HISTORY - IEEE OTTAWA SECTION[1]

The history of the IEEE in Ottawa is the story of the people and institutions and industries that created one of the largest concentrations of information communications technology in the world.

For example, the IEEE Canada Showcase of Canadian Engineering Achievements[2] includes the following projects that were based in the Ottawa area, and involved many IEEE members.

> Radar[3], radio[4], electronic music[5], Telidon[6], the Crash Position Indicator[7], the Alouette[8], Anik[9] and ISIS[10] satellites, the pacemaker[11], and the Sudbury Neutrino Observatory [12].

According to the Ottawa Centre for Research and Innovation (OCRI) "Ottawa boasts the highest percentage of university graduates in Canada and the second largest concentration of science and technology employment of 316 North American cities, surpassed only by California's Silicon Valley"[13]. The development of the "high tech" community, which some termed "Silicon Valley North" is outlined in the book "Silicon Valley North: A High-Tech Cluster of Innovation and Entrepreneurship", edited by Larisa V. Shavina[14].

Institutions

Ottawa is the location of a number of Engineering and Scientific Research and Development Institutions in which IEEE members have played a large role.[15]

These Institutions consist of:

- the Communications Research Centre, or CRC, located in the west end of Ottawa;
- the Bell Northern Research Laboratories (BNR) located nearby;
- the National Research Council[16], located in the east end of Ottawa;
- Carleton University and The University of Ottawa, each of which has very active programs in electrical engineering, communications and computer technologies;

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[1] DRAFT version 4.0 D. C. Coll, March 9, 2009, dccoll@ieee.org
[2] http://www.ieee.ca/showcase/index.html
[3] http://www.ieee.ca/millennium/radar/radar_about.html
[4] http://www.ieee.ca/millennium/radio/radio_about.html
[5] http://www.ieee.ca/millennium/electronic_music/em_about.html
[6] http://www.ieee.ca/millennium/telidon/telidon_about.html
[7] http://www.ieee.ca/millennium/cpi/cpi_about.html
[8] http://www.ieee.ca/millennium/alouette/alouette_about.html
[9] http://www.ieee.ca/millennium/anik/anik_about.html
[10] http://www.ieee.ca/millennium/isis/isis_about.html
[11] http://www.ieee.ca/millennium/pacemaker/pacemaker_about.html; NRC
[12] http://www.ieee.ca/millennium/neutrino/sno_about.html; Physics Department, Carleton University
[13] http://www.lindsayrgwatt.com/archives/old_blog/7_Cap_City__Land_o_Successful_Geeks.html
[14] Elsevier, 2004, ISBN 0-08-044457-1
[15] Canadian Developments in Telecommunications: An Overview of Significant Contributions, T. L. McPhail and D. C. Coll, eds, The University of Calgary, 1986, ISBN 0-88953-083-1
[16] http://www.nserc-crsng.gc.ca/NSERC-CRSNG/History-Historique/index_eng.asp

Laboratories

CRC[17] consists of three Laboratories: the Communications Laboratory, the Electronics Laboratory, and the Radio Physics Laboratory. It originated in the 1950's as the Defence Research Telecommunications Establishment[18], which was the home of extensive ionospheric HF communications research[19], which led to advanced HF radio communications systems and through the development of Alouette[20][21] – a top-side ionospheric sounding satellite - to Canada's Space Program[22]; the JANET meteor-burst communications[23]; one of the very first large-scale transistor test sites: the DRTE computer[24]; and Telidon[25], Canada's videotex system that led to the NAPLPS standard for videotex and teletext[26], and many other projects[27].

Bell Northern Research Laboratories[28] were founded in 1961. Many major innovations in digital telephony and data communications originated at this site.[29] Among these were the X.25 DataPac network (circa 1964) [30] and packet switching (1974).

Public data communications and ISDN are described in an article by **D. E. Sproule** entitled "Public Digital Data Communications In Canada: the First 15 Years", a chapter in ***"Canadian Developments in Telecommunications: An Overview of Significant Contributions", edited by T. L. McPhail and D. C. Coll,*** published by the University of Calgary in 1986. Notes on significant Canadian developments, such as Telidon, cable TV, channel equalization, JANET, and HF communications are presented there as well. A paper by **Roy M. Dohoo**, long time DRB research manager, on the development of Canadian satellite communications is presented. Elmer Hara reviews the state of fibre optic communications; and **Asrar Sheikh**, then of Carleton University, described the future of mobile wireless communications.

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[17] http://www.friendsofcrc.ca/; http://www.crc.gc.ca/en/html/crc/home/home; http://www.crc.gc.ca/en/html/crc/home/mediazone/milestones
[18] http://www.friendsofcrc.ca/Foundations.html; http://pubs.drdc.gc.ca/PDFS/unc17/p518800.pdf
[19] http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=4066900&arnumber=4066911&count=16&index=10
[20] http://www.ieee.ca/millennium/alouette/alouette_home.html
[21] http://www.ewh.ieee.org/reg/7/millennium/alouette/alouette_impact.html
[22] http://www.sciencetech.technomuses.ca/english/schoolzone/Info_Space.cfm
[23] http://en.wikipedia.org/wiki/Meteor_burst_communications
[24] Dirty Gertie: the DRTE computer, **Petiot,** L., Annals of the History of Computing, IEEE, Volume 16, Issue 2, Summer 1994 Page(s):43 – 52.
[25] http://www.friendsofcrc.ca/Projects/Telidon/Telidon.html
[26] http://www.spectralumni.ca/CommExpress_pdf/ceapr90es.pdf; http://www.spectralumni.ca/CommExpress_pdf/cejun83e.pdf; http://www.spectralumni.ca/CommExpress_pdf/cemar83e.pdf
[27] http://www.wtec.org/loyola/satcom2/e_05.htm
[28] http://en.wikipedia.org/wiki/Bell-Northern_Research; http://www.bink.org/Portfolio/Nortel1.htm; http://www.porticus.org/bell/northern_electric_history.html; http://www.nortel.com/corporate/corptime/; http://www.nortel.com/corporate/corptime/1960.html; http://www.nortel.com/corporate/corptime/past_leadership.html
[29] http://www.nortel.com/corporate/technology_new/index.html;
[30] http://en.wikipedia.org/wiki/DATAPAC; http://www.rogerdmoore.ca/PS/BNR/BNRnet.html;

The Radio and Electrical Division of the National Research Council of Canada (REED/NRC)[31] [32] was the locale of early work on radar, meteor burst communications, and a host of other related activities.

As far as power generation is concerned, Ottawa was the site of the first electric power generation station in Ontario.[33] The Ottawa River and its tributaries, particularly the Madawaska River, have continued to provide hydro-electric power to the region[34][35][36]. Ottawa is also reasonably close to Chalk River, the site of Atomic Energy of Canada's research station, where the Candu reactors were developed.

Universities and Colleges

Both Carleton University and the University of Ottawa have strong academic and research programs in IEEE-related fields. As well, both have strong IEEE Student Branches (http://www.ieee.engsoc.org/; http://www.ewh.ieee.org/sb/ottawa/uottawa/, http://www.ewh.ieee.org/sb/ottawa/algonquin/ about_memberships.htm).
At Carleton University the academic entities involved include the Department of Systems and Computer Engineering (http://www.sce.carleton.ca/dept/index.shtml) and the Department of Electronics (http://www.doe.carleton.ca/). Prominent Faculty, recognized by the IEEE as Fellows include Professors David Coll, David Falconer, Murray Woodside, and Yiyan Wu in Systems and Computer Engineering and Professors Boothroyd, Copland, and Nakhla in Electronics; while at the School of Information Technology and Engineering at the University of Ottawa (http://www.site.uottawa.ca/eng/index.html), Professors Dubois, Georganas, Mouftah, and Petriu have been so recognized.
Algonquin College offers more than 100 full-time programs, including certificates, diplomas, graduate programs and bachelor degrees in applied studies. Our degree programs provide the best of both worlds, combining the practical application of college education with the theoretical and critical foundations of university learning.

Programs in the School of Advanced technology include:

> Bachelor of Applied Technology (Photonics), Computer Programmer, Computer Systems Technology (Networking), Microelectronics Manufacturing, Technical writer, Wireless Mobility Telecommunications Engineering Technology, Computer Engineering Technology (Computer Science), Electro-Mechanical Engineering Technician (Robotics), Geographic Information Systems, and Electrical Engineering Technology.

[31] http://en.wikipedia.org/wiki/National_Research_Council_of_Canada
[32] http://www.nrc-cnrc.gc.ca/aboutUs/facts_history_e.html
[33] http://www.canhydropower.org/hydro_e/p_hyd_a.htm;
[34] http://aix1.uottawa.ca/~weinberg/chaudier.html
[35] http://www.hydroottawaholding.com/holding/site_map/index.cfm?dsp=template&act=view3&template_id=155&lang=e
[36] http://www.opg.com/power/hydro/ottawa_st_lawrence/

Algonquin also offers Collaborative Bachelor of Information Technology degrees in partnership with Carleton University in Interactive Multimedia Design and in Network Technology.

IEEE People

The IEEE Ottawa Section is the home to many renowned engineers and scientists[37]. For example, nine of our members have been recipients of the McNaughton Medal. They are John T. Henderson (1969), Robert H. Tanner (1974), John H. Chapman (1970), William J. M. Moore (1991), Nicholas Georganas (2000), and Hussein Mouftah (2006). Bob Tanner[38] was with BNR, and was Director of the Canadian Region of IEEE and in 1972 was the first non-US citizen to be President of the IEEE. John Chapman[39], who was with DRTE, is recognized as the Father of the Canadian Space Program. Bill Moore[40], who worked in NRC on power systems, was Chair of the Section in 1966.
David Vice[41] and **David Falconer**[42] are both Fessenden Medal[43] [44]winners.

David Vice was “An electrical engineer who worked for Nortel Networks for 37 years … helped mastermind a move to digital switching that transformed the Bell Canada subsidiary into an industrial powerhouse”[45]. He was a Queen’s University graduate who obtained his M.Eng. from Carleton University.

Vice received the 1988 A.D. Dunton Alumni Award of Distinction from Carleton's Alumni Association.[46] He received the 2000 Reginald A. Fessenden Award *"for initiating programs in satellite communications, radio and optical fibre transmission equipment, and for leading global expansion of Nortel Networks"*. He received the award from Celia Desmond, whose IEEE ties are described below.

The Toronto Globe and Mail, in an October 18, 2008 article[47] following his death, wrote that

> “David Vice was one of the smartest people in the phone business. An electrical engineer who worked for Nortel Networks for 37 years, he helped mastermind a move to digital switching that transformed the Bell Canada subsidiary into an industrial powerhouse.”

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[37] http://www.ieee.ca/awards/eic_award_list.htm
[38] http://www.ieee.org/web/aboutus/history_center/biography/tanner.html
[39] http://en.wikipedia.org/wiki/John_Herbert_Chapman; http://en.wikipedia.org/wiki/John_H._Chapman_Space_Centre; http://www.famouscanadians.net/name/c/chapmanjohnh.php
[40] http://www.ieee.ca/awards/bios.htm#William%20J.M.%20Moore
[41] http://business.theglobeandmail.com/servlet/story/RTGAM.20090114.wnortelregimes/BNStory/Business; http://www.ece.queensu.ca/alum/news/davidvice.html
[42] http://www.sce.carleton.ca/faculty/falconer/falconer.html; http://www.cnsr.info/cnsr2007/keynotes.php ;
[43] http://www.ieee.ca/awards/descriptions.htm
[44] http://www.ieee.ca/awards/fess_recipients.htm
[45] http://www.theglobeandmail.com/servlet/story/LAC.20081018.OBVICE18/TPStory/?pageRequested=all
[46] http://alumni.carleton.ca/alumni/greatgrads_profile.cfm?gradid=178
[47] http://www.theglobeandmail.com/servlet/story/LAC.20081018.OBVICE18/TPStory/?pageRequested=all

Other Presidents of BNR with IEEE ties included **Donald A. Chisholm** and **Walter Frederick Light.**

Donald A. Chisholm[48]

A brilliant physicist who worked on the U.S. Apollo space program, Mr. Chisholm came to be known as the father of the digital world. At age 44, he became the first president of Bell-Northern Research Laboratories Ltd., which was formed when the R&D departments at Bell and Northern Electric were merged.

By the time he left the company, 75 per cent of Nortel's sales came from internally developed products, up from 10 per cent when he arrived. During his tenure, the company embarked on an ambitious project known as Digital World, that sought to create a full line of digital switching and transmission products. Digital World products would go on to revolutionize the telecommunications business and laid the foundations for the Internet.

He also oversaw the creation of the DMS-100 in 1979, the first fully digital central office switch capable of handling up to 100,000 telephone lines, which would become a major source of Nortel's revenue for more than 15 years and one of the most influential inventions in the history of the company.

Walter Frederick Light[49][50]

After 25 years at Bell Canada, Mr. Light took over as president of Northern Electric in 1974 and instituted a culture that stressed low-cost production, market-driven technology and the retention of its best employees. In 1979, he took over the CEO's post when the company still enjoyed a two-year lead over its competitors in the telecom switching market. Mr. Light guided Northern into a head-on collision with IBM over its Open Protocol Enhanced Networks project and oversaw the creation of the Displayphone, one of the first attempts by any technology company to marry the telephone with early personal computers.

He received the Order of Canada in 1986 and the computer and electrical engineering at Queen's University is named in his honour.

“If you don't make the right decisions,” he told The Globe in 1983, “you won't be in business. If you hesitate, someone will leapfrog you. And mistakes – well, when you make them, you have to abort. We've aborted, but I won't tell you what.”

Celia L. Desmond[51]

Celia L. Desmond is one of the IEEE Ottawa Section’s most dedicated IEEE members. Section Chair (1984-85), Celia was awarded the Donald J. McLellan Award for meritorious service to

[48] http://www.globecampus.ca/in-the-news/article/at-the-helm-of-nortel/
[49] http://www.globecampus.ca/in-the-news/article/at-the-helm-of-nortel/
[50] http://www.ece.queensu.ca/department/WalterLightHall.html
[51] c.desmond@ieee.org

IEEE Communications Society, the Engineering Institute of Canada John B. Sterling Medal in May 2000, and the IEEE Millennium award. She is a Senior Member of IEEE.

Celia's IEEE positions include:

- 2008 Project Director for Certification in Wireless Engineering Technology for IEEE, managing a team of over 100 people in 8 different development areas
- 2007 Director and Secretary of IEEE
- 2006 IEEE Vice President – Technical Activities
- 2002-2003 President of IEEE Communications Society
- 2001 President of IEEE Canada, and Region 7 Director
- 1997-1998 Division III Director.
- IEEE Canada Foundation Board member and previous Donations Chair.

She is currently a member of the IEEE Governance Committee a standing committee of the Board of Directors responsible for reviewing proposed amendments to IEEE's governing documents to assure clarity, consistency, and legal compliance. The committee makes recommendations to the Board of Directors on matters affecting governance, including, but not limited to, the IEEE Constitution, Bylaws, Policies and other related governing documents.

Ms Desmond is the President of World Class-Telecommunications, a company that provides training, consulting and management skills in the telecommunications engineering and business environment. Celia Desmond helped establish a Masters of Engineering in Telecommunications program at University of Toronto, which started in September 1998. She created and manages a continuing education Certificate program in Telecommunications Management, at the University of Toronto. WC-T manages a program for entrepreneurs offered through Ontario Society of Professional Engineers. WC-T provided expert witness support to industry as recently as January 2003. Celia Desmond has lectured internationally on Programs for Success in Today's Changing Environment, on Project Management at Steven's Institute of Technology and also on telecommunications at University of Toronto, and at Ryerson.

Celia holds M. Eng. (Carleton), B.Sc. Mathematics & Psychology, Ontario Teaching Certificate and PMP certification. Celia has taught kindergarten, high school, and university at Ryerson School of Business, Stevens Institute of Technology, and University of Toronto.
Celia Desmond helped establish a Masters of Engineering in Telecommunications program at University of Toronto, which started in September 1998. She created and manages a continuing education Certificate program in Telecommunications Management, at the University of Toronto. WC-T manages a program for entrepreneurs offered through Ontario Society of Professional Engineers. WC-T provided expert witness support to industry as recently as January 2003. Celia Desmond has lectured internationally on Programs for Success in Today's Changing Environment, on Project Management at Steven's Institute of Technology and also on telecommunications at University of Toronto, and at Ryerson. She is the author of two books on telecommunications management: Comsoc Pocket Guide to Managing Telecommunications Projects and Project Management for Telecommunication Managers.

She is a member of the IEEE Foundation[52] as described in the following write-up (2006):

Celia L. Desmond, M. E.E., SM IEEE
President, World Class - Telecommunications
Mississauga, Ontario, Canada
c.desmond@ieee.org

Celia Desmond is President of World Class - Telecommunications, which provides training in management skills in business and telecommunications engineering environments. She was instrumental in creating a Masters Program and a Certificate Program at University of Toronto. She has lectured internationally on programs for success in today's changing environment. At Stentor Resource Centre Inc. she was instrumental in establishing the Stentor culture and processes, and in obtaining buy-in from the employees to adopt and grow the new organization. She developed and implemented processes for service/product development and for project governance. As Director - Industry Liaison, she was the external technical linkage to the Stentor owner companies, their customers, and the international technical community In various positions at Bell Canada, Celia provided strategic direction to corporate planners, ran technology and service trials, standardized equipment, and issued guidelines for the member companies. In Celia's previous line positions, her groups provided technical and project management support to large business clients. She is author of Project management for Telecommunications Managers, published by Kluwer Academic Publishers (now Springer).

Celia is the 2006 IEEE Vice President - Technical Activities. She is also Vice President Membership for IEEE Engineering Management Society. She was 2002-2003 President of IEEE Communications Society. In 2000-2001 Celia was President of IEEE Canada, and she served her second term on the Board of Directors of IEEE as Region 7 Director. She was 1997-1998 Division III Director. She has twice served in the IEEE Audit Committee, including serving as Chair, and actively participated in numerous other TAB, RAB, IEEE and Society committees. She was 2004 Chair of the IEEE Transnational Committee. She is a member of the Board of Directors of the IEEE Canada Foundation since 2004, where she is the Donations Chair. Celia was awarded the Donald J. McLellan Award for meritorious service to IEEE Communications Society, the Engineering Institute of Canada John B. Sterling Medal in May 2000, and the IEEE Millennium award. She is a Senior Member of IEEE.

Celia holds a Masters degree in Electrical Engineering from Carleton University, a B.Sc. in Mathematics & Psychology from Queens University, an Ontario Teaching Certificate, and a Project Management Professional (PMP) certification. Celia has taught kindergarten, high school, and at three universities, Ryerson School of Business, Stevens Institute of Technology, and University of Toronto.

[52] http://ieeecanadianfoundation.org/EN/bios/desmond.htm

David D. Falconer

Professor **David Falconer** of Carleton University is a distinguished IEEE Fellow. He received the B.A. Sc. degree in Engineering Physics from the University of Toronto in 1962 and the S.M. and Ph.D. degrees in Electrical Engineering from M.I.T. in 1963 and 1967 respectively. After a year as a postdoctoral fellow at the Royal Institute of Technology, Stockholm, Sweden he was with Bell Laboratories, Holmdel, New Jersey from 1967 to 1980, as a member of the technical staff and later as group supervisor. During 1976-77 he was a visiting professor at Linköping University, Linköping, Sweden. Since 1980 he has been with Carleton University, where he is now Professor Emeritus and Distinguished Research Professor in the Department of Systems and Computer Engineering. He was awarded IEEE Communications Society Prize Paper Awards in Communications Circuits and Techniques in 1983 and 1986. He was a co-recipient of the IEEE Vehicular Technology Transactions best paper of the year award in 1992. From 1981 to 1987 he was Editor for Digital Communications of the IEEE Transactions on Communications. He was Director of Carleton's Broadband Communications and Wireless Systems (BCWS) Centre from 2000 to 2004. He was the Chair of Working Group 4 (New Radio Interfaces, Relay-Based Systems and Smart Antennas) of the Wireless World Research Forum (WWRF) in 2004 and 2005. He received the Canadian Award for Telecommunications Research in 2008, and he is one of the two winners of the **2008 IEEE Technical Committee on Wireless Communications Recognition Award**. This award, given every year by the IEEE Technical Committee on Wireless Communications (TWC), recognizes researchers with outstanding achievements and contributions in the area of wireless and mobile communications theory, systems, and networks.

Colin Franklin

Colin Franklin[53] is a leading pioneer of the Canadian Space Program[54]. He was appointed to the Order of Canada in 1990. He is a Fellow of the Royal Society of Canada and Fellow of the City and Guilds Institute of London. He was the 1996 recipient of the annual Alouette Award from the Canadian Aeronautics and Space Institute. In 1994, on the 50th anniversary of the IEEE Ottawa Section, he received the IEEE "Pioneers in Technology" Award for "Leadership in the establishment of Canada's satellite program". He was the 2002 recipient of the annual John H. Chapman Award of excellence from the Canadian Space Agency. The Award is the ultimate recognition of the individuals behind the Canadian Space program. The Award highlights an outstanding achievement, its socio-economic benefits and the recipient's merits.

The IEEE Canada citation for Dr. Franklin's award of the EIC Julian C. Smith Medal[55] reads as follows[56]:

> "Colin Franklin was chief electrical engineer for Canada's first satellite, the Alouette topside sounder, named by the Canadian government as one of the ten most outstanding achievements of Canadian engineering in the country's first century. He was subsequently chief engineer for the ISIS series of scientific satellites and head of the Space Electronics Laboratory at the Defence [sic] Research Telecommunications Establishment (DRTE) in Ottawa. In 1993, the Institute of

[53] http://en.wikipedia.org/wiki/Colin_Franklin
[54] http://www.ieee.ca/millennium/alouette/alouette_about.html
[55] http://www.ieee.ca/awards/haf/2008.htm
[56] http://www.eic-ici.ca/english/tour/cit08/Franklin.pdf

Electrical and Electronic Engineers designated the Alouette / ISIS program an International Milestone of Electrical Engineering. After fulfilling the role of chief engineer on the very successful ISIS satellites, Colin Franklin became Project Manager for the communications technology satellite Hermes, the forerunner of the direct-to-home TV broadcast satellites.
Turning his talents beyond project management and technical design, Colin chaired the NRC University Grants Committee for Electrical Engineering and produced the 1976 Department of Communications report leading to Canadian cooperation with the European Space Agency. He carried on at the Ministry of State for Science and Technology to contribute to plans for a Canadian Space Agency and for the first Long Term Space Plan which underwrote Canadian participation in the International Space Station and the Mobile Communications Satellite (MSAT) and the remote sensing RADARSAT-1. Colin later became Director General of Space Programs and then Director General of Space and Industry Development Programs in the Department of Communications.

In the last century our beloved country was bound together by rails of steel; today Canada is tied by space-borne communications and remote sensing, materially advanced by Colin Franklin. He dared to undertake very difficult challenges in space, and then exhibited brilliance in implementing the agreed projects. He inspired technical experts and laymen alike in demonstrating what Canada could achieve, and helped lay the groundwork for the next generation of space enthusiasts."

John (Jack) Belrose

John (Jack) Belrose[57] is one of Canada's leading radio physicists. He is the holder of the Radio Club of America's (RCA) Armstrong Medal[58]

Jack Belrose and Walter Cronkite receive Armstrong Medal

Jack Belrose received the Radio Club of America's (RCA) Armstrong Medal at an awards banquet on November 16, 2007 in New York City.

Belrose was honoured to receive this award alongside Walter Cronkite, famous anchor of The CBS Evening News. "Thank you for giving me the Armstrong Medal. When I look at it, I will think perhaps I did contribute something, rather than nothing, to the book of knowledge." Belrose received the Award for his lifetime contributions and commitment in advancing radio communications. Jack Belrose had a 55-year career in radio sciences at the Communications Research Centre Canada and continues to work there as Emeritus Researcher. Belrose has written more than 150 paper and articles on the subjects of radio science and antennas and propagation. He is a licensed ham radio operator with the call sign VE2CV.

Recently, he has been researching the history of radio and has authored several papers recognizing the contributions of Canadian born Reginald Aubrey Fessenden (1866-1932) to the development of radio. Belrose has been member of the RCA for 15 years and was the first Canadian to be elected to the CRC Advisory Council for 2008-2009.

Jack Belrose received his BASc and MASc degrees in Electrical Engineering from the University of British Columbia, Vancouver, B.C. in 1950 and 1952. He joined the Radio Propagation Laboratory, of the Defence Research Board, Ottawa, ON in September 1951. While

[57] http://www.friendsofcrc.ca/Articles/Belrose-EarlyYears/Belrose%20remembrances.html
[58] http://www.crc.gc.ca/en/html/crc/home/mediazone/whatsnew/jan14-18_08_1

on an Athlone Fellowship he received his PhD degree from the University of Cambridge (PhD Cantab) in Radio Physics in 1958. From 1957 to present he has been with the Communications Research Centre (formerly Defence Research Telecommunications Laboratory), where until December 1998 he was Director of the Radio Sciences Branch. He continues to work at CRC (2 days/week) devoting his time to radio science research in the fields of antennas and propagation. Dr. Belrose was Deputy and then Chairman of the AGARD (Advisory Group for Aerospace Research and Development) Electromagnetic Propagation Panel from 1979-1983). He was a Special Rapporteur for ITURadiocommunications Study Group 3 concerned with LF and VLF Propagation. He is Technical Advisor to the American Radio Relay League, Newington, CT in the areas of radio communications technology, antennas and propagation; a Fellow and member of the Board of Directors of the Radio Club of America; and Life Senior Member of the IEEE (AP-S). He has been a licensed radio amateur since 1947 (present call sign VE2CV). He is the author or co-author of over 125 papers, articles, and technical correspondence letters written relevant to the fields of radio communications, radio science, antennas and propagation; author of 2-chapters in a Prentice-Hall book on Physics of the Earth's Upper Atmosphere; author of a chapter in an IEE Publication The Handbook on Antenna Design; Lecturer and AGARD Lecture Series Director for four published lectures; and author of five papers concerned with the history of wireless communications.

Among his other achievements, Dr. Belrose is the champion whose efforts have led to the recognition of Reginald Fessenden as the founder of wireless telegraphy.[59] His efforts have resulted in the award of an **IEEE Milestone Event Award** to commemorate Fessenden's work, as described below:

> BTS Supports IEEE Milestone Event Related to Broadcasting
> By Eric Wandel
>
> BTS AdCom member and Principal Engineer Wavepoint Research, Inc. The IEEE Broadcast Technology Society (BTS) recently sponsored an IEEE Milestone Event Award Program at Brant Rock, Massachusetts, to commemorate what was billed as the "First Wireless Radio Broadcast" by Canadian-born American inventor Reginald A. Fessenden in 1906. This broadcast event took place on 24 December 1906, and is touted as the first radio broadcast for entertainment and music to the general public. Reginald Aubrey Fessenden is credited for years of development work leading to his building a complete system of wireless transmission and reception using amplitude modulation (AM) of continuous electromagnetic waves. The significance of this development was that it represented a revolutionary departure from transmission of dots and dashes in widespread use at the time. Dr. **John S. Belrose** was among presenters at the

[59] http://www.radiocom.net/Fessenden/Belrose.pdf
http://www.nps.gov/caha/parknews/know-your-park-radio-scientist-john-s-belrose-to-speak-on-reginald-fessendens-contributions-to-voice-radio.htm
http://www.ieee.ca/millennium/radio/radio_differences.html
http://ieeexplore.ieee.org/Xplore/login.jsp?url=/ielx5/74/21666/01003633.pdf?arnumber=1003633
http://www.newsm.org/Wireless/Fessenden/Fessenden.html
http://www.ieeeghn.org/wiki/index.php/Milestones:First_Wireless_Radio_Broadcast_by_Reginald_A._Fessenden,_1906

Milestone Event held on 13 September 2008, at Marshfield and Brant Rock, Massachusetts. [Editor's Note: Belrose was the principle speaker, and the President of the IEEE Lewis Terman officiated. Lewis' father was The Terman that wrote The Radio Engineers' Handbook.]

Belrose spent a career as a researcher at Communications Research Center (CRC) in Canada, and he spoke of the history behind the development efforts of Fessenden. It is clear that Fessenden was a true broadcast engineer employing scientific methods to advance the level of understanding of radio transmission. Reportedly, on the night of 24 December 1906, Christmas Eve, Fessenden transmitted voice and music to an audience of listeners on ships up and down the East coast of the United States as far south as Guantanamo Bay, Cuba. It was the first scheduled voice-and-music radio broadcast in history. A plaque was mounted on the tower base rock to commemorate the milestone (picture inset). The Broadcast Technology Society gives its salute to Reginald Fessenden for his accomplishment of helping to launch the broadcast industry. Attending on behalf of BTS were AdCom members Eric Wandel and James Fang as well as Publications Coordinator Jenn Barbato. More details about Fessenden as written by **Dr. Belrose** can be found at: http://ewh.ieee.org/reg/7/millennium/ radio/radio_radioscientist.html.

Dr. Belrose provided the following notes on the history of the IEEE and radio engineering, with some details of Ottawa Section members.

History of the IEEE

- The American Institute of Electrical Engineers (AIEE) was formed in 1884, in Boston;
- The Society of Wireless Telegraph Engineers (SWTE) was formed on 25th February, 1907, and so it was the first group in United States, if not in the world, to get together to develop wireless communications;
- The organization meeting of The Wireless Institute (TWI) was held on 10th March 1909;
- The SWTE and TWI, after some discussion, consolidated to form the Institute of Radio Engineers (IRE) on 13th May 1912;
- At that time the dominant organization of electrical engineers was the AIEE. In the first half of the 20th Century, wireless (radio) communications experienced great expansion, and there was clearly a need for an authoritative journal disseminating new results among practitioners. The Proceedings of the IRE (Proc IRE) was established in 1913. Alfred N. Goldstein, an honorary member of The Radio Club of America, which was founded on 2 January, 1909, was the editor of the Proc IRE, and he edited that Journal for 41 years;
- Until about the 1940s the IRE was a relatively small engineering organization, but the growing importance of electrical communications and the emergence of the discipline of electronics resulted in negotiations about merging the IRE and the AIEE, in c1957, which resulted in the establishment of the ***Institute of Electrical and Electronic Engineers*** (IEEE) in 1963. December 1962 was the last issue of the Proc IRE, and January 1963 was the first issue of the Proc IEEE. Gone was radio from the title of the new organization, but the IEEE today has scores of Societies, the Antennas and Propagation Society is the one that Belrose actively participates in.

The forerunner of the IEEE A&P Society was known as the IRE Professional Group on Antennas & Propagation (PGAP), which was formed in 1949 --- and so the present A&P Society predates other Societies. Some Institute/Societies seem to want to tie themselves back to the beginning (as you know) --- 1884. It seems we can say however old we would like to be, but not older than 125 years.

Special Issues of the Proc IRE/IEEE

There have been many special issues of the IRE/IEEE, but in my [J. S. Belrose] field of work at DRTE/CRC I am only familiar with two:

In 1959 the IRE published a special issue on **Government Research.** There were several DRTE papers in this publication. The one I wrote was: Belrose, J.S., W.L. Hatton, C.A. McKerrow and R.S. Thain, "The Engineering of Communication Systems for Low Frequencies", Proc. IRE, **47**, May 1959, pp. 661-680.

Ten years later, in 1969, the IEEE published a special issue on **Top Side Sounding of the Ionosphere**[60]. CRC scientist/engineers were the authors of many papers.

The only experiment that Belrose had anything to do with was the VLF experiment. Ron Barrington wrote a paper for this Special Issue entitled "Ion Composition Deduced from VLF Observations". This paper was Barrington's overview of a jointly authored paper published earlier: Barrington, R.E., J.S. Belrose and G.L. Nelms, "Ion Composition and Temperature at 1000 km as deduced from Simultaneous Observations of VLF Plasma Resonance and Topside Sounding Data from Alouette I Satellite", J. Geophy. Res., **70**, April 1965.

J. Rennie Whitehead

One of the most distinguished and influential IEEE Ottawa Section Fellow members is **Dr. J. R. Whitehead**[61], whose memoirs, "Memoirs of a Boffin"[62], describe the early British radar developments, development of early warning radar in Canada: the McGill Fence, the origins of the Science Secretariat, and the start of the Club of Rome in Canada. His memoirs are indeed an invaluable record of the development of science and engineering in Canada, with special relevance to the Ottawa Section.

Dr. George Glinski

Dr. **George Glinski**[63], a Professor of Electrical Engineering[64] at the University of Ottawa was a faithful member of the IRE, a pioneer in computing, modern communications and systems theory, and an entrepreneur. He is remembered for his contributions to Electrical Engineering

[60] Proceedings of the **IEEE**, Special Issue on **Topside Sounding** and the **Ionosphere**, Volume 57, Number 6, June 1969
[61] http://www.clubofrome.at/news/newsflash30.html
[62] http://www3.sympatico.ca/drrennie/radar.html
[63] http://www.cs.ualberta.ca/~smillie/ComputerAndMe/Part11.html
[64] http://www.site.uottawa.ca/events/history_elg_dept.pdf

Education at the University of Ottawa and for the founding of Computing Devices of Canada (CDC).

Donald A. George

Prof. **Donald A. George**[65], first Chair of Systems Engineering at Carleton and, later, Dean of Engineering, was a co-researcher in the Wired Scientific Simulation Laboratory at Carleton. He went on after being Dean of Engineering to lead Carleton's' Instructional Aids and Television Department with an eye to the future of broadband multimedia distance education. He left Ottawa to found the School of Engineering Science at Simon Fraser University[66] and then to create the School of Engineering at the Hong Kong University of Science and Technology, where he was Associate Pro-Vice-Chancellor for Academic Affairs and Professor of Electrical and Electronic Engineering.
Prof. **Roy Boothroyd**, an IEEE Fellow, came to Ottawa from the UK where he supervised several Commonwealth Ph.D. students in the then new field of semiconductor electronics. Prof. Boothroyd was the founding Chair of the Department of Electronics at Carleton where he specialized in basic design, modelling, and application of semiconductor devices and integrated circuits. Dr. Boothroyd not only formed a faculty that trained students for the coming solid state world, his former students are among those who created it.

Michel Nakhla

IEEE Fellow **Michel Nakhla**, Chancellor's Professor, is a member of the Electronics Department, Carleton University. His fields of interest are modeling and simulation of high-speed interconnects, signal integrity, packaging, nonlinear circuits, multidisciplinary optimization, model-reduction techniques, parallel simulation, statistical analysis, wavelets and neural networks, opto-electronic systems, design centering, thermal design, electromagnetic radiation and interference. Professor Nakhla is Associate Editor of the IEEE Transactions on Circuits and Systems - Fundamental Theory and Applications; Circuits, Systems and Signal Processing Journal, and the IEEE Transactions on Components, Packaging and Manufacturing Technology: Advanced Packaging. Dr. Nakhla is Co-chair of the IEEE Topical Meeting on Electrical Performance of Electronic Packaging (EPEP) and a Member of the EPEP Executive and Technical Program Committees; a Member of the Executive Committee of the IEEE International Signal Propagation on Interconnects Workshop (SPI) since 1998; a Member of the Technical Program Committee of the IEEE International Microwave Symposium (IMS) since 2000; and a Member of the CAD committee (MTT-1) of the IEEE Microwave Theory and Techniques Society since 1999.

David C. Coll

David C. Coll[67][68] is a Life Fellow of the IEEE, cited for "pioneering work in adaptive equalization, and leadership in communications research and education". He is a registered

[65] http://www.chamblycounty.com/George.html
[66] http://www2.ensc.sfu.ca/about/history.html
[67] http://www.sce.carleton.ca/faculty/coll.html

Professional Engineer in the Province of Ontario, and is a Member of the Order of Honour of the Association of Professional Engineers of Ontario reflecting his contributions to the profession. Dr. Coll is also a Fellow of the Canadian Academy of Engineering. From 1980 to 1991, he was the Editor for CATV of the IEEE Transactions on Communications. At the present time, he is the Chair of the IEEE Ottawa Section Life Members Affinity group. Coll received the B.Eng. degree in Engineering Physics and the M.Eng. degree in Electrical Engineering from McGill University, in 1955 and 1956, respectively. He studied Information Theory at the Massachusetts Institute of Technology, Cambridge, from 1957 to 1959, and received the (first) Ph.D. degree in Engineering from Carleton University, Ottawa, Canada in 1966.

From 1956 to 1967, he was with the Defence Research Board of Canada. During this time he conducted research in ionospheric sounding; HF, meteor-burst and spread spectrum communication systems; signal processing, real-time computing and adaptive data communications systems. In 1967 he joined the Department of Systems and Computer Engineering at Carleton University where he was a Professor until his retirement as Professor Emeritus in 1998. Prof. Coll was Chairman of the Department on two occasions and was the Director of the M. Eng. in Telecommunications Technology Management (TTM) Program at the time of his retirement. He is the creator of the new B. Eng. degree program in Communications Engineering, introduced at Carleton University in the Fall of 1998.

Prof. Coll taught and conducted research in the areas of computers, communications and digital television, digital signal processing, and applications of enhanced, broadband communication networks, cable television, image communications, and the application of multimedia in distance learning. Professor Coll was a Co-founder of, and a Principal Investigator in, the Carleton University Wired City Simulation Laboratory from 1971 to 1978, a multi-disciplinary laboratory where applications of enhanced broadband networks were investigated[69][70].

He was active in the Telidon program, as a member of technical and educational committees. Dr. Coll was the Carleton Co-ordinator for OCRInet, serving on the OCRInet Policy and Applications Committees. He was the Project Leader for a TeleLearning National Centre of Excellence Project from 1995-1999.

Dr. Coll was a member and Chair of the APEO Academic Requirements Committee for many years. He was the author of the 1986 Canadian Council of Professional Engineers Common Syllabus of Examinations in Computer Engineering, and as the CEAB Visitor for the inaugural visits to many new programs. He also was the author of the 1992 CCPE Syllabus in Electrical Engineering. At the provincial level, Prof. Coll was a member from 1995 to 1998 and Co-Chair in 1997-1998 of the Ontario Council on Graduate Studies Appraisals Committee.

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[68] http://www3.sympatico.ca/dccinfo/

[69] http://books.google.com/books?id=RVA7XW1_EyQC&pg=PA33&lpg=PA33&dq=carleton+university+wired+city&source=bl&ots=oNhV8ermA6&sig=wI_tj7eb-JlyuXWSdMcYe6-KOwE&hl=en&ei=6EGYSbTEF4zgMNWR6O8L&sa=X&oi=book_result&resnum=1&ct=result

[70] http://adsabs.harvard.edu/abs/1974STIN...7521499C

Nicolas Georganas

Prof **Nicolas Georganas**[71], of the University of Ottawa, has been a major contributor to electrical engineering in the Ottawa area for many years. The following is taken from the Orion Award citation:

> Technological change is now such a constant factor in our lives, we are rarely, if ever, surprised by the new marvels that regularly come our way, and we probably never even think about the people who, over the last four decades, have been making it all happen.
>
> One such person is Dr. Nicolas Georganas, one of Canada's most accomplished information technology and networking research pioneers and world authority on interactive multimedia communications. The winner of the 2007 ORION Leadership Award, Dr. Georganas, Associate Vice-President of Research (External) at the University of Ottawa, has made substantial and enduring technical contributions in computer, cellular and multimedia networking.
>
> Widely regarded as one of the "fathers" of high technology in Canada, he helped train and mentor the community researchers that has made Ontario a global leader in information technology. As a working researcher, he is currently involved in at least six highly relevant projects. His many honours include the Order of Ontario and the Queen's Golden Jubilee Medal. He was recently invested as an Officer of the Order of Canada.
>
> Born in Greece in 1943, he received his undergraduate electrical engineering degree in Athens, then earned two doctorates, one in Germany, the other at the University of Ottawa, which has been his home ever since. In the early 1970s, he was one of the first Canadians to make major contributions to the foundations of information networks. Initially, this involved work on the optimal design and the flow and congestion control of such networks. The result was several well-published algorithms, which are still pertinent and useful in today's high-speed networks and are often cited in the literature.
>
> Dr. Georganas turned his attention to local area networks (LANs). One of his endeavours in this field resulted in a breakthrough algorithm for the exact numerical analysis of queuing networks. It was that field's premier discovery of the decade, and his book on the subject was published by MIT Press in 1989. Subsequently, Dr. Georganas' work on the modeling of "fractal" data traffic and its implications in designing switches for high-speed networks earned him the Institute of Electrical and Electronic Engineer's (IEEE's) coveted Prize Paper Award in 1995. He also did substantial work on wireless traffic and was among the early major global contributors to the optimal dynamic and hybrid channel allocation assignment in wireless mobile cellular networks.
>
> He founded a multimedia lab at the University of Ottawa, the first of its kind in Canada, with a radically diverse team of engineers, psychologists, economists and people from other disciplines. To date, Dr. Georganas has received $55 million in research grants and contracts. The money has been used to fund both his own and many other people's research and help build institutions that bring together government, academia and private industry. Dr. Georganas was instrumental in establishing the Ottawa Centre for Research and Innovation's research programs, and was principal investigator at the National Capital Institute of Telecommunications (NCIT) from 2003-2005, which he helped to create. While at NCIT, Dr. Georganas worked in a field called collaborative virtual environments and co-founded the DISCOVER laboratory, (Distributed and Collaborative Virtual Environments Research Laboratory).

[71] http://www.uottawa.ca/services/markcom/gazette/001103/001103-art22d-e.html ; http://www.discover.uottawa.ca/people/Nicolas_Georganas/SITE/; http://www.orion.on.ca/2007orionawards/georganas.html

> Dr. Georganas can point to a long list of awards, citations and achievements, including recognition as a Fellow of the Academy of Sciences (Royal Society of Canada). He's also received the Pioneer in Computing in Canada Award from the IBM Centre of Advanced Studies and earlier this year, he received the very first Canada Computer Medal from the Institute of Electrical and Electronic Engineering.

Hussein Mouftah

Prof. **Hussein Mouftah**[72] is a renowned and high honoured Professor in the School of Information Technology and Engineering at the University of Ottawa. In addition to his academic work, Dr. Hussien is a tireless IEEE worker. The following[73] is the citation accompanying his award of the Julian C. Smith Award by the Engineering Institute of Canada.

> "Hussein Mouftah is a Tier 1 Canada Research Chair and Professor in the School of Information Technology & Engineering at the University of Ottawa. He is also an Adjunct Professor in the Electrical & Computer Engineering Department at Queen's University. Hussein Mouftah has made substantial contributions to the Canadian telecommunications industry. He is the author of several books as well as hundreds of refereed journal and conference papers, and his work in photonic networks, computer networks, weather optical networking, photonic switching and wireless communication networks is the standard taught at schools around in the world.
> Hussein Mouftah has developed leading technologies, including a new service-guaranteed end-to-end shared protection scheme called Short Leap Shared Protection (SLSP) and a signalling and dynamic routing protocol for wavelength-routed optical networks called Asynchronous Criticality Avoidance (ACA) Protocol. Hussein's work has garnered him several awards including Fellowships from the EIC, the IEEE and the Canadian Academy of Engineering; the prestigious Edwin Howard Achievement Award from the IEEE; and several others from Canadian Government organizations and Professional Engineers Ontario.
> Hussein Mouftah's service to Canada, the profession and the community has been exemplary. He has been the Chair and/or Technical program Chair of more than 25 well known national and international conferences on telecommunication networks and information systems. We are fortunate to have many internationally recognized Canadian researchers who have made significant contributions to the expansion of knowledge and within this select group, Hussein Mouftah stands out as a renowned researcher, a true academic and a perfect gentleman. Tonight, we present him with [the prestigious Julian C. Smith Medal]".

Tyseer Aboulnasr[74]

Tyseer Aboulnasr, O.ONT., FCAE, FEIC, SMIEEE, P.Eng., is currently Dean of The Faculty of Applied Science and Professor of Electrical Engineering at The University of British Columbia. As Dean, she leads the Faculty of Applied Science, bringing together 11 engineering programs along with three schools: Architecture and Landscape Architecture, Nursing and the School of Engineering at the Okanagan campus.

Dr. Aboulnasr received the Bachelor of Engineering degree from Cairo University, Egypt and M.Sc. and Ph.D. degrees from Queen's University all in Electrical Engineering. She was Dean of the Faculty of Engineering at University of Ottawa from 1998–2004 and Associate Dean

[72] http://www.site.uottawa.ca/~mouftah/Biography/index.html
[73] http://www.site.uottawa.ca/~mouftah/; http://www.eic-ici.ca/english/tour/cit06/Mouftah.pdf
[74] http://www.apsc.ubc.ca/about/dean/biography.php

(Academic) from 1996–1998. She chaired the Council of Ontario Deans of Engineering from 2001–2002. She was the first woman to do so.

Dr. Aboulnasr received the Ottawa-Carleton YWCA Women of Distinction Award (Education) in 1999 and was elected Fellow of the Engineering Institute of Canada in 2002 and Fellow of the Canadian Academy of Engineering in 2003. She was named one of the 100 most influential people in Ottawa in 2001. She received her highest honour in 2005 when she was named a 2004 recipient of the Order of Ontario.

Dr Aboulnasr's research is in the area of digital signal processing. She is currently the principal investigator on an interdisciplinary inter-university project on smart hearing aids with Siemens, Germany. Her research has been funded by Natural Science and Engineering Research Council (NSERC), Communications and Information Technology Ontario (CITO), National Capital Institute for Telecommunications (NCIT) as well as industry. She maintains status as Adjunct Professor at University of Ottawa

Dr. Yiyan Wu

Dr. Yiyan Wu of CRC, PhD Carleton, and an Adjunct Professor in Systems and Computer Engineering there, was in Las Vegas recently to pick up an Emmy Award from the Academy of Television Arts and Sciences on behalf of the Communications Research Centre, the former Advanced TV Test Centre where first year Carleton Psychology students by the busload evaluated various HDTV standards, and the International HDTV Standards Committee of which he is a member.

The story of CRC's role in the development of HDTV standards is included in the next section.

Dr. Wu is the recipient of the CRC **Innovator Award,** ***"In recognition of the exceptional innovation capabilities and scientific contribution to digital television research and standards development."***

The citation reads as follows:

> A research scientist of international repute, Dr. Yiyan Wu is an engineering pioneer whose innovative work in communications technologies is helping to revolutionize the way people interact around the world. Renowned for his expertise in digital television (DTV) research and standards development, Dr. Wu is a leading authority in a host of multimedia fields, including satellite broadcasting, local multi-point microwave distribution systems and terrestrial broadcasting. Most telling is the esteemed position he holds among his international peers. In December 2000, the Institute of Electrical and Electronics Engineers (IEEE), the world's largest professional organization, awarded Dr. Wu its highest honour by electing him as an IEEE Fellow, a status achieved by less than one per cent of its 300,000 members. As senior researcher with the Broadcast Technology Branch of the Communications Research Centre Canada (CRC), Dr. Wu has worked closely with the Canadian broadcast industry to improve its technological competitiveness during the transition from analogue television to a new and vibrant generation of digital television. Integral to that task is Dr. Wu's groundbreaking contribution to international and domestic industry standards that will shape the future of global multimedia communications. In 2000, Dr. Wu led a collaborative research team in the establishment of a three-dimensional

broadcast antenna pattern — now recognized as a worldwide standard — that protects existing North American direct satellite broadcasting services such as ExpressVu and StarChoice in Canada from possible interference of future mobile satellite services. Also frequently cited is a prototype system developed by Dr. Wu that improves emission mask and system protection ratios covering the transition from analogue to DTV, a set of parameters that is expected to reduce significantly the implementation and operational costs for Canadian broadcasters.

Typical of classic innovators, the list of Dr. Wu's accomplishments is long and varied. He has continued his relationship with his alma maters, Beijing University of Posts and Telecommunications and Carleton University, as an adjunct professor in system and computer engineering in Canada and as an advisory professor in China. Before joining CRC in 1992, Dr. Wu was a senior research scientist at Telesat Canada, leading projects such as digital audio/video compression and transmission and satellite communications. With a publication list of more than 150 papers, Dr. Wu has spoken at conferences in at least 13 countries and is cited in Cambridge's 1997 *International Who's Who of Intellectuals* as well as American Biographic Institute's 1996 *International Book of Honor*.

Another characteristic of innovators is a willingness to share their expertise to the benefit of others. In 1994, Dr. Wu participated in a multinational research project sponsored by Canadian, Brazilian and U.S. broadcasters to develop a multi-carrier digital broadcasting system. As the sole scientific authority for the system design and testing, Dr. Wu implemented and fully tested the technology within 10 months.

At CRC, Dr. Wu has assisted a number of Canadian companies, including Wavesat, Larcan, WiLAN, Alcatel and Telesat Canada, on a variety of technology transfer projects. The recipient of three CRC awards for his research achievements and entrepreneurial initiative, Dr. Wu's economic impact upon companies that he has guided is conservatively estimated at more than $1 million. His exemplary work has cinched Canada's reputation as a telecommunications leader and established a standard of excellence for future research scientists and engineers to follow.

Industry

In addition to BNR, there have been a very large number of companies and corporations involved in the history of the IEEE in the Ottawa area[75][76][77].

Computing Devices of Canada[78] was a pioneering computer company in the Ottawa area. They produced equipment for the military, and were representatives for the Bendix line of computers[79]. CDC designed a 16-bit minicomputer with many advanced features for airborne use, but it was rejected by the Canadian services before it was developed.

[75] http://members.virtualtourist.com/m/p/m/17aa58/
[76] http://www.cosmin.com/hightech.html
[77] http://www2.canada.com/ottawacitizen/features/hightech/index.html
[78] http://encyclopedia2.thefreedictionary.com/Computing+Devices+Canada+Ltd
[79] In particular the G-15: http://en.wikipedia.org/wiki/Bendix_G-15

Other companies soon followed. They included **Mitel**[80], **Newbridge**[81], and **Corel**[82], companies started by Terry Matthews[83] and Mike Cowpland [84]. Mike and Terry are legends in the Ottawa community, leaving **Microsystems International**[85] when it was closed by Northern Telecom, to start up Mitel - designing, manufacturing and marketing telephone switch gear. Terry moved on to found Newbridge, producing frame relay equipment, while Mike created Corel (and purchasing WordPerfect along the way) to pursue his long term belief in the future of office productivity software.

Another pioneering company was **Gandalf** [86] a company that built modems, among other devices, to connect terminals to computers. As described in Wikipedia:

> "Gandalf was originally formed by Desmond Cunningham and Colin Patterson (not to be confused with the hockey player of the same name) in 1971, and started business from the lobby of the Four Seasons Hotel on Albert Street in Ottawa".

Their "star" product was a 9600 bps modem that used a group of harmonically-related tones to carry the data … sound familiar?

The computer age really arrived in Ottawa in 1963 when Stan Brown, the salesman for Digital Equipment Corporation (DEC) asked their only customer in Ottawa if he would be interested in setting up a local office for them. He (David Coll[87], LFIEEE) declined, but recommended that a colleague might be interested. The colleague (**Denzil Doyle**[88]) agreed to do so, and DEC Canada was born, complete with its own woollen mill in Carleton Place. (The DEC home office and manufacturing facility was located in a Civil War vintage woollen mill in Maynard, Massachusetts).

Denny, who is recognized as "the Father of Silicon Valley North" [89], has been a dominant force in the development of industry in the area. Following a stint as a member of the Scientific Staff at DRTE, where he co-authored an IEEE paper on sounder-assisted HF radio communication systems[90], he was involved through his company, Doyletech[91], in the start up and development of several high technology firms and as an advisor to government.

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[80] http://en.wikipedia.org/wiki/Mitel
[81] http://en.wikipedia.org/ wiki/Newbridge_Networks
[82] http://en.wikipedia.org/wiki/Corel_Corporation
[83] http://en.wikipedia.org/wiki/Terry_Matthews, http://blog.tmcnet.com/blog/rich-tehrani/ip-communications/sir-terry-matthews.html
[84] http://en.wikipedia.org/wiki/Michael_Cowpland, http://people.forbes.com/ profile/michael-cowpland/88205
[85] http://en.wikipedia.org/wiki/Michael_Cowpland, http://people.forbes.com/ profile/michael-cowpland/88205
[86] http://en.wikipedia.org/wiki/Gandalf_Technologies
[87] http://www.sce.carleton.ca/faculty/coll.html
[88] http://www.doyletechcorp.co/ doyletech-aboutus.html
[89] See: http://www.doyletechcorp.com/doyletech-hb-hotspot.html
[90] Frequency Sounding Techniques for HF Communications over Auroral Zone Paths, Jull, G.W., Doyle, D.J, Irvine, G.W. Murray, J.P., Defence Research Telecommunications Establishment, Ottawa, Ontario, Canada; Proceedings of the IRE, July 1962, Vol 50, No 7, 1676-1682
[91] http://www.doyletechcorp.com/

Denny left DEC to become CEO of a start-up called **Nabu**[92][93]. The basic concept of Nabu was to connect subscribers owning a Nabu Computer (a microprocessor-based computer) to a central computer utility through broadband multimedia communications i.e., coaxial cable or cable TV. Nabu was an idea ahead of its time, but the venture failed to realize the potential of the concept.

Subsequently, Doyle led investments in technology companies in Ottawa and Ontario as Chairman of Capital Alliance Ventures Inc. and he has served on the boards of directors of numerous companies. In recognition of his activities in technology commercialization, he was invested as an Officer of the Order of Canada in 2005.

[92] http://en.wikipedia.org/wiki/Nabu_Network
[93] http://www.ieee.ca/millennium/telidon/telidon_nabu.html

1996 Snapshot of Companies: Ottawa Citizen March 7, 1996.

The following Companies were among those listed in the Ottawa Citizen's High Technology Section on March 7, 1996.

ActiveSystems Inc. SGML applications
AJJA Information Technology Consultants Inc. Business and IT Solutions
Akran Services System Integrator
Ameridata Canada Inc. Acquirer of international operations of Control Data Systems
Anderson Consulting. Global management and technology consultants.
Applied Silicon. Custom engineering solutions.
Aprel Laboratories. Independent research, engineering and testing laboratory.
Authentex Software Corporation.
CAL Corporation (Canadian Astronautics Limited)
Calian Technology Ltd. Custom applications in satellite communications.
CMC - Canadian Marconi Corporation.
CGI Group. IT Consulting.
Chipworks Inc. Analysis of IC's.
Cognos. Business intelligence software
Computer Sciences Canada. IT professional services.
Computing Devices Canada Ltd. Defence electronics.
Conference Coll Inc. Conference services for high tech industry.
Consolidated Communications Inc.
Corel Corporation
Crosskeys Systems Corporation
Dataware Technologies
DGS Information Consultants
Dicasp Corporation
Dipix Technologies Inc.
DMR Group
Domus Software
DVS Communications Inc.
Dy4 Systems Inc.
EDS Canada
Exocom Group
Fifth Dimension
Filtran Microcircuits
Fulcrum Technologies Inc.
Gandalf Technologies Inc.
Gentian Electronics Ltd.
Hardware Canada Computing
Hexacon Computer Systems Inc.
High-Tech Direct
HST Group Ltd.
Ingenia Communications Corporation

Instantel
Intelligent Touch Solutions Inc.
Inqare Solutions Inc.
IOTA Information Management Ltd.
IST Group Inc.
ISM Information Systems Management
IStar Internet
ITI Information Technology Institute
Ivation Datasystems Inc.
Jetform Corporation
KAO Infosystems Canada Inc.
KOM Optical Storage
Lansdowne Technologies Inc.
LANVista Corporation
Learning Tree International
Learnix
Lexmark Canada Inc.
LGS Group Inc.
Libaxus Inc.
Linkage Software Inc.
Linktek Corporation
Logas Manufacturing. PC boards
Lumonics Optics Group
MacDonald Dettwiler
Microstar Software Inc.
Moneco AGRA Systems
Mosaid Technologies Inc.
MPC Circuits. PCBs
Newbridge Networks Corporation
NIVA. Documentation
Nordion Inc.
Nortak Software Ltd.
Nuvo Network Management
Objectime Limited
Object Technology International Inc.
Optitek Ltd.
OTG Ottawa Telephone Group
Plaintree Systems Inc.
Prior Data Services Ltd.
Prism Printed Circuits Inc.
Procom
Pryor Metals Limited
PSC Group
QNX Software Systems Ltd.
ROMifications Publishing Inc.
Sage Data Solutions Inc.

SHL Systemshouse
Simware
Sirius Consulting Group Inc.
Software Kinetics
SPAR Applied Systems
Spectrum Sciences Technology Gallery
Sterling Software
Synercard Corporation. Smart card solutions
Telesat
Terra Aerospace Corporation. Robotic systems.
Thermazone Informatics Inc. Fax services
Theratronics International Ltd. Cancer treatment.
Thomson-CSF Systems Canada Inc.
Timestep Corporation. Cryptographics
TMI Communications. MSAT – mobile satellite communications.
TRW Canada Ltd.
Tydac. Spatial analysis software.

Cooperative Agencies

The Ottawa area has seen the formation of many agencies committed to university-government-industry co-operation.

OCRI[94]**, t**he Ottawa Carleton Research Institute[95], now known as the Ottawa Centre for Research and Innovation, was set up to provide the infrastructure to support university/industry collaboration – a basic requirement of most funded research. The OCRI Mission is stated as

> "… to lead Ottawa in economic development by connecting business, research, education, government and talent to advance the competitiveness of our knowledge-based industries and institutions, to build wealth and enhance our quality of life".

As well, there have been a number of attempts to create networks linking appropriate institutions to foster not only collaboration but also the quality of life in the Ottawa area[96][97][98].

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[94] http://www.ocri.ca/about/assets/Sages2008.pdf
[95] http://www.ocri.ca/about/assets/StratPlan_feb1307.pdf
[96] http://www.cata.ca/Media_and_Events/Press_Releases/cata_pr06170801.html
[97] http://www.ottawawirelesscluster.com/_news/news_2.php
[98] http://www.ieee.ca/diglib/library/9705carty/carty-ppt/sld001.htm

CATA[99], the Canadian Advanced Technology Alliance (formerly "Association[100]").

> "The Canadian Advanced Technology Alliance grows the revenues of its 28,000 members by creating a collaborative edge -- a chain of expanding value that ripples across Canada's Innovators, Commercializers, Users, and Professionals.
>
> The largest high-tech association in Canada, CATA*Alliance* matches businesses with opportunities across almost every sector, so that we can all do business together. Reaching out from Canada, CATA*Alliance* members are connected with investment and partnership opportunities with the major global companies. As 80% are exporters, CATA's members are the arrow-head for global growth.
>
> Through its "Innovation Nation" program, CEOs come together to catalyze the development of the Canadian business environment. CATA is the foundation for commercialization, market research, networking, events, access to other associations, and professional development, across the nation".

Projects

There have been a number of projects in the Ottawa Valley aimed at interconnecting institutions, governments, schools, public buildings, and so on, through broadband multimedia networks. Included among these are:

The Wired Scientific City Laboratory[101] at Carleton University in the 1970's. These are described in[102]

> **Multidisciplinary Applications of Communication Systems in Teleconferencing and Education**
> Coll, D.; George, D.; Strickland, L.; Guild, P.; Paterson, Si.
> Communications, IEEE Transactions on
> Volume 23, Issue 10, Oct 1975 Page(s): 1104 - 1118
>
> **Summary:** This paper describes a laboratory facility and the multidisciplinary research that has been carried out in it relevant to the application of communications technology in such areas as teleconferencing and education. This facility at Carleton University, Ottawa, Canada, provides multichannel multipoint audio and video communications, and information storage and control facilities to simulate a wide variety of uses. The research program, conducted by communication technologists, systems engineers, and social psychologists, is outlined and the results of a number of teleconferencing and educational experiments are presented. The forthcoming communications technology satellite (CTS) Stanford-Carleton Universities Curriculum-Sharing

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[99] http://www.cata.ca/

[100] http://www.ic.gc.ca/app/ccc/srch/nvgt.do?lang=eng&prtl=1&sbPrtl=&estblmntNo=234567081940&profile=cmpltPrfl&profileId=21&app=sold

[101] http://books.google.com/books?id=RVA7XW1_EyQC&pg=PA40&lpg=PA40&dq=wired+scientific+city&source=bl&ots=oNhV4juqC5&sig=NXyDFTjtXopWrehjsYhO-GYBgTU&hl=en&ei=E_iSSdLMJIzgML_l6e8L&sa=X&oi=book_result&resnum=1&ct=result

[102] http://ieeexplore.ieee.org/Xplore/login.jsp?url=/iel5/8159/23836/01092703.pdf?arnumber=1092703

Experiment is described, as are the preparations for a project in the educational applications of communications technology.

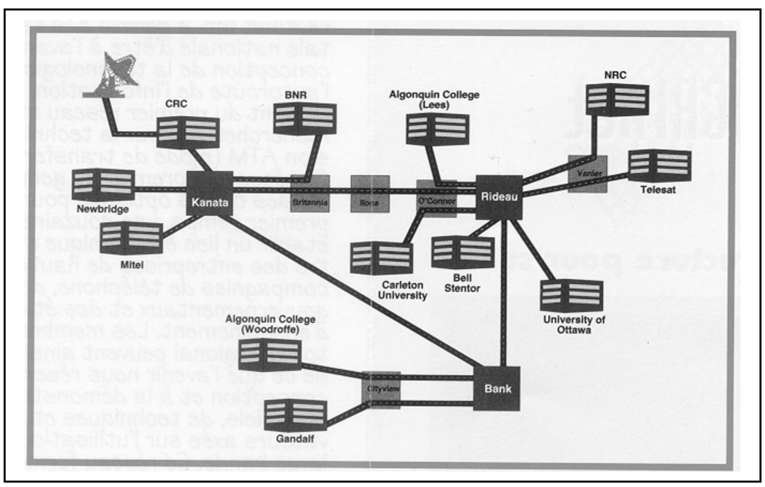
A course exchange program between Carleton University and Stanford Universities is described in[103].

College curriculum-sharing via CTS

HUDSON, H. E., Stanford University, Stanford, Calif.; GUILD, P. D., Carleton University, Ottawa, Canada; COLL, D. C., Carleton University, Ottawa, Canada; LUMB, D. R., NASA, Ames Research Center, Moffett Field, Calif.
AIAA-1975-905
American Institute of Aeronautics and Astronautics, Conference on Communication Satellites for Health/Education Applications, Denver, Colo., July 21-23, 1975, 6 p.

Other References are http://adsabs.harvard.edu/abs/1974STIN...7521499C**;**

OCRInet[104] was a fibre optic network set up in 1994 under the management of OCRI. The founding partners were: Algonquin College, Bell Canada, Bell Northern Research (now Nortel), Carleton University, Communications Research Centre, Gandalf Technologies, Mitel Corporation, National Research Council, Newbridge Networks, Stentor Resource Centre, the Telecommunications Research Institute of Ontario (TRIO), Telesat Canada, the University of Ottawa, and OCRI.



Many experiments[105][106] were run on OCRInet during its lifetime. It was one of the first examples of an ATM network and operated with permanent virtual circuits.

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[103] http://www.aiaa.org/content.cfm?pageid=406&gTable=mtgpaper&gID=46770 ; http://pdf.aiaa.org/preview/1975/PV1975_905.pdf; https://ottawa.ca/calendar/ottawa/archives/rmoc/Corporate_Services_and_Economic_Development/20May97/Stewart.pdf
[104] http://www.miruscom.ca/under/atm.htm
[105] For example, see; http://www.sce.carleton.ca/tln/ITVMBONE.htm
[106] http://www.wtec.org/loyola/satcom2/e_05.htm

Telidon[107][108]

As cited as an IEEE Canada Showcase of Canadian Engineering Achievement[109],

> "Although videotex was born in Europe, Canada was very much interested in the technology and undertook to further improve it. The result was "Telidon", a second generation videotex system, invented at the Communications Research Centre, research arm of the federal Department of Communications. Telidon placed Canada as a world leader in two-way TV technology, and offered the potential to revolutionize telecommunications in Canada.
>
> The development of Telidon was rapid, and many envisaged Telidon performing many of the services in the wired cities of tomorrow. Unfortunately, by 1985 those utilities providing Telidon went off-line, overtaken by the rapid rise in personal computer technology with its plethora of games and software options. Few expectations were met, as networks did not catch on due to lack of accessible resources".

As described on the Friends of CRC web site[110], the Telidon program began officially on August 15, 1978 and ended on March 31, 1985. Its objectives were to promote development of a national videotex infrastructure through appropriate standards, regulations and technology; encourage the creation of a viable Telidon industry producing hardware, software, systems and services; and to encourage joint government-industry research and development, product development, promotional activity and support market trials and operational systems.

Herb Bown is widely considered the "Father" of Telidon. Others team members included **C.D. O'Brien, Bill Sawchuck, J.R. Storey** and **Bob Warburton**.

The Telidon concept and its origins are outlined in "Canadian Developments in Telecommunications[111] as follows:

> Telidon, the Canadian videotex phenomenon, had many facets. It was involved with the definition of a language of instructions which could he used to draw pictures: it was conceited with the transmission of these drawing instructions; it was concerned with equipment on which the instructions could draw pictures: it was concerned with the creation of public data bases containing (the instructions to draw) pictures which subscribers could retrieve in response to their queries for information. [As well as its impact on education, society, and so on.]
>
> A set of Graphics Transmission Instructions (GTIs) were developed as part of a DRTE research program in multiple user access to shared computer graphics visual spaces. They were developed so that remote users of a graphics display could interact with the display by directly modifying the file that contained the image drawing commands. The modification was achieved by transmitting graphics commands in the guise of ASCII characters. Thus the capability existed at DRTE for the creation of computer graphics images from a remote location over telephone lines when the Minister of Communications at the time (Mme. Jeanne Sauve, [subsequently] the Governor General of Canada) asked whether or not this was the same as the European videotex systems she had seen. She was

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107 http://archives.cbc.ca/science_technology/computers/topics/1738-11979/
108 http://www.telecommunications.ca/loveaffair.htm
109 http://www.ieee.ca/millennium/telidon/telidon_about.html
110 http://www.friendsofcrc.ca/Projects/Telidon/Telidon.html
111 "Canadian Developments (Contributions) to Telecommunications: An Overview of Significant Contributions". T.L.McPhail and D. C. Coll, Eds. The University of Calgary, 1986.

informed that it was not, it was much better. And, in fact, it was a better picture because the display was a vector computer graphics terminals and not a block mosaic character display.

What was to become known as 'Telidon grew from the original DRTE research program project in response to competition from Prestel and Antiope – [European videotex systems.] The GTIs became PDIs: a set of Picture Description Instructions which, when received with the proper equipment could create an image on a television set. These PDIs were coded as strings of standard (ASCII) teletype characters so that they could he transmitted to the Telidon terminals in the same way that text files were. As well, means were developed a transmit Telidon PDIs as data signals on the spare lines in broadcast television signals. The idea was that every TV set would become a graphics terminal for information systems. As a potential application for this new communication mode, Telidon was advertised as the coming of the information age: "two-way' television", "Talk back to your 'IV set", and so on. The expectations were that Telidon would provide the means to access data bases: access to all the world' information in every home!

There were national committees established to provide for public input in a variety of areas: education at a number of levels, societal impact, standards, and so on.

A major accomplishment was the adoption of the Telidon coding scheme as the NAPLPS[112] , (**N**orth **A**merican **P**resentation **L**evel **P**rotocol **S**yntax) for videotex and teletext services.

Telidon was adopted by the Canadian government as a flagship hi-tech project to demonstrate Canadian competence. It was also supported as the foundation of a new industry — the information marketplace. However, it was never clear whether the DOC role was to create the technology, establish a world of information systems in which Telidon would be used, assure Telidon's future by establishing it as a world standard (a major DOC strategy that dissipated the technical efforts and drained the project of its brilliant technical leadership — the small group of original inventors were involved in all aspects: invention, design, debugging, contracting, standards, and marketing, as well as promotion and selling of the concepts), or whether market forces should rule to accept or reject the idea.

JANET[113][114][115]

From [76]:"When a meteoric particle enters the region of the ionosphere in the height range of 80-120 kilometres, it becomes heated as a result of many collisions with air molecules. … Such collisions … may cause the excitation or ionization of the atom. … The ionization produces a trail of free electrons in the wake of the meteor, and it is this trail which is detected by radio methods. While only two or three meteors are visible in any given hour, hundreds of trails can be detected in the same period, using sensitive radio equipment. The electrons partially scatter any radio waves incident on a trail, and it is this phenomenon which is utilized in the Janet system".

"… D.W.R. McKinley and other discussed the idea of using meteor signals for communication purposes as early as 1950. … the emphasis … shifted to forward-scatter measurements. These measurements led to a detailed investigation of the forward scattering of radio signals from meteor trails and a study of the utility of these signals for communication purposes. By 1954,

[112] http://en.wikipedia.org/wiki/NAPLPS
[113] http://www.friendsofcrc.ca/Projects/Janet/janet.html
[114] http://www.globalsecurity.org/space/library/report/1990/JJP.htm
[115] http://en.wikipedia.org/wiki/Meteor_burst_communications

communication via VHF signals reflected from individual meteor trails had been achieved and development of equipment for this purpose was under way".

"DRTE's objectives were:

- To assess the utility of meteor signals for communication purposes.
- To demonstrate that meteor signals could be used for carrying coded information.
- To improve the reliability of long distance communication over the HF/VHF frequencies.

Work began at RPL in the Fall of 1952. JANET was headed by Dr. P.A. Forsyth. A number of other individuals were instrumental, including E.L. Vogan, D.R. Hansen, C.O. Hines, L.L. Campbell, D.W.L. Davis, S.J. Gladys, G.R. Lang, L.M. Luke and M.K. Taylor"

The development of the JANET meteor-burst system is described in:

"The Principles of JANET: A Meteor-Burst Communication System", Forsyth, P.A. Vogan, E.L. Hansen, D.R. Hines, C.O., Radio Physics Lab., Defence Research Board, Ottawa, Canada. Proceedings of the IRE, vol. 45, no. 12, 1642-1657, December 1957.

Abstract
The JANET system of long-range communication employs vhf radio signals which are forward-scattered by the ionized trails of individual meteors. The propagation characteristics and design considerations of such a system are surveyed in this paper, and preliminary operating experience is summarized.

CRC and the North American Digital Television System

The achievements of the CRC Broadcast Technologies Research Branch regarding its participation in the evolution, development and evaluation of the North American Digital Television System including HDTV are described in the articles that follow.

In January 2009 this effort was recognized by the Academy of Television Arts and Sciences by awarding a technical Emmy at the annual Consumer Electronics Show in Las Vegas.

The following papers describing CRC projects related to HDYV and fibre optic communications were written by Dr.Metin Akgun. **He** received his diploma in Electrical Engineering from Istanbul Technical University (Turkey) and his Ph. D. degree from the Swiss Federal Institute of Technology in Zurich. During his career in Turkey, Switzerland and Canada he was involved in the development of solid state communication equipment for use over high voltage power lines, the development of digital telephone equipment and networks, the application of fibre optic transmission systems for providing integrated communications services to homes.

In 1986 he was appointed as Director in the Broadcast Technologies Research Branch at the Communications Research Centre with the responsibility to establish a Television Broadcast Technologies Research division. The division made significant contributions towards the development of the North American digital television system including HDTV. In 1998 he became VP of the Broadcast Technologies Research Branch.

Dr. Akgun also represented for many years Canadian interests as head of delegation at the ITU-R's Study Group 6 participating in the development of recommendations for broadcast services. He retired in December 2003.

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Summary

On January 9, 2009 at the International Consumer Electronics Show (CES) in Las Vegas the National Academy of Television Arts and Sciences presented the 60th Annual Technology & Engineering Emmy Awards. At this event the organizations which were involved in the development, testing and evaluation and finally standardization of the North American digital television system including HDTV were recognized and presented an Emmy award each (See Fig 1). The Advanced Television Evaluation Laboratory (ATEL) of the Broadcast Technologies Research Branch of the Communications Research Centre in Ottawa was one of the Emmy award recipients.

Fig 1. Emmy Award by the Academy of Television Arts and Sciences presented to the Advanced Television Evaluation Laboratory of the Broadcast Technologies Research Branch on January 9, 2009

Many distinguished researchers, engineers and technologists including a number of IEEE members at various levels up to the Fellow level were involved in the establishment of the Broadcast Technologies Research Branch and contributed to its research projects. At this point in time, the Broadcast Technologies Research Branch is the only research laboratory in North America that is neither funded nor associated with a broadcaster or manufacturer and can therefore develop and test technologies and systems without any commercial considerations.

The following is a historical perspective, how the Broadcast Technologies Research Branch was created, its achievements and its involvement in the design, evolution and evaluation of advanced television technologies and systems that have led to the Advanced Television Systems Committee (ATSC) standard for the North American digital television system, including HDTV.

1. Background

In the early 1970's the Japanese National Broadcaster NHK started research into the next generation of television with the goal to achieve a picture resolution that would be twice as high as the then existing television systems worldwide.

Towards the end of the 1970’s they had progressed sufficiently to prove that such a higher resolution television system was technically feasible. They also had made several contributions to the International Telecommunications Union’s (ITU) relevant Broadcasting Study Groups. They eventually developed their analog HDTV system MUSE for satellite broadcasting.

The Canadian Broadcasting Corporation (CBC) at that time had a significant engineering department that not only was providing technical support to its operation, but also was planning for the future technical evolution of the corporation. In the Planning Department Mr. Kenneth Davies was quite aware of the developments at the NHK. In the 1970’s there still existed in Canada a sizable broadcast equipment manufacturing industry. The CBC had over many years, through their Engineering Department, fostered a number of new equipment in the industry through their purchasing policy. Such equipment eventually found good international markets. However the CBC also recognized that there was a need to provide larger support than the CBC could provide in order for this industry to make the necessary transition towards a next generation of broadcast technologies. In order to convince government and industry of the impending changes in broadcast technologies, with the leadership of Ken Davies the CBC and the then existing Department of Communication (DOC) of the Government of Canada convened in 1982 the first High Definition Television (HDTV) Colloquium in Ottawa, Canada. This was also the world’s first conference (colloquium) dedicated entirely to HDTV.

This colloquium demonstrated very convincingly and visibly that a technological transition was going to happen in broadcasting in the not too distant future. This change would not only have an impact on the equipment manufacturing industry, but also potentially impact the use of the radio spectrum. Since the DOC was responsible for the management of the radio spectrum for the benefit of Canadians, the DOC decided to carry out a comprehensive study regarding the evolution of broadcasting.

In 1983 an extensive contract was awarded to Nordicity, a consulting company with expertise in broadcasting to carry out such a study. Significant input to this study was provided, among others, by the CBC. In addition in 1985 a second HDTV Colloquium was organized which attracted speakers and delegates from around the globe. It further demonstrated the rapid evolution of new broadcast technologies, in particular for television. Further HDTV conferences were organized in 1987, 1990, 1993 and finally 1996, at which time digital television and HDTV had found its way into many other conferences and hence there was no need to continue with these workshops.

Creation of the Broadcast Technologies Research Branch

The results of the Nordicity study highlighted the need for the DOC to develop in-house expertise to provide guidance both with respect to the development of an industrial development policy and perhaps more importantly to guide its spectrum management responsibility. As a result the DOC decided in 1986 to establish a broadcast research capability at the Communications Research Centre (CRC). The responsibility to establish a Broadcast Technologies Research Branch at the CRC was given to Dr. William Sawchuk, who just had completed the management of certain research activities regarding the Canadian teletext technology Telidon. A number of the researchers who had been involved in the Telidon development, in particular in its application to broadcasting were assigned to this new branch. Dr. Metin Akgun was appointed Director for the Television Broadcast Technologies Research division.

The CRC was fortunate that at this time the Assistant Deputy Minister, who was responsible for Spectrum Management and Information Technology, was Mr. Richard Stursberg (currently President of the CBC), who both recognized the potential impact of future broadcast technologies and furthermore that any research in such a new area would require significant new and expensive equipment to permit timely and state of the art research to be conducted. In addition to the normal resource allocation to this new branch, he also agreed to provide additional $500,000 per year for 5 years for the necessary equipment purchase.

The Broadcast Technologies Research Branch was also to carry out research in advanced sound broadcasting systems. In Europe some research was being carried out to establish a digital sound broadcasting system that would be superior to FM Radio in both sound quality as well as in its propagation characteristics. The remainder of this document will only deal with the television technology aspect of the Broadcast Technologies Research Branch.

Collaboration with the Canadian Broadcast Industry

From the experience that had been gained in the development of the Telidon technology and its transfer to the industry, Dr. Yun Foo Lum, who was made responsible for broadcast systems and standards, immediately created the Canadian Advanced Broadcast Systems Committee (CABSC) including Industry, research and government groups.

Collaboration with the USA Broadcast Industry

In about 1986 the federal Communications Commission (FCC) was under the pressure to provide additional radio spectrum for the growing need for mobile radio communications. The FCC recognized that a significant amount of the higher UHF band originally allocated to television broadcasting was largely underutilized by the broadcast industry. This frequency band was at that time a highly desirable piece of spectrum; the FCC suggested that it may be reallocated from broadcasting to mobile radio communication. This suggestion prompted a significant reaction from the broadcast industry. While until that time the US broadcast industry had shown little interest in HDTV, they suddenly realized that they may need this spectrum to implement HDTV also in the USA. In order to convince the FCC and legislators in the Congress, they set up in 1987 with the support of NHK a MUSE HDTV demonstration transmitter in Washington, D.C. The broadcasters did realize, however, that the MUSE system may not necessarily be suitable for the USA as a terrestrial television broadcast technology and something different may eventually have to be developed.

The FCC in the USA decided to create a Blue-Ribbon committee from the executives of the television broadcast industry including the equipment manufacturing industry, terrestrial off-air broadcasters, cable television networks and satellite broadcasters to deal with the development and selection of a future HCTV system. It was named the Advisory Committee for Advanced Television Systems (ACATS). Richard Wiley, a well known communications industry lawyer and former chairman of the FCC was appointed chairman of ACATS. ACATS created several working subcommittees to deal with the various aspects of the development, testing and implementation of a future advanced television system.

The establishment of such a high level industry committee in the USA, prompted the DOC in Canada to also establish a high level industry committee in Canada instead of the working level CABSC. The new committee was named Advanced Broadcast Systems of Canada (ABSOC).

Since it was important for the Broadcast Technologies Research Branch at the CRC to know what the thinking in the Canadian Broadcast Industry would be regarding the future of broadcast technologies, the Director of the Television Technologies Research division, at his request, was permitted to attend the ABSOC meetings as an observer. Very soon ABSOC members recognized that they in turn needed some expert technical advice in order to make sensible decisions. Thus the Broadcast Technologies Research Branch once again actively started working together with ABSOC, representing the industry to the benefit of both parties.

In Canada it is the Government of Canada that had, and still has, the legal authority to reach agreements with the USA regarding the use and sharing of the spectrum, in particular at the long border regions between Canada and the USA. Hence the DOC representing the Government of Canada was regularly dealing with the FCC regarding spectrum use policies.

Since the meetings of the Working Groups of ACATS were open to all, and recognizing that ABSOC had made the decision that a future Canadian advanced television system had to be compatible with that in the USA as had been the case for the NTSC system (it still is being used), the Broadcast Technologies Research Branch researchers started attending the relevant ACATS Working Groups as well as making well appreciated technical contributions to them.

Very early in the advanced television system development the Broadcast Technologies Research Branch and the DOC's Spectrum Regulations Branch came to an important understanding, that while the Broadcast Technologies Research Branch could and should participate in the technical development of an advanced television system, it would not engage in any policy decisions; these were to be handled by the DOC and the FCC as the appropriate government representatives.

Development of the North American Advanced Television System

In the USA ACATS decided, in order to provide the best advanced television system, that the development and selection of a system should be decided through a competitive process. The competition would be wide open and proposed systems would have to pass a rigorous testing process.

In order to test the systems the broadcast industry in the USA set up the Advanced Television Test Centre ATTC) in Alexandria, Virginia. The test laboratory was headed by Peter Fannon. This laboratory was primarily going to test the proposed systems' transmission – propagation characteristics, in particular their performance in a multipath environment as well as their interference into existing television transmissions and their susceptibility to the existing NTSC television signals. Quality of the pictures was to be evaluated by so-called expert viewers. This included professionals from the television and film industry.

However it was also recognized that the evaluation of the picture quality by expert viewers was not sufficient. There was a need to know how non-expert viewers, which are ordinary viewers of television, would evaluate and compare different systems.

The Broadcast Technologies Research Branch's Television Transmission Research group under its manager Bernard Caron (currently VP of Broadcast Technologies Research Branch) participated in the transmission and propagation tests as well as made significant contributions to these tests by developing test procedures. During the teletext development years, in order to evaluate the performance of digital teletext signals embedded in the analog NTSC signal, significant amount of terrestrial propagation path multipath characteristics had been collected which permitted to simulate in the laboratory these paths in support of developing transmission technology for teletext systems. This information was shared with ATTC and provided the testing process with realistic bounds for the transmission and modulation system evaluation.

During the Telidon system development at the CRC it was realized that there was a need to better understand the human-machine interface for a system to be accepted by users. A small group of industrial psychologists were involved in this process. These experts eventually got involved in the evaluation of the proposed advanced television systems with non-expert viewers. The ATTC in the USA did not have this expertise. The CRC had this expertise and it also recognized this as an opportunity to have a decisive influence in the selection and standardization of the future advanced television system for North America. The CRC researchers had already in the past been involved in the development and refinement of the ITU-R Recommendation 500, dealing with the visual assessment of television images.

The CRC therefore made the offer to ACATS to provide a video quality evaluation facility at the Broadcast Technologies Research Branch. With the acceptance of this offer, largely based on the recognition that the CRC had the necessary credentials and expertise, and furthermore that it was an industry-independent research organization and hence unbiased, the Advanced Television Evaluation Test Laboratory (ATEL) was created. Its first Manager was Dr. Paul Hearty (now with Ryerson University in Toronto). This laboratory was later integrated into the Video Signal Processing group under its manager André Vincent.

Fig 2. Viewing Room of ATEL. The lighting level and colour of the back-lit viewing wall meets the requirements of ITU-R Recommendation 500. Viewers are seated at a distance as is appropriate for HDTV or Standard TV.

Fig 3. Control and Switching Room Equipment to display images in the ATEL Viewing Room

This laboratory meets and exceeds all the environmental requirements prescribed in ITU-R Recommendation 500 with respect to lighting, ambient noise level, viewing distance, etc. The key requirement for meeting the ITU-R Recommendation 500 was the design of the back-lit wall where the display screen was to be inserted for viewing of the test image sequences. To meet the colour temperature and light intensity of this translucent wall, a complex lighting system had to be designed. Mainly dimmable fluorescent tubes were used and over some of them translucent colour tapes had to be wrapped to achieve the Recommendation 500 colour temperature requirements. In addition the wall had to allow interchanging of display screens with different aspect ratios; primarily 3 x 4 for standard television and 16 x 9 for HDTV.

ATEL is the only picture quality evaluation laboratory in Canada and perhaps in North America that meets all these requirements (See Figs 2 and 3). For the selection of non-expert viewers rigorous procedures were established, insuring that these viewers had good vision, were not connected in any way professionally to the television or film industry and also had not participated previously in any picture quality evaluation tests. For this purpose Carleton University in Ottawa was retained for the screening of viewers.

The initial call by ACATS for proposals prompted close to 20 responses. Many of them were no more than ideas or paper designs. When the time came to actually deliver a prototype and pay a testing fee, only seven systems from following organizations were ready:

Sarnoff
General Instruments
MIT
Philips
Zenith
AT&T
NHK

Eventually NHK withdrew from the competition, since they felt, that their MUSE system was already being used in Japan and had been proven to provide a satisfactory HDTV service. Certainly they also may have sensed that the USA industry was favouring a made-in-USA solution.

Most of the other proposed systems were analog and tried to provide some backward compatibility with the existing NTSC system by providing the additional high definition enhancement information on a separate channel. Only General Instruments provided the world's fully digital advanced television system, capable of providing HDTV. It was a real breakthrough. Furthermore it could be transmitted in a regular 6 MHz television channel, thus it was also in terms of radio spectrum use efficient.

The first round of tests showed that none of the six systems were able to meet all the requirements that had been specified. This was true with respect to transmission interference, etc. as well as with respect to picture quality and some visible artefacts. The two testing laboratories recognized that all proposed systems could be corrected which additional design effort. While often there were arguments regarding the test results and their interpretation, the rigour that the ATEL applied to its testing process, its results were never questioned – the CRC certainly was proud of this achievement.

During the first phase of testing there also emerged a realization, that the future advanced television system should be fully digital. In all the presented systems already significant digital signal processing was taking place. In a second round of testing a number of the proponents contemplated to replace their original systems with fully digital systems.

In order to avoid any future litigation by potential losers in a second round of testing, ACATS Chairman Richard Wiley suggested that all six proponents create a so called Grand Alliance and merge their systems into a single system by using the best parts of each of the original systems to design a final advanced television system. With some arm twisting this was finally achieved in May 1993. This was considered at that time a master stroke of Chairman Richard Wiley.

The final testing took place about a year later in both the ATTC and ATEL. In parallel the newly created Advanced Television System Committee (ATSC) started developing the standards documents so that a standard could be submitted to the FCC shortly after the completion of all tests.

Like in any larger engineering project there are sometimes unexpected problems that could delay the project and some ingenuity is needed to overcome them. At one point some tapes containing visual test material showed some visible artefacts at the edges of some frames, which would adversely impact the visual evaluation test results at ATEL. Recreating corrected new test material could have caused several months of delay in the test schedule, which was considered highly undesirable. While ATTC was adamant that new test tapes had to be produced, at ATEL the scientists, engineers and technicians found a way to hide these artefacts during the viewing tests. They were also able to demonstrate to ATTC and the proponents, that the measures taken would in no way put the test results in any doubt. Such things get forgotten in the long run but are part of the long saga of developing the Advanced Television System for North America.

Digital Television Coverage Studies

The transmission technology used by the North American digital television system is 8-VSB, similar to the transmission technology used in the NTSC system.

At the television UHF bands, large buildings and large natural elevations become a barrier for television signals to reach receivers. Furthermore, such obstructions also create multiple paths, which in analog television produce ghosts on the receiver, but can prevent from any signal being decoded at all in a digital television receiver.

While this problem could be solved with additional transmitters operating on a different channel, this is highly undesirable from an efficient spectrum use point of view. Furthermore in large metropolitan areas where many different transmitters may provide different programs, there may not be additional television channels available to establish additional transmitters.

The European digital television system uses for transmission OFDM (orthogonal frequency division multiplex) technology. This technology can not only deal with multipath signals, it in fact can benefit from multipath signals in that it can use the additional power from the different paths.

Fig 4. Equipment at the Transmission Laboratory to simulate transmission environments for testing and comparing robustness to transmission impairments of different transmission and modulation technologies

Fig 5. Mobile Transmission Laboratory for television transmission and coverage tests (Picture shows tests being carried out at Parliament Hill in Ottawa)

Fig 6. Interior of the Mobile Transmission Laboratory for television transmission and coverage tests

Fig 7. Installation of an 8-VSB Gap-Filler transmitter

The Broadcast Technologies Research Branch carried out studies, laboratory simulation experiments and field trials to establish practical guidelines how on-channel “gap-fillers” could be deployed with the 8-VSB transmission system to overcome non reception or multipath problems (See Figures 4, 5, 6 and 7 for facilities for TV transmission research). This work was highly appreciated by ATSC since it solved a serious problem and also made the North American digital television system competitive in the marketplace vis-à-vis the European digital television system. Some joint field trials between Canada and the USA were also carried out in several USA metropolitan centres which also proved that on-channel gap-fillers were a viable solution.

Research with International Partners

The significance of the research carried out by the Broadcast Technologies Research Branch was noticed by many researchers and organizations in other countries who were interested in manufacturing and/or introducing advanced television systems in their own countries. In addition to USA organizations, organizations from the Republic of China (Taiwan), Peoples Republic of China (Mainland), South Korea, Mexico and Brazil either contracted some research work to the Broadcast Technologies Research Branch or entered into collaborative research projects. In some instances collaborating organization sent also researchers to the Communications Research Centre. Contracted or collaborative research covered transmission technologies, video signal processing and video quality assessment work.

Conclusions and the Future of Digital Television

The decision to establish a broadcast technologies research capability in Canada has proven to be highly fruitful and also is a perfect example of the capabilities of Canadian researchers, engineers and technologists to carry out world-class research with relatively modest resources. The Broadcast Technologies Research Branch continues to contribute towards the solution of many problems including the future use of broadcasting for new services and the possibility how to better utilize the broadcast spectrum by studying the potential use of broadcast channels not used for broadcasting for a variety of other wireless consumer services.

Most recently research is being carried out in mobile digital television. The challenge was to provide a robust and reliable television reception with the 8-VSB transmission system. The research in the Broadcast Technologies Research Branch has demonstrated that mobile television is indeed possible with the ATSC television system.

There is currently significant interest in 3D-Television. In particular the film industry recognizes this technology as an important means to capture a larger share of the viewing public. The Broadcast Technologies Research Branch has recently developed a 3-D image technology which is being considered as a candidate for standardization by ATSC.

ELIE – St. EUSTACHE FIBRE OPTIC FIELD TRIAL DELIVERY OF TELECOMMUNICATIONS SERVICES TO RURAL RESIDENTS

Metin Akgun, Ph.D., P.Eng., LMIEEE

Background

In the 1970's there was a realization in the Department of Communications (DOC) that there was significant discrepancy in the level of telecommunications services that was provided between urban residents and rural residents. At that time, for cost reasons many rural residents were receiving multiparty telephone service, whereby anywhere up to 8 residences could be sharing a single telephone line. Furthermore, while increasing number of urban resident had access to a large number of television channels through cable television, such services were almost non-existent for rural residents.

As part of remedying the situation the telephone companies were asked to reduce part line service over a number of years to no more than two residences sharing a single telephone line in rural communities.

Also in the 1970's it was realized that the emerging information technology would enable new services to be provided by the existing telecommunications infrastructure, such as online information, fire and intrusion alarm monitoring, remote utility meter reading, etc. In support of these concerns at the Communications Research Centre (CRC) the late Dr. George Jull initiated a study regarding what services would likely take off and whether there were cost differences with respect to the use of any delivery system alternative.

In the same time frame, significant research in fibre optic technology, of which CRC was a significant contributor, was pointing towards a new and wideband delivery system that would permit the delivery of a variety of telecommunications, entertainment and information services over a single optical fibre. Some field trials were already underway to apply optical fibre technology to telecommunications networks, but not to the home yet. The DOC contracted Northern Telecom Limited Canada (NTLC) to carry out an extensive study on the feasibility and potential of using fibre optic technology to provide with a single delivery medium telecommunications, entertainment and information services to homes. The study report, delivered in March 1978, was very encouraging.

Worldwide there was also research being carried out with respect to data services delivery technology. At the CRC the Telidon project to provide videotext services was being pursued and was coming to a successful conclusion.

The Manitoba Telephone System (MTS) also carried out some studies and submitted in 1977 a proposal to the DOC for carrying out a fibre optic field trial in the villages of Elie and St. Eustache to provide over a single delivery network a variety of services.

The Launch of the Fibre Optic Field Trial in the Villages of Elie and St. Eustache

It was in this environment that the DOC decided to accept the proposal by MTS and launch a field trial in Manitoba. The DOC, however, requested that the trial be a cost shared project. Since this trial would be of interest not only to MTS but all other Telecommunications carriers in Canada, MTS requested that the members of the Canadian Telecommunications Carriers Association (CTCA) share the cost of this trial. A Memorandum of Agreement was signed between the DOC and CTCA in January 1979 for the system implementation and operation. The field trial would also serve as a trial site for the Telidon technology to provide information services.

The villages of Elie and St. Eustache were chosen, since they represented a small rural agricultural community yet with a good mix of other occupations as well as being progressive and forward looking. They had telephone service but did not have cable television as most such communities did not have. They were also at a distance from the Canada – USA border that they were unable to receive US TV stations over the air. It was decided that a total of 150 homes would be included in this trial in order to also obtain meaningful statistical data with respect to the technical performance of the system as well as being able to collect some marketing information with respect to what services would be of interest in the future development of commercial systems and services.

PROJECT PHASE	SPONSOR	CONTRIBUTIONS IN DOLLARS	TOTALS
I	DOC CTCA NTCL	3,182,000 2,530,000 653,000	6,365,000
II	DOC MTS Infomart	1,720,000 700,000 1,020,000	3,440,000
TOTAL PROJECT COST			**9,805,000**

Table 1. Sponsor Contributions to the Project

It was decided to implement the field trial in two phases:

Phase 1: Develop and implement the basic system to provide telephone, cable-TV and FM radio services and full duplex 56 kb/s data channel. The cost of this phase of the project was $M 6.365. The agreement between DOC, CTCA, MTS and NTCL was signed in 1979 and the installation of the system was completed in October 1981.

Phase 2: Develop, operate and maintain additional technical facilities required to provide Telidon services, develop Telidon data bases and conduct user surveys. The cost of this phase was $M 3.440. The contract was signed in October 1981 and the official trial ran from October 1981 to March 1983. At the end of the official trial, MTS decided to continue the operation of the system for a few additional years.

The various participants in this project were also sponsors of this trial by contributing to the cost. Table 1 shows the sponsors and their contributions to the two phases of the project.

Trial System Technical Details

The basic system had a centrally switched star figuration with two distribution centres. The system details are shown in Fig. 1.

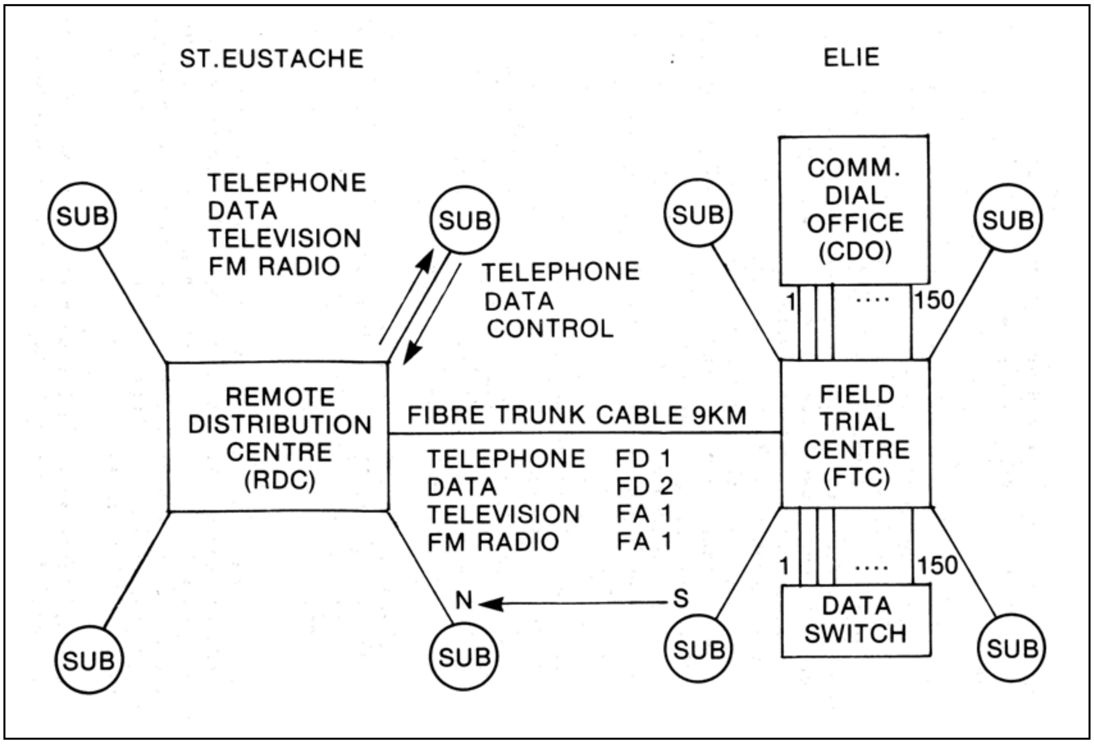

Fig 1. Elie – St. Eustache trial system block diagram

The equipment, which was designed and manufactured by Bell-Northern Research (BNR) was installed in a trailer. Since 90 of the trial users were located in Elie one trailer, the Field Trial Centre (FTC), was placed adjacent to MTS's Community Dial Office in Elie. A second trailer, the Remote Distribution Centre (RDC), was placed in St. Eustache to serve the remaining 60 trial participants. The RDC was connected by an 8.5 km fibre optic trunk to the FTC in Elie.

Each subscriber was connected to the FTC or RDC with two fibres; one for signals from the subscriber and the other one for signals to the subscriber. In order to interface the fibre optic trial system, a Subscriber Entrance Unit (SEU) was installed at the participant's location. In addition to residences, the existing three schools in these communities as well a few local businesses were also connected to the trial system.

The FTC provided the interface with the switched telephone network, the TV and FM Radio sources and the digital data switch for the Telidon services for all subscribers. Generally Light Emitting Diodes (LED) were used as the optical source. Fig 2 provides the block diagram of the SEU.

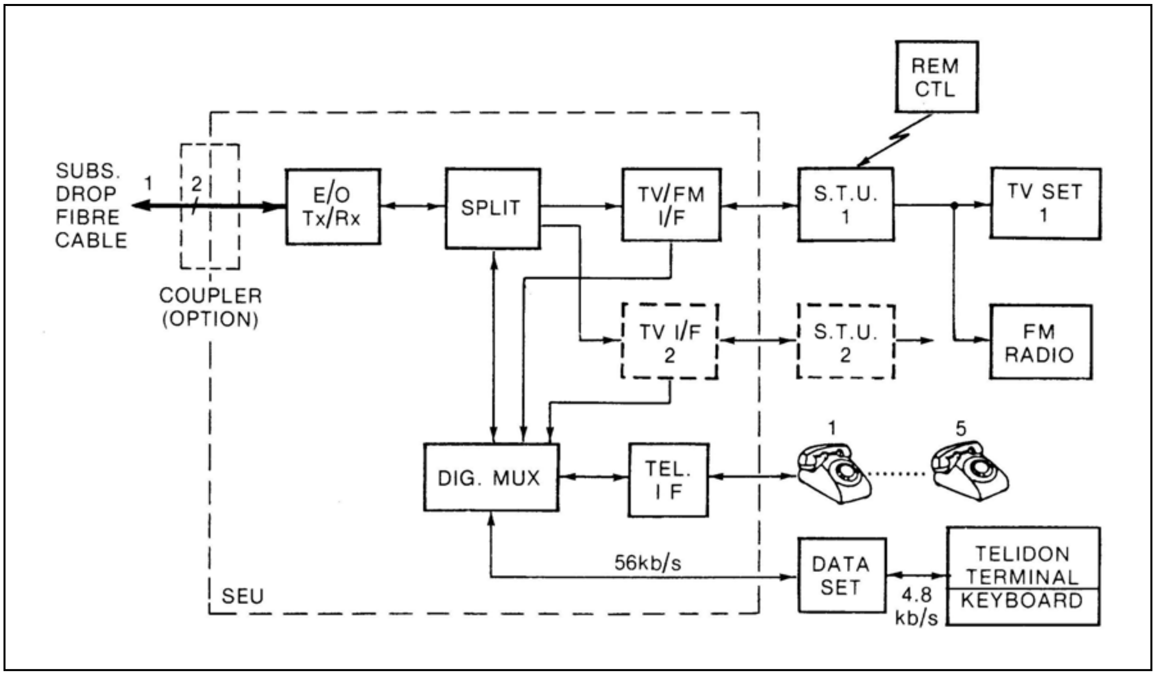

Fig 2. Block Diagram of the Subscriber Entrance Unit (SEU)

Video was transmitted on the fibre loop in the standard NTSC VSB – AM format on a visual carrier frequency of 7.6 MHz. Access to up to 9 video channels was provided by an FDM switch associated with each subscriber loop in the FDC or RDC. Control of the switching was by means of signals from a hand-held TV channel selector relayed upstream to the switch.

A TV head end was established at Elie. Four Winnipeg broadcasting channels and the FM radio channels were picked up off-air and were combined with four USA TV network station signals which were tapped off the Winnipeg – Brandon intercity broadband network.

As part of the technology demonstration, 25 subscriber locations were provided with bidirectional transmission over a single fibre. A wavelength selective directional coupler based on a dichroic filter design was used to separate upstream/downstream wavelengths. While these technologies since have become rather common, in the time frame where this trial was carried out, this was a rather novel approach.

35 lasers were provided in the downstream direction for certain loops. 25 shorter loops equipped with lasers were used to demonstrate the simultaneous transmission of two

TV channels. All bidirectional loops were equipped with lasers. All loops over 3.0 km up to 5.0 km in length were laser driven.

In order not to leave the non-trial residences and businesses without cable-TV service a coaxial cable based system was installed in both communities. At the end of the Field Trial all participants had the option to be connected to the cable-TV system.

Usage Measurement System

In addition to evaluating the technical performance of the system for use in the design of future commercial systems, facilities were incorporated to collect data regarding the usage of Television and Telidon services. Since the selection of a television channel was at the FTC or the RDC it was relatively easy to know when a television set was "ON" and which channel it was watching. This data was also used for marketing purposes. It also showed the potential for billing for future Pay-TV services.

Similarly Telidon usage was monitored. Again it was possible to know which Telidon terminal was 'ON" at what time and for how long. Telidon Service was primarily provided by Infomart who was contracted by MTS and DOC for this purpose. In addition to the data collected by MTS, Infomart was also able to monitor for marketing purposes at its service centre which pages were being viewed, thus giving an indication of the popularity of the information.

Field Trial Technical Performance

At the time of the field trial there was very little experience at telephone companies regarding installation and splicing of optical fibre cables. It was therefore very pleasing for MTS that they had no difficulties in the installation of the outside cable plant. Regular buried cable installation equipment could be used. Similarly the installation of pole mounted optical fibre drop cables to the subscriber did not create any problems.

During the field trial the NTLC supplied equipment both in the two trailers as well as in the subscriber premises (SEU's) exceeded the design objectives after some additional SEU protection measures were taken. Similarly user reported troubles were also well within at that time accepted telephone Company limits. The trouble reports per month for both cases are shown in Table 2.

	REPORTED TROUBLES PER MONTH			
SERVICE	EQUIPMENT	DESIGN OBJECTIVE	CUSTOMER	TELCO OBJECTIVE
Telephone	3.2	8.4	5.2	3 – 6.75
Cable - TV	4.0	11.7	5.6	--
Telidon	2.8	6.2	6.4	--

Table 2. Equipment and Customer Trouble Reports

Telidon Service Trial Results

The second and no less important purpose of this trial was to evaluate both the technical performance of the Telidon technology as well as gauge the usage and reaction of customers to such a service.

Infomart, an information data base operator, was contracted jointly by the DOC and MTS to provide an experimental Telidon Service to the trial participants in Elie – St. Eustache. In addition to a large selection of general information, some games, an agricultural data base was created considering the primary occupation of the trial participants.

Table 3 provides information on the Telidon service usage by age and gender at the beginning of the trial and 8 months into the trial. While initially the heaviest users were children at the second survey there was a notable increase in adult users. Nevertheless children remained the heaviest users.

Table 4 provides statistical information on the most used information categories. Electronic Games ranked the highest followed by Community information. Surprisingly agricultural information did rank rather low.

USER CATEGORY	% OF USERS	
	FEB. 1982	NOV 1982
Children	52.8	43.4
Adult Males	19.5	30.3
Adult Females	10.6	23.7
All about the same	13.8	2.6
No response	3.3	0.0

Table 3. Telidon Usage by Age Category

TELIDON SERVICE	% OF RESPONDENTS
Agricultural Information	28.2
Community Information	79,7
Consumer Information	42.3
Teleshopping (viewed only)	58.5
School Courses	26.0
Electronic Games	93.5
Messaging	50.4

Table 4. Telidon Usage by Information Category

Conclusions

The fibre optic field trial to provide on a single delivery system a variety of services in a rural community did achieve its goal by proving the technical feasibility of using state of the art technology for this purpose. It also was an important proving ground for videotext services using the Telidon technology.
Since it was a one of a kind design it was not possible to directly draw conclusions regarding the economics of the system.

Since then, all these technologies have significantly been further developed. Personal computers which barely were available at that time have now entered a majority of households and businesses which enable the provision of many new services much easier. While today's implementation of similar services may be quite different, the trial certainly provided a showcase for the future.

The Field Trial also attracted significant interest world wide. A large number of presentations on the system were provided at national and international conferences. The trial site also attracted many visitors from foreign countries who were interested in providing new services to their residents. In addition to many visitors from Canadian organizations and businesses, visitors from organizations and businesses from foreign countries included Israel, France, Germany, New Zealand, U.K, Japan, Denmark, South Africa and the USA. The trial also provided a showcase for Canadian advanced technologies and systems.

3 March 2009

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