Communications Research Centre Canada
An Agency of Industry Canada

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

Rural and Remote Broadband Access Program

First-Year Report, **2002–2003** >>>>>

Canada

CRC

Communications Research Centre Canada (CRC), an agency of Industry Canada, is the leading federal laboratory for research and development (R&D) in advanced telecommunications. It is a mission-focused laboratory that prides itself on excellence in gathering technical intelligence and providing independent advice to help shape public policy. CRC builds partnerships to bridge innovation gaps in Canada's telecommunications sector, and assists small and medium-sized enterprises through technology transfer.

By being a national leader in collaborative R&D on leading-edge telecommunications and information technologies, CRC supports Canada's drive to increase its innovation capacity and to become the world's most connected nation.

CRC's critical mass of researchers and facilities is dedicated to R&D on the technologies that form the basic communications across Canada: radio, satellite, broadcasting and fibre optics. CRC's R&D focus is to understand how these technologies can mesh to create affordable, quality communications networks – ones that serve all Canadians, regardless of where they live in a country characterized by its huge size and widely dispersed population.

To support Industry Canada's priorities for connecting Canadians and increasing their capacity to innovate via broadband technology, CRC established a formal R&D program called the ***Rural and Remote Broadband Access (RRBA) Program***. The Program began in April 2002 and will run until March 2007.

. . . helping the Canadian technology industry to bring broadband access to rural and remote communities.

Industry Canada's 2003-2004 Report on Plans and Priorities

Industry Canada is implementing a $105 million pilot program called Broadband for Rural and Northern Development (BRAND). It is part of the Government of Canada's commitment to ensure that all Canadian communities have high-speed broadband Internet access by 2005. CRC is providing technical advice to the program.

PROGRAM DESCRIPTION

The RRBA Program:

- supports Industry Canada in making Canada the most connected country in the world;
- focuses on finding technological solutions that extend broadband services to rural and remote areas;
- creates synergy among CRC's various expert groups, capitalizing on their unique expertise in the essential technologies needed for the deployment of broadband access (i.e. satellite communications, terrestrial wireless, fibre optics, etc.);
- engages public- and private-sector partners to carry out collaborative demonstrations of broadband applications.

Rural, remote and First Nations communities are more in need of broadband than many other communities to bridge the gaps that exist in employment, business, learning, culture and health care. Broadband will provide the infrastructure needed to develop and deliver advanced applications and services that will bring greater economic and social benefits to these communities.

Achieving Excellence: Investing in People, Knowledge and Opportunity (Canada's Innovation Strategy)

PROGRAM MANDATE

The RRBA Program's mandate is to conduct innovative R&D on technologies and systems that will facilitate rural and remote access to interactive broadband multimedia services. Broadband technology can provide all Canadians with equitable access to education, health care, global business opportunities and more. CRC's RRBA Program is conducting research, development and testing of innovative, cost-effective broadband technologies. It is also demonstrating system concepts and applications that will help the private sector deliver broadband services to Canada's under-served areas.

PROGRAM OBJECTIVES

The core objectives of the RRBA Program are to foster innovative R&D and to evolve CRC's research programs toward broadband solutions not addressed by industry. CRC is doing this by:

- identifying the areas that need more technical R&D work and where CRC can make a valuable contribution;
- providing a unified focus for CRC's research groups and R&D activities to develop timely solutions related to the Program's mandate;
- collaborating with industry partners for guidance based on practical experience, and facilitating the transfer of technologies and expertise;
- collaborating with Canadian universities to share expertise;
- providing scientific and engineering expertise to Industry Canada for the development of policies, regulations and standards related to broadband;
- developing proof-of-concept systems and subsystems that demonstrate the feasibility and advantages of broadband access in rural and remote areas;
- participating in international standards activities with the aim of lowering the costs of broadband equipment through large-volume manufacturing;
- promoting Canadian expertise and technologies to other countries that face similar challenges.

This report is about an end point — how to ensure that all Canadians have access to broadband services by 200[5].

The priority of the broadband deployment strategy should be to link all First Nation, Inuit, rural and remote communities to national broadband networks using appropriate technology.

National Broadband Task Force Report, June 2001

RRBA Program Budget	
$1M seed funding	$3.3M salary, operating and maintenance funds from CRC's research branches

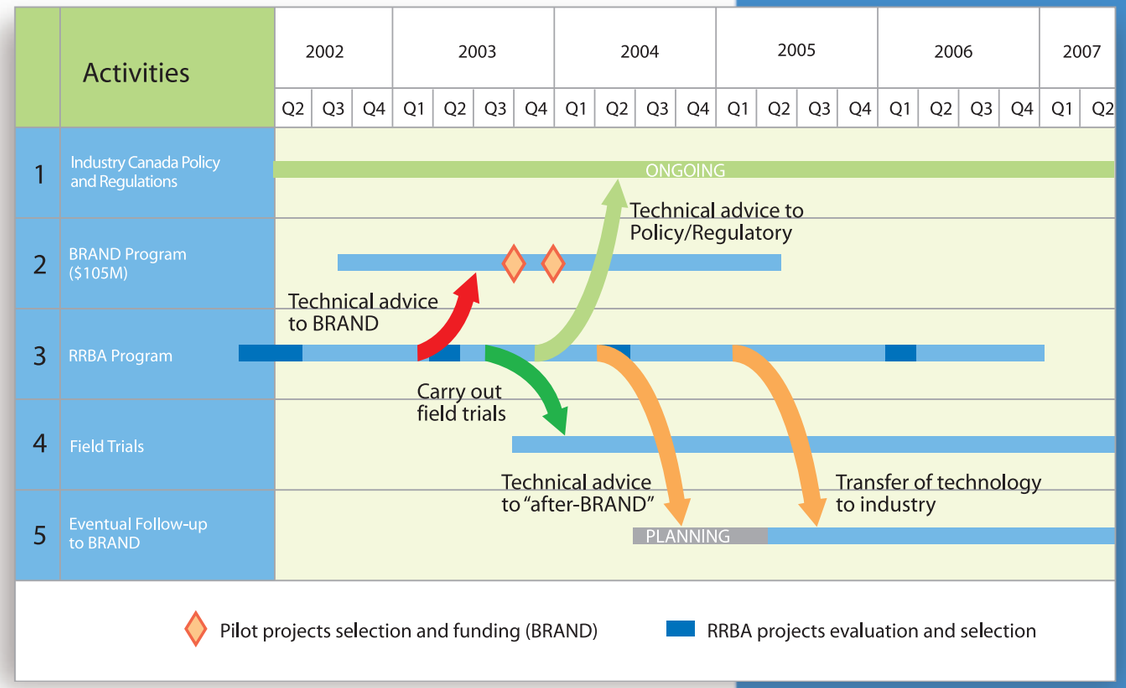
PROGRAM GOVERNANCE

A Steering Committee composed of a broad cross-section of participants came together to help define the RRBA Program. The committee is chaired by RRBA Program Manager Gérald Chouinard and consists of CRC research managers, as well as representatives from Industry Canada, universities and private industry.

The Steering Committee is a key element in the RRBA Program's rigorous guidance and performance assessment processes: at the end of each fiscal year in March/April, the Steering Committee evaluates the R&D project results. It then recommends to the CRC R&D Committee (CRC's President and Vice-Presidents) which projects should continue and in which new R&D areas CRC should perform research.

At the start of the next fiscal year, the Steering Committee evaluates the CRC research managers' proposals for continuing and new R&D projects, prioritizes them, and recommends directions for each project. The RRBA Program Manager then brings the recommendations to the CRC R&D Committee for final decisions on project selection, directions and funding.

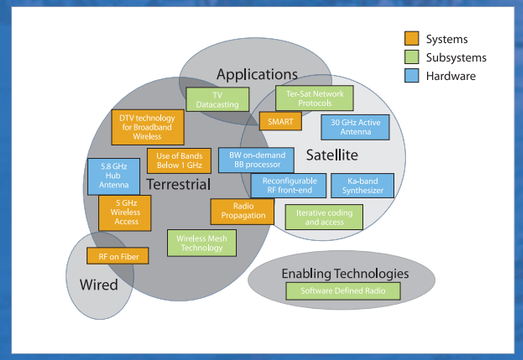
PROGRAM SCHEDULE AND LINKAGES



RRBA PROGRAM ACTIVITIES IN 2002–2003

Of the 25 R&D projects proposed at the beginning of the RRBA Program's first year, 15 were approved and carried out in 2002–2003. In addition to the R&D projects, CRC developed systems studies and field trial proposals, and conducted related satellite broadband applications demonstrations (i.e. the Satellite Multimedia Applications Research and Trials (SMART) Program).

R&D Projects in 2002–2003



A - R&D PROJECTS

The R&D projects mainly addressed terrestrial and satellite terminal technologies, as well as specific technologies such as RF on Fiber, Software Defined Radio and a bandwidth-on-demand baseband processor. Following is a summary of the projects and their results, categorized by technology area. For more information, please visit the RRBA site (**www.crc.ca/broadband).**

Wireless broadband access using frequencies below 1 GHz

CRC conducted a general review of RF propagation phenomena below one GHz. The purpose of using lower transmission frequencies is to extend the reach of wireless broadband access systems for non-line-of-sight transmission over a few tens of kilometres. Other aspects relating to lower frequencies were also analyzed. These included identifying the bands that could be used globally, and the availability of basic RF devices and antennas in this frequency range. Researchers found that, typically, an aggregated bandwidth of about 25 MHz would be needed in the low or medium UHF band for the delivery of broadband services to rural areas over cell sizes of 15 to 25 kilometres. Dynamic frequency allocation would be needed to adaptively use RF spectrum in this range.

Terrestrial wireless technologies

- CRC conducted an evaluation of eight commercially available IP-based wireless technologies operating in licence-exempt bands. These included Bluetooth®, Wi-Fi® and Mesh technologies. Researchers found that although transmission overhead varies among these systems, it is typically around 50 percent. For mesh networks, the throughput drops by half for every hop.
- CRC continued to develop its five GHz multimedia wireless access line-of-sight system called MILTON, which includes low-cost subscriber terminals and a 24-petal rosette hub antenna. It also includes flat-plate phased array antennas that CRC developed as part of another RRBA project. MILTON is well suited for small rural towns and villages. It can provide up to 20 Megabits-per-second of broadband capacity to about 700 subscribers within a radius of a few kilometres. CRC developed network controls for MILTON that make cells highly adaptive in the presence of interference. MILTON's development is expected to take another year before it is ready to be commercialized.

Broadcast transmission technologies

Because of their wider coverage capabilities, broadcast transmission technologies can cover rural areas efficiently. Digital television (DTV) can carry about 20 Megabits-per-second of broadband capacity per six MHz TV channel. CRC reviewed the three current DTV technology standards used in the world, and found them to be well suited for carrying broadband applications in the forward direction. CRC also measured the extent of coverage in the field. Researchers demonstrated the feasibility of encapsulating Internet Protocol (IP) data over the DTV transport stream, using a high-capacity data server, and integrating multimedia applications and a prototype of a low-cost IP receiver.

Satellite broadband access technologies

- CRC's work on satellite broadband access concentrated on trying to reduce the cost and complexity of the Ka-band terminal that will likely be used with the new Anik F2 satellite. Researchers investigated reflect-array technology and spatial power-combining techniques to produce flat-plate satcom antenna terminals with high transmit power. The terminals use direct transceiver architecture to simplify the hardware needed. CRC developed compensation techniques for receiver gain/phase balance and power amplifier linearization, and contracted out the design of a frequency synthesizer for direct Ka-band channel selection to a private company. Researchers completed the design of basic prototype Ka-band electronic components such as microstrip and stripline power-splitters, with a vision of their possible integration into re-configurable RF front-ends for frequency agile receivers.
- CRC investigated possible improvements of the open standard used for multimedia transmissions over satellite (DVB-RCS[1]). Researchers developed an iterative coding scheme that reduces the required satellite transmit power. They also proposed a more efficient scheme for random access by multiple users.

Safeguard, enrich and strengthen the social and economic fabric of Canada and its regions

Render reliable and affordable telecommunications services of high quality accessible to Canadians in both urban and rural areas

Canada's *Telecommunications Act*

- CRC also developed improved packet-based communications protocols. These allow the seamless integration of terrestrial and satellite networks through dynamic satellite bandwidth allocation, latency reduction and provision of Quality-of-Service.

Other broadband technologies

- CRC successfully demonstrated a proof-of-concept system that transmits RF signals by carrying wireless LAN (802.11a) at 5.3 GHz over optical fibre.
- CRC also developed a generic operating system for Software Defined Radio. The system uses hardware and system-dependent applications to make radios adaptable to different communications environments and protocols.
- In addition, CRC developed a baseband processor to provide bandwidth-on-demand for broadband-type applications. This processor uses a multi-carrier and discrete Fourier transform approach to dynamically allocate transmission spectrum on demand.

B - SYSTEMS STUDIES

In parallel with its R&D projects in 2002–2003, CRC conducted systems studies. A contract, co-funded by Industry Canada's BRAND Program and CRC's RRBA Program, was awarded to Icebridge Consulting for a Rural UHF Broadband Study. This study involved a survey of existing terrestrial wireless technologies and an evaluation of the size and location of the Canadian population not yet served by high-speed broadband access. The study used a simple sustainable business model (i.e. 40 residential and four business subscribers to support the initial cost and ongoing operation of a local terrestrial wireless broadband access system). The study used Canada's population database to establish percentages of unserved population as a function of cell size and initial take-rate for broadband service.

CRC used the results to estimate the market potential for broadband technologies using terrestrial wireless for different ranges of coverage. The results were also used to establish an initial split of the rural and remote market between satellite and terrestrial wireless to determine the maximum reach for which terrestrial wireless systems need to be designed. Together with Industry Canada's Spectrum Engineering Branch, CRC conducted an initial evaluation of the frequency bands in the UHF range that could be used for rural and remote broadband access, which was complemented by an actual measurement of RF spectrum use in the Ottawa area.

C - FIELD TRIALS PROPOSAL

In collaboration with industry, CRC will also demonstrate and conduct field trials of the technologies it develops under the RRBA Program. As a first step, CRC conducted a survey of available or soon-to-be-available technologies. The survey explored technologies for broadband wireless access and network backhaul in licence-exempt (e.g. Wi-Fi®) and licensed bands, as well as broadcasting and cable-over-radio (DOCSIS) systems. CRC also assessed the initial equipment costs for field trials.

CRC is now proposing broadband field trials to be held in a rural community near Ottawa. This is an extension of an initial technical trial that CRC plans to carry out in fall 2003 with its five GHz licence-exempt technology, MILTON. Instead of deploying about five user terminals, CRC is proposing to identify about 30 potential users and provide them with terminals. These users would be trained to use advanced multimedia applications. This in turn will allow CRC and its partners to test the network extensively with applications that would be typical of broadband use three to five years from now. CRC is also proposing to expand this trial to include monitoring of network traffic and user preferences, with a vision of developing a model of future broadband requirements. CRC presented its proposal to Industry Canada's BRAND Program for funding.

D - RELATED BROADBAND APPLICATIONS DEMONSTRATIONS

Together with partners such as the National Research Council, Telesat, CANARIE Inc. and others, CRC has been carrying out demonstrations of broadband applications in Canada's northern communities. The demonstrations mainly use broadband satellite technologies, and although not included in the RRBA Program governance, they do complement it. The applications demonstrated require broadband capacity and little infrastructure.

SMART

CRC's Satellite Multimedia Applications Research and Trials (SMART) Program demonstrates satellite communications services and applications. Together with national and international public- and private-sector partners, CRC demonstrates tele-health, tele-learning, tele-justice and more. Details on projects conducted under this $860 000 program can be found at **www.crc.ca/cantech** and **www.crc.ca/citizen**. CRC and its partners are now focusing on demonstrating more advanced broadband multimedia applications that will be commercially feasible with the next generation of Ka-band satellites.

LEARNCANADA

The LearnCanada program (**www.learncanada.ca**) used broadband multimedia technologies and CA*net3 to establish a tele-mentoring community among Canadian teachers coast to coast. The project was deemed a success, and the participating school boards remain connected to CA*net4 even after the program's conclusion in fall 2002.

MUSICGRID

Launched in February 2003, and championed by Maestro Pinchas Zukerman of the National Arts Centre Orchestra, MusicGrid (**www.musicgrid.ca)** is bringing music students and instructors together via CA*net4. The program involves many national and international partners in the public and private sectors, including renowned music conservatories.

[1] Digital Video Broadcasting – Return Channel Satellite (ETSI EN 301 790)

Our objective should be no less than to be recognized as one of the most innovative countries in the world.

…making broadband access widely available to citizens, businesses, public institutions and to all communities in Canada by 200[5]

Speech from the Throne, January 30, 2001

A LOOK FORWARD

CRC's RRBA Program tries to focus on the critical issues related to the delivery of broadband services in rural and remote areas. These issues include cost, flexibility, reach, spectrum availability and interference, standardization and potential international markets. This results in the need to support a variety of R&D projects that must be rigorously evaluated and compared to get the most out of the relatively limited amount of seed funding available.

There also needs to be a good balance of short-, medium- and longer-term R&D projects. The majority of the projects funded during the first year were multi-year projects that will continue into the second year of the Program. The seed funding for the second year is $830 000, which will be supplemented again by the operating resources of CRC's research branches.

The R&D work in the second year of the RRBA program will concentrate on:

- developing the MILTON technology to a point where this five gigahertz licence-exempt technology can be demonstrated in the field and transferred to industry, and experimenting with the system in lower frequency bands to extend its reach;
- using frequencies below one gigahertz for extending the reach of existing low-cost broadband technologies (e.g., Wi-Fi®);
- completing the development of key technologies that can reduce the cost of Ka-band satellite terminals, and demonstrating their potential to do so;
- continuing R&D on "flexible radios" to enable more effective use of spectrum in rural and remote areas;
- continuing to explore the potential of digital television broadcasting technologies to provide broadband access over larger areas;
- investigating technologies for the return channel to enable television broadcast technologies to be used for bi-directional communications.

In addition, CRC will undertake further systems studies and field trials. CRC's RRBA Program will continue to provide solid technical advice to Industry Canada's BRAND Program as well as to policy, regulatory and standards activities. It will also transfer, in a timely fashion, technologies to Canadian companies so that they can deploy affordable broadband access systems in rural and remote areas.

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