 million, which is approximately 5% of CRC's total budget. These resources are used to support up to 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: Radio Science 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

2.2.3 Reach

Radio Science Branch has a number of Canadian and international public and private sector partners, collaborators and clients with whom they interact. Within the public sector, they include the following:

- Canadian communications regulators (Industry Canada Spectrum Engineering Branch);
- Department of National Defence;
- Canadian Space Agency;
- Universities;
- International telecommunications organizations; and,
- Other foreign government agencies.

In the private sector, the branch works primarily with Canadian wireless communications services and manufacturing firms.

The total number of organizations with which the branch has significant interactions is estimated to be 30-40. However, taking account of multiple interaction partners in some organizations such as Spectrum Engineering and universities, the total number of interaction partners rises to approximately 50.

2.2.4 Intended Results

The intended results of branch activities and interactions vary by type of partner or client. For public sector partners, intended results include:

- Technically informed communications policy and regulatory decision making within Canada;
- Best use of the communications radio frequency spectrum;
- Canadian influence in international broadcast and telecommunications policy and regulatory bodies; and,
- support for the development and use of advanced communications systems by DND and CSA.

For private sector partners intended results focus on the improved competitiveness of the Canadian wireless communications services and equipment manufacturing firms and sectors.

2.2.5 Radio Science Branch Performance Framework

The description in the previous sections of the major elements of the Radio Science Branch can be summarized in terms of an overall Performance Framework, which is presented in **Table 2,** next page

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 ▸ Wireless services 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

3.0 Study Purpose and Issues

3.1 Study Objectives

As discussed in the introduction, CRC management decided several years ago that a review of specific research activities and programs could provide useful information to assist decision making and support accountability. The Broadcast Technologies Research Branch was chosen for the first in-depth review, which was completed in September 1999.

Based on the results of that review, CRC management decided to continue the process, and has selected the Radio Science Branch for the next review. This second study will follow the general methodological approach used for the first study, and will benefit from several lessons learned.

Government policy with respect to the role of government research laboratories has evolved considerably over the past 10 years and CRC management is interested in whether the activities and objectives of the branch remain appropriate and effective in meeting government needs. In making this assessment, it will be important to determine, as in the previous review, who the beneficiaries of branch activities are and what benefits they receive. The study will also examine what benefits CRC receives from its clients and collaboration partners.

Management of government laboratories has also evolved considerably. S&T initiatives, like other government programs, are required to demonstrate the effective use of taxpayers resources. These include determining and ensuring the most effective mix of strategic and collaborative research, development and testing to meet client needs and to achieve the best results and impacts. Management is also interested to determine to what extent the objectives of the branch activities are being met.

Recently, government has asked that all its organizations take account of client feedback, particularly concerning the quality of services and interactions. CRC is no exception, and a review provides an opportunity to obtain client perspective on a number of aspects of the Branch, including the capabilities of Branch staff, quality of facilities, advice and test results, and client relations.

This review of the Radio Science Branch will benefit from the experience gained in conducting the previous review study.

3.2 Study Issues

Based on the input from CRC management and their requirements for information to demonstrate accountability and support decision making, the following two issues have been developed. Each issue has a number of sub-issues to help define information and analytical requirements. While the specific issues developed for this study were determined by CRC management, they are consistent with generic review topics suggested for use in the federal government, which include rationale and relevance, objectives achievement, design and delivery and alternatives.

Issue 1. To what extent are the programs and activities carried out within the Radio Science Branch relevant and effective in terms of the appropriate role of government laboratories?

1.1 Is there a continuing need for the research and testing carried out within Radio Science Branch programs?

1.2 Who benefits from the Radio Science Branch programs? In what manner?

1.3 How effectively is the Radio Science Branch meeting Canadian public and private sector needs for information and advice about existing and emerging radio science knowledge, technologies and systems?

1.4 In what manner does the Radio Science Branch contribute to the mission of CRC?

1.5 Is the Radio Science Branch within CRC filling an appropriate role for government?

Issue 2. To what extent does the quality of research, advice and services provided by the Radio Science Branch meet the needs of clients and collaborators?

2.1 In what manner do publications from the Radio Science Branch contribute to meeting Canadian and international needs for new knowledge?

2.2 Do clients and collaborators have confidence in the quality of research, advice, testing and other services provided by the Radio Science Branch?

2.3 Are Radio Science Branch collaborations and services meeting the needs of clients?

2.4 Are the capabilities of Radio Science Branch staff and the quality of facilities appropriate to the needs of clients and collaborators?

2.5 What is the nature and extent of collaboration with other CRC Branches and with other organizations?

4.0 Review Study Plan

This section presents the overall approach chosen to gather appropriate evidence to reach credible conclusions on the study issues and sub-issues. The approach is based on normal review practices of using several complementary methodological approaches to gather multiple lines of evidence. For each issue and sub-issue, there is at least one major source of information, with several supplementary ones. Each of the methods will be tailored to the specific information sources and requirements.

Based on the information provided in the preliminary document review, interviews and preparation of the profile, the following methods are proposed:

- Industry Canada, CRC and branch document and file review and analysis;
- Publication analysis;
- CRC and branch staff interviews;
- Personal and telephone interviews with partners, collaborators and clients;
- Expert interviews;
- Interviews with students; and,
- Case studies.

In addition, a workshop with CRC and Branch management and possibly selected stakeholders to review study results and provide input on draft conclusions and recommendations is proposed.

Table 3 provides an overview of the applicability of each methodology to the issues and research questions. As stated previously, several lines of evidence contribute to providing credible analysis and conclusions on each sub-issue. Each methodology is described in more detail in the sections which follow. In most cases, each methodology will be adjusted to the different information sources contained in each category. For example, the interviews with partners, collaborators and clients will be modified by subgroup, with Spectrum Engineering interviewees being asked different questions than fee-for-service clients receiving test results.

Table 3: Linkage of Methodological Approaches to Study Issues

Issues	Doc / File	Publ'n Anal	CRC Int #	External Int #	Expert Int #	Case Studies	Work Shop	Analysis & Int
Issue 1								
1.1	M	L	M	H	H	L	M	H
1.2	H	M	M	H	L	H	M	H
1.3	M	M	M	H	M	L	M	H
1.4	M	L	H	H	L	M	M	H
1.5	M	L	M	H	H	M	H	H
Issue 2								
2.1	L	H	M	M	M	L	L	H
2.2	M	L	M	H	H	M	L	H
2.3	L	L	M	H	M	M	L	H
2.4	M	L	M	H	H	M	L	H
2.5	H	M	M	H	L	M	M	H

Key H = high relevance / importance - a key method
M = medium relevance / importance - a contributing method
L = low relevance / importance - a method which may provide useful insight
# interviews to be carried out by professional interviewer with experience in S&T evaluations

4.1 Document and File Review and Analysis

Document and file review and analysis forms the foundation on which other elements of the review are built. A number of different types of reports and files will be used both for providing evidence to answer the issues and also to support study design. For example, a review of Industry Canada and CRC documentation will provide insight into the objectives of CRC and the branch and contribute to the analysis of the role expected and played by the branch. The recent special review of CRC's implementation of the Lortie model will provide a strategic perspective. At the other extreme, Branch files and data will be important sources of information to support analysis of the types of interactions, client profile, and to select interviewees and case studies.

4.2 Publication Analysis

This plan recommends that publications from the past 3 years be analyzed in terms of their intended audience and for evidence of formal collaborations with other CRC branches and partner organizations. Other than to identify which publications are in peer reviewed journals, no separate review of the quality of publications is intended. Rather, independent information on research quality will be obtained from interviews with partners, collaborators, clients and experts.

4.3 CRC and Branch Interviews (Internal)

Once again, this methodological approach will gather information on strategic and operational issues, depending on whether the interviewees are primarily managers or researchers. A total of 10 interviews averaging 30 minutes are proposed with both managers and operational staff in both professional and technical support roles.

4.4 Partner, Collaborator and Client Interviews (Interaction partners / recipients)

This interview group is made up of a variety of subgroups from academia, and the public and private sectors. The ability of each subgroup to provide relevant information varies depending on the issue and research question. A total of about 30 interviews averaging 30 minutes are proposed for this group using an interview guide modified for the various subgroups. Interviews will focus on service quality, benefits and impacts and relevance of branch research to public and private sector operational and strategic level needs.

4.5 Expert Interviews

Interviews with 6 individuals selected on the basis of their in-depth knowledge of the role of radio science research and technology in the development and implementation of wireless communications policies and regulations will complement the other interviews and contribute to the issues of relevance and appropriateness.

4.6 Case Studies

Case studies are a valuable tool to probe more deeply into specific aspects of programs, in particular what outcomes and impacts are achieved by recipients as a result of working with the Branch. While information from case studies cannot be considered representative of all projects, these studies are valuable for describing the types of results which can result. Careful choice of cases is important to choose examples which demonstrate the various pathways by which public and private sector benefits occur. This is particularly important in this study, since CRC has major public and private sector relationships with differing objectives. A structural approach to carrying out the case studies is recommended which will provide broad strategic insight into benefit streams. **Annex B** describes the approach in some detail. It captures information on linkages between activities and results to deal with attribution and causality concerns and describes outcomes and impacts at the organizational, sector and societal levels. The approach is consistent with the Industry Portfolio S&T Performance Framework and recent model's of the role of government S&T in the economy.

Each case study will involve document review and 3 - 5 interviews with branch staff, beneficiaries and stakeholders. It is recommended that a minimum of 4 case studies be performed, one for each of the three Branch research groups, and one additional case to explore the relationship between the Branch and DND.

4.7 Analysis, Integration and Linkage to S&T Policy Issues

Analysis of the multiple lines of qualitative and quantitative evidence and integration into coherent credible findings and conclusions on each issue and sub-issue requires an experienced review team and attention to detail. The previous sections and Table 3 provide an overview of the importance of each methodology in addressing the 2 issues and 10 research questions.

In addition to normal professional practices, it is recommended that this study take account of recent work by the Committee of Science and Technology Advisors which is defining the strategic role of government S&T activities, the 1996 Position Paper of the government entitled "Science and Technology for the New Century", and the Industry Portfolio Action Plan developed in response. The study will also take account of the S&T Performance Framework, which describes S&T outcomes and impacts in terms of their contribution to government objectives for S&T, namely:

- Advancement of knowledge;
- Application of technology to create economic growth;
- Innovation infrastructure support; and
- Performance management.

It is recommended that the review study of the Radio Science Branch demonstrate how the Branch contributes to achievement of these broad government objectives. For consistency, the Case Study Outline shown in Annex B can also be used to categorize the outcomes and impacts identified from the interviews with partners, collaborators and clients. In addition, the study should take account of the work of Tassey and Lipsey in describing the appropriate role of government R&D in contributing to both broad public

benefits as well as more narrow private sector benefits at the industrial sector and firm levels.

This is particularly important in the case of the Radio Science Branch which has important roles in supporting the work of other CRC Branches in the public and private sectors, Industry Canada's statutory responsibilities in telecommunications infrastructure development such as policies and regulations, and helping DND and the Canadian Space Agency achieve their mandates.

4.8 Workshop

An additional step to review the study evidence and conclusions and help CRC and Branch management understand the context of the evidence and recommendations would be a workshop following completion of the data collection and analysis, but before completion of the final report. It is proposed that CRC management, Branch management, and possibly representatives of major stakeholders and selected experts would participate. It may be appropriate for senior Branch researchers to attend as observers. As well, if the next Branch to be reviewed is known at that time, it may be appropriate for that Branch's Vice President to attend as an observer.

Based on experience, it is likely that the participation by CRC and Branch management provided by this element would increase the credibility of the study and increase its utilization.

5.0 Study Schedule

The study schedule depends to a large extent on the nature of interactions with the Radio Science Branch. As a contact person within the Branch has been designated to act as liaison, this will facilitate gaining access to required reports and files and generally improve the management of the evaluation study. While it is expected that the study will be completed much earlier, it will be important to ensure that the work is finalized by the end of March, 2001, in order to have information which can contribute to the upcoming CRC annual performance report. The schedule shown in Table 4 provides the current best estimate of the study schedule.

Table 4: Radio Science Branch Review Study Schedule

Steps	Sept 00	Oct 00	Nov 00	Dec 00	Jan 01	Feb 01
Inst Design						
Doc Rev						
Interviews						
Case Study						
Analysis						
Prelim Rpt						
Workshop						
Final Rpt						

Annex A- Profile of Radio Science Branch
(under separate cover)

Annex B - Case Study - Structural Assessment Outline

Table B-1: Impacts - A Structural Assessment Outline

Project Incrementality (influence)	Direct User Impacts	Industry Sector / Supply Community Impacts	Economy / Societal Impacts
Involvement ▸ helped in completing the project more quickly ▸ helped in completing the project more thoroughly ▸ helped do R&D that otherwise would not have been done	Technical results ▸ new or improved product ▸ new or improved process advancement of knowledge ▸ increased technical capabilities ▸ improved quality control ▸ new skills internally ▸ increased efficiency / improved productivity ▸ technology transfer Policy / legislative results ▸ policy behavioral changes ▸ agreement / accord ▸ legislative / regulation ▸ acceptance of standards Commercial results ▸ increased sales ▸ increased market share ▸ increased profitability ▸ cost savings Organizational effects ▸ increase in jobs ▸ diversification ▸ expansions ▸ strategic alliances / partnerships ▸ achievement awards / recognition	▸ production process efficiencies ▸ science and technology information ▸ increased sales ▸ cost savings ▸ changes to industry structure (e.g., concentration, competitiveness internationally) ▸ spin-off companies ▸ technology infrastructure (e.g., standard scientific and engineering data, industry standards, test protocols, and instrumentation) ▸ training of technological problem-solvers whose talents can be applied in many areas ▸ establishment of quality standards	▸ reduced consumer costs ▸ protection of environment ▸ improved energy efficiency savings ▸ improved public health and safety ▸ education / awareness ▸ public service efficiency gains ▸ increased employment ▸ reduction in subsidies