Dollars & Sense
Une question de gros sous et de bon sens

OTTAWA, CANADA

20 & 21 November / Novembre 1996

The Radio Advisory Board of Canada and Industry Canada
Le conseil consultatif canadien de la radio et Industrie Canada

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VidéoRouteMC

En direct vers la salle du conseil, la salle de classe, l'usine... par le service de transmission d'entreprise *VidéoRoute*

Songez au nombre de fois où vous devez transmettre d'importantes informations à des tas de gens répartis dans différents lieux — lancement de produits, formation, annonce d'une politique et de procédures nouvelles, séance d'information pour gestionnaires, actualisation des produits et des services, démonstration technique, remise de prix, publication des résultats trimestriels, briefing des analystes sectoriels.

Songez combien tout serait plus facile si vous pouviez diffuser des informations cruciales à une multitude de gens, où qu'ils soient, à partir d'un point unique et au moyen d'une seule transmission. Cela est désormais possible grâce au service de transmission d'entreprise ***VidéoRoute***MC.

Vous êtes maître à bord

Le service de transmission d'entreprise ***VidéoRoute*** combine la technologie terrestre des fibres optiques et celle des satellites pour assurer des transmissions unidirectionnelles point-multipoint. Vous réservez le service selon vos besoins, peu importe la fréquence, et vous êtes facturé à l'utilisation.

Le service de transmission d'entreprise ***VidéoRoute*** révolutionnera votre façon de communiquer avec vos employés, fournisseurs, clients, collègues et étudiants. En exploitant en temps réel les ressources d'une télédiffusion de qualité, vous pourrez propager vos messages instantanément et simultanément partout au Canada, comme vous l'entendez et au moment de votre choix.

Vous tenez les commandes grâce au service de transmission d'entreprise *VidéoRoute*

Vous décidez comment et avec qui vous souhaitez communiquer, que votre public se trouve dans un grand centre urbain ou dans une collectivité éloignée. Vous dictez l'heure, la destination et la durée de la diffusion. Vous déterminez si l'émission se fera en français, en anglais, ou dans les deux langues. Tout ce dont vous avez besoin aux emplacements désignés est une petite antenne parabolique et, sur le poste de télévision, un décodeur.

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Pour passer une commande et réserver le temps d'antenne, il vous suffit de composer le **1 800 361-8989**. Notre service de réservation bilingue est à votre disposition chaque jour ouvrable de 8 h à 17 h, HAE. En dehors de ces heures, nos techniciens répondront à vos appels 24 h sur 24, sept jours sur sept pour assurer la diffusion de vos messages.

Le service de transmission d'entreprise ***VidéoRoute*** sera pour vous synonyme de haute qualité, de confidentialité, de fiabilité et de rentabilité en tout temps et pour toute destination.

Renseignez-vous

Vous souhaitez savoir comment le service de transmission d'entreprise ***VidéoRoute*** métamorphosera votre façon de communiquer? Alors appelez la compagnie de téléphone Stentor de votre région qui figure à la liste ci-desous.

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Welcome by

The Honourable John Manley

Minister of Industry

It is again my pleasure to welcome you to Spectrum 20/20. Experience tells me that you can look forward to a Symposium with distinguished speakers on the radiocommunication issues of today and tomorrow, and to the opportunity to discuss these issues with leaders from industry, academia and government.

This year's theme, "Dollars and Sense," is particularly timely. We are witnessing an explosion of new technology that will have billions of dollars worth of impact on the world economy, creating new opportunities for jobs and growth. A balanced, sensible approach to spectrum management will ensure that industrialized and developing countries benefit fully from these opportunities, while enjoying the smooth and efficient delivery of spectrum services.

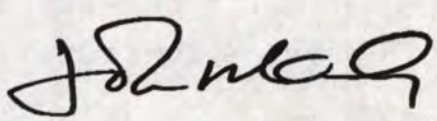
Mots de bienvenue par

l'honorable John Manley

Ministre de l'Industrie

C'est avec grand plaisir que je vous souhaite la bienvenue à nouveau à Spectre 20/20. D'expérience, je peux vous assurer que le symposium sera pour vous l'occasion d'entendre des conférenciers de renom et de discuter avec des chefs de file de l'industrie, du monde universitaire et du gouvernement de questions d'actualité et d'avenir dans le domaine des radiocommunications.

Je crois que le thème de cette année, «Question de gros sous et de bon sens», est particulièrement bien choisi. Nous sommes témoins d'une explosion de nouvelles technologies qui auront, de par le monde, des retombées économiques se chiffrant en milliards de dollars, créeront de nouveaux emplois et favoriseront la croissance. Une gestion du spectre équilibrée et méthodique permettra aux pays industrialisés et en développement de tirer pleinement avantage de ces débouchés, tout en ayant accès à des services harmonieux et efficaces.



John Manley

Welcome by

Phil Saunders

President, RABC

With the explosive growth of the radio communication industry in progress, creating new opportunities and changing the parameters of how we communicate with voice, data and broadcasting services, it is indeed timely to also consider the economics of spectrum issues.

Few, if any, conferences in the world provide this type of high-level focus dedicated to understanding the changing nature and implications of the radio communications industry. What new services can be offered and when? how is the current shape of wireline and wireless going to be changed forever? what are the demands on the spectrum? how can spectrum be fairly valued, allocated and aligned to achieve the benefits of affordable, effective global services and deployment?

Welcome to Spectrum 20/20, which plans to address these issues and more, head-on, with your help. Our theme is Dollars and Sense - (we hope you make a lot of both!). Our sessions include top experts to address the issues and I hope you will fully avail yourselves of the opportunity to participate and contribute to the success of this conference. Let's learn together, and make a difference, to help realize the potential of the wireless services evolution of which we are part.

Mots de bienvenue par

Phil Saunders

Président, CCCR

L'essor phénoménal que connaît actuellement l'industrie des radiocommunications a pour effet de créer des débouchés et de modifier les paramètres de transmission de la voix, des données et des services de radiodiffusion. Il est donc opportun de se pencher sur les aspects économiques de la gestion du spectre.

Très de peu de conférences au monde, s'il en est, offre ce genre d'instance de haut niveau consacrée à l'étude du caractère évolutif et des incidences de l'industrie des radiocommunications. Quels nouveaux services peuvent être offerts et quand? De quelle manière les communications par câble et sans câble telles qu'on les connaît aujourd'hui seront-elles transformées à jamais. Quelles sont les besoins en matière de spectre? Comment peut-on équitablement évaluer, répartir et rajuster le spectre de manière à profiter de la prestation et du déploiement de services internationaux efficaces et abordables?

Bienvenue à Spectre 20/20 qui se propose d'aborder franchement avec vous ces questions et bien d'autres. Notre thème est «Une question de gros sous et de bon sens» - (nous espérons que vous aurez une bonne dose des deux!). Des conférenciers réputés sont invités à nos séances pour discuter de ces questions, et nous espérons que vous profiterez de l'occasion pour participer et contribuer au succès de la conférence. Ensemble, nous pouvons apprendre et influencer le cours des choses afin que l'évolution des services sans fil, dont nous faisons partie, se réalise entièrement.

Phil Saunders

Phil Saunders
President
Radio Advisory Board of Canada

Phil Saunders
Président
Conseil consultatif canadien de la radio

Programme générales

Mardi, le 19 novembre

17 h 30 à 20 h	Inscription	Salon «Drawing»(foyer)
17 h 30 à 20 h	Réception IRIDIUM	Salon «Drawing»(foyer)

Mercredi, le 20 Novembre

de 07 h	Inscription	Corridor «French »
08 h 30	Ouverture et mots de bienvenue	Salle de bal
08 h 40 à 09 h 30	Conférencier principal	Salle de bal
09 h 30 à 10 h	Café	Salon Banquet
09 h 30 à 19 h	Exposition	Salon Banquet
10 h à 12 h	Séance 1	Salle de bal
12 h à 14 h	Déjeuner	Salle Adam
14 h à 17 h 30	Séance 2	Salle de bal
15 h 30 (environ)	Café	Salon Banquet
18 h	Réception	Salon Banquet
19 h	Dîner	Salle Adam

Jeudi, le 21 Novembre

08 h 30 à 12 h	Séance 3	Salle de bal
10 h (env.)	Café	Corridor «French »
12 h à 13 h 30	Déjeuner	Salle Adam
13 h 30 à 15 h 30	Séance 4	Salle de bal
15 h 30	Clôture	

Program Outline

Tuesday, 19 November

17:30 - 20:00	Registration	Drawing Room Foyer
17:30 - 20:00	IRIDIUM Reception	Drawing Room Foyer

Wednesday, 20 November

From 07:00	Registration	French Corridor
08:30	Opening and Welcoming Addresses	Ballroom
08:40 - 09:30	Keynote Speaker	Ballroom
09:30 - 10:00	Coffee	Banquet Room
09:30 - 19:00	Exhibits	Banquet Room
10:00 - 12:00	Session 1	Ballroom
12:00 - 14:00	Lunch	Adam Room
14:00 - 17:30	Session 2	Ballroom
15:30 (appx.)	Coffee	Banquet Room
18:00	Reception	Banquet Room
19:00	Banquet	Adam Room

Thursday, 21 November

08:30 - 12:00	Session 3	Ballroom
10:00 (appx.)	Coffee	French Corridor
12:00 - 13:30	Lunch	Adam Room
13:30 - 15:30	Session 4	Ballroom
15:30	Closure	

Speakers & Papers

Wednesday, 20 November

Opening Address — Phil Saunders (RABC)

Keynote Speaker — **John T. McLennan**

Welcoming Address — Kevin Lynch (Industry Canada)

Session 1

Theme — Dollars & Sense: Challenges and Changes

Chairman — Michael Binder (Industry Canada)

1.1 The Non-Renewable Resources and their Role in the 21st Century Economy
W. M. 'Mac' Evans (Canadian Space Agency)

1.2 Customer First — C. Michael Ennis (Nortel)

1.3 Generating Profit from New Broadcast Technologies
Michael McCabe (Canadian Association of Broadcasters)

Luncheon Speaker — **Kevin G. Lynch**

Session 2

Theme — Dollars & Sense: Commercialization of Satcom Services

Chairman — Val O'Donovan (COMDEV)

2.1 Space Sciences Tomorrow — Robert Taylor (Taylor T&C Inc., U.S.)

2.2 Global Satellite Communications — Guy Boulay (IRIDIUM Canada Inc.)

2.3 The Challenge of Global Broadband Internet Access
Russell Daggatt (Teledesic Corporation, U.S.)

2.4 Introduction of Mobile Satellite Messaging Services for North America
Larry O'Brien (Calian Technology Inc.)

2.5 Positioning Technologies for ITS Navigation Systems
Edward Krakiwsky
(University of Calgary & IDI Ltd.)

2.6 Homestar - A Digital Television Service for All Canadians
Mark Pezarro (Shaw DBS Ventures)

2.7 VideoRoute™ Business Broadcast Service
Ted Hardy (Stentor)

Paper 2.7 is a supplementary invited paper. The author will be available for questions.

Banquet Speaker — **H. E. The Hon. Maurice Mctigue**
New Zealand High Commissioner

Thursday, 21 November

Session 3

Theme	Dollars & Sense: The Role of Terrestrial Services in a Competitive Economy
Chairman	Lis Angus (Angus TeleManagement)
3.1 The Local Loop of the Future	Roger Hay (Arthur D Little of Canada Limited)
3.2 Evolution of the Wireless Local Loop	Michael Hayes (Nortel, U.S.)
3.3 Working Wireless - A Cost/Benefit Justification	James Balsille (Research in Motion)
3.4 Challenges and Opportunities for Canadian Manufacturers of DAB Equipment	Stephen Edwards (Rogers Broadcasting Inc.)
3.5 Convergence: Simplicity for the Customer	Randall Reynolds (Bell Mobility)
3.6 Information Security - What Does the Customer Want?	Richard Barth (Motorola, U.S.)
Luncheon Speaker	**Michael Binder**

Session 4

Panel Session	Dollars & Sense: Spectrum Economics
Moderator	Roger Poirier (CWTA)
4.1 Proposed Market-based Mechanisms for Spectrum Management	John Reynolds (Radiocommunications Agency, U.K.)
4.2 Spectrum Pricing	Bruce Franca (Federal Communications Commission, U.S.)
4.3 The Consequences of Resale for Auctions	Daniel Vincent (University of Western Ontario)
4.4 Globalization of Services	Merrill Shulman (Integrated Messaging)
Closure	Roger Poirier

Conférenciers et Papiers

Mercredi, le 20 novembre

Ouverture — Phil Saunders (CCCR)

Conférencier principal — **John T. McLennan**

Allocution des bienvenues — Kevin Lynch (Industrie Canada)

Séance 1

Thème — Gros sous et bon sens - Enjeux et changements

Président — Michael Binder (Industrie Canada)

1.1 Les ressources non renouvelables et leur rôle dans l'économie du XXIe siècle
W. M. 'Mac' Evans (Agence spatiale canadienne)

1.2 Le client en premier — C. Michael Ennis (Nortel)

1.3 Retirer les profits des nouvelles technologies de radiodiffusion
Michael McCabe (Association canadienne des radiodiffuseurs)

Déjeuner

Conférencier invité — **Kevin G. Lynch**

Séance 2

Thème — Gros sous et bon sens - La commercialisation des services satcom

Président — Val O'Donovan (COMDEV)

2.1 L'avenir des sciences de l'espace — Robert Taylor (Taylor T&C Inc., É.-U.)

2.2 Communications satellites mondiales — Guy Boulay (IRIDIUM Canada Inc.)

2.3 Le défi mondial de l'accès à large bande à Internet
Russell Daggatt (Teledesic Corporation, É.-U.)

2.4 Introduction aux services mobiles de messagerie par satellite pour l'Amerique du Nord
Larry O'Brien (Calian Technology Inc.)

2.5 Technologies de localisation pour les systèmes «ITS»
Edward Krakiwski (University of Calgary & IDI Ltd.)

2.6 Homestar - Un service de télévision numérique pour tous les Canadiens
Mark Pezarro (Shaw DBS Ventures)

2.7 VidéoRoute[MC] - Le service de transmission d'entreprise
Ted Hardy (Stentor)

Papier 2.7 est un papier sopplimentaire invité. L'auteur sera disponsible aux questions.

Banquet

Conférencier invité — **S. E. l'honorable Maurice Mctigue**
Haut-commissaire au Canada de la Nouvelle-Zéaland

Jeudi, le 21 novembre

Séance 3

Thème	Gros sous et bon sens - Le rôle des services au sol dans un économie concurrentielle
Président	Lis Angus (Angus TeleManagement)
3.1 Le circuit local du futur	Roger Hay (Arthur D Little of Canada Limited)
3.2 Évolution du circuit local sans fil	Michael Hayes (Nortel, É.-U.)
3.3 Travailler sans fil: la justification coûts-avantages	James Balsille (Research in Motion)
3.4 Défis débouchés pour les fabricants canadiens d'équipment RAN	Stephen Edwards (Rogers Broadcasting Inc.)
3.5 La convergence: la simplicité à la portée du consommateur	Randall Reynolds (Bell Mobilité)
3.6 La securité de l'information - que voulait le consommateur?	Richard Barth (Motorola, É.-U.)

Déjeuner

Conférencier invité — **Michael Binder**

Séance 4

Panel de discussion	Gros sous et bon sens - Les aspects économiques du spectre
Moderator	Roger Poirier (ACTS)
4.1 Méchanismes de gestion du spectre proposés en fonction du marché	John Reynolds (Radiocommunications Agency, R.-U.)
4.2 L'établissement du prix du spectre	Bruce Franca (Federal Communications Commission, É.-U.)
4.3 Les conséquences de la remise en vente aux enchères	Daniel Vincent (Université Western Ontario)
4.4 La mondialisation des services	Merrill Shulman (Integrated Messaging)

Clôture

Roger Poirier

What is the RABC ? Qu'est-ce que le CCCR

RADIO ADVISORY BOARD OF CANADA
CONSEIL CONSULTATIF CANADIEN DE LA RADIO

The Radio Advisory Board of Canada (RABC) is a non-profit association of twenty-five organizations which are concerned with the use of the radio spectrum. These in turn represent the users of radio communications and related service providers and manufacturers. There are nearly 2000 organizations and 10,000 radio amateurs represented by the member organizations of the RABC.

Known as the Canadian Radio Technical Planning Board when it was founded in 1944, the Board has worked with the Government of Canada for over fifty years for the co-operative administration of a major public resource - the radio spectrum.

The Board's purpose is to advise Industry Canada on behalf of the Canadian radio industry on matters concerning the management of the radio spectrum and the development of standards and radio regulations. The Board's resources, because of its broad industry representation, provide a powerful and recognised voice in technical, economic and policy dimensions of radiocommunications. In recent years and with government encouragement, the Board has adopted a pro-active role in advising Industry Canada on telecommunications matters affecting the radio spectrum.

Today the Board is recognised by the Federal Government as industry's voice in spectrum affairs.

RABC/CCCR
201 - 883 Lady Ellen Place
Ottawa, ON, K1Z 5L9
Tel: (613) 728-8692 Fax: (613) 728-3278

Le Conseil consultatif canadien de la radio (CCCR) est une association à but non lucratif réunissant vingt-cinq organismes qui s'intéressent à l'utilisation du spectre des fréquences radioélectriques. Ces organismes, pour leur part, représentent les utilisateurs et fournisseurs de services de radiocommunications et des fabricants. Les organismes membres du CCCR représentent, quant à eux, près de 2 000 organismes et 10 000 radioamateurs.

Fondé en 1944 sous le nom *Canadian Radio Technical Planning Board*, le Conseil a, pendant plus de cinquante ans, servi de tribune à la gestion coopérative d'une des plus importantes ressources publiques, le spectre des fréquences radioélectriques.

Le Conseil représente l'ensemble de l'industrie canadien de la radio auprès de l'Industrie Canada et a pour mandat de conseiller ses représentants sur la gestion du spectre des fréquences radioélectriques et l'élaboration de normes et de règlements sur la radiodiffusion. Étant donné qu'il regroupe un très grand nombre de représentants de l'industrie, le Conseil dispose de ressources qui lui permettent d'être reconnu et considéré pour tout ce qui touche les aspects techniques, économiques et politiques de la gestation du spectre. Grâce à l'appui du gouvernement, le Conseil a, au cours des dernières années, joué un rôle de premier plan auprès de Industrie Canada en le conseillant en matière de télécommunications en ce qui concerne le spectre des fréquences radioélectriques.

Aujourd'hui, le gouvernement fédéral considère le Conseil comme étant le porte-parole de l'industrie pour toutes les questions relatives au spectre.

Radio Advisory Board of Canada

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Comité sur les services radio mobiles marine

Comité sur les services radio terrestres fixes et mobiles

KEYNOTE SPEAKER/ CONFÉRENCIER PRINCIPAL

JOHN T. McLENNAN

President and CEO - Bell Canada
Président et chef de la direction - Bell Canada

John T. McLennan was appointed President and Chief Executive Officer of Bell Canada on January 1, 1994.

In September 1993, Mr. McLennan was appointed President of Bell Ontario, the division of Bell Canada which provided telecommunications services in the province of Ontario.

From April 1990 until joining Bell Ontario, Mr. McLennan served as President and Chief Executive Officer of BCE Mobile Communications Inc. (BCE Mobile). He became Chairman of the Board of BCE Mobile in April 1993 and continued in this position and as a member of its Executive Committee until 1994.

Prior to assuming his positions at BCE Mobile, Mr. McLennan was the President and founder of his own firm, Jenmark Consulting Inc. Jenmark specialized in strategizing, financing and managing technology companies in Canada and the U.S. with a primary focus on telecommunications. In this capacity Mr. McLennan worked with more than 30 companies, including a period as President and Chief Executive Officer of Cantel Inc.

Before founding Jenmark, Mr. McLennan was Vice-President, then Executive Vice-President, Operations of Mitel Corporation during that company's period of rapid growth. Prior to his work with Mitel, he also worked with several Canadian organizations, increasing his extensive experience in the management of high-growth, technology-based companies.

John T. McLennan est nommé président et chef de la direction de Bell Canada le 1er janvier 1994.

En septembre 1993, M. McLennan est nommé président de Bell Ontario, la division de Bell Canada fournissant des services de télécommunications de l'Ontario.

D'avril 1990 jusqu'à son arrivée à Bell Ontario, M. McLennan a été président et chef de la direction de BCE Mobile Communications Inc. (BCE Mobile). Il devient président du conseil d'administration de BCE Mobile en avril 1993 et continue d'occuper ce poste et demeure membre de son Comité exécutif jusqu'en 1994.

Avant d'entrer à BCE Mobile, M. McLennan fut président-fondateur de sa propre société, Jenmark Consulting Inc., spécialisée en conception stratégique, financement et gestion d'entreprises technologiques au Canada et aux É.-U., notamment en télécommunications. À ce titre, M. McLennan a travaillé avec plus de 30 entreprises, y compris pendant un certain temps à titre de président et chef de la direction de Cantel Inc.

Avant de fonder Jenmark, M. McLennan fut vice-président, puis vice-président exécutif à l'exploitation de la Mitel Corporation pendant sa période de pleine expansion. Avant de travailler pour Mitel, il aussi a été au service de plusieurs organisations canadiennes, ce qui lui a permis d'enrichir sa vaste expérience de la gestion d'entreprises du secteur technologique en forte croissance.

John T. McLennan (cont.)

Mr. McLennan is a director of Bell Canada, BCE Mobile Communications Inc., Maritime Telegraph & Telephone, Bell Canada International Inc., Stentor Resource Centre Inc., Teleglobe Inc., Hummingbird Communications Inc. and Telesat Canada. In May 1994, Mr. McLennan was convoked as Chancellor of the University College of Cape Breton. He holds Bachelor of Science and Master of Science degrees from Clarkson University in Potsdam New York and currently serves as a member of Board of Trustees at Clarkson University.

John T. McLennan (suite)

M. McLennan est directeur de Bell Canada, de BCE Mobile Communications Inc., de Maritime Telegraph & Téléphone, de Bell Canada International Inc., du Centre de ressources Stentor Inc., de Téléglobe Inc., de Hummingbird Communications Inc. et de Télésat Canada. En mai 1994, M. McLennan devient chancelier de l'University College of Cape Breton. Il possède un baccalauréat et une maîtrise en sciences de Clarkson University à Potsdam (New York) et est présentement membre du conseil d'administration de cette université.

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THE NON-RENEWABLE RESOURCES AND THEIR ROLE IN THE 21ST CENTURY ECONOMY
LES RESSOURCES NON RENOUVELABLES ET LEUR RÔLE DANS L'ÉCONOMIE DU XXIe SIÉCLE

W. MacDonald 'Mac' Evans

President
Canadian Space Agency
6767 route de l'Aeroport
St. Hubert, Quebec, J3Y 8Y9
514 926-4301

BIOGRAPHY

Mr. Evans graduated from Queen's University, Kingston, Ontario, and as an Athlone Fellow, pursued his advanced studies at the University of Birmingham in England and was successful in obtaining his Masters Degree in Electrical Engineering.

A veteran Federal Public Servant who, for more than two decades, actively participated in and led the Canadian Space Programs and Activities, gaining extensive knowledge and experience in the areas of Space Research, Project Management, Policy Development and International Relations in the senior management capacity. His major accomplishments in the National Space Program Development include realization of long term space plan for Canada, spearheading Canadian participation in international space station program, key player in the creation of the Canadian Space Agency.

In November 1994, Mr. Evans was appointed the President of the Canadian Space Agency.

BIOGRAPHIE

M. Evans obtient son diplôme de l'University Queen's, Kingston (Ontario), et comme titulaire d'une bourse Athlone, il poursuit ses études avancées à l'University of Birmingham en Angleterre et obtient une maîtrise en génie électrique.

C'est un fonctionnaire chevronné qui, pendant plus de deux décennies, a participé activement aux activités et aux programmes spatiaux canadiens, accumulant de vastes connaissances et une riche expérience comme cadre supérieur en recherche spatiale, en gestion de projets, en élaboration de politiques et en relations internationales. Parmi ses principales réalisations relatives au Programme spatial national, citons l'établissement du plan spatial à long terme pour le Canada, son rôle clé dans la participation canadienne au programme de station spatiale internationale et son rôle majeur dans la création de l'Agence spatiale canadienne.

En novembre 1994, M. Evans est nommé président de l'Agence spatiale canadienne.

INTRODUCTION

The Canadian Space Agency was created in 1989 by an Act of Parliament, bringing under one roof space activities that hitherto had been conducted by separate government departments. In this fashion, the Canadian space program, already 30 years old, was given a unity of purpose that enabled the strategic drive in a more focused way.

The agency's mandate is to meet Canadian needs in areas such as telecommunications and earth observation and to foster the development of an internationally-competitive industry. The agency's mission statement, a declaration of purpose that binds the agency employees to apply space knowledge for the benefit of Canadians and humanity.

Canada's heritage in space is rich and meaningful. One of the leading countries in space science and space exploration, Canada was also the first country to establish a "national" satellite communications network, a need dictated by geography.

Presently, the agency's framework is the implementation of the space activities approved in the long term space plan - June 1994 - which comprises major crown projects such as radarsat and the Canadian space station program. The former was successfully launched in November 1995 and is now providing invaluable environmental data to users the world over; the latter is progressing well and involves the manufacture of an advanced robotic system that will be used to assemble and maintain the international space station.

The agency's international activities are conducted in cooperation with the space agencies of other space-faring nations, chiefly NASA and ESA. On 15 October 1996, the Canadian Space Agency and the Indian Space Research Organization signed a memorandum of understanding thus providing a framework for cooperation in the field of exploration and utilization of space for peaceful purposes.

It follows from the above notes that orbits and radio spectrum are an essential feature of space programs. Indeed, spectrum and orbits are key elements of future economic success of space activities as they are to space exploration and space exploitation.

SESSION 1: CHALLENGES AND CHANGES
SÉANCE 1: ENJEUX ET CHANGEMENTS

Chair: Michael Binder

Assistant Deputy Minister, SITT
Industry Canada
300 Slater Street
Ottawa, ON, K1A 0C8

BIOGRAPHY

The Assistant Deputy Minister, Spectrum, Information Technologies and Telecommunications is responsible for the orderly development of communications systems and services in Canada, including the design and implementation of a strategy for a Canadian "information highway", promoting the growth and international competitiveness of the information technology, communications and new media industries, and ensuring easy and affordable access by all sectors of the economy, and consumers, to these products and services.

Professional Experience

July 1993 to present
Assistant Deputy Minister, Spectrum, Information Technologies and Telecommunications, Industry Canada (998-0368)

1990 to June 1993
Senior Assistant Deputy Minister, Department of Communications

1985 to 1990
Assistant Deputy Minister, Corporate Management, Department of Communications

1981 to 1985
Director, Program Evaluation, Office of the

BIOGRAPHIE

Le sous-ministre adjoint, Spectre, Technologie de l'information et télécommunications, est chargé du développement ordonné des systèmes et services de communications au Canada, y compris de l'élaboration et de la mise en oeuvre d'une stratégie pour une «autoroute canadienne de l'information», pour promouvoir la croissance et la compétitivité internationale de la technologie de l'information, des communications et des industries des nouveaux médias, et d'assurer un accès facile et abordable à tous les secteurs de l'économie, et aux consommateurs, à ces produits et services.

Expérience professionnelle

Juillet 1993 jusqu'à présent
Sous-ministre adjoint, Spectre, Technologie de l'information et télécommunications, Industrie Canada (998-0368)

1990 à juin 1993
Sous-ministre adjoint principal, ministère des Communications

1985 à 1990
Sous-ministre adjoint, Gestion intégrée, ministère des Communications

1981 à 1985
Directeur, Évaluation des programmes, Bureau du

Comptroller General of Canada

1971 to 1981
Various positions in the Canada Mortgage and Housing Corporation; the Ministry of State for Urban Affairs; and the Defence Research Board

Education

PhD (Theoretical Physics), University of Alberta, 1971

contrôleur général du Canada

1971 à 1981
Divers postes à la Société centrale d'hypothèques et de logement, ministère d'État chargé des Affaires urbaines et Conseil de recherches pour la Défense

Études

Doctorat (physique théorique), University of Alberta, 1971

CUSTOMER FIRST
LE CLIENT EN PREMIER

C.M. (Michael) Ennis

Group Vice President & General Manager,
American Cellular
Nortel
Mississauga

BIOGRAPHY

After a career in banking and consumer electronics manufacturing, Mike Ennis joined Northern Telecom in 1978 and has held the positions of Director, Corporate Purchasing, Director PBX Manufacturing, Assistant Vice President Productivity and Planning, Vice President and General Manager Business Products Division.

In October of 1992, Mike moved to the Switching Networks organization to lead the Synergy project. The project scope encompassed the re-engineering of the Switching Networks Business from design through to customer including both the DMS product hardware platforms and the business processes. Additional responsibilities included the International PLM organization.

In February of 1994, Mike returned to the Multimedia Communication Systems organization as Group Vice President Manufacturing and in July, 1994, assumed the additional responsibility for the Meridian 1, SL 100, Norstar, Terminals and Public Payphone (Millennium) businesses as Group Vice President and General Manager, Multimedia Communications Systems.

In May 1996, a new position was created within our Wireless line of business to focus on the impending market opportunity in the Wireless Local Loop. As Group Vice President, Fixed Wireless Access, Mike is responsible for the development and execution of market and product strategies in this high growth area.

In September of 1996 the American Cellular business was added to Mike's responsibility. Mike's current title is Group Vice President & General Manager, American Cellular

GENERATING PROFIT FROM NEW BROADCAST TECHNOLOGIES
RETIRER DES PROFITS DES NOUVELLES TECHNOLOGIES DE RADIODIFFUSION

Michael McCabe

President & C.E.O.
Canadian Association of Broadcasters
PO Box 627, Station B
Ottawa, K1P 5S2
613 233-4035

BIOGRAPHY

Michael McCabe left his own communications consulting firm in 1988 to become President and Chief Executive Officer of the Canadian Association of Broadcasters, which represents most of Canada's private radio and television stations. Under his leadership, the CAB has launched many new strategic directions, made impressive gains for members and developed a four-cornerstone Canadian Programming Initiative to help Canada compete effectively with the best the world has to offer. The association has introduced bold policies to return radio to profitability, including bringing Digital Radio to Canada. Michael has overseen the CAB's six point action plan against Violence, including a tough Violence Code and national PSA campaign that have made private broadcasters world leaders in dealing with the violence issue. Michael began his private career in marketing with Lever Brothers and was founding director of a venture capital fund. He has held senior positions with the federal government and crown corporations, including terms as Executive Director of the Canadian Film Development Corporation (now Telefilm Canada), Assistant Deputy Minister for Consumer and Corporate Affairs, and Chairman of Policy and Research, Canada Mortgage and Housing Corporation.

BIOGRAPHIE

Michael McCabe quitte sa propre société d'experts-conseils en communications en 1988 pour devenir président et chef de la direction de l'Association canadienne des radiodiffuseurs (ACR), qui représente la majorité des stations de radio et de télévision privées du Canada. Sous sa direction, l'ACR lance bien des nouvelles orientations stratégiques, fait des gains impressionnants pour ses membres et élabore une initiative de programmation à quatre piliers pour aider le Canada à concurrencer efficacement le monde entier. L'Association introduit des politiques audacieuses pour ramener la rentabilité dans l'industrie de la radio, y compris l'introduction de la radio numérique au Canada. Michael supervise le plan d'action en six points de l'ACR contre la violence, y compris un Code d'éthique sur la violence et une campagne nationale de messages d'intérêts publics qui font des radiodiffuseurs privés des chefs de file mondiaux en matière de lutte contre la violence. Michael débute dans le secteur privé en s'occupant de marketing chez Lever Brothers et il est le directeur-fondateur d'un fonds à capital de risque. Il occupe des postes supérieurs au gouvernement fédéral et dans des sociétés d'État, y compris comme directeur exécutif de la Société de développement de l'industrie cinématographique canadienne (devenue Téléfilm Canada), sous-ministre adjoint de Consommation et Corporations et président de la Politique et des recherches, Société canadienne d'hypothèques et de logement.

LUNCHEON SPEAKER / CONFÉRENCIER INVITÉ

Kevin G. Lynch

Deputy Minister / Sous-ministre
Industry Canada / Industrie Canada

Mr. Lynch was born in Nova Scotia and studied economics at Mount Allison University (BA), received a masters degree in economics from the University of Manchester (MA) which he attended on a Commonwealth Scholarship and holds a doctorate in economics from McMaster University.

Mr. Lynch was a Lecturer at McMaster University in 1975. In 1976, Mr. Lynch joined the Bank of Canada where he became a Senior Economist in both the Monetary and Financial Analysis, and Research, Departments. He moved to the Department of Finance in 1981 as Assistant Chief in the Capital Markets Division. In 1983, Mr. Lynch became Director of the Economic Forecasting Division, and was appointed General Director of the Fiscal Policy and Economic Analysis Branch in 1986. Mr. Lynch became Assistant Deputy Minister, International Trade and Finance, in 1988. In October, 1989, Mr. Lynch was made Assistant Deputy Minister, Fiscal Policy and Economic Analysis Branch, with primary responsibility for the preparation of the federal budget.

In February, 1992, he was appointed Senior Assistant Deputy Minister in the Department of Finance. As part of his departmental responsibilities, Mr. Lynch was a member of the Senior Executive Committee of the Department of Finance, and was head of the Canadian delegation to the Economic Policy Committee of the OECD. Mr. Lynch was Chairman of Working Party One of the OECD from 1990 to 1992.

In October, 1995, Mr. Lynch was appointed Deputy Minister of the Department of Industry.

M. Lynch est né en Nouvelle-Ecosse et a étudié l'économie à l'Université Mount Allison. Il a obtenu une maîtrise en économie à l'Université de Manchester, grâce à une bourse du Commonwealth, et il détient un doctorat en économie de l'Université McMaster.

M. Lynch a été conférencier à l'Université McMaster en 1975. En 1976, M. Lynch joint la Banque du Canada et devient économiste principal chargé des services de l'analyse monétaire et financière ainsi que des services de recherche. Il a débuté sa carrière au Ministère des Finances en 1981 en tant que chef adjoint de la Division des Marchés de capitaux. En 1983, M. Lynch est devenu directeur de la Division des Prévisions économiques et il a été nommé directeur général de la Direction de la Politique fiscale et de l'Analyse économique en 1986. M. Lynch est devenu sous-ministre adjoint de la Direction des Finances et Commerce internationaux en 1988. En octobre 1989, il a été nommé sous-ministre adjoint de la Direction de la Politique fiscale et de l'Analyse économique avec comme tâche principale, la préparation du budget fédéral.

En février 1992, M. Lynch a été nommé sous-ministre adjoint principal au Ministère des Finances. Dans le cadre de ses responsabilités, M. Lynch a été membre du comité exécutif principal du Ministère des Finances et a dirigé la délégation canadienne au comité de la politique économique de l'OCDE. M. Lynch a été président du groupe de travail numéro 1 de l'OCDE de 1990 à 1992.

En octobre 1995, M. Lynch a été nommé

From November 1992, to this appointment, Mr. Lynch had been Associate Deputy Minister in the Department of Industry. Mr. Lynch is also a Director of the Business Development Bank of Canada and the Canadian Tourism Commission, and is a former Director of the Cape Breton Development Corporation.

sous-ministre du ministère de l'Industrie. De novembre 1992 à cette date, M. Lynch a été sous-ministre délégué au sein du ministère de l'Industrie. De plus, M. Lynch agit à titre d'administrateur auprès de la Banque de développement du Canada et de la Commission canadienne du Tourisme et il fut également administrateur auprès de la Société de développement du Cap-Breton.

Meeting our Global Economic Challenges

Presentation to the Spectrum 20/20 Symposium

by

Kevin G. Lynch
Deputy Minister
Industry Canada

November 20, 1996

TABLE OF CONTENTS

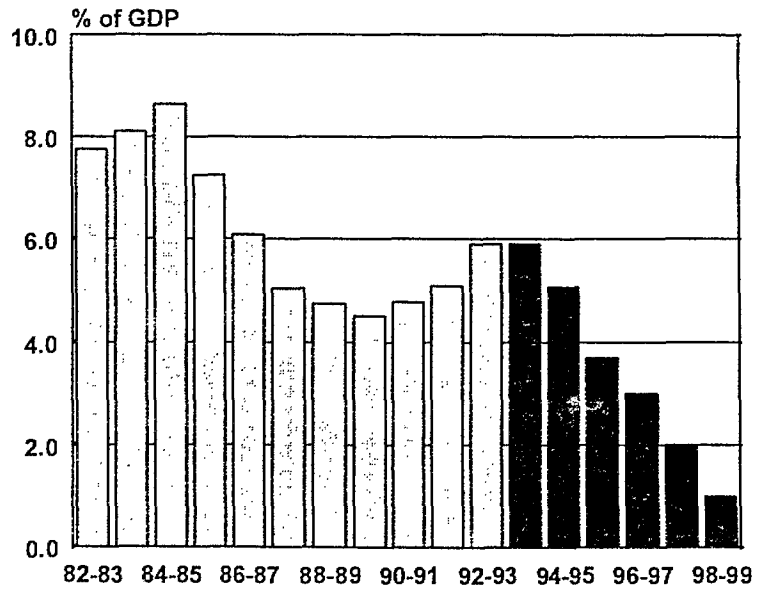
- Macroeconomic Challenges and Progress Made
- Microeconomic Challenges Ahead
- Wireless Communications Positive Economic Outlook - Progress through Partnership

Macroeconomic Challenges and Progress Made

After more than a decade of high deficits, a balanced fiscal situation is in sight

- Today, the deficit (as a % of GDP) is half of what it was in 1993-94.
- The federal government continues to make progress on deficit reduction -- it is well on track to meet the deficit target of 2 per cent of GDP for 1997-98 and 1 per cent for 1998-99.
- 7 provinces were in fiscal balance by the end of 1995-96.

Federal Deficit to GDP Ratio

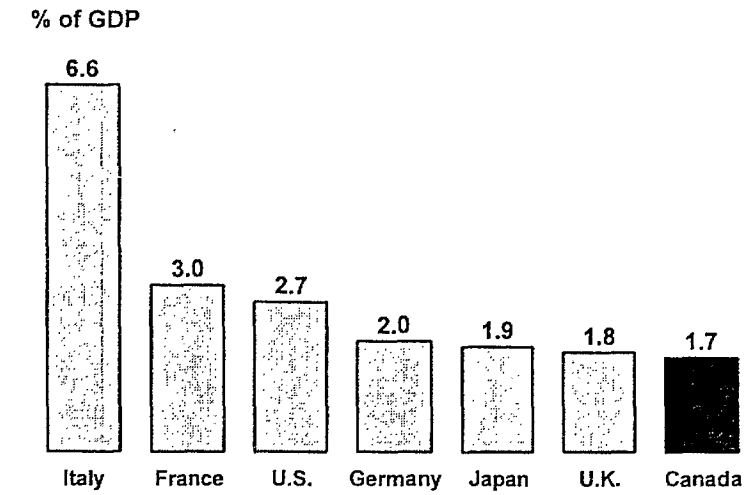


Source: Department of Finance and Statistics Canada

And Canada's fiscal position is rapidly improving relative to its major trading partners ...

- For this fiscal year, the ratio of federal borrowing requirements-to-GDP declines to 1.7% -- the lowest among the G-7.
- Borrowing requirements will drop to 0.7% of GDP in 1997-98, (lower than any G-7 country) and will be in a surplus position by 1998-99 -- the first time since 1969-70.

Projected 1996-97 Financial Requirements

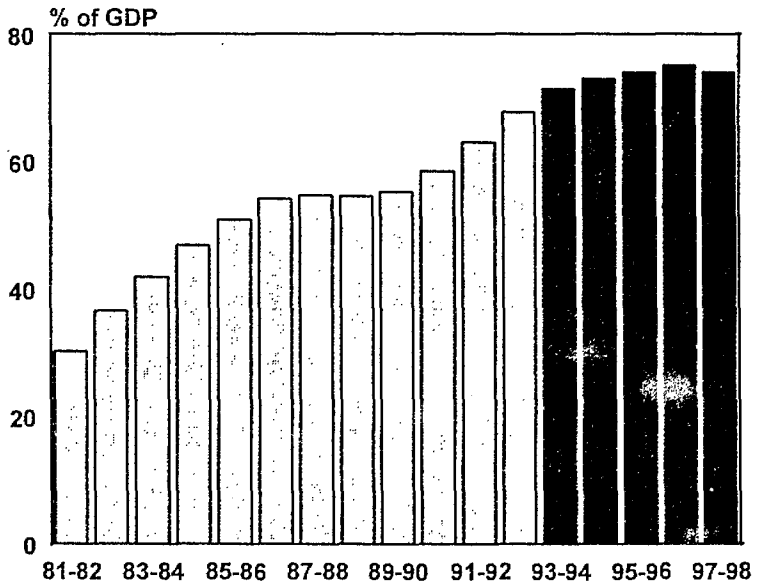


Source : National Budget Plans, OECD

But, the debt-to-GDP ratio is still very high

- From 1974-75 to 1994-95, the debt-to-GDP ratio quadrupled, from 18.7 per cent to 72.8 per cent.
  - One-third of this increase occurred over the last five years.
- Even as the deficit-to-GDP ratio declined after 1993-94, the debt-to-GDP ratio continued to rise.
  - As the deficit increasingly comes under control, the focus of fiscal policy will shift to reaching an appropriate debt ratio.

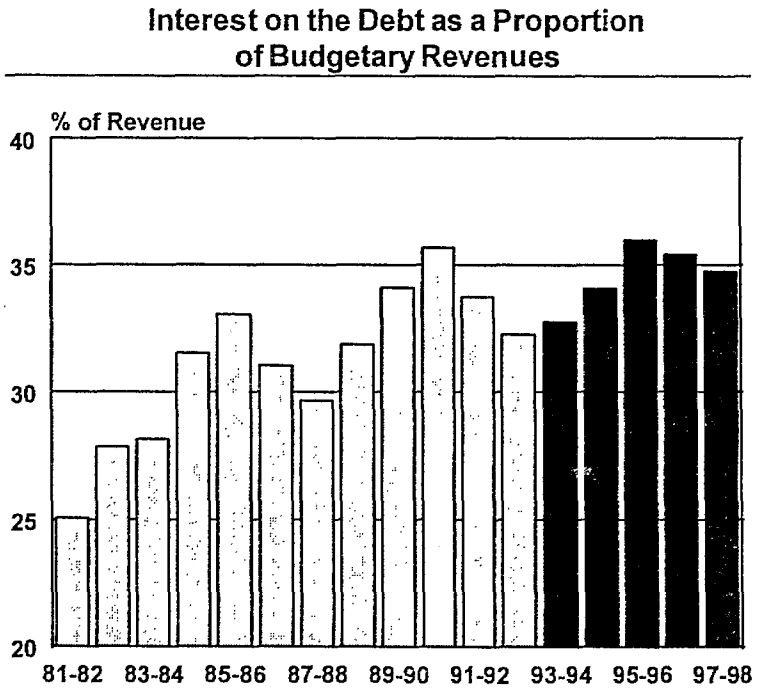
Ratio of Net Debt to GDP



Source: Department of Finance

And the consequence of high debt is high debt servicing that crowds out government spending priorities

- The legacy cost of high debt levels is high debt servicing levels.
- Currently, 36 cents of each dollar of revenue must go to servicing the debt -- the largest government expenditure item.
- This crowds out government spending priorities and constrains government's flexibility.

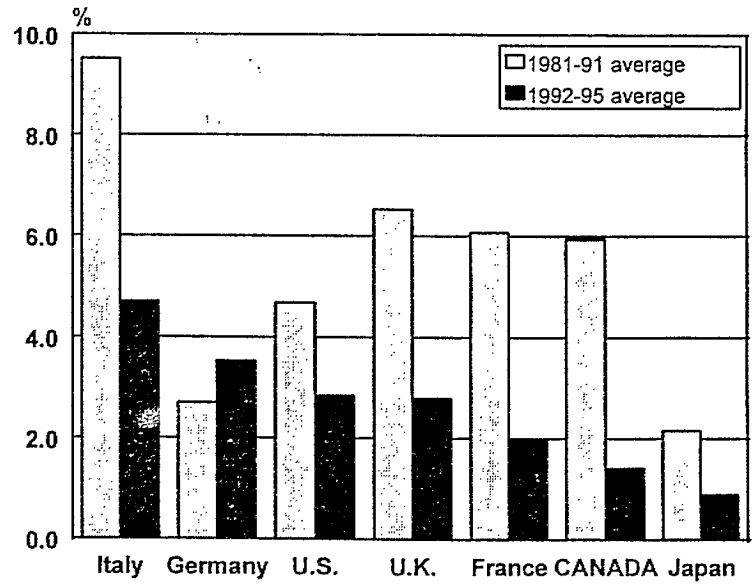


Source: Department of Finance

Dramatic turnaround on inflation front

- In the last four years, Canada's inflation rate has gone from one of the higher among the G-7 economies to one of the lowest in the world.
  - For four years now, Canadian inflation averaged under 2%.
  - For four years Canadian inflation has averaged 1.1% less than the U.S.
- The inflation target locks the inflation rate in the 1%-3% range for the future.
  - The average inflation rate to date in 1996 is under 1.5%.

Inflation in G-7 Countries

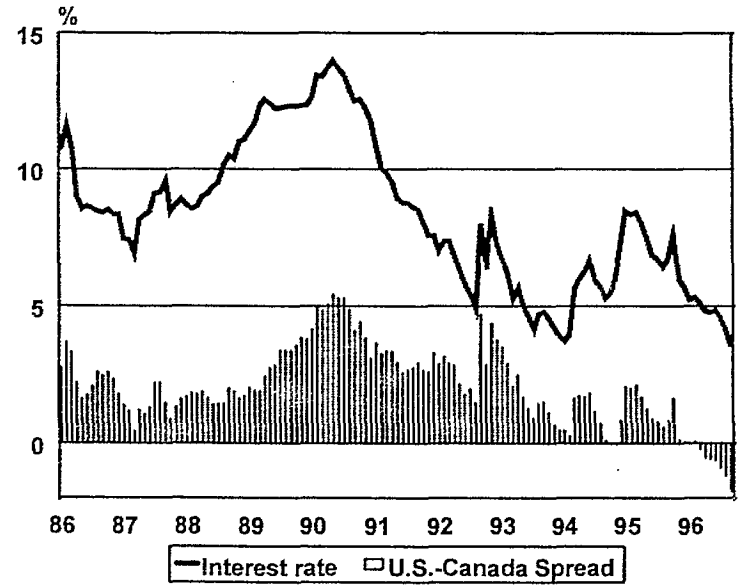


Source: OECD

Low inflation and falling fiscal deficits have pushed interest rates to their lowest levels in a generation

- Low inflation has pulled Canadian interest rates down dramatically since the early 1990s.
- Lower inflation in Canada than in the U.S. has opened up negative spreads vis-à-vis the U.S.
- Canada's yield curve out to 5 years is below that of the U.S. -- the first time in 12 years.
  - Short-term rates are 217 basis points below those in the U.S.

Short-Term Interest Rates

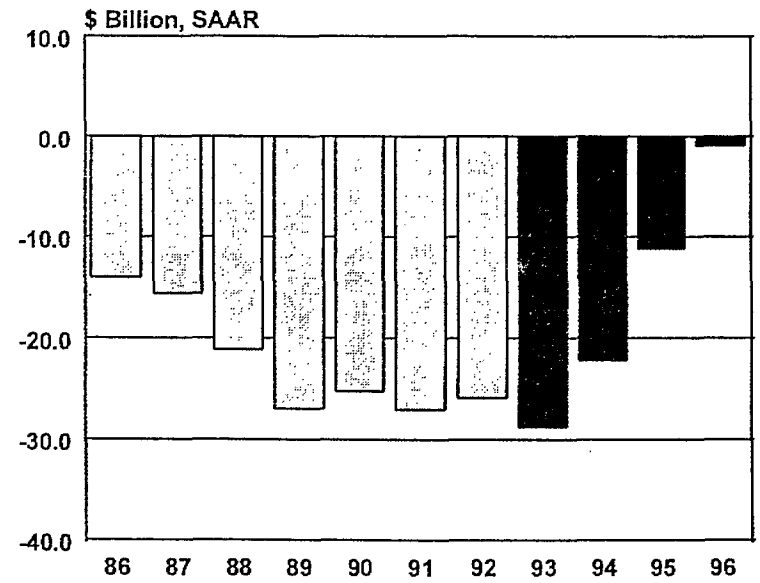


Source: Bank of Canada, 90 day commercial paper

Improved competitiveness -- costs and productivity -- is showing up in dramatic improvement in the current account balance

- The emphasis on competitiveness is paying off:
  - Canada went from $30 Billion (4% of GDP) current account deficit in 1993 to a surplus in two and a half years (1996Q2) -- the first surplus in 12 years.
- Trade is powering Canada's economic growth:
  - One job in three depends on trade;
  - Trade accounts for more than 50% of recent economic growth.

Current Account Balance: 1986-96

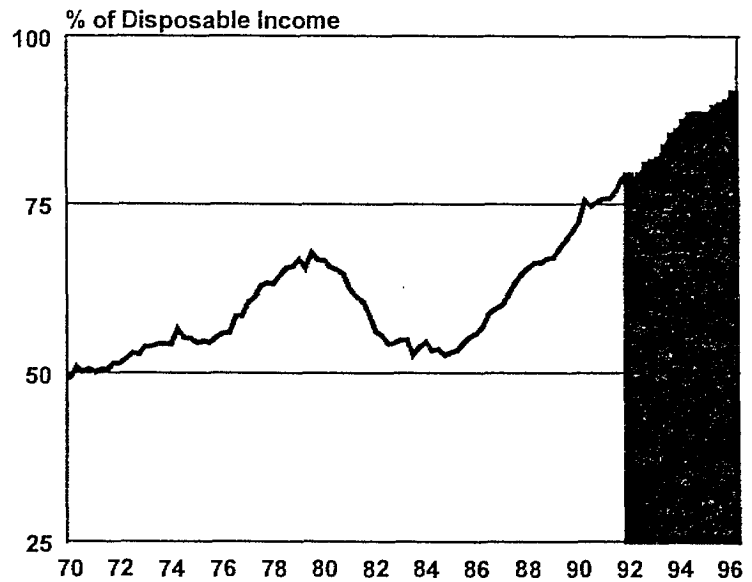


Source: Statistics Canada

But, domestic spending is still weak as consumers, like governments, have a debt problem

- Consumer indebtness has run up to record levels (94% of disposable income).
- Lower interest rates will take longer to stimulate consumers than business as household balance sheets will take time to repair.
  - Improvements in household balance sheets will help to restore the long term health of the economy, but constrains short term spending.

Consumer Indebtedness: 1970-96

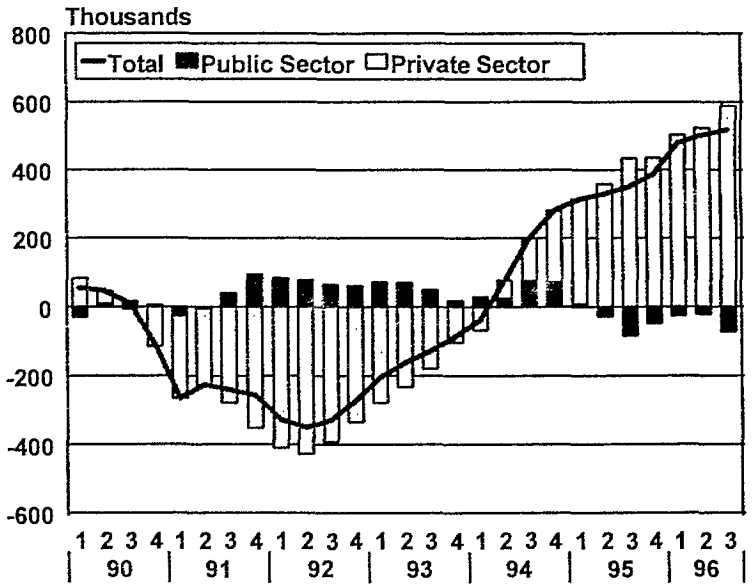


Source: Statistics Canada

Employment growth dichotomy: private sector creates jobs while public sector cuts back

- Employment growth is going to have to come from a competitive private sector. And it has, despite cost cutting and downsizing in private sector firms.
  - Since the end of 1992, the private sector has created more than 900,000 jobs.
  - Over the same period, the public sector shed over 125,000 jobs (in contrast to increasing by 75,000 over the previous 3 years).

Cumulative Employment Change : Since 1990



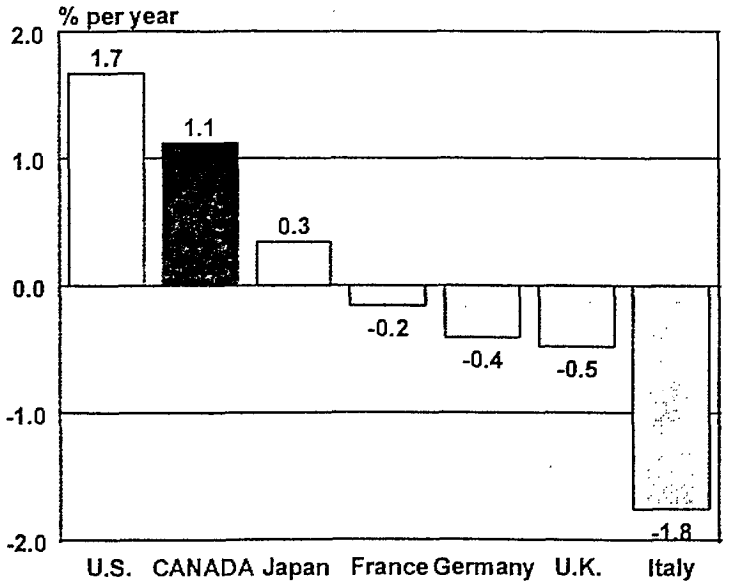
Source: Statistics Canada

Microeconomic Challenges Ahead

Unemployment

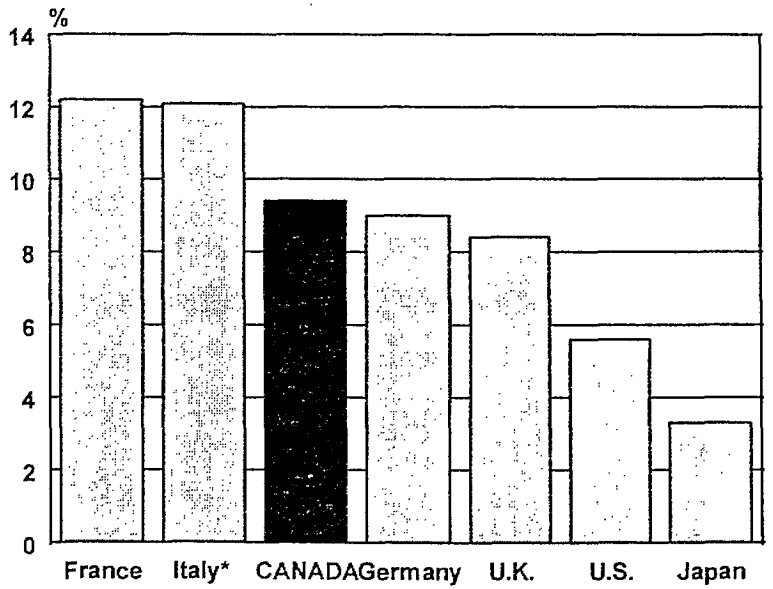
While employment growth in Canada is second highest in G-7...

Employment Growth in G-7: 1991-95



Source: OECD

Standardized Unemployment Rates in G-7: 1996,Q1

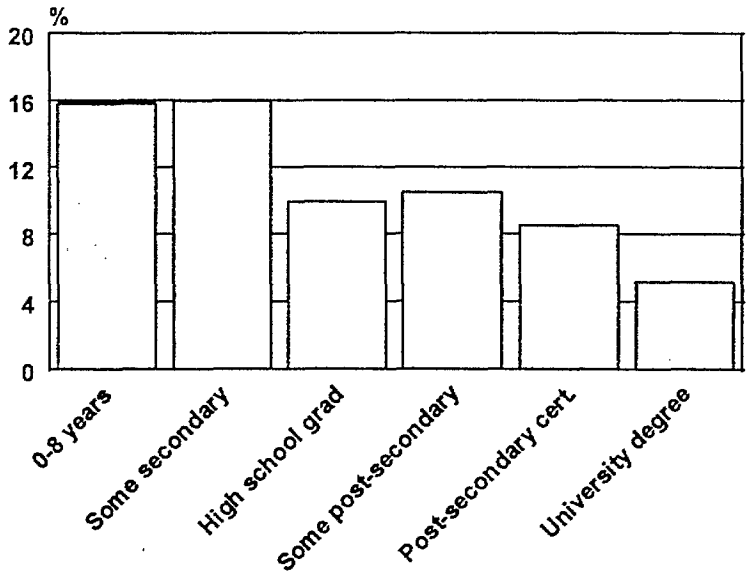


Note: * for 1995, Q2.
Source: OECD

... the unemployment rate remains stubbornly high

...especially among the unskilled...

Unemployment Rate by Education, 1996

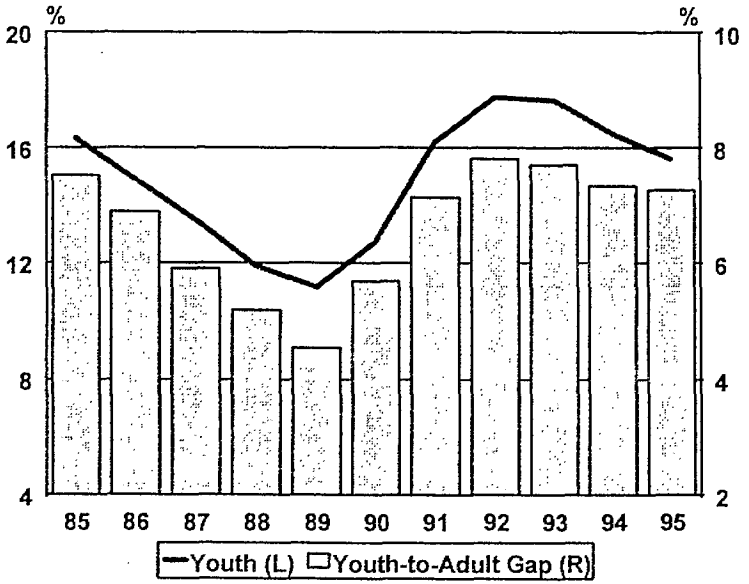


Source: Statistics Canada

- **Low-skilled/less educated workers are staying unemployed increasingly longer.**

...and among youth

Youth Unemployment Rate



Source: Statistics Canada

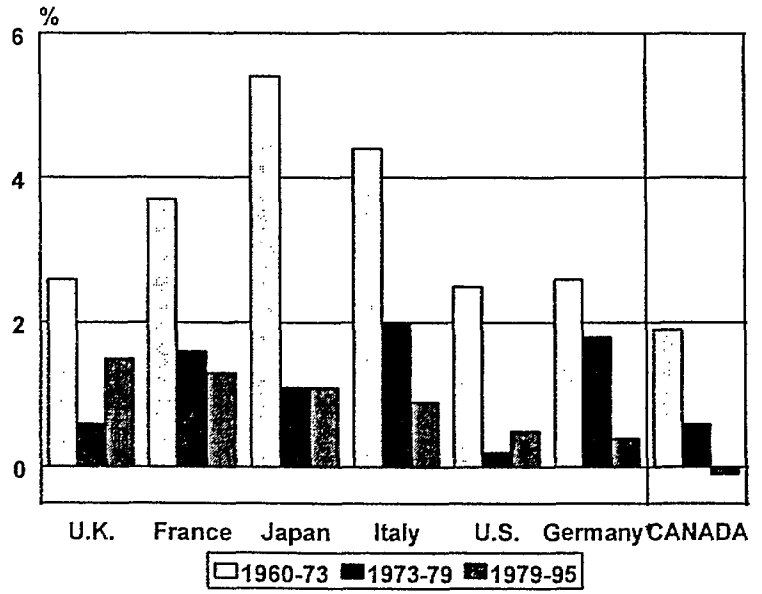
- **Youths are having difficulty getting a first job experience.**

Productivity Growth Puzzle

Productivity growth, which is the key to long term competitiveness and rising incomes, has been very slow in Canada for some time

- While Canada has one the highest levels of productivity among industrial countries, we had the lowest rate of growth in productivity among G-7 countries over the last fifteen years.
- Productivity growth will be ignited, according to research, by:
  - Adopting and diffusing technology faster;
  - Becoming more innovative in management, marketing and finance;
  - Continuously improving labour skills.

Total Factor Productivity (TFP) Growth in G-7

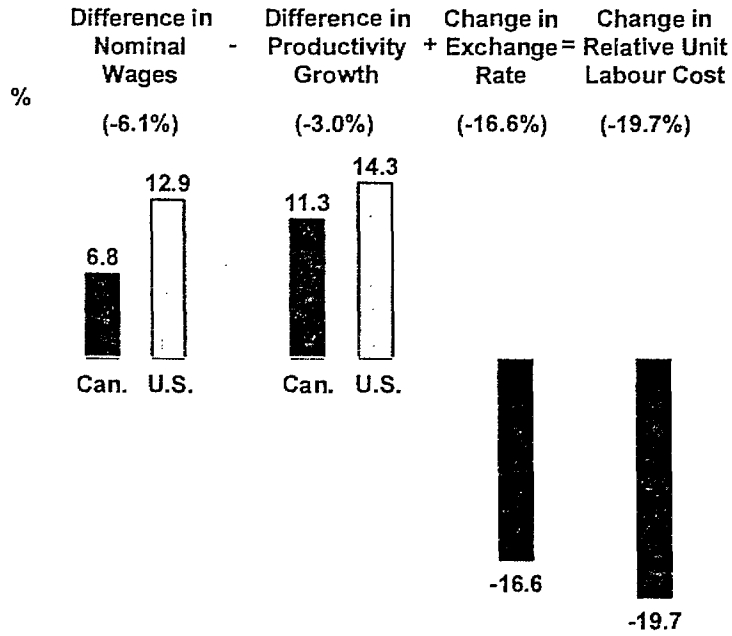


Source: OECD
* Or the latest years available, 1993 for Germany and 1994 for Japan, France and the U.K.

Reflecting this, recent competitiveness gains have come mainly from lower wage costs and currency depreciation

- **Since 1991, Canadian competitiveness has improved 19.7% relative to U.S. (and 48% relative to Germany).**
- **This improvement has been mainly due to a lower Canadian dollar as productivity growth has been relatively worse than that in the U.S., although wage growth has been slower in Canada.**

Cumulative Change in Competitiveness: 1991-95
(Unit labour cost in common currency)



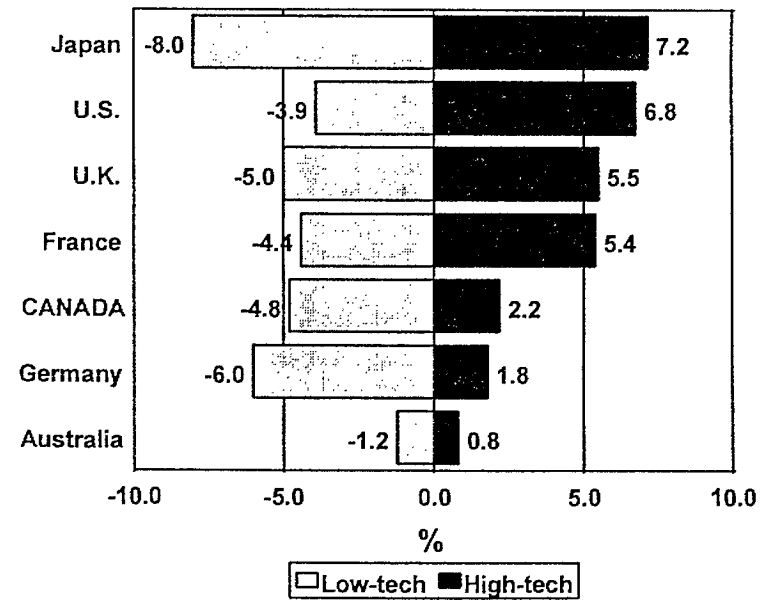
Source: Bureau of Labour Statistics

Innovation Gap

OECD analysis suggests that Canada has an innovation gap, and this gap is part of our productivity puzzle and a constraint on our long term growth and standard of living prospects

- According to the OECD, important elements of this innovation gap include:
  - Low R&D spending as % of GDP, particularly by private sector
  - Weak technology diffusion and adoption
  - Mismatch of skill needs and supply

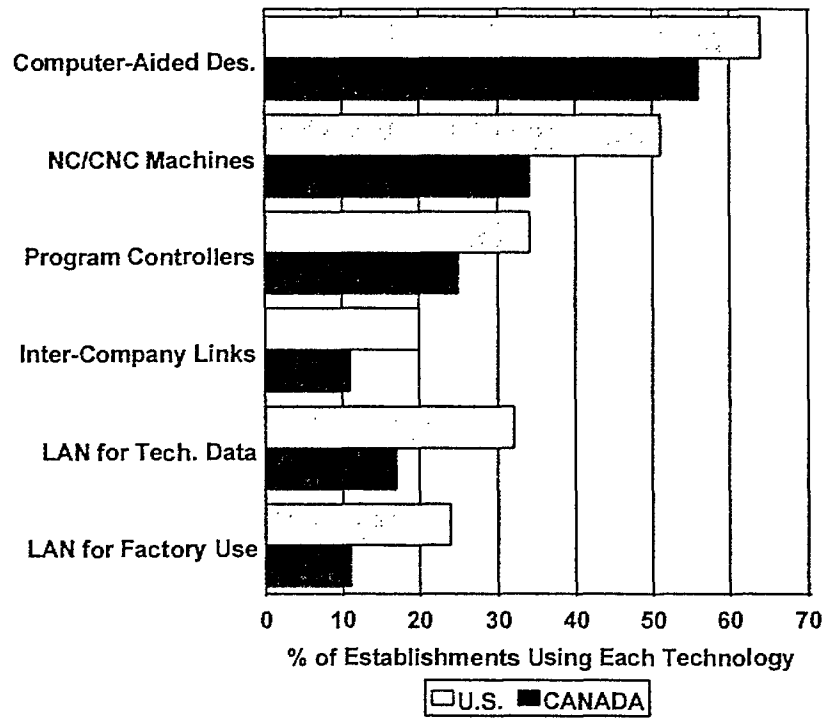
Change in Output Share by Level of Technology, 1970-90



Source: OECD, 1995, OECD Economic Surveys Canada.

Canada lags U.S. in diffusion and adoption of advanced technologies ...

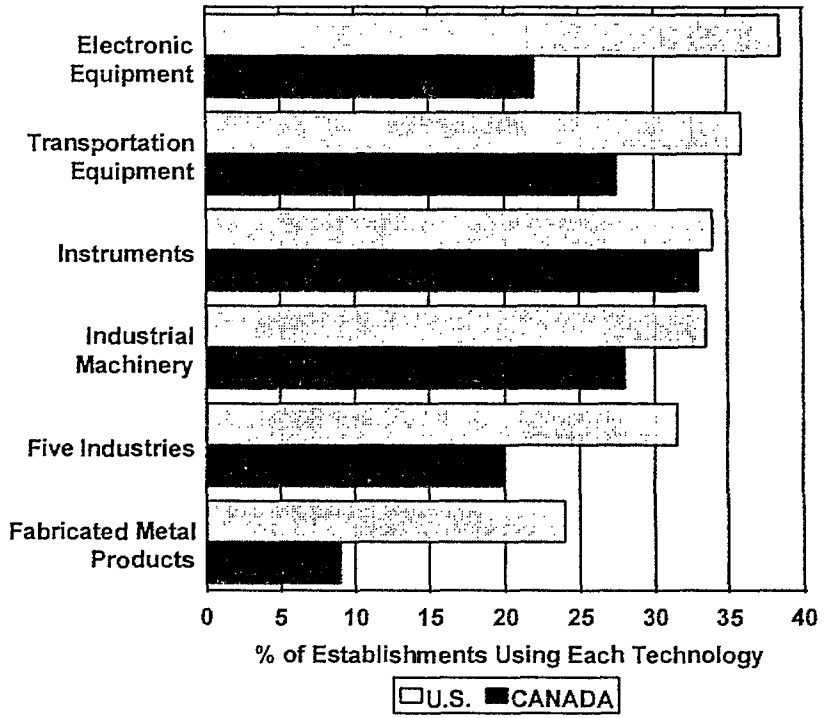
Use of Technology in Canada and U.S., 1993



Source: Statistics Canada

- General use of technology is less in Canada.

Use of Five or More Technologies by Industry, 1993

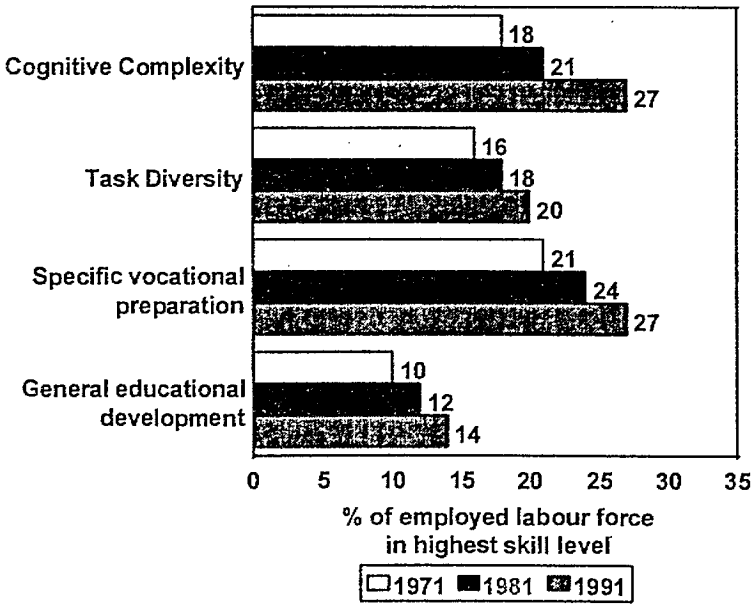


Source: Statistics Canada

- As is intensive technology usage in strategic sectors.

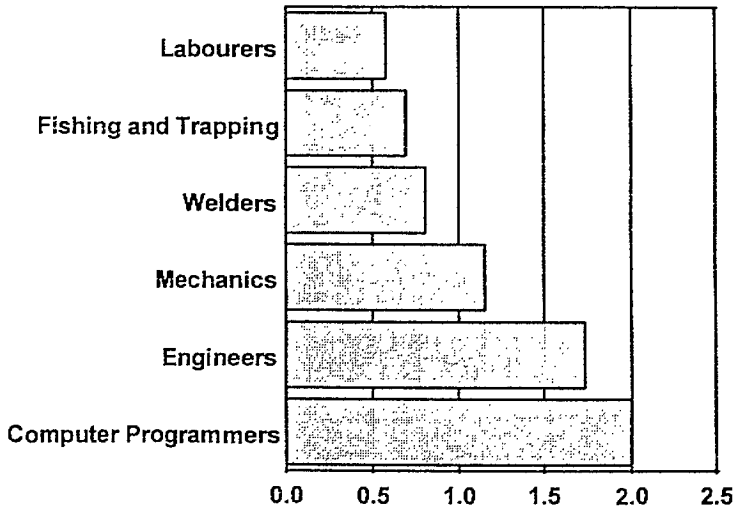
Knowledge based industries (KBI) demand different skills, and we have growing evidence of skill mismatches

Trends in Skill Requirements



Source: Ekos Research Associates Inc. based on Census of Canada, Employed Labour Force

Index of Skill Shortage*, 1994



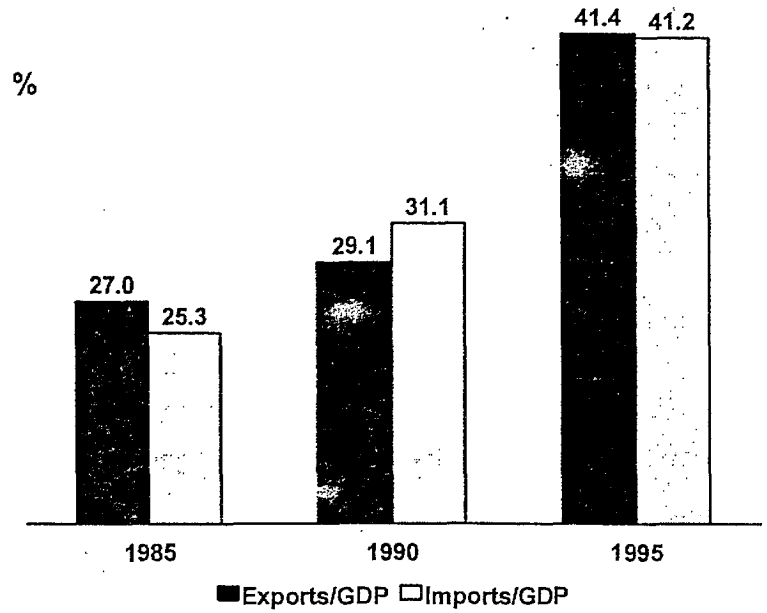
* Aggregate unemployment rate divided by unemployment rate of occupation

Source: Based on Jobs Futures (HRDC)

Trade Diversity

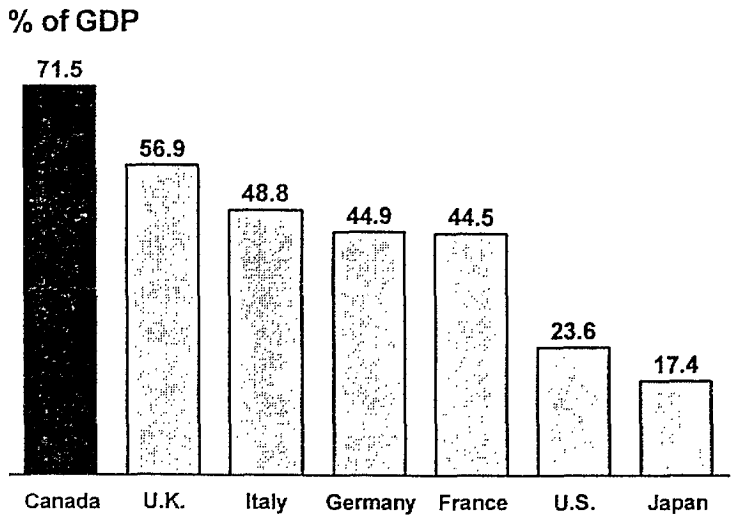
Taking advantage of globalization, the FTA and NAFTA, Canada is now one of the most open economies in the world ...

Real Exports/GDP and Real Imports/GDP



Source: Statistics Canada

Trade in Goods and Services: 1995

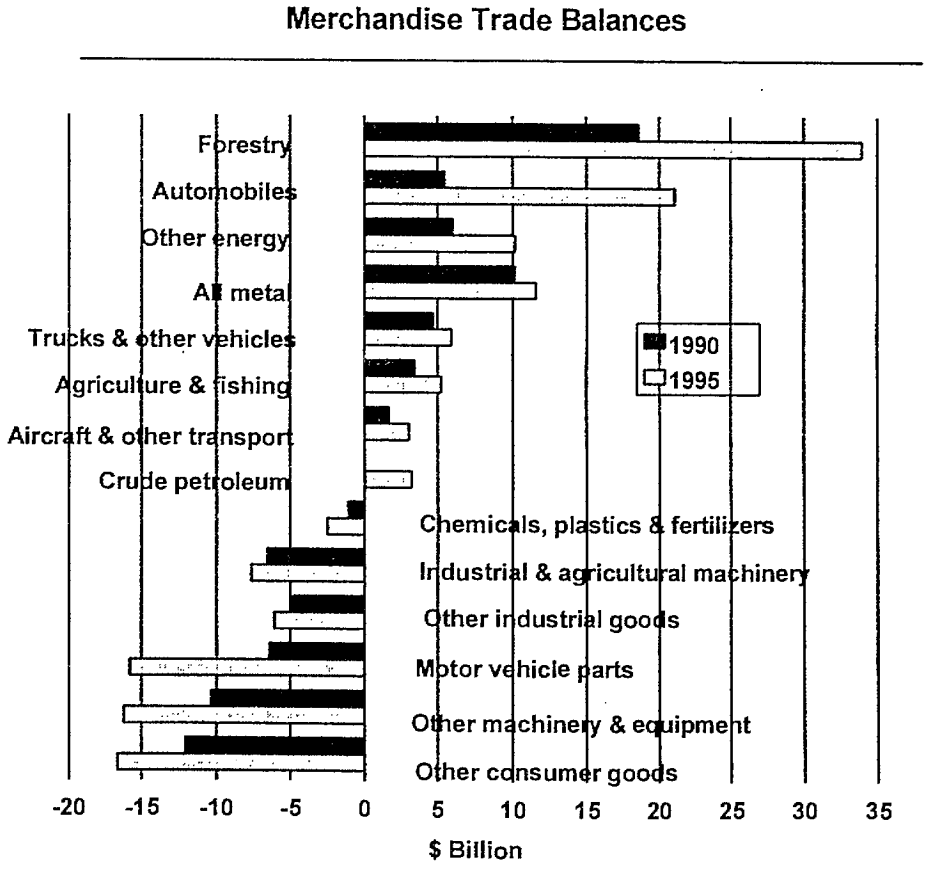


* (Exports + Imports)/GDP
Source: OECD

... and growth in Canadian exports has been astounding in recent years (up almost 60% since 1991).

But, Canada's trade is still too concentrated in too few sectors ...

- Exports are highly concentrated (resources and auto products accounting for 55% of the total).
  - Canadian knowledge based industries can do much better in global markets.
- Sectors that have traditionally produced surpluses are running increasingly large surpluses.
  - Deficit sectors have not yet improved to the extent possible.

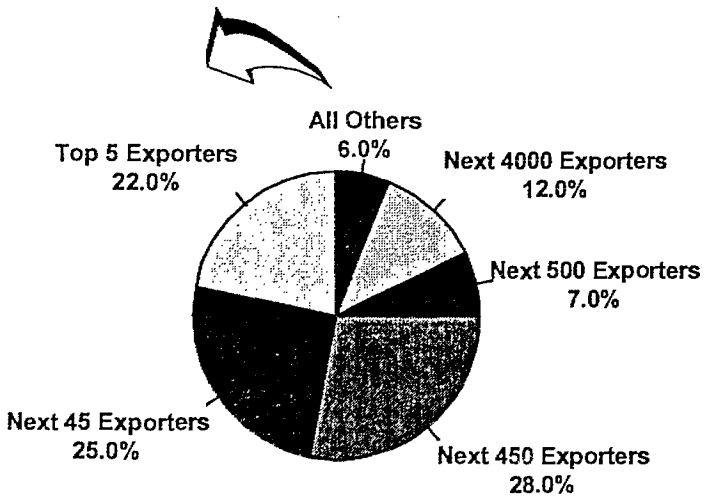


Source: Statistics Canada

... and too few firms. We have become a world class trading nation, but not yet a nation of traders

- Large firms account for a disproportionate amount of our export activity:
  - The top 5 exporters account for 22% of Canadian exports.
  - The top 50 exporters account for almost half of exports.
- SME's -- flexible, innovative and great job creators -- have great "trading potential".
  - But, less than 10% of SMEs now take advantage of globalization.

Concentration of Merchandise Exports by Number of Firms, 1994

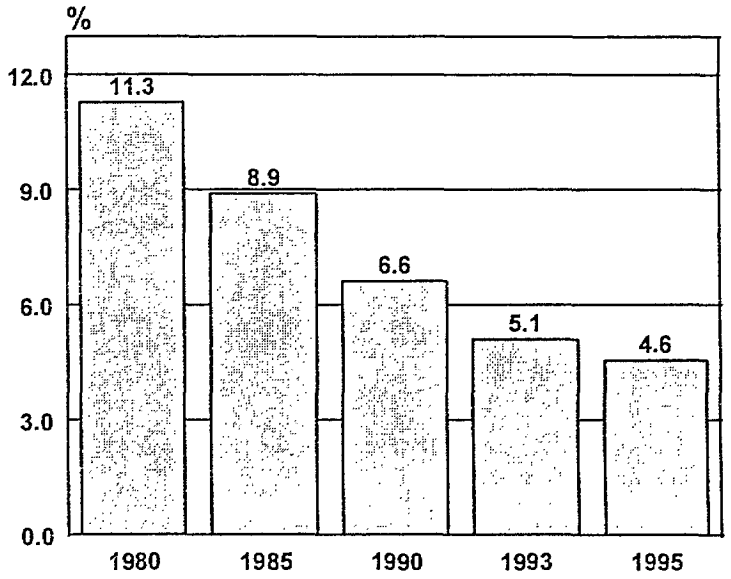


Source: Compilation based on Statistics Canada data

Canada is attracting Foreign Direct Investment (FDI), but aggressive global competition and our fiscal and competitiveness problems in the late 1980s and early 1990s meant we have lost share of world total FDI

- FDI in Canada doubled between 1985 and 1995 to $168 billion, but we have lost global share.
- FDI provides a powerful stimulus to economic growth and job creation:
  - $1 billion increase in FDI creates about 45,000 new jobs and increases real GDP by about $4.5 billion over a five year period.
- With our improved economic fundamentals, Canada has again become a more attractive place to invest:
  - But success will require investment attraction strategies sector-by-sector.

Share of Canada's FDI Inward Stock to World Total



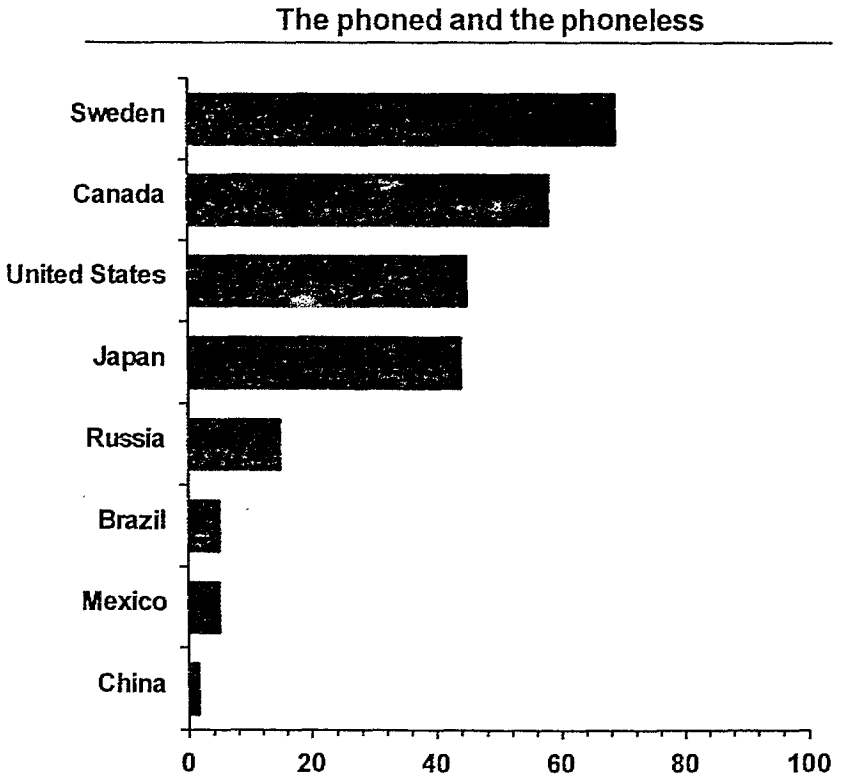
Source: United Nations, 1995, World Investment Report

Wireless Communications Positive Economic - Progress Through Partnership

Phenomenal Growth Potential of Wireless...

- **Half the world's population (3 billion people) has never made a phone call**
- **Only 600 million telephone numbers for 6 billion people**
- **North America, Western Europe and Japan have 75% of phones, 15% of people**
- **Estimate 50% of calls will be wireless by year 2005**

Source: Greg LeVert, president of MCI's Integrated Client Services Division, Toronto Star (Telecon '94)

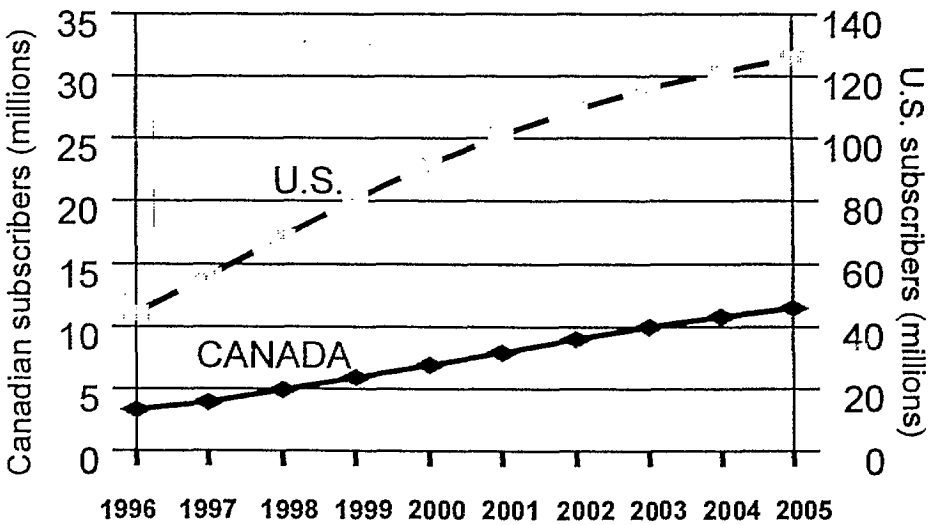


Source: OECD

Estimates suggest...

- IN U.S. BY 2005
- Cellular could have 24% penetration
- PCS some 17% penetration
- 125 million subscribers (Cellular and PCS), up from 43 million today.
- IN CANADA BY 2005
- Similar penetration rates (Cellular and PCS)
- 11 1/2 million subscribers (Cellular and PCS), up from 3 million today

Combined Cellular / PCS Growth Rates for Canada and the U.S.



Source: TR Wireless News / Midland Walwyn

Partnership Key to Growth and Jobs for Canadians...

- Government Has:
  - used spectrum policy, management and licensing powers to speed up deployment of new services, thereby helping industry's competitiveness.
  - represented Canadian interests at international negotiations to liberalize trade in telecommunictions and in international standards fora.
  - introduced significant telecommunications policy and regulatory changes to encourage increased competition, new investment and innovation.
  - encouraged new technologies.
  - encouraged new alliances and partnerships to accelerate time to market and share the risks of expensive R&D.
  - worked closely with RABC, industry, others.

"TEAM CANADA" APPROACH TO CHALLENGES / OPPORTUNITIES WORKS!

Relever nos défis économiques mondiaux

Présentation au Symposium Spectre 20/20

par

Kevin G. Lynch
Sous-ministre
Industrie Canada

20 novembre 1996

TABLE DES MATIÈRES

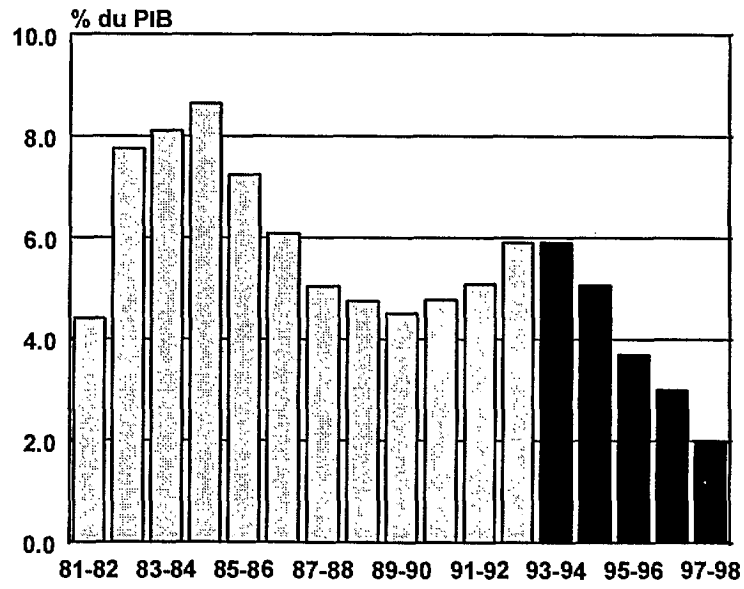
- **Les défis macro-économiques et les progrès accomplis**
- **Les défis micro-économiques qui s'annoncent**
- **Perspective économique positive dans le domaine des communications sans fil - Le progrès au moyen du partenariat**

Les défis macro-économiques et les progrès accomplis

Après plus d'une décennie de déficits élevés, nous pouvons entrevoir un solde budgétaire équilibré

- **Aujourd'hui, le déficit (en pourcentage du PIB) est la moitié de ce qu'il était en 1993-1994.**
- **Il chutera à 2 p. 100 du PIB, soit 17 milliards de dollars, en 1997-1998 -- le niveau le moins élevé par rapport au PIB depuis le milieu des années 70.**
- **En outre, d'ici la fin du présent exercice, le budget de sept provinces sur dix sera en équilibre.**

Ratio du déficit fédéral au PIB



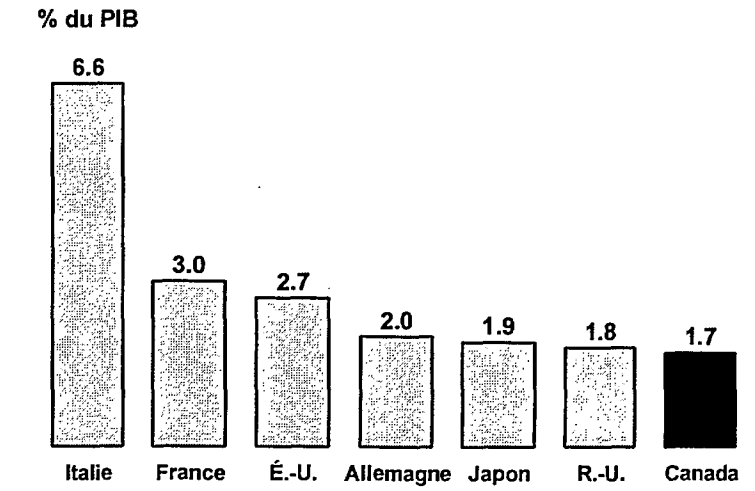
Sources : Ministère des Finances et Statistique Canada.

Et la situation budgétaire du Canada s'améliore rapidement par rapport à celle de ses principaux partenaires commerciaux

- **Pour le présent exercice, le ratio des besoins d'emprunt fédéraux au PIB tombe à 1,7 % -- le moins élevé des pays du G-7.**

- **En 1997-1998, les besoins d'emprunt tomberont à 0,7 % du PIB (6 milliards de $), le niveau le moins élevé des pays du G-7 et le plus bas au pays depuis 1969-1970.**

Projection des besoins financiers à 1996-1997

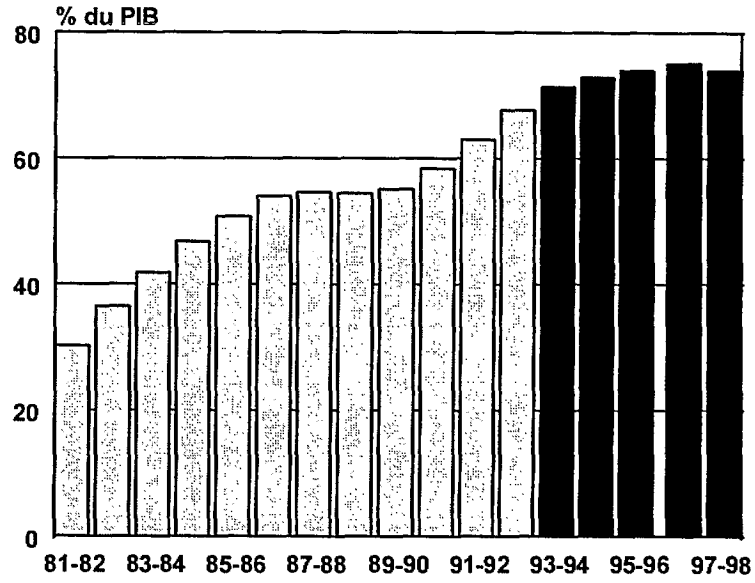


Source : Plans budgétaires nationaux, OCDE.

Mais, le ratio dette/PIB demeure très élevé

- **Entre 1974-1975 et 1994-1995, le ratio de la dette au PIB a quadruplé, passant de 18,7 p. 100 à 72,8 p. 100 .**
  - **Le tiers de cette augmentation s'est produit au cours des cinq dernières années.**
- **Même si le ratio du déficit au PIB a diminué après 1993-1994, le ratio de la dette au PIB a continué d'augmenter.**
  - **À mesure que le déficit est réduit, la priorité de la politique budgétaire ira vers l'atteinte d'un ratio d'endettement approprié.**

Ratio de l'endettement net au PIB

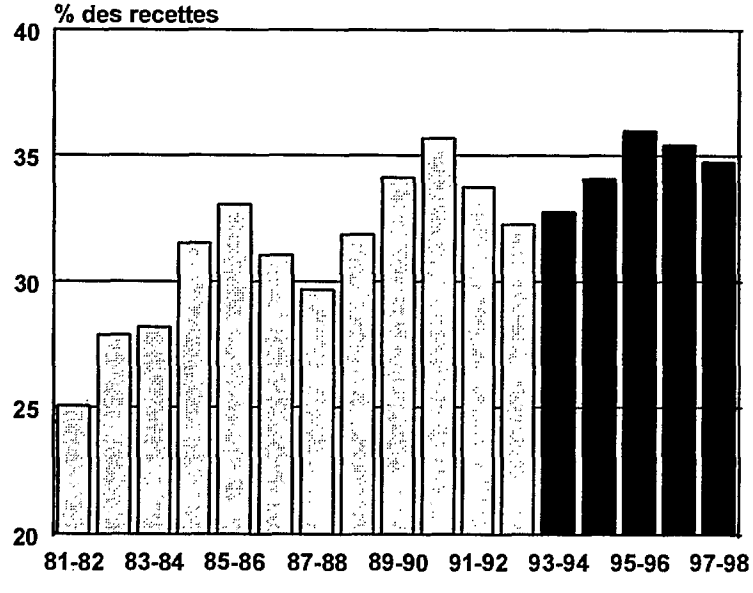


Source : Ministère des Finances.

Et la conséquence d'un endettement élevé est le coût élevé du service de la dette, qui rivalise avec les priorités du gouvernement au chapitre des dépenses

- **Les niveaux élevés d'endettement engendrent un lourd fardeau au chapitre du service de la dette.**
- **Actuellement, 36 cents de chaque dollar de recettes va au service de la dette -- le plus important poste de dépenses du gouvernement.**
- **Ces besoins rivalisent avec les priorités de dépenses du gouvernement et restreignent sa marge de manoeuvre.**

Intérêt sur la dette en pourcentage des recettes budgétaires

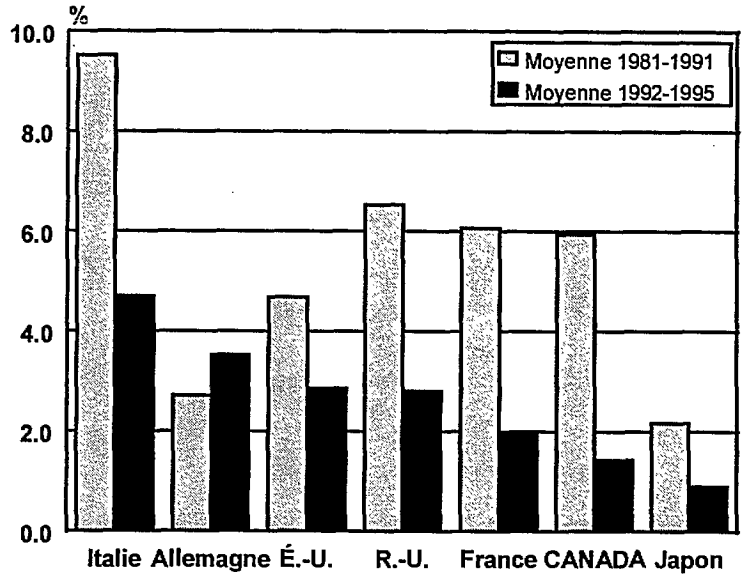


Source : Ministère des Finances.

Un revirement spectaculaire sur le front de l'inflation

- **Au cours des quatre dernières années, le taux d'inflation au Canada est passé de l'un des plus élevés des économies du G-7 à l'un des plus faibles au monde.**
  - **Depuis maintenant quatre ans, le taux moyen d'inflation au Canada a été inférieur à 2 p. 100.**
  - **Depuis maintenant quatre ans, le taux moyen d'inflation au Canada a été inférieur à 1.1 p. 100 par rapport aux États-Unis.**
- **La fourchette visée pour le taux d'inflation dans les années à venir est de 1 à 3 p. 100.**
  - **Le taux moyen d'inflation depuis le début de 1996 est inférieur à 1,5 p. 100.**

Inflation dans les pays du G-7



Source : OCDE.

Le faible taux d'inflation et la réduction des déficits budgétaires ont permis aux taux d'intérêt d'atteindre leur plus bas niveau en une génération

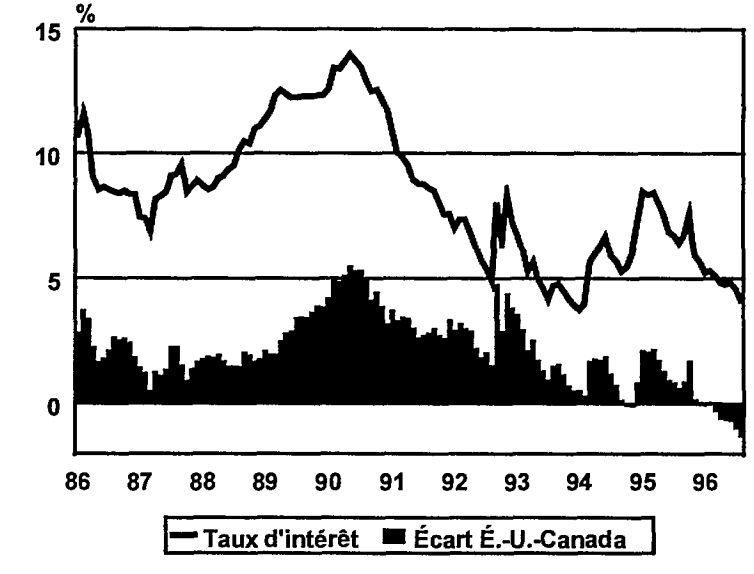
- Le faible taux d'inflation a fait chuter de façon spectaculaire les taux d'intérêt depuis le début des années 90.

- En raison de l'inflation moins élevée au Canada, nous enregistrons des écarts de taux négatifs avec les États-Unis.

- La courbe des rendements du Canada jusqu'à l'horizon de cinq ans est inférieure à celle des États-Unis -- pour la première fois en douze ans.

  - Les taux à court terme sont de 217 points de base inférieurs à ceux des États-Unis.

Taux d'intérêt à court terme

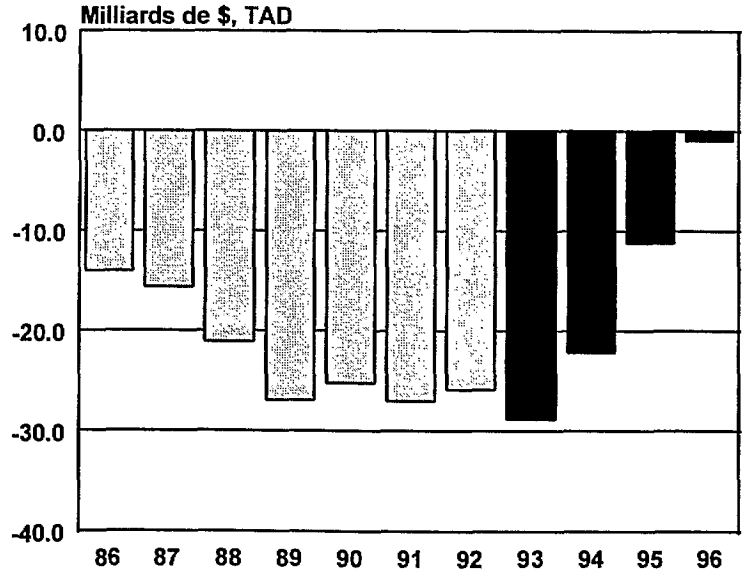


Source : Banque du Canada, effets commerciaux à 90 jours.

La compétitivité accrue -- sur le plan des coûts et de la productivité -- a entraîné une amélioration spectaculaire du solde du compte courant

- **L'accent mis sur la compétitivité rapporte des dividendes :**
  - **Le Canada est passé d'un déficit du compte courant de 30 milliards de dollars (4 p. 100 du PIB) en 1993 à un excédent, deux ans et demi plus tard (1996T2) -- le premier en douze ans.**
- **Le commerce est le moteur de la croissance économique du Canada :**
  - **Un emploi sur trois dépend du commerce extérieur.**
  - **Les échanges commerciaux représentent plus de 50 p. 100 de la croissance économique récente.**

Solde du compte courant, 1986-1996



Source : Statistique Canada.

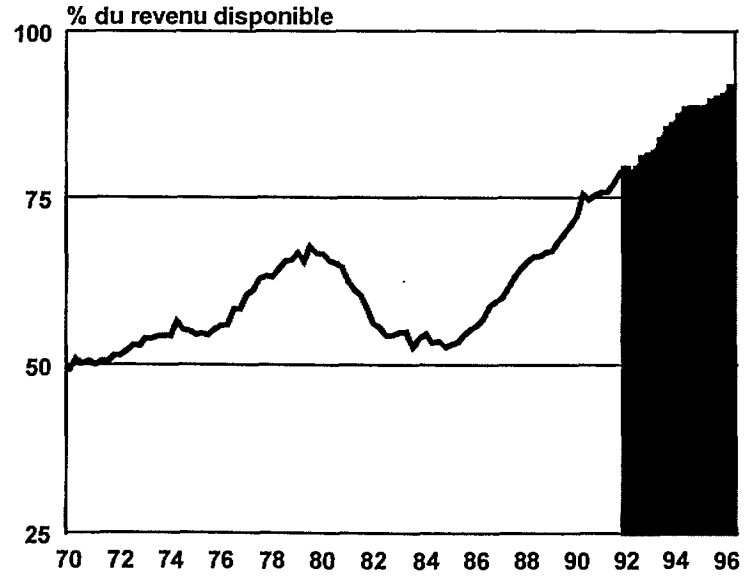
Mais la dépense intérieure demeure faible parce que les consommateurs, à l'instar des gouvernements, ont un problème d'endettement

- **L'endettement des consommateurs a atteint des niveaux records (94 p. 100 du revenu disponible).**

- **Les taux d'intérêt plus bas prendront plus de temps à stimuler les dépenses de consommation que celles des entreprises parce que le bilan des ménages ne se rétablira que progressivement.**

  - **Les améliorations enregistrées dans les bilans des ménages aideront à raffermir le dynamisme de l'économie à long terme mais elles ont pour effet de limiter les dépenses à court terme.**

Endettement des consommateurs, 1970-1996

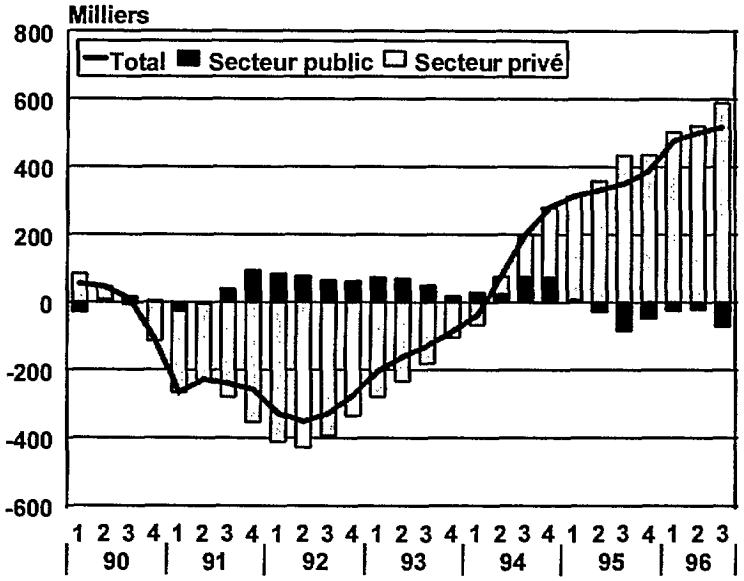


Source : Statistique Canada.

Dichotomie de la croissance de l'emploi : le secteur privé crée des emplois tandis que le secteur public fait des coupures

- **La croissance de l'emploi devra provenir d'un secteur privé concurrentiel. Il en a d'ailleurs été ainsi, en dépit des réductions de coûts et d'effectifs opérées par les entreprises du secteur privé.**
  - **Depuis 1993, le secteur privé a créé plus de 900 000 emplois.**
  - **Au cours de la même période, le secteur public a supprimé plus de 125 000 postes (contrairement à une hausse de 75 000 au cours des trois années antérieures).**

Évolution cumulative de l'emploi depuis 1990



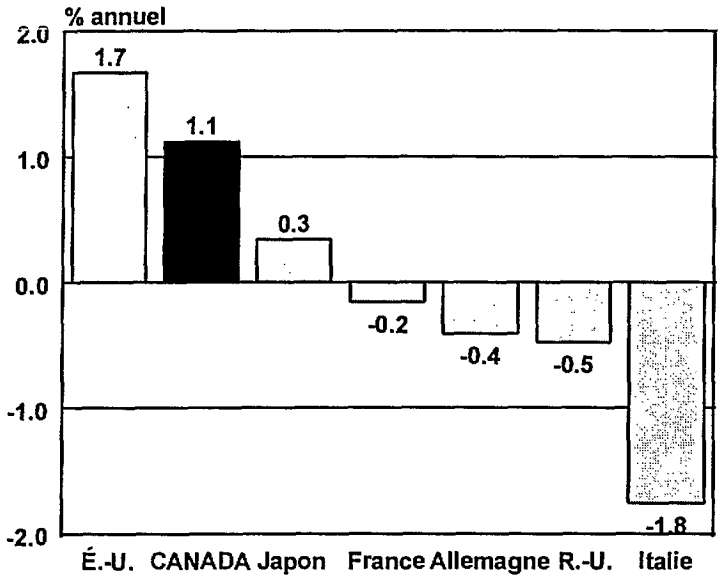
Source : Statistique Canada.

Les défis micro-économiques qui s'annoncent

Le chômage

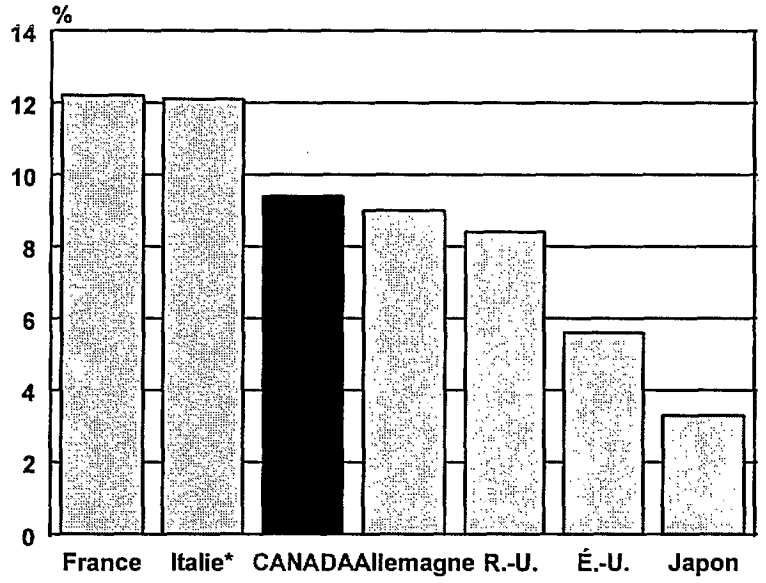
Même si la croissance de l'emploi au Canada est la deuxième plus forte des pays du G-7...

Croissance de l'emploi dans les pays du G-7, 1991-1995



Source : OCDE.

Taux de chômage normalisés dans les pays du G-7, 1996,T1



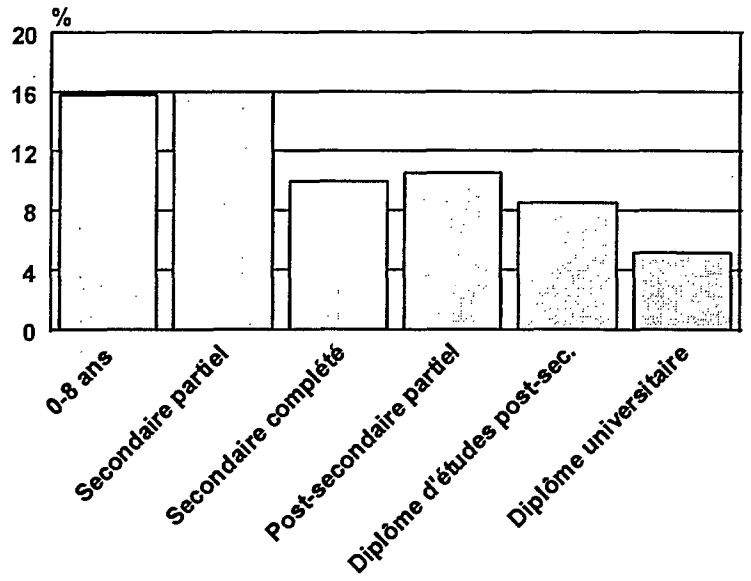
Note : * pour 1995, T2.

Source : OCDE.

... le taux de chômage demeure obstinément élevé

...particulièrement parmi les travailleurs non spécialisés...

Taux de chômage selon la scolarité, 1996

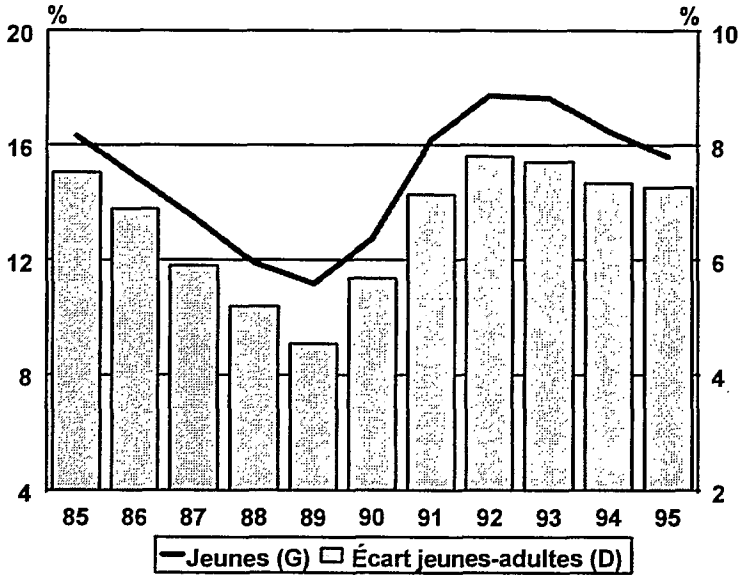


Source : Statistique Canada.

- **Les travailleurs moins spécialisés et moins scolarisés demeurent en chômage de plus en plus longtemps.**

...et parmi les jeunes...

Taux de chômage chez les jeunes



Source : Statistique Canada.

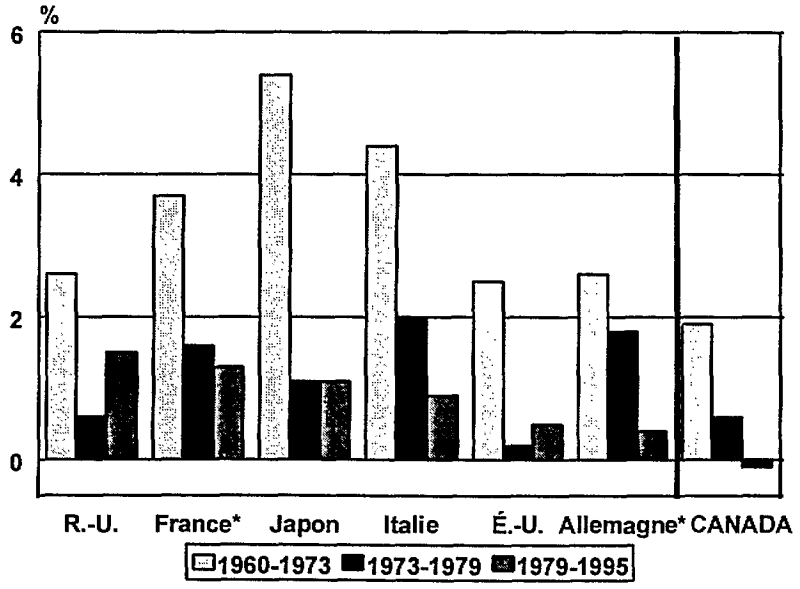
- **Les jeunes ont de la difficulté à obtenir un premier emploi.**

L'énigme de la croissance de la productivité

La croissance de la productivité, qui est la clé de la compétitivité à long terme et de la hausse des revenus, a été très lente au Canada depuis quelque temps

- **Si le Canada a l'un des niveaux de productivité les plus élevés parmi les pays industrialisés, il a enregistré le plus faible taux de croissance de la productivité parmi les pays du G-7 au cours des quinze dernières années.**
- **La recherche indique que la croissance de la productivité sera relancée :**
  - **En adoptant et en diffusant plus rapidement la technologie.**
  - **En devenant plus innovateurs sur les plans de la gestion, de la commercialisation et du financement.**
  - **En perfectionnant constamment les compétences de la main-d'oeuvre.**

Croissance de la productivité totale des facteurs (PTF) dans les pays du G-7



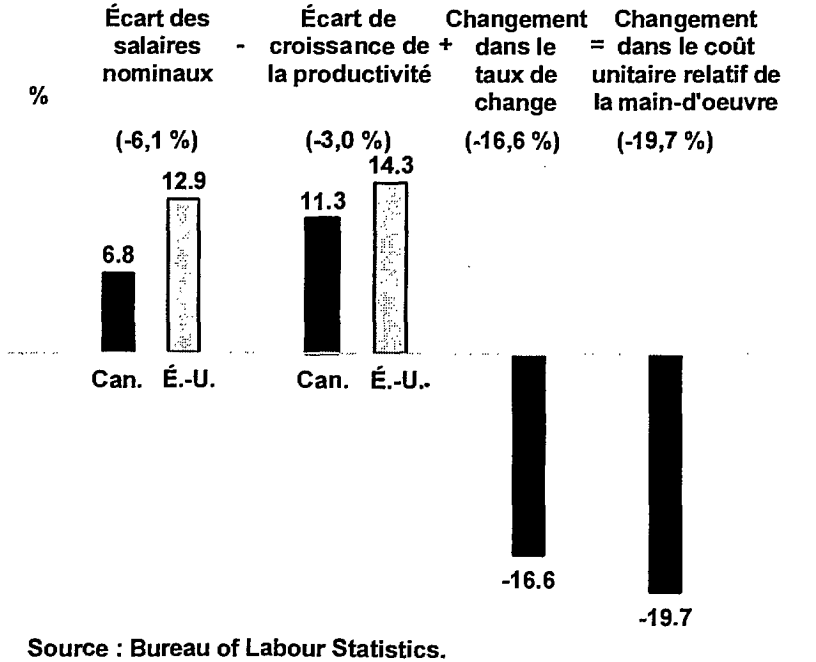
Source : OCDE.
* Ou la dernière année pour laquelle des données étaient disponibles : 1993 pour l'Allemagne et 1994 pour le Japon, la France et le R.-U.

Reflet de cette réalité, les gains récents sur le plan de la compétitivité proviennent principalement des coûts salariaux moins élevés et de la dépréciation de la monnaie

- **Depuis 1991, la compétitivité au Canada a progressé de 19,7 p. 100 par rapport aux É.-U. (et de 48 p. 100 par rapport à l'Allemagne).**

- **Cette amélioration est principalement attribuable à un dollar canadien plus faible étant donné que la croissance de la productivité a été relativement moins bonne qu'aux États-Unis, même si la croissance des salaires a été plus lente au Canada.**

Évolution cumulative de la compétitivité, 1991-1995
(Coût unitaire de travail en monnaie courante)



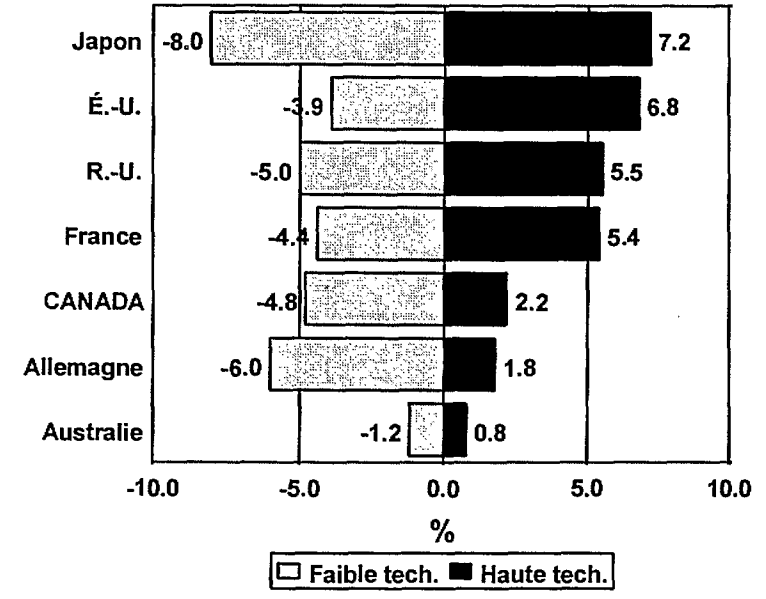
Source : Bureau of Labour Statistics.

L'écart sur le plan de l'innovation

Une analyse de l'OCDE indique que le Canada accuse un écart sur le plan de l'innovation et que cet écart fait partie intégrante de l'énigme de la productivité, agissant comme une contrainte sur notre croissance à long terme et les perspectives d'amélioration du niveau de vie

- **Selon l'OCDE, les éléments importants de cet écart sur le plan de l'innovation sont notamment :**
  - **De faibles niveaux de dépenses de R-D en pourcentage du PIB, notamment dans le secteur privé.**
  - **Un faible taux de diffusion et d'adoption de la technologie.**
  - **Une mauvaise concordance des besoins et de l'offre de compétences.**

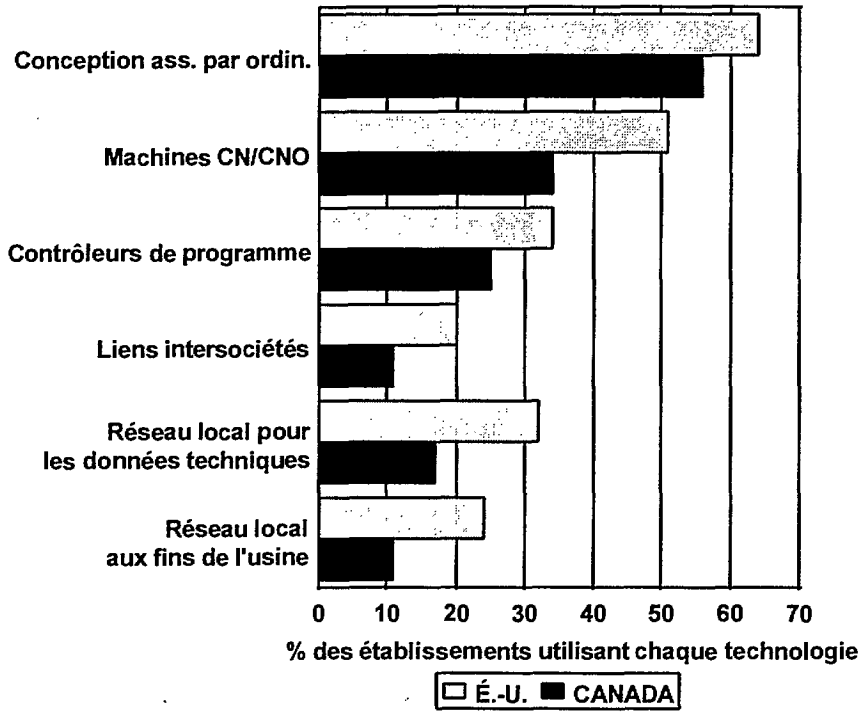
Évolution de la part de la production selon le niveau de technologie, 1970-1990



Source : OCDE, *Études économiques de l'OCDE -- Canada*, 1995.

Le Canada tire de l'arrière sur les États-Unis sur le plan de la diffusion et de l'adoption de technologies de pointe ...

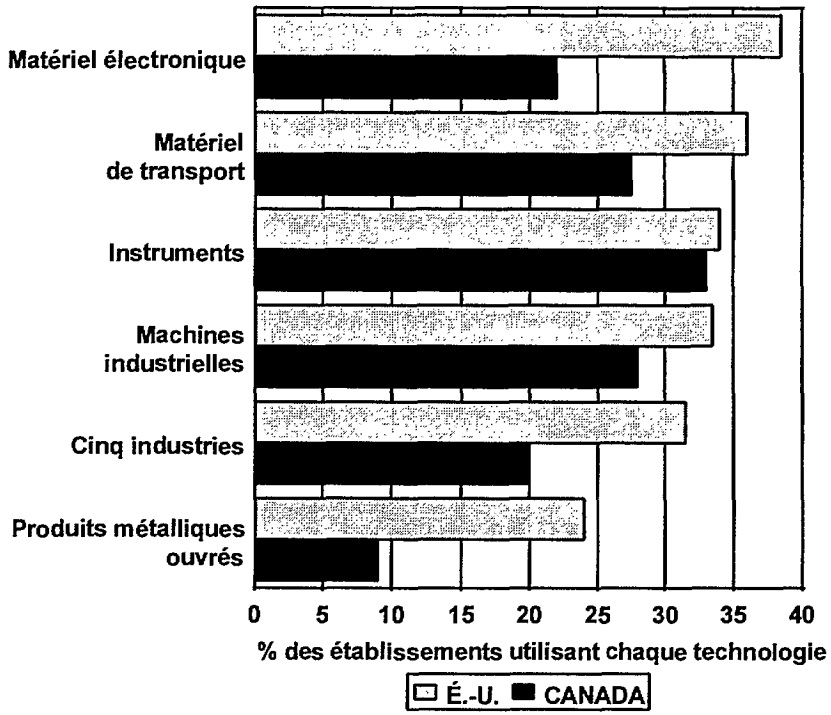
Utilisation de la technologie au Canada et aux États-Unis, 1993



Source : Statistique Canada.

- **L'utilisation générale de la technologie est moins répandue au Canada.**

Utilisation de cinq technologies ou plus par industrie, 1993

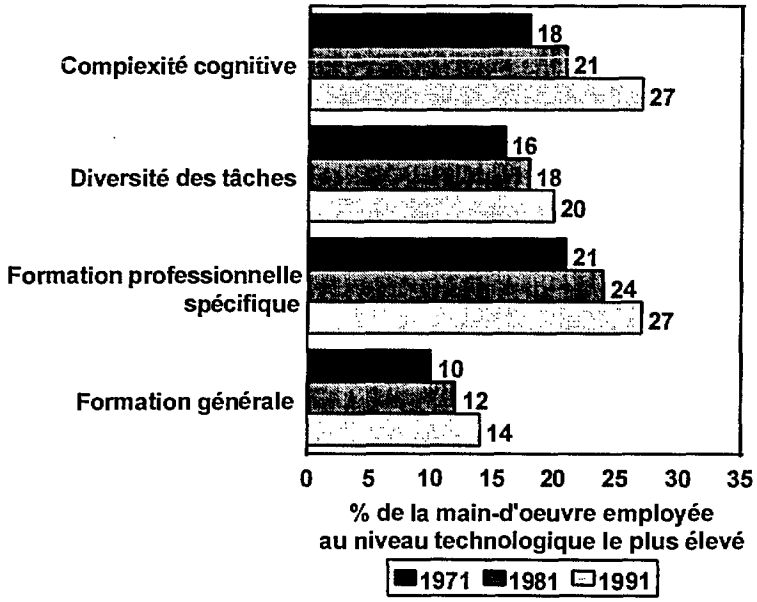


Source : Statistique Canada.

- **Comme c'est le cas de l'utilisation de technologies intensives dans les secteurs stratégiques.**

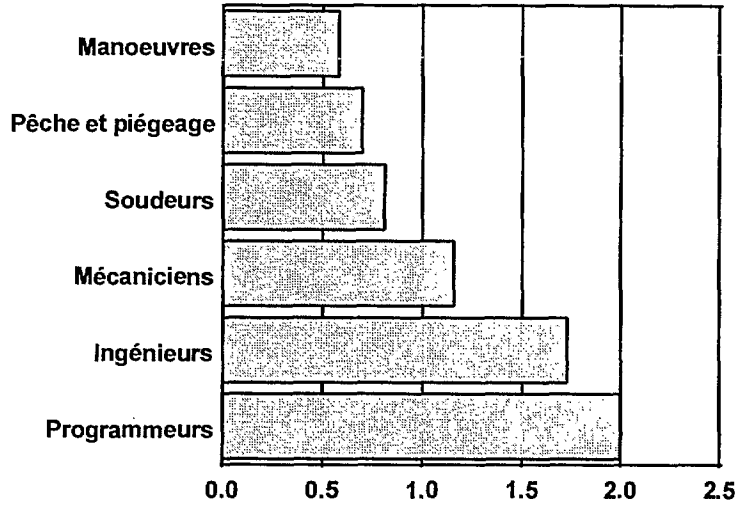
Les industries axées sur la connaissance (IAC) ont besoin de compétences différentes et les données indiquent de plus en plus qu'il y a des problèmes de concordance à cet égard

Tendances des besoins de compétences



Source : Ekos Research Associates Inc., calculs faits à partir des données du recensement sur la population active employée.

Indice des pénuries de compétences*, 1994



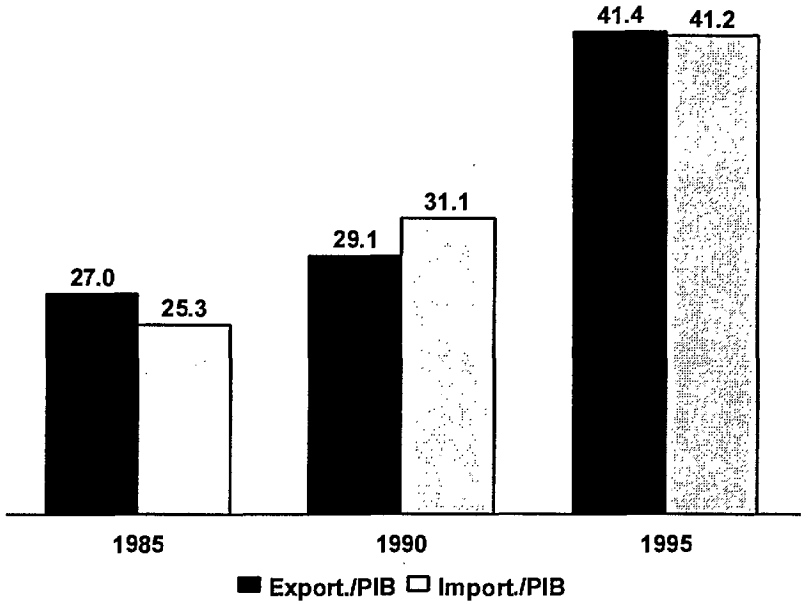
*** Le taux de chômage global divisé par le taux de chômage dans la profession.**

Source : Fondé sur des données tirées de *Des emplois durables* (DRHC).

Diversité des échanges

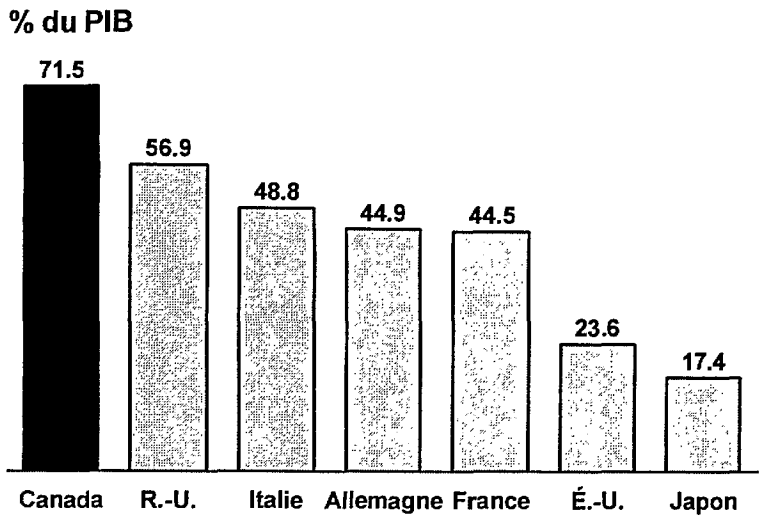
Profitant de la mondialisation, de l'ALE et de l'ALENA, le Canada est maintenant l'une des économies les plus ouvertes au monde ...

Exportations réelles/PIB et importations réelles/PIB



Source : Statistique Canada.

Échanges de biens et services, 1995



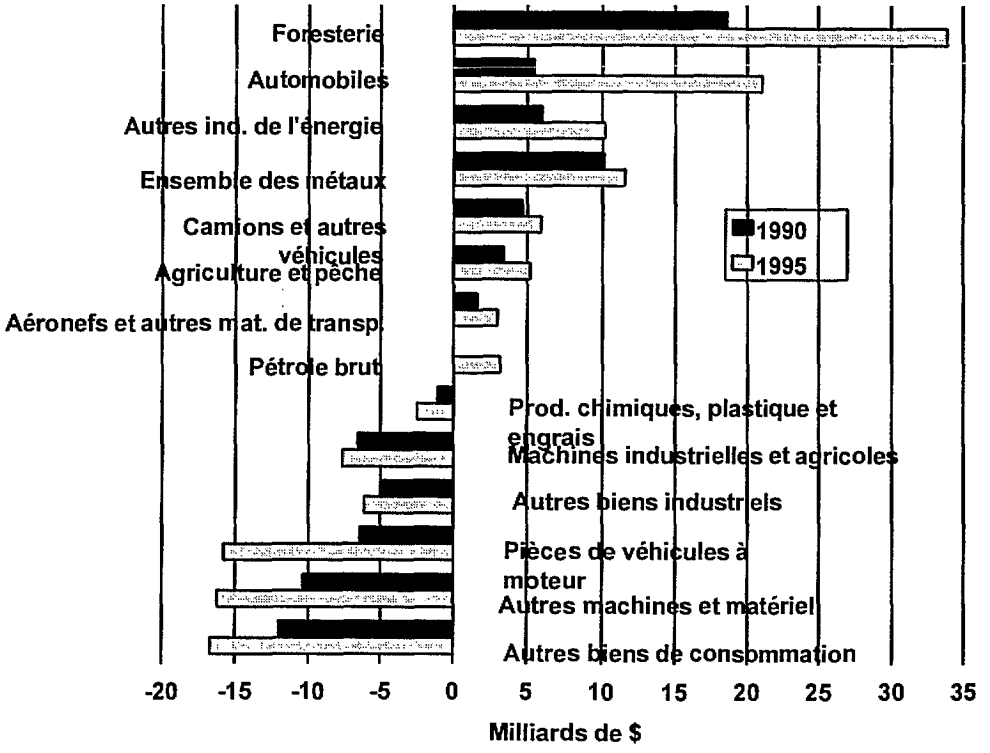
* (Exportations + importations)/PIB
Source : OCDE.

... et la croissance des exportations canadiennes a été spectaculaire ces dernières années (en hausse de près de 60 % depuis 1991).

Mais le commerce du Canada est encore trop concentré dans un nombre trop restreint de secteurs ...

- **Les exportations sont fortement concentrées (les ressources et les produits de l'automobile représentant 55 p. 100 du total).**
  - **Les industries canadiennes axées sur la connaissance peuvent faire beaucoup mieux sur les marchés mondiaux.**
- **Les secteurs ayant connu des excédents dans le passé enregistrent des excédents de plus en plus élevés.**
  - **Les secteurs déficitaires ne se sont pas améliorés autant qu'ils le pourraient.**

Soldes des échanges de marchandises

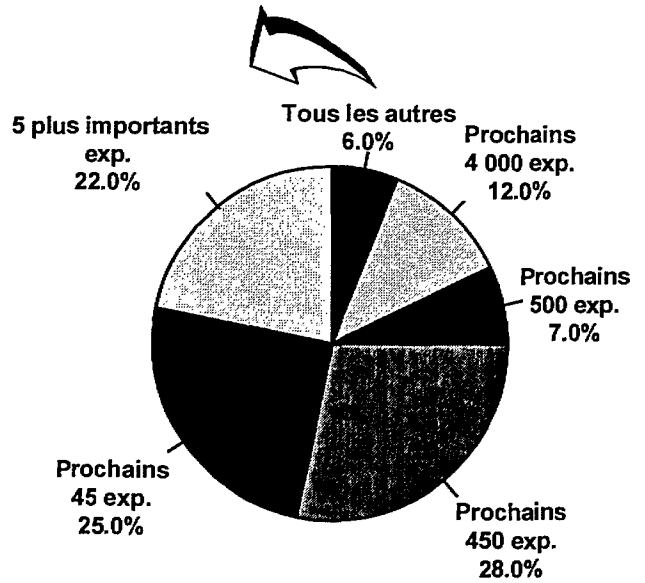


Source : Statistique Canada.

... et d'entreprises. Nous sommes devenus une nation commerçante de calibre mondial, mais nous ne sommes pas encore une nation de commerçants

- **Les grandes entreprises représentent un volume disproportionné de nos activités d'exportation :**
  - **Les cinq plus grands exportateurs représentent 22 p. 100 des exportations canadiennes.**
  - **Les 50 plus grands exportateurs représentent près de la moitié des exportations.**
- **Les PME -- souples, innovatrices et excellentes créatrices d'emplois -- ont un " potentiel commercial " élevé.**
  - **Mais, moins de 10 p. 100 des PME profitent actuellement de la mondialisation.**

Concentration des exportations de marchandises selon le nombre d'entreprises, 1994

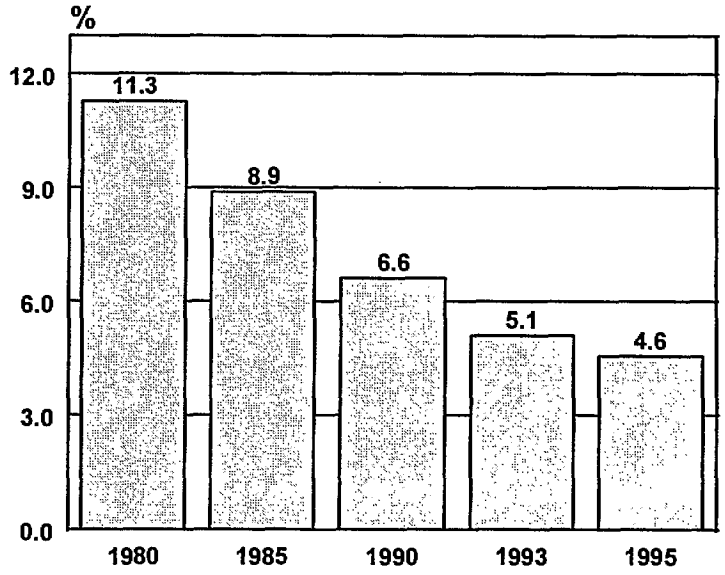


Source : Compilations faites à l'aide de données de Statistique Canada.

Le Canada attire des investissements directs de l'étranger (IED), mais la vive concurrence mondiale et nos difficultés sur le plan budgétaire et celui de la compétitivité à la fin des années 80 et au début des années 90 ont fait en sorte que notre part de l'IED total dans le monde a diminué

- L'IED au Canada a doublé entre 1985 et 1995 pour atteindre 168 milliards de dollars, mais notre part du marché mondial a diminué.
- L'IED fournit un puissant stimulant à la croissance économique et à la création d'emplois :
  - Une augmentation de un milliard de dollars de l'IED engendre la création d'environ 45 000 nouveaux emplois et une hausse du PIB réel d'environ 4,5 milliards de dollars sur une période de cinq ans.
- Devant l'amélioration de sa situation économique fondamentale, le Canada est à nouveau devenu une destination intéressante pour l'investissement.
  - Mais le succès exigera des stratégies sectorielles spécifiques visant à attirer des investissements.

Part du stock d'IED entrant au Canada dans le total mondial



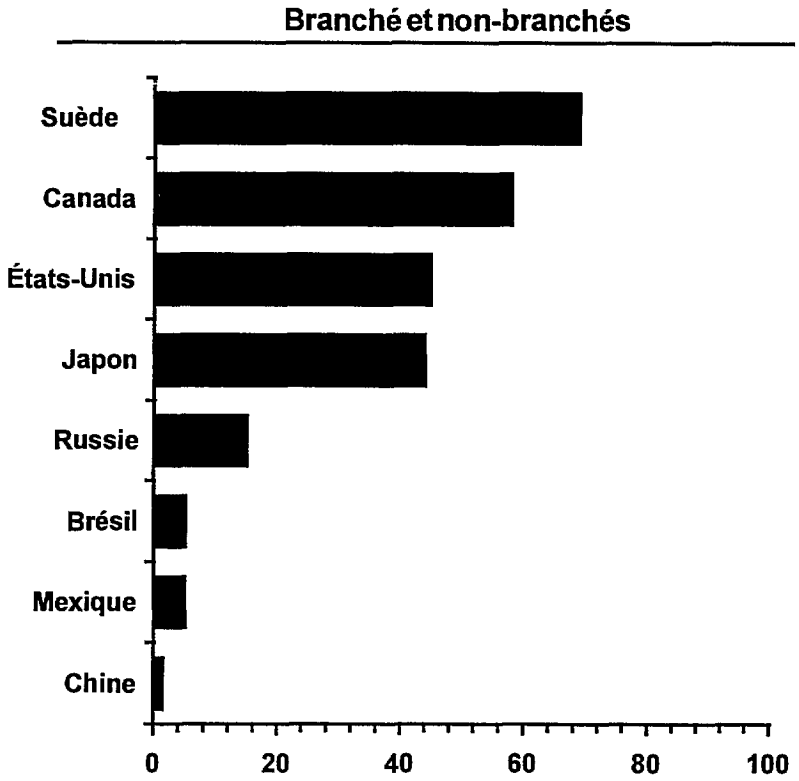
Source : Nations Unies, *World Investment Report, 1995.*

Perspective économique positive dans le domaine des communications sans fil - Le progrès au moyen du partenariat

Potentiel de croissance phénoménale des télécommunications...

- La moitié de la population mondiale (3 milliards de personnes) n'a jamais fait un appel téléphonique.
- Il n'y a que 600 millions de numéros de téléphone pour 6 milliards de personnes).
- L'Amérique du Nord, l'Europe de l'Ouest et le Japon possèdent 75 % des appareils téléphoniques, mais ne comptent que 15 % de la population mondiale.
- On estime que 50 % des appels se feront au moyen d'appareils sans fil d'ici l'an 2005.

Source : Greg LeVert, président de la MCI's Integrated Client Services Division, Toronto Star (Telecom '94).



Lignes téléphoniques terrestres par tranche de 100 personnes, selon les données les plus récentes

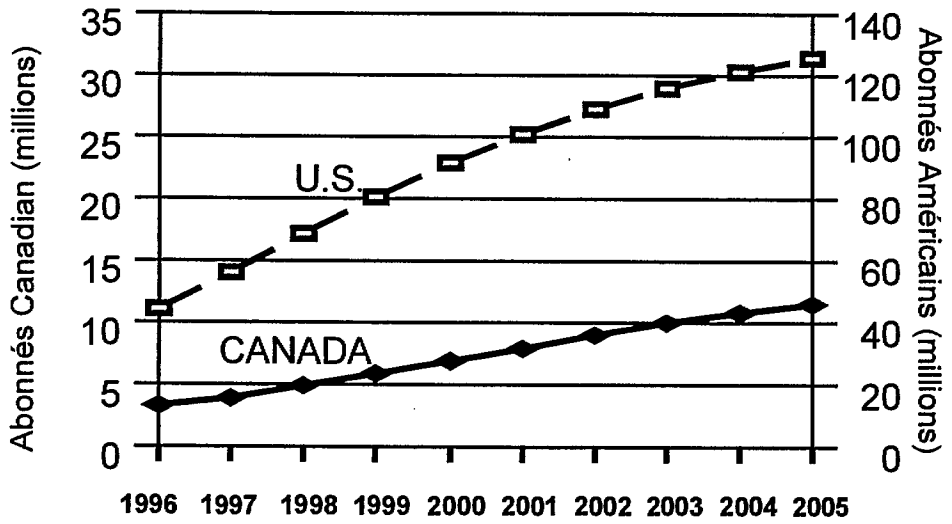
Source: OCDE

Selon les prévisions...

- **Aux É.-U. d'ici 2005.**
- **La pénétration du service cellulaire pourrait atteindre 24 %.**
- **La pénétration des SCP pourrait atteindre 17 % environ.**
- **125 millions d'abonnés (service cellulaire + SCP) par rapport aux 43 millions actuels.**
- **Au Canada d'ici 2005.**
- **Pourcentages de pénétration comparables (service cellulaire et SCP).**
- **11,5 millions d'abonnés (service cellulaire + SCP) par rapport aux 3 millions actuels.**

Source: TR Wireless News / Midland Walwyn

La croissance des tarifs Canadiens et Américains des services Cellulaire et du SCP



Le partenariat est la clé qui contribue à la croissance économique et à la création d'emploi pour les canadiens...

- **Apport du gouvernement**

  - **A utilisé la politique du spectre, ainsi que ses pouvoirs de gestion et de délivrance de licence pour accélérer le déploiement de nouveaux services, favorisant du même coup une plus grande compétitivité de l'industrie.**
  - **A représenté les intérêts canadiens lors de négociations internationales pour libéraliser le commerce dans le domaine des télécommunications et dans les forums de normalisation internationaux**
  - **A adopté des changements importants en matière de réglementation et de politiques de télécommunications pour encourager une concurrence accrue, de nouveaux investissements et des innovations**
  - **A encouragé l'adoption de nouvelles technologies.**
  - **A encouragé la constitution de nouvelles alliances et de nouveaux partenariats pour réduire le temps d'accès au marché et partager les risques d'une R&D coûteuse.**
  - **Travaille en étroite collaboration avec le CCCR, l'industrie et d'autres intervenants.**

L'APPROCHE «ÉQUIPE CANADA» POUR RELEVER LES DÉFIS ET SAISIR LES OPPORTUNITÉS : UN GAGE DE RÉUSSITE.

Please pick-up a copy of Mr. Lynch's

presentation at the luncheon

Statement

SPEAKING NOTES

FOR MICHAEL BINDER

ASSISTANT DEPUTY MINISTER

SPECTRUM, INFORMATION TECHNOLOGIES

AND TELECOMMUNICATIONS

INDUSTRY CANADA

TO SPECTRUM 20/20

OTTAWA

NOVEMBER 21, 1996

Check Against Delivery

Thank you for the kind introduction. Bonjour Mesdames et Messieurs.

In a small churchyard in Bermuda lie the mortal remains of Reginald Fessenden. He was laid to rest there in 1932. His tombstone reads:

By His Genius

Distant Lands Converse

And Men Sail

Unafraid

Upon the Deep.

Fessenden was the inventor of so much radio technology that, late in his life, the US Radio Trust paid him $2.5 million to compensate him for lost royalties.

From Montreal on Christmas Eve, 1906, he made the first public broadcast of music and voice.

Think of the cosmic silence of the broadcast spectrum on that night. Think about the joy of not having to worry about interference, spectrum coordination, ITU, Industry Canada, or licence fees.

Today, Reginald Fessenden would find the airwaves that had been so silent on Christmas Eve, 1906, crowded with activity: radio broadcasts and taxi

dispatches, time signals and tv sitcoms, mobile telephony and pocket pagers.

What would he have made of the ham radio operator in Tiger Lily, Saskatchewan, talking to Astronaut Chris Hadfield as he orbited the earth? What would he make of our ability to export Canadian services by *satellite*? Or that telecommunications technologies now represent close to a 2 *trillion* dollar industry worldwide?

What would he make of the information highway?

I believe that building the information highway is the single most important project that Canadians of this generation will undertake. We're building a technological infrastructure that will be as critical to Canada in the next century as building the railway was in the last century.

Three years ago, we established a policy framework to guide us in the development of the Canadian Information Highway. Our overarching aim is to ensure that Canadians continue to receive world class communication services, at competitive prices

from a strong domestic industry. We have set three objectives for this policy framework:

- Create jobs through innovation and investment;
- Reinforce Canadian sovereignty and cultural identity; and
- Ensure universal access at a reasonable cost.

Everything we have been doing the last few years has been consistent with this policy framework. From the advancement of the policy and regulatory agenda of our telecommunications industries; to the introduction of new telecommunications services and

products; to the negotiations on basic telecommunication services on the international level - all have been implemented according to our Information Highway policy framework and work plan.

Spectrum issues are at the heart of this plan. Wireless technologies contribute to the infrastructure, provide new competition to bring prices down, and encourage innovation and new products and services.

Take, for example, the three new licences for Local Multipoint Communication Systems. LMCS will now provide competition to cable, telephone and satellite

distribution systems. The applicants propose to invest over a billion dollars and create up to 8,000 new jobs over the next five years in the wireless industry.

The US is not expected to award its first LMCS licences until early next year. Canada has moved ahead in a race to create the kind of infrastructure that will provide a competitive advantage in a global, knowledge-based economy. Canadian companies will have products and services to export when other nations are ready to create their LMCS networks. And as Kevin Lynch has demonstrated to us yesterday through exports we create jobs here in Canada.

We must continue to expand our global orientation. Canadian businesses are beginning to compete globally where the playing field is becoming more level; where distance from market is no longer the factor it was. Using the information highway technologies, a company's worldwide customers are as far away as a computer terminal.

L'édification de l'autoroute de l'information exige un effort conjoint de la part du secteur industriel, des établissements de recherche, de la communauté universitaire et des gouvernements. Le gouvernement du Canada joue plusieurs rôles, mais dans la plupart des cas, il reviendra à votre industrie de construire l'inforoute.

Un des principaux rôles du gouvernement est de proposer une série de règles très précises qui serviront à encourager l'investissement, l'innovation et une concurrence équitable. Nous avons un objectif ambitieux, mais il est simple : nous voulons qu'à la fin

de 1997, le Canada dispose de la meilleure politique et du cadre réglementaire le plus limpide, le plus durable, le plus concurrentiel et le plus solide du monde en matière de communications.

Your industry has welcomed our efforts to streamline the regulatory process. You've requested that, where possible, we use technical standards, rather than prescribed regulations.

I agree. We want to devolve authority where it will be most flexible. We don't want to use legislative authority when regulatory authority will do. We don't

want to use regulations when one can achieve the same result through industry standards.

While we've been restructuring our regulatory framework, we have also conducted a review of some key issues and challenges affected by them, and the role of government in addressing them.

One of the major issues is how to clarify the regulatory status of new content services delivered by telecommunications. Right now Canadians can receive commercial or educational multimedia services over the Internet. These may include video, sound and text;

and they may be interactive. They can also receive News World on their computers via satellite through DirecPC.

The government is aware of the current ambiguity as to whether some of these services fall under the *Broadcasting Act* or the *Telecommunications Act*. We are considering the views of stakeholders on this issue. Uncertainty here means delayed investment decisions. That means lost opportunities for jobs and growth of new information highway industries.

Another challenge for the government in building the information highway is to make spectrum utilization policies flexible enough to respond to emerging needs. It should be flexible enough so that providers can respond to changing consumer demand. Flexible enough to address compatibility issues quickly -- between analogue and digital systems, between domestic and international systems.

As data transmission plays a bigger role in international commerce, business customers demand global communications that are easier, faster, more reliable, and more secure. We want to provide the

environment where the industry can address these concerns and treat them as market opportunities.

A third challenge for government: assigning licences.

We're taking a close look at whether market forces should be the principal determining factor in who gets a share of the spectrum.

As you all know more and more countries are turning to auction as a market based approach for licencing.

We, in Canada have relied upon administrative decision: the Minister of Industry selects successful licensees from among the competing applicants. We base our decision on assessment of the relative merits of submissions.

The difficulty with administrative decisions is that they are time consuming, and they are always open to the criticism of favouritism. Moreover, we have difficulty in deciding how much a licence is worth.

In 1994, we launched a public review of licensing processes and began research on the practices in other countries. Many of those who participated in the public review opposed the introduction of auctions in Canada. But research into auctioning found compelling arguments as to why it's good public policy and we are, therefore, determined to try auctions for awarding licences; especially in the small portion of spectrum where demand exceeds supply. We believe that this will make the process more transparent, easier to administer and will ensure that the public gets full rent for its resource. It will also ensure that the spectrum is used as efficiently as market forces allow.

A fourth role for government in helping your industry build the information highway is to secure international regulations and standards that help Canadian companies compete globally.

Canada is one of 170 members of the International Telecom Union. If we can help shape the agenda of the ITU, we can have our industry's technical proposals implemented as international standards. This is a key to capture markets. It requires diligent and aggressive representation of Canada's views by industry and government.

The results of WRC-95 were particularly noteworthy from a Canadian perspective. Decisions were made to enable the development and operation of global non-GSO satellite systems of particular interest to Canada (Iridium and Odyssey). It is our estimation that $50B worth of international satellite business was approved. As well, existing Canadian interests were protected through maintenance of spectrum allocations for present and future terrestrial and satellite systems. I believe we can be justly proud of the Canadian Delegation's achievements.

But international spectrum negotiations and telecommunications-related trade negotiations are becoming more complex. They're moving at a faster pace. We need the support and partnership of Canadian industry to help present the Canadian case.

We have the foundations for this support and partnership through the Radio Advisory Board of Canada. The RABC also helped advise us on PCS allocations and the evaluation of new digital technology. This partnership demonstrates how government and industry can work together to promote the competitiveness of Canadian industry.

And this partnership is critical in each of the four areas of government concerns I've talked about today:

- Getting the right policy and regulatory environment;
- keeping spectrum allocation flexible;
- assigning licences using a market-based process; and finally
- taking a Team Canada approach to building the international market.

Just to repeat

Our common objective is to create an environment where business and government can respond quickly to change.

We want industry to compete effectively for spectrum use. We want Canadians to become competitive players in a global marketplace driven in part by the changes in radio-telecommunications. We want the spectrum technology industries to be key players in building an information highway that will create jobs through innovation and investment.

Pour bâtir l'autoroute de l'information au Canada, nous allons utiliser des ressources canadiennes. Nous

voulons nous servir de l'autoroute de l'information pour renforcer la souveraineté et l'identité culturelle du Canada. Nous voulons également nous assurer que nos citoyens auront un accès universel et raisonnable à l'inforoute. C'est ainsi que nous en arriverons à l'équité économique et sociale en faveur de tous les Canadiens.

I began today by speaking about the technological vision of Reginald Fessenden, one of Canada's great radio pioneers. I believe that Canada today has many such visionaries, many such pioneers. Many of them are gathered in this room.

In the course of his lifetime, Fessenden saw radio move from theory to experimentation, from experimentation to broadcast, from a lone voice broadcasting on Christmas Eve to an industry that where one in three Canadian homes had a radio.

That is an impressive rate of change. But today we're living in a time when the pace of change is faster than anything that could have been conceived at the beginning of this century. It's transforming: the telecommunication industries. It is transforming how all industries compete and how all Canadians live.

Our ambition is to make sure that Canadians ride the wave of change. We're building the infrastructure for Canadians for the century to come. Together we can do it.

Merci beaucoup.

Thank you.

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Session 2

SESSION 2: ROLE OF TERRESTRIAL SERVICES IN A COMPETITIVE ECONOMY
SÉANCE 2: LE RÔLE DES SERVICES AU SOL DANS UNE ÉCOMOMIE CONCURRENTIELLE

Chair: Val O'Donovan
President
ComDev
155 Sheldon Drive
Cambridge, Ontario, M1R 7H6
519 622 2300

BIOGRAPHY

Valentine O'Donovan was born in Clonakilty, County Cork, Ireland on February 14, 1936. In his teens, he went to work for Pye Ltd. in Cambridge, England as an engineering apprentice. Using the company funded part-time day release program he studied engineering at the Cambridge College of Arts and Technology. He graduated in 1959 and joined the staff of Pye Telecommunications as a professional engineer. In 1962 he invented a new type of microwave multiplexer and his paper describing it, "Microwave Branching Systems", was published in the Journal of the Institution of Electronic and Radio Engineers. It was awarded the Leslie McMichael Premium for the best paper published in the Journal on the topic of Radio Communications in 1963.

In 1963 he emigrated to Canada and joined the Communications Division of RCA in Montreal where he participated in the engineering development of the first generation of satellite earth stations. These had antennas more than 100 feet in diameter and communicated with the very first "Early Bird" geo-synchronous satellites. In 1969 he transferred to the Space Systems Division and led the team developing the technology required for advanced microwave payloads for

BIOGRAPHIE

Valentine O'Donovan est né à Clonakilty, County Cork, Irlande le 14 février 1936. Durant son adolescence, il part travailler pour Pye Ltd. à Cambridge, Angleterre, comme apprenti-ingénieur. Grâce au programme de libération à temps partiel financé par la société, il étudie le génie au Cambridge College of Arts and Technologie. Il est diplômé en 1959 et entre à Pye Telecommunications comme ingénieur professionnel. En 1962, il invente un nouveau type de multiplexeur à micro-ondes et sa communication décrivant l'appareil, intitulée «Microwave Branching Systems», est publiée dans le Journal of the Institution of Electronic and Radio Engineers. Il reçoit le prix Leslie McMichael Premium pour la meilleure communication publiée dans le Journal sur le sujet des radiocommunications en 1963.

La même année, il émigre au Canada et entre à la Division des communications de RCA à Montréal où il participe au développement technique de la première génération de stations terriennes de satellite, dotées d'antennes de plus de 100 pieds de diamètre et communiquant avec les tout premiers satellites géosynchrones «Early Bird». En 1969, il est muté à la Division des systèmes spatiaux et dirige l'équipe chargée de mettre au point la

Communication Satellites. In 1971 he became the manager of the Satellite Transponder Department which was responsible for designing the payloads used in the Canada-USA Communications Technology Satellite (Hermes) and the first USA Domestic Satellites (RCA Satcom). In 1973 he co-authored a book entitled "Microwave Filters for Communications Systems".

IN January 1974 he left RCA to become President and Chief Executive Officer of COMDEV, a new start up company. Ten years later COMDEV was the first gold medal winner in the category of "Technology Innovation" when the Canada Awards of Excellence were inaugurated. In May 1990 he became chairman of the Board and Chief Executive Officer.

Mr. O'Donovan is a member of the Association of Professional Engineers of Ontario, the American Institute of Aeronautics and Astronautics and the Institution of Electrical and Electronic Engineers. In 1992 he was the winner of the Institution's McNaughton Gold Medal, bearing the citation: "for sustained leadership in the development of space technology and for transforming a fledgling company into a significant international player in the field of satellite communications". One year later he received the Laurier Outstanding Business Leader Award from Wilfred Laurier University and in 1995 the University of Waterloo awarded him the degree of Doctor of Engineering (Honoris Causa).

He is a director of Raderst International Inc., Research In Motion Ltd. and the Phase Group of Companies in the UK. He is also Chairman of Kang Da, a joint venture of COMDEV and the Xian Research Institute of China. This company will manufacture satellite equipment and will be the first equity based joint venture space company in China.

Mr. O'Donovan lives in Cambridge, Ontario with his wife Sheila. They have three sons, a daughter and five grandchildren. He enjoys reading, gardening, swimming and good wine.

technologie perfectionnée requise pour la charge utile à micro-ondes pour les satellites de télécommunications. En 1971, il devient directeur du Service de répéteurs de satellite, chargé de concevoir la charge utile utilisée dans le satellite canado-américain de technologie des communications (Hermes) et les premiers satellites nationaux des É.-U. (RCA Satcom). En 1973, il écrit en collaboration un livre intitulé *Microwave Filters for Communications Systems.*

En janvier 1974, il quitte RCA pour devenir président et chef de la direction de COMDEV, une nouvelle société. Dix ans plus tard, COMDEV remporte la médaille d'or dans la catégorie «Innovation technologique» lors de l'instauration des Prix d'excellence du Canada. En mai 1990, il devient président du conseil d'administration et chef de la direction.

M. O'Donovan est membre de l'Association of Professional Engineers of Ontario, de l'American Institute of Aeronautics and Astronautics et de l'Institution of Electrical et Electronic Engineers. En 1992, il remporte la médaille d'or McNaughton de l'Institution, avec la mention: «pour une carrière consacrée au développement de la technologie spatiale et à la transformation d'une société naissante en une entreprise jouant un rôle clé sur le plan international en matière de satellites de télécommunications». Un an plus tard, il reçoit le Laurier Outstanding Business Leader Award de la Wilfred Laurier University et en 1995 l'Université de Waterloo lui décerne un doctorat honorifique en génie.

Il est directeur de Raderst International Inc., de Research In Motion Ltd. et du Phase Group of Companies au Royaume-Uni. Il est aussi président de Kang Da, une coentreprise de COMDEV et de l'Institut de recherche Xian en Chine, qui fabriquera de l'équipement pour satellites et sera la première coentreprise du secteur spatial en Chine.

M. O'Donovan vit à Cambridge (Ontario) avec son épouse Sheila. Ils ont trois fils, une fille et cinq petits-enfants. Il aiment la lecture, le jardinage, la natation et le bon vin.

SPACE SCIENCES - TOMORROW
L'AVENIR DES SCIENCES DE L'ESPACE

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ABSTRACT

A brief description of typical space science activities is followed by a discussion concerning the relative roles of the public and the private sector in future space science ventures. The paper outlines space science activities of tomorrow in seven categories; transportation; communications, remote sensing; manufacturing; tourism; resource exploitation and infrastructure. Example applications are described based on known space mission plans, and commercial activities in the space science arena are identified. Issues arising from the need for the public sector to continue to provide basic research and to supply services into the foreseeable future are discussed.

RÉSUMÉ

Une brève description d'activités typiques des sciences spatiales est suivie d'une discussion concernant les rôles relatifs des secteurs public et privé dans les futures initiatives en sciences spatiales. Le document classe les activités de sciences spatiales de demain dans sept catégories; transport; communications, télédétection; fabrication; tourisme; exploitation des ressources et infrastructure. Le document donne des exemples d'applications, décrits d'après des plans de missions spatiales connues, et mentionne des activités commerciales dans le domaine des sciences spatiales. On y discute de points découlant de la nécessité pour le secteur public de continuer à effectuer des recherches de base et à fournir des services dans un avenir prévisible.

SPACE SCIENCES - TOMORROW

Introduction

What is Space Science?

The conventional view of space science is that of a *melange* of somewhat esoteric disciplines concerning observations of various physical phenomena from the vantage point of an observing platform in space. The most commonly seen products of such observations include photographs of the surfaces of distant planets, enhanced views of specific Earth locations from Landsat-type spacecraft, and spectacular views of spacecraft launching or landing.

The popular image of space exploration is encapsulated in movie and television productions such as Star Wars and Star Trek, which are still viewed as exciting science fiction, and tend to shroud the real ongoing work of exploring our space neighborhood.

Real space science, while dealing on daily basis with advanced scientific theories, is in fact a much more mundane business. However, as this real work progresses more and more facets of it pervade our everyday lives and become more ubiquitous.

For example, who would travel to a distant city

without first checking the weather forecast for that location? How does space science provide this information? A number of satellites orbiting the Earth obtain real-time data on various physical elements in the atmosphere, e.g., temperature, water vapor density *et al*, and transmit this data to numerical analysis units in certain cities. The data are analyzed and manipulated to produce weather forecasts. The weather forecasts are made available rapidly through the means of wideband communication systems enabled by the space science studies of yesteryear.

Weather forecasting is just one example of an industry dependent on space science data. The study of crystal dynamics of the Earth may lead to the ability to predict earthquakes; the study of environmental data may lead to drought prediction, crop rotation advice, better fishing husbandry and many other products to make life safer and more productive for all mankind.

So much for the commercial! What this leads to is the recognition that, to date, space science endeavors have been supported by public funds. It is the taxpayer who provides the means for accurate weather prediction etc. The data from space science activities is public data, albeit used by only a small, specialized sector of the community.

Further, the delivery of such data to the appropriate analysis point on the Earth, can only be accomplished by means of communication links which must make use of the radio frequency spectrum. Most space science data are obtained from satellites in low Earth orbit. They move around the Earth at an apparent speed, when viewed from a single spot on the Earth's surface, of about 18,000 miles per hour. Wires, fibers or any other connection to the Earth are, of course, unthinkable. Stories of potential "tethered-satellites" are just so much 'hooey'. Such stories originate because of the misunderstanding of what is and is not a satellite. Suffice it for this paper to say that if does not escape the drag of the Earth's atmosphere with sufficient velocity to sustain itself for at least one orbit, then it is not a satellite.

Additionally, public demand for accuracy in predictions based on space science data is increasing. Inaccurate weather forecasts can have dire consequences for the public at large. Data acquisition is conducted at frequencies based on physical phenomena, such as oxygen absorption spectral lines. Accurate data requires that data acquisition and delivery be as free from the deleterious effects of radio frequency interference as possible. This does not lead directly to the need for exclusive frequency allocations, but it does require the very careful selection of allocations and critical scrutiny of the parameters of active radio systems which might also make use of frequencies allocated for space science purposes.

So, in introduction what have we learned? That space science is not as esoteric as we might have thought. In reality it is rather mundane and concerns itself with understanding scientific phenomena so that life on Earth may be improved. It is funded for the most part by public rather than private dollars. It is totally dependent on the radio frequency spectrum to achieve its deliverables, and is susceptible to radio frequency interference.

Public/Private Sector Collaboration

Improvement in collaboration between the public sector and the private sector is one of the goals of many administrations in the western world. Private sector uses of space science studies include many success stories, although mostly related to the telecommunication industry. Geostationary communication satellite networks, mobile satellite networks, and broadcasting satellite networks all owe their origins to studies conducted in the space sciences. Weather forecasting, while another huge success story, has not yet caught the eye of the entrepreneur. That situation seems about to change. In the very near future, accurate weather forecasts in developed countries will be available primarily by subscription. Accurate navigation data from space science is available now by subscription and marketing of that data is proceeding apace, and provides benefits, inter alia, to the terrestrial transportation industry on land, in the air, and at sea.. The marketing of other space science data such as environmental and ecological data will become commonplace in the near future as administrations find the fiscal burden associated with data acquisition and delivery too heavy to continue to bear.

A variety of private ventures are in development which will provide up-to-date information to users such as farmers, news rooms and mineral exploration companies. Satellite imagery's use, once the staple of some government scientific research budgets, now sees commercial growth driven by technology jumps in information and telecommunications. To bring images to new types of customers, new partnerships are being formed. Such partnerships bring together the talents of satellite operators that take Earth images in raw data form (such as Spot Image and Orbcomm); value adding resellers that convert raw data into customized products to meet customer requirements; desktop software tool makers; and new kinds of distributors, such as aerial survey firms, needing to broaden their image product line. While it is clear that some public-funded programs will be needed for some time, the next generation of Earth observing satellite programs are well established within the plans of a number of such private companies and consortia. (Barnett, 1996)

The need for public sector involvement in the space science programs of the future is also clear. The public sector is better equipped to perform basic scientific research, while the private sector performs better in the applications of science, driven as it is by the marketplace. The need for enabling technologies will continue and the public sector will continue to find itself pacing these enabling technologies based on scientific research. The public sector will also provide the legal and regulatory infrastructure that will be needed to regulate and govern space commercial activities in the same way that such controls are required on Earth.

Within space science it is the national space agencies which will provide the necessary research, and identify the enabling technologies. A new paradigm must be developed to establish a regulatory structure for future space science activities incorporating international collaboration, especially in research and technology development, international infrastructure, social benefits, risks and responsibilities. Clear understanding of the roles of the public sector participants and the private sector participants in space science projects of the future must result from the new paradigm. Partnerships, both domestic and international, must be undertaken with a reliable level of commitment to social benefits as well as commercial advantage.

Of critical interest to space science deliverables will be the future development of the International Radio Regulations. Dependent as they are on the availability of radio frequency spectrum, space science programs can only succeed if certain frequency bands already allocated continue to be available. Such programs can be sidelined for indefinite periods of time if frequency bands in use today become unusable or not available in the future. The costs to develop new communication technology in other (higher) frequency bands can delay or even terminate space science programs. The advent of fee-based spectrum licensing activities in a number of administrations gives rise for grave concern. The merits of such fee-based spectrum licensing techniques are not within the ambit of this paper. Suffice it to point out this potential paradox for the man in the street: "My taxes were just raised by $300 per year, to find new frequencies for displaced science services, so that my personal telephone company can provide me with mobile telephone service for $2.00 per minute instead of $2.50 per minute. Go figure!!".

Additionally, a review of the methods by which radio frequencies are allocated should be undertaken in the near future. One administration, Canada, as long ago as 1992 advocated that two new radio services be defined, the General Satellite Service and the Space Communication Service. These changes were not accepted by WARC-92, but the basic concepts have some merit and should not be forgotten. With the advent of an ubiquitous digital data stream, the differences between the fixed, fixed-satellite, mobile, mobile-satellite, broadcasting and broadcasting-satellite services are not so clear within the current radio service definitions. Likewise, within the space science community, a digital data stream may include space research service, Earth exploration-satellite service, meteorological-satellite service and space operation service data.

While the bands used for observing scientific phenomena may clearly be divided into those required for passive observations and those needed

for active sensing, the resultant data stream and hence the communication services may well need to be re-defined. The block allocation method of frequency management has served well for seventy years, and will no doubt be required in some (developing) countries and in some parts of the frequency spectrum for a number of years to come, but new service definitions, perhaps based on data rate and power, and new methods of allocating frequencies will be essential for the husbanding of this finite resource in the 21st century.

Space Science Applications of the Future

In his 1984 book, "Space Commerce: Free Enterprise on the High Frontier", Nathan Goldman put forth a model for space commercialization which organized space commerce into four sectors: transportation, communications, remote sensing, and manufacturing. (Goldman, 1984). He noted that all space commercialization is dependent upon transportation to space. He could well have added that all space commercialization is dependent upon the availability of the radio frequency spectrum. Today we could expand this model to address three additional sectors; tourism, fast becoming a driving force in determining the corporate involvement in space; resource exploitation, since mining of lunar helium^3 could satisfy Earth's energy needs for many years; and infrastructure, without which anarchy will rule in space.

What are the space science activities that will provide the basis for commercial activities in the 21st century? Using Goldman's model sectors, supplemented with our additions we will try to identify the types of activity and the commercial involvement, as succinctly as this short paper will allow:

Transportation

The launch vehicle industry is still led by established aerospace corporations although demands for their services are now emerging from commercial entities which will rival those formerly provided by governments. For example, the contract to launch communication satellites for Teledesic has a dollar value higher than the launch contracts for many governments over the program's lifetime.

A significant portion of the investment in early commercial space launch ventures was provided by Texans who invested in start-up companies in the Houston area, such as Space Services Inc. (eventually bought by EER Systems). A number of attempts to provide commercial launch vehicle systems were postulated in the 1980s, and after a considerable shake-out some niche market providers remain and seem to flourish. Examples include OSC's Pegasus and Taurus launch vehicles. (Barnett, 1996)

Even the bigger operations have their problems, which when they occur, cause the whole launch industry to gasp and re-evaluate the prevailing situation. Examples include the Shuttle program's Challenger disaster of 1986, the Ariane 4 problem of 1990, and the Ariane 5 problem of 1996. Emerging launch vehicle endeavors such as those in China indicate that overcoming launch difficulties is not a simple nor inexpensive matter. With the successful additions from Japan and Russia to the free world's launch vehicle industry, coupled with changes U.S. policy on expendable launch vehicles, and the success of niche market launchers like Pegasus, obtaining a launch support contract would seem to be easier than ever. The cost of launch insurance, however may be sobering factor in judging competitors for such a contract.

The single most difficult decision facing a would-be commercial space science program today is that of finding a safe, reliable and cost-effective launch vehicle. If one weighs in the need for improved safety concomitant with human presence aboard such a flight, it may be a number of years before space flight is available for travel buffs. It will take the efforts of government agencies, perhaps in an international cooperative endeavor, to provide new enabling technology as an alternative to the vertical take-off, explosion-powered, launch that is commonplace today. Get me to orbit safely, reliably, is the cry from a burgeoning industry.

Given the multitude of reasons for launch delay today, not the least of which is the vagaries of local weather conditions, the eventual solution may well be an international launch entity offering the customer a choice of customized launch vehicles, short payload integration times, and a selection of

launch sites.

Communications

Perhaps the most consistently successful space science performer, the communications industry is still growing to meet public demand for more and more information. Even navigation data plays a part in this industry, witness the explosion of cheap GPS commercial receivers on the market, and the spread of satellite delivered, real time, aircraft communications including public correspondence, in-flight entertainment, et al.

However, these comments are related to industries which have blossomed as a result of earlier space science contributions. What of tomorrow? Space science activities being planned today, reported to SPACE V, the Fifth International Conference on Space '96, include some innovative ideas and concepts, for example:

The International Space Station, on schedule for deployment of its first in space component, the Functional Cargo Block, in late 1997. Scheduled for permanently manned presence in early 2000, this space station will provide the foundation for future developments in space including, engineering, construction, and operations in zero gravity, industrial, medicinal and food production, and for space business parks.

Earth observing systems will require huge bandwidths to accommodate the increasing data rates needed to satisfy demand for images with higher resolution. Some of these requirements will be satisfied by commercial entities at both ends of the market, i.e. acquiring the data, then processing and selling the finished product. In one basic research category postulated for implementation in the first decade of the next century, Very Long Baseline Interferometry from Space (Space VLBI), real-time instantaneous bandwidths ranging up to 10 GHz are foreseen to satisfy the data requirement.

Industrial development in the space environment will continue, and the crystal growing market, which was over-hyped to the point of disinterest in the 80s, will take its place as a profitable commercial space venture. Demand for real time video in the case of manned systems, or telepresence and remote control, and remote monitoring will enable this type of activity to move from the drawing board and into production.

Medical research and pharmaceutical production will be stimulated by access to a micro-gravity environment. The need for biomedical data will place greater demands on communication systems. High resolution requirements will spur the development of High Definition Television standards and common transmission standards worldwide.

Food production does not seem to offer much of a challenge to the communication industry, however, with the recent news that the gestation period of a rice crop grown in micro-gravity conditions is shortened to one third that of the same crop grown in 1g conditions, the potential for food production in space for consumption on Earth becomes attractive. Because of the large areas required to enable even hydroponics production, it will no doubt await the advent of space business parks before investors come forward. Once again, the monitoring of growing conditions and crop status will be conducted remotely by means of communication links.

In a shorter time frame, within the first few years of the next century, a number of missions are proposed to return to the moon. These missions as proposed are scientific in nature, but given success, there are commercial entities aching to take advantage of a proven launch and return capability. These include several large companies interested in mining the moon for helium^3, a basic element which when returned to Earth can fuel a safe fusion process which could provide this planet with more clean fuel than ever before postulated. Astronomers gaze longingly at Luna with dreams of an observatory free from the restrictions and aberrations of an atmosphere polluted by heat and radio waves. Additionally, miners are already seeking the mineral rights to certain asteroids. Plans to put humans on Mars are some way into the future but development of interplanetary cruise-ships to enable such colonization are well developed. To date such plans involve using the moon as a base for supplies and fuel for these cruise-ships.

Permanently manned space bases, in Earth orbit or a planetary surface speaks to permanent human presence in space. This in itself will require much in the way of communication support to and from the Earth, as well as on and around the occupied planetary surface. Essential communications may be implemented in the first place by the public sector, however comfort communications must be provided for the various settlements. For example, a miner will be working eight hours a day, resting eight hours a day and relaxing eight hours a day, what to do during relaxation...Exercise some, read some, call home? Watch a movie? Play an interactive game? With whom? The computer, a competitor in station, a competitor on Earth? The resolution of these and other social issues related to humans living for long periods in a remote environment will provide the impetus for commercial investment in communications systems to satisfy these needs.

Remote Sensing

The wide range of Earth observing satellites (EOS) scheduled for launch between 1996 and 2004; the variety of their intended science and research missions; the growth of commercial sensor systems and private launch capabilities; and the miniaturization of sensor systems for orbit insertion from small vehicles testify to significant changes in Earth data collection technology. In the government sector, small satellites designed for filling gaps in atmospheric, geophysical, and biological measurements that can be fused with data being collected by EOS observatories are preferred over larger and more costly systems. In the growing private sector, satellites that collect data for specific markets and that can be launched at low cost, are preferred over more complex or more general purpose systems that must then search for markets. (Morain, 1996) Governments will continue to be expected to provide basic services such as weather data, both raw and processed.

Remote sensing is rapidly emerging as a first-order operational exploration tool and is no longer a secondary complement to other geophysical techniques. That position is built on a solid platform of basic and applied research addressing the capabilities and limitations of remote sensing in detecting surface phenomena associated with, for example mineral deposits. (Sabine, 1996) The distribution and focus of greater, more affordable computing power on the desktop has been one key driver; another is the push to squeeze more data faster through land lines and air waves. The result is that larger and more detailed satellite scenes will be moved quickly to a customer's desktop computer, where new processing software will help the user to manipulate and interpret an image faster. (Barnett, 1996)

Manufacturing

In the eighties, based on the success of the Space Shuttle as the world's first re-usable launch vehicle, emphasis was placed on the prospect of conducting materials processing leading to predictions of huge profits that never materialized. This contributed to a distorted understanding of the meaning of commercial space, and tended to overshadow more established and revenue-producing sectors of satellite-based communications and satellite launch insurance.

Today, material processing is again coming to the forefront of technologies which will take advantage of conditions in space. This time however the approach is more firmly based, with experimenters having enjoyed access to wide array of facilities and hardware on various space missions, such as the space shuttle. Over the past several years it has been demonstrated that organic crystals grown in a low-gravity environment are often of higher quality than their 1g grown counterparts.

Biomedical research has been and will continue to be of critical importance to understanding how the human body reacts to conditions in space. The long duration of astronauts/cosmonauts living aboard space station MIR is of particular importance in these studies. The advent of permanent orbiting facilities, purpose built for medical research will allow the study of Earth-based disease and disease control in a micro-gravity environment. The results of such studies, will be of great public interest, and will probably be the outcome of some inter-governmental initiative, yet to be made.

Pharmaceutical production taking advantage of low-gravity conditions has already attracted the attention of several large pharmaceutical manufacturers. The provision of stable, space platforms with purpose-built modules and laboratories will no doubt follow the establishment of a successful international space station.

Crops can be grown in micro-gravity having shorter gestation periods than for their counterparts grown in 1g. This is good news for those individuals living on a space station, they will not be so dependent on supplies from Earth. However, when space business parks come into being, it may make commercial sense to grow some crops in space for consumption on Earth. In particular, crops having a natural long life, for example cereal crops which do not start to decay if not brought to market immediately.

Does manufacturing include real estate? This is an interesting idea, perhaps because in space, there can be no real estate unless it is manufactured. The concept is the basis behind the initiative known as a space business park. A commercial entity, perhaps learning lessons from the construction of the international space station, undertakes to provide a multi-purpose business environment in space with customized modules to satisfy each manufacturer's requirements. This business park then leases the real estate thus created, much in the way that a mall owner on Earth leases stores to retailers. Some of the customers for such space business parks are those mentioned above.

Tourism

One very important and influential proponent of space business parks may well be the hotel and resort owner. In spring 1993 the Japanese Rocket Society started a formal study program on space tourism. The objective of this research is to determine how to establish a successful commercial service offering short visits to low Earth orbit for fare paying passengers. To date the services required have been studied; a passenger vehicle has been designed and the necessary propulsion and propellant supply systems have been analyzed. Ongoing studies today focus on; the passenger vehicle's developmental and manufacturing costs; facilities required at airports; accommodation facilities required in orbit; and potential business development scenarios. (Collins, 1996)

One of the authors is somewhat cautious, and has not yet purchased shares in this venture. He has however, made reservations in the Hyatt Space Regency to celebrate his Silver Wedding Anniversary! He would also like to attend, while on orbit 333 miles above the planet, the opening night of the latest movie: Star Trek 15; USS Voyager Comes Home! He can do this courtesy of the Ted Turner/Rupert Murdoch joint venture TV channel "Movies TO the Stars".

Resource Exploitation

Already mentioned in the communication section, is the subject of mining Helium^3 from the lunar regolith for return to Earth. It is variously estimated that the amount of Helium^3 required to provide all the Earth's energy requirements for the next 100 years could be brought from the moon in just three trips! Studies have been under way for a number of years on the basic elements required to enable such a project. Such studies have included subjects such as, the type of concrete required to support mining structures; processing concrete from local materials; the optimum vessel shape and size for conveying the gas; building large structures, including lunar habitats; and many more. At least three large Japanese corporations are ready to support this venture. The next step, for which there is now a wait, is the return to moon. A successful lunar mission will probably provide the springboard for this type of commercial activity.

Asteroids are fruitful ground for exploitation. Minerals such as nickel, iron, cadmium et al are postulated to predominate the core structure of many asteroids. Plans are under way for various missions to asteroids in close vicinity to the Earth, with a view to landing on the asteroid, and later to mining such an asteroid and returning its yield to Earth. Some plans even look at the possibility of attaching a power plant to an asteroid, and propelling it into an Earth orbit for processing at our leisure!

Infrastructure

With all this projected public and private sector

activity on the horizon, space will be a very disorganized territory (rather like the Wild West of the 19th century), unless an infrastructure of regulations, codes, treaties, laws is established. Most commercial organizations see the need for this, and are participating in discussions on this topic. The safety of property and personnel will take on a different degree of urgency when commercial participants and customers leave the planet's surface. Today's astronauts are very brave individuals who understand the risks to their own safety that they face in the space environment. A simple tourist will require far more infrastructure support.

In Conclusion Issues

This paper has discussed briefly a number of topics relevant to future activities under the general heading of 'space science'. The broad issue of space science activities in the near future is too voluminous to be discussed here, but the attention of the reader is drawn to the biennial series of conferences hosted by the American Society of Civil Engineers and titled 'Engineering, Construction and Operations in Space'. The proceedings from these conferences give a much greater insight into both public sector and private sector activities in space science than we can do in this short paper.

However, we raised some issues which are worth further thought. In all of these commercial ventures there is an element of waiting for something. As an example, space business parks are looking for a successful international space station. The entrepreneurs of space business parks will study the construction, operation and maintenance of the international space station in minute detail, before making their final implementation and deployment decisions. Another example is that of lunar mining corporations, they will scrutinize the return to the moon mission(s) to learn all they can before committing personnel and other resources to operating in the lunar environment. These are, of course, simply steps of prudence, but they help us to define the line between public sector and private sector responsibilities. In these cases, the public sector is expected to take the first risky steps in testing and proving technology. What should also be clear is that with a real partnership between the two sectors, the later innovations made by the private sector to optimize its operations, will be available for incorporation in future public sector ventures.

Into the foreseeable future the public sector must expect no lessening in demand for delivery of certain basic space science products, such as weather, environmental, ecological, and navigation data.

What does all of this have to do with today's Dollars and Sense? Where might governments, with dwindling coffers, best apply those few remaining research dollars to effectively maximize their leverage for embryonic commercial activities in space science?

Large-scale development of the obvious eventual market for space tourism, the apparent market for space-based entertainment and sport, and the potential market for space-based manufacturing, hinges on private investment. Clarity and stability of governance, proof of technological readiness, and availability of the necessary infrastructure are all essential. These three components are uniquely within the power of governments to arrange. (Sherwood, Lauer, Hopkins, 1996)

Enabling transportation performance is crucial, and the four primary contributing factors are: Capacity, Price, Safety, and Reliability.

Technology developments that must be brought to maturity include: big windows; space suits that don't require individual tailoring; man-rated orbital maneuvering vehicles; microgravity food production; robotics systems for operational tasks; and deployment and outfitting of large pressure vessels.

Telecommunication systems are already available to satisfy the majority of the demands foreseen in the near future. Innovative system applications will be required to provide solutions to unique requirements of the commercial space customer of the future, particularly the entertainment user, the real time image processor, the telerobotic operator, and the Earth-based scientific observer.

Of paramount importance in the provision of these

new telecommunication systems will be the ability of administrations to act in concert in preserving access to frequency allocations in the face of increasing demands for terrestrial 'personal' services. The International Radio Regulations need to be comprehensively and critically reviewed for their applicability to modern telecommunication systems realities, e.g., the ubiquitous digital data stream.

Telecommunications service providers must be encouraged to look towards existing government space science systems as potential customers, e.g., low Earth orbit constellations may be able to provide extended coverage for the International Space Station traffic which, by itself may not be a tremendous revenue stream, but which would provide the base on which to service future business space parks.

In the future, commercial space will likely be characterized and motivated by economic necessity, resource scarcity, and helping the human condition on this planet. Many different types of companies will be involved, in addition to traditional aerospace corporations. Remote sensing data will become more and more a part of our surroundings and living conditions. The use of satellite constellations for telecommunications will have the effect of "plugging the developing world into the rest of the world". The apparent discovery of frozen water on our moon recently by the Clementine spacecraft lays a foundation for thought-provoking ideas about exploring new worlds. The International Space Station will provide a long-awaited platform where scientists and medical doctors can carry out materials processing and life sciences research for extended periods of time.

Commercial space has gone through many transformations in the last fifteen years. In the mid 1980s, commercial space scenarios, such as drug processing factories in space, conjured up visions that were quite spectacular. As commercial space revenues have increased, commercial space comes to us in rather routine forms, such as making an international telephone call, or surfing the Internet.

Today, the average Canadian is using or is exposed at an increasing rate to data and services that have been generated from space. It almost seems like the less a person realizes he or she is affected by commercial space, the more commercial space is developing. (Barnett, 1996)

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ARVIND BASTIKAR

Mr. Bastikar graduated from University of Bombay, in mathematics and he continued his post graduation studies in England, Canada and United States in the fields of advanced physics, chemistry and engineering.

He is a member of professional engineers association of province of Ontario as well as a chartered engineer of United Kingdom. He is also a senior member of Engineering and Physics Institutes of United Kingdom, United States and India. He has published and presented many papers at the international conferences for the past three decades as well as he is a holder of several patents in Canada, United Kingdom and United States.

Since coming to Canada, he was employed as a research scientist by Northern Electric Research and Development Laboratories where he pursued his interests in satellite communications. In 1973, he joined the Federal Government of Canada and the Department of Communications as the Director for International Activities. In late 80s, he took a special assignment as an advisor to Intelsat on behalf of the Federal Government of Canada. On return, Mr. Bastikar took a position in Space Technology Division of Canadian Space Agency where he is responsible for ESA Programmes, Telecommunication Programmes, Spectrum Management and Space Standards.

M. Bastikar obtient son diplôme en mathématiques de l'Université de Bombay, puis il poursuit ses études de deuxième cycle en Angleterre, aux États-Unis et au Canada, en physique et en chimie supérieures et en techniques avancées.

Il est membre de l'association des ingénieurs professionnels de l'Ontario et ingénieur breveté du Royaume-Uni. Il est aussi membre émérite d'instituts de génie et de physique au Royaume-Uni, aux États-Unis et en Inde. Il a publié et présenté de nombreuses communications lors de conférences internationales au cours des trois dernières décennies en plus d'être titulaire de plusieurs brevets au Canada, au Royaume-Uni et aux États-Unis.

Depuis son arrivée au Canada, il a travaillé comme chercheur aux Laboratoires de recherche et développement de Northern Electric où il a continué à s'intéresser aux télécommunications par satellite. En 1973, il entre au gouvernement fédéral du Canada et au ministère des Communications comme directeur des Activités internationales. À la fin des années quatre-vingt, il fait l'objet d'une affectation spéciale comme conseiller à Intelsat pour le compte du gouvernement fédéral du Canada. À son retour, M. Bastikar occupe un poste à la Division de la technologie spatiale de l'Agence spatiale canadienne où il est chargé des Programmes de l'ASE, des Programmes de télécommunications, de la Gestion du spectre et des Normes de l'espace.

ROBERT TAYLOR

Robert Taylor graduated with a Baccalaureate degree in Electrical in 1971, and is a member of the IEEE. He has represented the USA many times on delegations to the ITU, and is currently Chairman of both the Conference Preparatory Meeting for the 1997 WRC and of Working Party 7B (ITU-R). Mr. Taylor owns a private consulting corporation specializing in spectrum policies, regulation and technical analyses.

Membre de l'IEEE, Robert Taylor a obtenu son baccalauréat en génie électrique en 1971. Il a représenté les États-Unis à maintes reprises au sein de délégations de UIT et il est actuellement président de la réunion préparatoire en vue de la conférence qui aura lieu en 1997 et du comité de travail 7B (UIT-R). Il est propriétaire d'une petite entreprise de conseils spécialisés dans les politiques du spectre, la réglementation et les analyses techniques.

GLOBAL SATELLITE COMMUNICATIONSES
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He is currently the Director General of Engineering at IRIDIUM Canada, holding the same position in Iridium North America (which forms part of Iridium Canada). Currently Mr. Boulay is coordinating the deployment in Phoenix, Arizona, of the first gateway for the Iridium system.

Fred Christensen is the Director of Business Development for Iridium canada Inc. He is responsible for Sales, Marketing and Distribution of IRIDIUM services in Canada. Mr. Christensen has 24 years of experience in the communications industry with Bell Canada and BCE Mobile, the last 2½ on the IRIDIUM project.

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Guy Boulay a obtenu un baccalauréat en génie électrique de l'École Polytechnique (Université de Montréal) en 1974, en concentrations télécommunications et informatique. Il est membre de l'Ordre des Ingénieurs du Québec. Il oeuvre au sein de plusieurs sociétés de télécommunications depuis 1974, dont Bell Canada, Télébec, Harris Farinon, BCE Mobile.

Il est directeur général de l'ingénierie d'Iridium Canada. Il agit présentement comme directeur général de l'ingénierie d'Iridium North America (dont fait partie Iridium Canada), et coordonne le déploiement de la première station terrestre passerelle au monde du système IRIDIUM, à Phoenix, Arizona.

Fred Christensen est le directeur du développement des marchés de la firme IRIDIUM Canada Inc. Il est responsable des ventes, du marketing et de la distribution des services IRIDIUM au Canada. Il compte 24 années d'expérience en communications auprès de Bell Canada et de Radiocommunications BCE Mobile. Il a consacré les deux dernières années et demie au project IRIDIUM.

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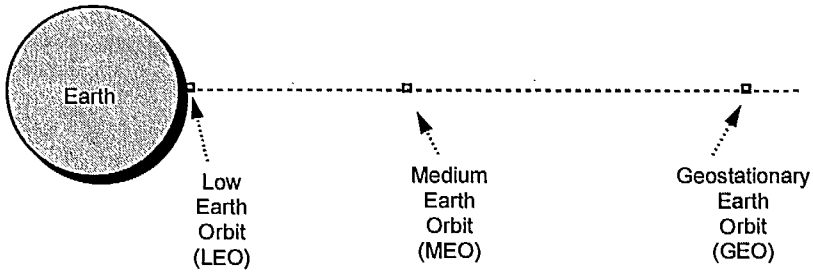
Presentation to Spectrum 20/20 1996
Ottawa - Ontario
Canada

Global Hand Held Phone

A new generation of Lower Earth Orbit satellite systems will soon bring truly global hand held phones.

Spectrum 20/20 *Ottawa, 20 November 1996*

Altitude



- **Lower altitudes means**
  - decreased voice delays
  - more power available to handheld units
  - more satellites needed for global coverage

Actual and Planned Systems

- **GEO**
  - TMI and AMSC (MSAT) (Regional)
  - Inmarsat (Global)
- **MEO**
  - Odyssey (Global)
  - ICO P (formerly Inmarsat P) (Global
- **LEO**
  - IRIDIUM (Global)
  - Globalstar (Global)

Systems Characteristics

	MSAT	"Big LEO's" Odyssey	ICO-P	Globstar	IRIDIUM
Altitude (km)	35,900	10,300	10,300	1400	780
No. of Satellites	1 + 1	12	10	48	66
Access	FDMA	CDMA	TDMA	CDMA	TDMA
Handheld Units	No	Yes	Yes	Yes	Yes
RF Margin (dB)	N/A	4-10?	4-10?	4-10?	16
Intersatellite Links	No	No	No	No	Yes
Coverage					
Global	No	Yes	Yes	Yes	Yes
Polar	No	?	?	?	Yes
Int'l Waters	No	?	?	?	Yes
Int'l Air Space	No	?	?	?	Yes

Intersatellite Links

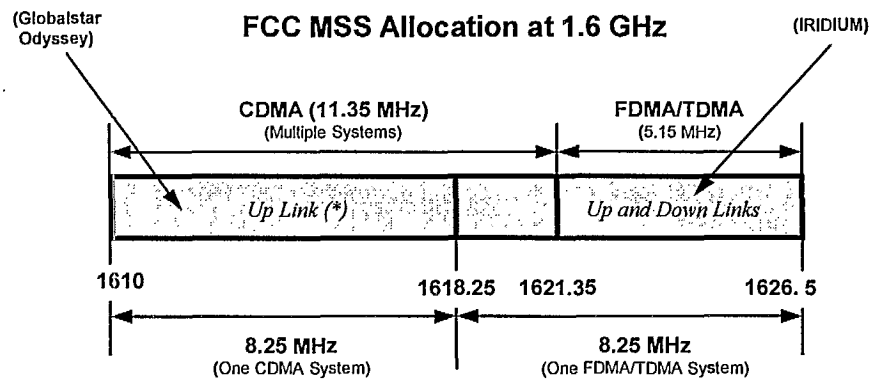
Intersatellite Links (cont'd)

- **Without Intersatellite Links**
  - The subscriber unit and the PSTN gateway have to be within reach of the same satellite
- **With Intersatellite Links**
  - The call can be routed from any subscriber unit to any PSTN gateway in the world

Intersatellite Links (cont'd)

- **Intersatellite crosslinks carry traffic to the destination gateway, enabling call delivery regardless of terrestrial network availability**
  - calls can be routed to an alternate gateway if one is down
  - calls can be routed through alternate crosslinks if one satellite is down.
  - in theory, the whole system can work with only one gateway
  - inter-satellite links ensures coverage in areas where there is no gateways (international waters and air space, poles)

Service Links



(*) Proportionate amount of down link spectrum allocated in the 2483.5 to 2500 MHz band

"Bearer" Services

- **Voice (telephony)**
- **Paging**
- **Short Messages**
- **Data**
  - **Circuit**
  - **Packet**

IRIDIUM PRODUCTS

- **Handset**
  - Personal, Hand-Held
  - Dual Mode --- Cellular/PCS/PCN + IRIDIUM
  - Standard Data Interface
  - Smart Card
  - At Least 2 Hour Talk Time, 24-hr. Standby
  - Mobile Docking Accessory
  - Transportable/Fixed Accessory Chassis
- **Pager**
  - Pocket-Sized with Belt Clip
  - 64 Character Display
  - International Character Set
  - Disposable Battery
  - One Month Battery Life
- **Phone Booth**
- **MultipleXed Exchange Unit (MXU)**
- **Aeronautical Radio Channel Unit**

IRIDIUM VOICE SERVICES

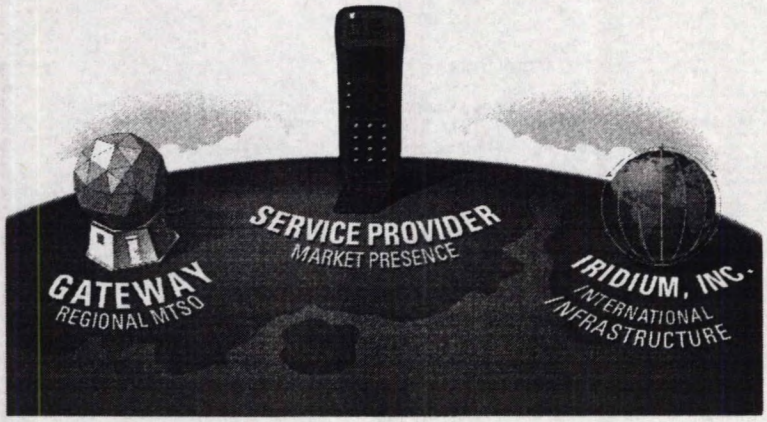
- **Voice**
  - Digital Call Quality
  - Frequency Division/Time Division Multiple Access Integrity
  - 16db Average Link Margin to Serve Hand-Held Telephones
  - Standard 011+ International Dialing Expected
- **Advanced Calling**
  - Enhanced Call Completion/Paging
  - Call Forwarding, Voice Mail, Call Waiting, Conference Calling, Call Holding, Call Barring

IRIDIUM FAX, DATA & PAGING

- **Data**
  - 2.4 kbs
  - Two-way Data Transmission Capability
  - Built-in Data Port on Hand-Held
- **Facsimile**
  - Group III Facsimile Compatible
  - Facsimile Storage and Retrieval
- **Alphanumeric Paging**
  - 64 Character Display
  - 30 db Average Link Margin for Reliable Message Delivery

DISTRIBUTON STRUCTURED FOR SUCCESS

Designed to Expand Availability of Communications



SERVICE PROVIDERS

Offer IRIDIUM System Access to their Customers

TARGET MARKETS

- Global Traveling Professional
- Industrial
- Government
- Marine
- Rural
- Transportation
- Automotive
- Safety/Security
- Aeronautical

NATIONAL GOVERNMENT USERS

- Disaster Relief
- Emergency
- Border Patrol
- Drug Enforcement
- Diplomatic Missions
- Humanitarian Aid Missions
- Dignitaries
- Police/Military/ Intelligence
- Wildlife Preserve/ Game Commissions

THE CHALLENGE OF GLOBAL BROADBAND INTERNET ACCESS
LE DÉFI MONDIAL DE L'ACCÈS À LARGE BANDE À INTERNET

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ABSTRACT

Using a constellation of several hundred low-Earth-orbit satellites -- a global, broadband "Internet-in-the-sky", Teledesic will enable affordable access to fiber-like telecommunications capability anywhere in the world. The Teledesic Network will allow local Service Providers to extend their networks in terms of both scope of services and geographic reach. It will be a local service provided through a global network. Backed by telecommunications pioneer Craig McCaw and Microsoft Chairman Bill Gates, and scheduled to begin service in 2002, the Teledesic Network will provide two-way, broadband connections for applications such as voice, data, videoconferencing and high-performance Internet access. In its distributed architecture, dynamic routing, and robust scalability, the Teledesic Network emulates the most famous distributed network, the Internet, while adding the benefits of real-time capability and location-insensitive access. Teledesic offers the potential to become the ubiquitous information infrastructure for much of the developed and developing world.

RÉSUMÉ

À l'aide d'une constellation de plusieurs centaines de satellites en orbite basse terrestre -- un « Internet dans le ciel » mondial, à large bande, Teledesic permettra un accès abordable à des moyens de télécommunications tels que les fibres optiques partout dans le monde. Le réseau Teledesic permettra aux fournisseurs de services locaux d'accroître leur réseau pour ce qui est de l'étendue des services et de la portée géographique. Ce sera un service local fourni par l'intermédiaire d'un réseau mondial. Le réseau Teledesic, qui sera appuyé par le pionnier des télécommunications Craig McCaw et par le président de Microsoft, Bill Gates, et qui devrait entrer en service en 2002, fournira des liaisons bidirectionnelles, à large bande, pour des applications telles que les communications vocales, les données, les vidéoconférences et la distribution Internet à haute performance. Grâce à son architecture répartie, à son acheminement dynamique, à sa variabilité dimensionnelle robuste, le réseau Teledesic imite le réseau décentralisé le plus célèbre, l'Internet, tout en présentant les avantages de la capacité en temps réel et de la distribution, quel que soit l'endroit. Teledesic pourrait devenir l'infrastructure de l'information pour une bonne partie des pays développés et des pays émergents.

Fixed Satellite Services and Challenges

As you may know Teledesic is building a network comprising several hundred low-Earth-orbit satellites. Teledesic was formed in June of 1990 –over six years ago – but it wasn't until early 1994, when we filed our application with the FCC, that Teledesic was brought out into the daylight.

At that time – two years ago – most people seemed to have difficulty comprehending the services that the Teledesic Network would provide. It is not cellular-like hand-held phones, of the kind to be offered by Iridium and Globalstar. And it is not broadcast video delivery, like Hughes's DirecTV.

Since then, the emergence of the Internet – particularly the World Wide Web – and network-based computing have provided a compelling model for a different kind of telecommunications: switched, broadband services. Peer-to-peer networking, based on the ubiquity and exponential improvements of personal computing, is transforming the way individuals live and businesses create value. Switched connections communicate from anyone to anyone, and broadband allows the transmission of all forms of digital information – voice, data, videoconferencing, and interactive multimedia. As a network model, clearly, the Internet is it.

But the Internet today is still at a relatively primitive stage of development, comparable to the first personal computers in the late 1970's. At that time, it was difficult to imagine the pervasiveness and range of applications of personal computing today. By contrast, the World Wide Web already provides a revealing glimpse of the promise of the Internet, with tens of thousands of companies and millions of individuals exploring, publishing and developing on this new medium. Any and all information can and will be digitized, uploaded, and transmitted anywhere.

Well, not quite anywhere. The promise of the information age is constrained by the lack of access to switched, broadband access in most of the developed and virtually all of the developing world. The Teledesic Network will provide a means to help extend these switched, broadband connections on demand anywhere on Earth.

Information is becoming increasingly essential to all those things we associate with quality of life: Economic opportunity, education, health care, public services. Yet, most people and places in the world do not now have access even to basic telephone service. Even those who do have access to basic phone service get it through 100-year-old technology – analog copper wire networks – that for the overwhelming part will never be upgraded to an advanced digital capability. Even in the developed countries, there is a risk that whole areas and populations will be denied access to the powerful digital technologies that are changing the world.

The digital revolution is just as fundamental as the industrial revolution and the agricultural revolution before that. It will change all aspects of our societies. Those previous changes took place over many generations – indeed, in parts of the world they are still ongoing today. Driven by advances in microelectronics technologies, where product generations are measured in months, the digital revolution is taking place at a breathtaking pace. The digital technologies that grow more powerful every day in our notebook computers will soon be exploding out through network

connections. Yet, outside of the most advanced urban areas, most of the world will never get access to these technologies through conventional wireline means.

While there is a lot of fiber out there in the world – and the number of places is growing – it is used primarily to connect countries and telephone company central offices. Even in a country like the United States, little of that fiber will be extended for local access to individual offices and homes, which represents 80% of the cost of a network. In most of the world, fiber deployment likely never will happen in the local access network.

This is a big problem for all of our societies. If these powerful technologies are available only in advanced urban areas, people will be forced to migrate to those areas in search of economic opportunity and to fulfill other needs and desires. Society now is organized around the economics of infrastructure. With the agricultural revolution, technology – seeds – tied people to the land and brought them together in towns and villages. With the industrial revolution people came together in increasingly congested urban areas, all organized around the economics of industrial infrastructure – wires, rails, highways, pipes, machinery. To the extent the digital revolution is tied to wires, it is just an extension of the industrial age paradigm. Like the highways and the railways before that, wires are rigidly dedicated to particular locations. If you live along side the mainline you prosper. If you live a few miles distant, you are left behind.

It is no longer sound – economically or environmentally – to force people to migrate to increasingly congested urban areas in search of opportunity. The real potential of the information age is to find a means of allowing people to choose where they live and work based on things like family, community and quality of life rather than access to infrastructure. We've done a very good job extending one-to-many communications to most of the world through broadcast technologies – TV, in particular. But having created a means for everyone to see all the benefits of our societies we have also created expectations – legitimate expectations – that will seek fulfillment. We need to provide the means for people to participate fully in the benefits of our societies where they are. We need to create the two-way network links that allow people to participate economically and culturally with the world at large without requiring that they pick up and move to where the infrastructure is.

That is the challenge we set for ourselves with Teledesic. To date, Teledesic has received most of its funding from Bill Gates – the founder of Microsoft, the world's largest computer software company – and Craig McCaw – who founded McCaw Cellular, the world's largest cellular communications service provider before its sale to AT&T in 1994. In some ways, their investments are symbolic as well as financial.

Moore's Law, which says that a microprocessor will do twice as much for the same cost every 18 months, has correctly predicted the exponential growth of the computer industry for over 20 years. However, while computers today are thousands of times faster than those available a decade or two ago, networking has shown only linear growth. Improvements in networking performance, which have required backhoes to dig-up streets and replace antiquated copper with modern fiber-optic technology, have not come close to keeping pace. Backhoes do not obey Moore's Law.

The solution we seek to bring into being is

wireless access to advanced network connections. Unlike wireline technologies, the cost of wireless access is largely indifferent to location. But in order to get the bandwidth required for fiber-like service through wireless means it is necessary to move way up in to the millimeter-wave frequencies – in the 20 to 30 GHz range (what's known as the "Ka band"). But, as you know, sending signals horizontally, over the land, in those frequencies is problematic. They are subject to rain attenuation and blocking by terrain, foliage and buildings. The solution we adopted was simple. Send the signals vertically. This led us to a satellite-based solution.

The next issue we faced was, What kind of satellite system? Viewed from 1996, it is difficult to predict with certainty all the advanced applications and data protocols that such a network will be called upon to accommodate in the 21st Century. But it is reasonable to assume that those applications will be developed for the wireline networks in the advanced urban areas – in other words, the fiber networks.

To ensure seamless compatibility with those fiber networks, it is important that the satellite network have the same essential characteristics as fiber. Those characteristics include: Broadband channels, Low error rates, and Low delay.

The advanced digital broadband networks will be packet-switched networks in which voice, video, data are all just packets of digitized bits. In these networks you cannot separate out the applications that can tolerate delay from those that can't. People will not want to maintain two networks: one for delay sensitive applications and another for applications that can tolerate delay. Traditional geostationary orbit (GSO) satellites will never be able to provide fiber-like delays.

This lead us to a low-Earth-orbit (LEO) network. To put this in perspective, the space shuttle orbits at about 250 kilometers above the Earth. As you probably know, there is only one geostationary orbit, and that is over the Equator at 36,000 kilometers – almost 150 times further out than the space shuttle. By contrast, Teledesic's satellites would orbit at about 700 kilometers – 50 times closer to Earth than geostationary satellites.

With the combination of a very high minimum vertical angle to the satellite – to overcome the blocking and attenuation problems associated with the Ka band – and the low altitude, geometry takes over and a constellation of hundreds of satellites is required to provide continuous coverage over all the Earth. The large number of satellites also allows economies of scale in manufacturing and creates a system with very large capacity which allows a low cost of service.

The concept of a network consisting of hundreds of satellites may seem like a radical concept when compared to traditional geostationary satellites but it is less radical when compared with the evolution of networks on the ground. Computer networks have evolved from centralized systems built around a single mainframe computer to distributed networks of interconnected PCs. Similarly, satellite networks (for switched network connections) are evolving from centralized systems built around a single geostationary satellite to distributed networks of interconnected low-Earth-orbit satellites. The evolution in both cases is being driven by some of the same forces.

A decentralized network offers other advantages: A distributed topology provides

greater reliability. Redundancy and reliability can be built more economically into the network rather than the individual unit. Also, because a low-Earth-orbit satellite has a smaller footprint within which frequencies can be reused, it is inherently more efficient in its use of spectrum resources. Geostationary satellites will continue to have an important role to play, particularly for broadcast applications where their large footprint is advantageous. But increasingly, geostationary satellites will co-exist with non-geostationary orbit (NGSO) satellite networks.

This evolution toward NGSO systems has resulted in three LEO system types, each focused on a different service segment and using a different portion of the radio frequency spectrum. The best way of distinguishing between these three LEO system types is by reference to their corresponding terrestrial services:

The so-called "Little LEOs," like OrbComm, are the satellite equivalent of paging.

The so-called "Big LEOs" like Iridium, Globalstar and ICO, have received the most attention. They are the satellite equivalent of cellular phone service.

Teledesic is the first proposed "Broadband LEO." It will provide the satellite equivalent to optical fiber with an Internet-type network architecture. Just as no one would think of cellular and fiber as being competitive on the ground, really the only thing we have in common with Iridium and the other Big-LEOs is the use of low-Earth-orbit satellites.

Because Teledesic will operate in the Ka band, essentially line-of-sight from the user terminal to the satellite is required, which makes it more appropriate for fixed applications, or mobile applications like maritime and aviation use, where line-of-sight is not an issue. It will provide the digital switched broadband network connections to all those parts of the world that are not likely to get those capabilities through wireline means.

There is an important aspect of these non-geostationary satellite systems that is worth noting. There have been many studies, many of them by the ITU, that show a direct correlation between economic prosperity and teledensity. In the absence of a high level of economic development, however, a country is not likely to attract the investment required for an advanced information infrastructure. NGSO systems like Teledesic can help developing countries overcome this "chicken and egg" problem in telecommunications development.

Once you come out of a geostationary orbit, then by definition, satellites move in relation to the Earth. With an NGSO system, continuous coverage of any point requires, in effect, global coverage. In order to provide service to the advanced markets, the same quality and quantity of capacity has to be provided to the developing markets, including those areas to which no one would provide that kind of capacity for its own sake. In this sense, NGSO satellite systems represent an inherently egalitarian technology that promises to radically transform the economics of telecommunications infrastructure. It is a form of cross-subsidy from the advanced markets to the developing world, but one that does not have to be enforced by regulation but rather is inherent in the technology.

I would like to return to the issue of latency in satellite networks that I mentioned earlier as one of our reasons for adopting an NGSO approach. This point is probably worth some elaboration – and please excuse me if I go into

too much detail. Even at the speed of light, round-trip communications through a geostationary satellite entail a minimum transmission latency – end-to-end delay – of approximately half a second. This latency causes the annoying delay in many intercontinental phone calls, impeding understanding and distorting the personal nuances of speech. What can be an inconvenience for analog voice transmissions, however, can be untenable for videoconferencing and many data applications.

Applications will be developed for terrestrial networks, not for special networks with non-standard characteristics. Companies that build networks that are not compatible with the predominant data protocols and applications are taking a big business risk that their systems will be usable only for specialized, proprietary applications. History has not looked favorably upon companies that have made big bets on low-quality service. And since telecommunications customers make purchasing decisions based on their most demanding – not their average – application, geostationary satellite systems may not be a feasible choice if even a relative minority of services are latency-sensitive. In fact, many switched data applications are adversely affected by high latency.

Instead of attempting to modify the entire installed base of network equipment with which one might want to communicate, receiving seamless compatibility with existing terrestrial networks becomes increasingly attractive. As both bandwidth requirements and the use of real-time data accelerate, the benefits of the fiber-like service that Teledesic offers are only growing in importance.

What all of this discussion makes clear is that no one single technology or satellite system type is going to be appropriate for all communications needs in all settings. The capabilities of fiber cannot be matched for very dense traffic. For basic telephone service, the economics of terrestrial cellular systems are compelling, particularly where no wireline infrastructure exists. Geostationary satellites will continue to play an important role, particularly for video distribution and other broadcast applications, where latency is not an issue and a large footprint is desirable. And each of the LEO system types has an important role to play.

Recognizing the importance of national sovereignty, Teledesic has put significant effort into designing its system for flexibility of local implementation. For instance, Teledesic is the only NGSO system that employs cells fixed on the ground, rather than moving with the satellite footprint. This Earth-fixed configuration and the small size of these cells enables Teledesic to conform service offerings to national boundaries. Other system features, such as the ability to route a country's traffic through an in-country gateway enhance Teledesic's ability to customize service to conform to each country's regulatory structure.

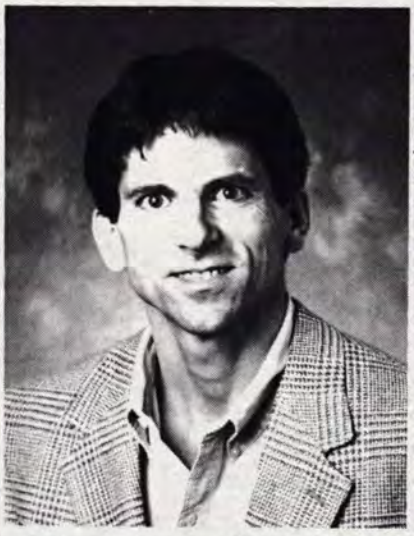
Also, we should emphasize that Teledesic does not plan to market service directly to end-useres, but rather will work in partnership with in-country service providers and, of course, will comply with the regulations of the host countries. Rather than competing with existing infrastructure, Teledesic represents a means by which local service providers can expand the geographic scope and range of services they offer. In this sense, Teledesic is a local service provided through a global network.

Of course, the value of systems like Teledesic – or any technology – ultimately is measured by their ability to enhance the quality and meaning

of our lives. The benefits to be derived from the advanced information services they enable are as vast as the areas of need to which they can extend. We hope Teledesic can help play a small role in extending the vision of a Global Information Infrastructure to all the world's citizens.

BIOGRAPHY

Mr. Daggatt is President of Teledesic Corporation of Kirkland, Washington. Teledesic has proposed a global constellation of low-Earth satellites that would provide low-cost "bandwidth on demand" to accommodate a wide range of services from basic voice channels to high-data-rate network connections and interactive multimedia applications. The company was formed in June of 1990 with the objective of providing a means of affordable access to advanced information services to rural and remote parts of the U.S. and the world that would not be economic to serve through traditional wireline means. Its principal shareholders are Craig O. McCaw and William H. Gates III.



Mr. Daggatt, 40, is a Harvard Law School graduate with extensive international legal and regulatory experience, including practice with a major Tokyo law firm. He has held a number of senior management positions and is co-author of the book, The Global Negotiator - Building Strong Business Relationships Anywhere in the World (HarperCollins, 1990).

BIOGRAPHIE

M. Daggatt est président de la Teledesic Corporation de Kirkland, Washington. Teledesic propose une constellation mondiale de satellites sur orbite basse terrestre fournissant de «la largeur de bande sur demande» à coût modique pour une vaste gamme de services, à partir des voies téléphoniques de base jusqu"aux connections de réseau à débit binaire élevé et aux applications multimédias interactives. La société, créée en juin 1990, vise à fournir un moyen d'accès abordable aux services d'information avancés dans les zones rurales et éloignées des É.-U. et du monde là où il ne serait pas économique de recourir à des lignes de transmission traditionnelles. Ses principaux actionnaires sont Craig O. McCaw et William H. Gates III.

M. Daggatt, 40 ans, diplômé de la Harvard Law School, possède une vaste expérience en réglementation internationale et en droit international, y compris au sein d'un grand cabinet d'avocats de Tokyo. Il a occupé un certain nombre de postes de cadre supérieur et est co-auteur du livre, *The Global Negotiator - Building Strong Business Relationships Anywhere in the World* (HarperCollins, 1990).

INTRODUCTION OF MOBILE SATCOM MESSAGING SERVICES IN NORTH AMERICA
INTRODUCTION AUX SERVICES MOBILES DE MESSAGERIE PAR SATELLITE POUR L'AMERIQUE DU NORD

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ABSTRACT

Widespread use of mobile satellite data communications in North America started in the late 1980's via Qualcomm's OmniTRACS1 Ku-band (12/14 GHz) system.

In 1995 and 1996 American Mobile Satellite Corporation (AMSC), and TMI Communications (TMI) respectively each launched powerful L-band geostationary mobile satellites (MSAT's) specifically designed to provide full North American coverage via spot beams. Now, for the first time, it became possible to achieve mobile data communications or messaging with terminals costing less than $1000.

This paper discusses our view of the emerging market for services based on these new satellites. Such services include Wide Area Paging, Asset and Fleet Tracking, Emergency Messaging and SCADA systems. Examples of operational systems and systems which could be implemented in 1-2 years will be used for illustration.

The paper concludes with a brief look at satellite systems which are planned for launch during the final three years of this decade and the prospects for improved service from them.

RÉSUMÉ

La généralisation du système mobile de télécommunication par satellite en Amérique du Nord a commencé à la fin des années 1980 via le système OmniTRACS1 Ku-band (12/14 GHz) de Qualcomm.

En 1995 et 1996, l'American Mobile Satellite Corporation (AMSC), et TMI Communications (TMI) ont lancé chacune de puissants satellites mobiles géostationnaires émettant dans la bande L (MSAT) conçus expressément pour assurer la couverture complète de l'Amérique du Nord via des faisceaux ponctuels. Maintenant, pour la première fois, il est possible d'assurer un service mobile de transmission des données ou de messagerie au moyen de terminaux coûtant moins de 1 000 $.

Le présent document traite de notre vision du marché naissant de services basés sur ces nouveaux satellites. Ces services comprennent les systèmes d'appel unilatéral à zone étendue, de localisation des biens et du parc, de messagerie d'urgence et SCADA. À des fins d'illustration, on utilisera des exemples de systèmes opérationnels et de systèmes qui pourraient être mis en oeuvre dans 1 ou 2 ans.

Le document se termine par un bref regard sur les systèmes par satellite que l'on prévoit lancer au cours des trois dernières années de la présente décennie, et sur les possibilités d'améliorer les services offerts par ces systèmes.

INTRODUCTION OF MOBILE SATCOM MESSAGING SERVICES IN NORTH AMERICA

Summary

Widespread use of mobile satellite data communications in North America started in the late 1980's via Qualcomm's OmniTRACS1 Ku-band (12/14 Ghz) system.

In 1995 and 1996 American Mobile Satellite Corporation (AMSC), and TMI Communications (TMI) respectively each launched powerful L-band geostationary mobile satellites (MSAT's) specifically designed to provide full North American coverage via spot beams. Now, for the first time, it became possible to achieve mobile data communications or messaging with terminals costing less than $1000.

This paper discusses our view of the emerging market for services based on these new satellites. Such services include Wide Area Paging, Asset and Fleet Tracking, Emergency Messaging and SCADA systems. Examples of operational systems and systems which could be implemented in 1-2 years will be used for illustration.

The paper concludes with a brief look at satellite systems which are planned for launch during the final three years of this decade and the prospects for improved service from them.

Early Systems

The first widely deployed mobile satellite messaging service in North America was Qualcomm's OmniTRACS system which began operational tests in January 1988 in the US. It entered commercial service shortly thereafter. OmniTRACS is still the most widely deployed mobile satellite messaging service in the world and the installed base is over 125,000 units.

A close relative of OmniTRACS is EUTELTRACS, which is Eutelsat's European two way Mobile Satellite Messaging and Position Reporting Service which commenced operation in 1991. Typical services offered include vehicle location and real time position reporting to 80m accuracy, management of vehicle load assignments, and vehicle-based data such as driver performance, engine diagnostics and reefer alarms.

The OmniTRACS mobile terminal, Fig (1), has a maximum message size of 1900 characters and can store up to 99 messages. It consists of the following units:

Table 1 OmniTRACS Terminal

Unit	Size	Weight
Antenna	11.6"dia x 6.7"h	8 lbs
Display Unit	12.8 x 9.3 x 2.9"	3 lbs
Comms. Unit	12.8 x 9.2 x 2.9"	7 lbs

On large trucks where OmniTRACS is typically used, installation time is normally less than a day. Terminal price is in the $4000 US range.

OmniTRACS was able to achieve operational success in North America several years in advance of MSAT because of its ingenious use of spread spectrum techniques to achieve compliance with FCC emission rules at Ku-band and, secondly because of Qualcomm's success in designing a small-aperture Ku band tracking antenna at reasonable cost.

North American MSATs

In the mid 1980's the widely held expectation was that MSAT, when it was launched, would primarily provide extended coverage for mobile telephone services to areas that were truly remote or were otherwise uneconomical to serve. Canadian market studies, for example, predicted that upwards of

100,000 mobile telephone subscribers would be served by a 2000-channel MSAT satellite.

Little attention was paid to the potential for mobile data or messaging services. Then a number of things happened to change this view of the world.

Firstly, cellular telephone service operators rapidly expanded their coverage areas in North America, thereby reducing the market for satellite voice terminals. Secondly, business people began to appreciate the ways in which mobile satellite messaging services could improve the efficiency and profitability of their operations, especially for land mobile fleets of trucks, cars, and buses. Finally, the availability low cost (under $60 US at the chipset level) Global Positioning (GPS) receivers in the last two years has made it possible to provide precise position reporting of mobiles with an accuracy of 100 metres anywhere on earth.

As a result, we anticipate mobile satellite operators will intensify their efforts to implement low-cost mobile messaging systems on the MSATs over the next few years.
Fig (2 inset) shows the Canadian MSAT spot beam coverage of North America and clearly illustrates the cross-border capability.

Applications

Literally dozens of distinct applications can be identified for mobile satellite messaging systems. They can be grouped into a small number of major classes as follows:

a) Data Broadcast/Paging
b) Asset Tracking and Fleet Management
c) Emergency Messaging
d) Supervisory, Control and Data Acquisition (SCADA)

These applications can be characterized by their need for small, low-cost, low-power terminals and low air time charges. In technical terms they tend to employ low speed transmission rates, (several hundred bps to a few kbps). A more detailed look at some specific applications follows:

a) Continent-Wide Paging Applications

In 1995, according to MTA-EMCI, terrestrial paging subscribers in the USA increased by 31% to 34.5 million users. In spite of the term "nation-wide paging" being used loosely by terrestrial service providers, there often is no paging service to many areas outside of the towns and cities. True continent wide paging can easily be provided only by mobile satellite delivery systems. In the spring of 1996 TMI commenced commercial service via MSAT for a true Canada-wide 1200 bps paging service. Using 1200 bps industry-standard POCSAG format signals this service delivers paging messages to unmodified numeric and alphanumeric pagers anywhere in Canada. The service is sold through Glentel whose published airtime pricing is between C$39.95 (numeric/single beam) and C$99.95 (alphanumeric/all beams) per month for 100 messages.

It is interesting to note that although this is a Canada-only service at the moment, the signals are currently receivable at full strength across the full US as well!

The approved terminals, shown in Fig (2), used for this service are designed and manufactured by Calian Communications Systems Limited of Kanata, Ontario. They can be leased through the service provider or purchased for a few hundred dollars.

In normal use the antenna is magnetically attached to the roof of a vehicle and signals are received at 1.5 GHz from MSAT by a receiver which is typically clipped to the driver's sun visor. The receiver down converts the signals to the commercial paging band (eg 929-932 MHz) and rebroadcasts the signal at ultra low power to the user's commercial paging receiver such as a Motorola Advisor. The pager indicates the reception of a message in the normal way (beeper/buzzer) and the user views and manages the messages in the pager in the normal manner.

Canada licence to operate. Performance is shown in Table 2.

Parameter	Specification
G/T (db/K)	-22.5
Band (MHz)	1525-1559
Data rate bps	1200
Signal format	POCSAG
Weight g	500
Power	12vdc @ 35 mA

Table 2 Calian Paging Receiver

b) Asset Tracking and Fleet Management

Asset Tracking and Fleet Management services can apply to any class of mobiles including trucks, cars, buses, ambulances, boats, trailers, and aircraft. The largest single market segment however is generally agreed to be in road transportation.

In its simplest form, asset tracking , provides a simple position report at predetermined times, for instance, every half hour. This position report, together with the vehicle's ID is transmitted automatically from the vehicle to a central Hub station without driver or dispatcher involvement. The Hub station forwards the message to the dispatcher and or vehicle owner by terrestrial means. The major benefit is that the dispatcher or vehicle owner knows where his vehicles are at all times. Benefits to fleet operators such as car rental companies, truck fleet operators and emergency response units are obvious. The position report is usually derived from a GPS receiver mounted on the vehicle. The mobile satellite messaging terminal takes the digital position report, formats the message appropriately and transmits it in a burst to the Hub. In a typical system many thousands of vehicles will share a single satellite channel in some form of shared access scheme. Simple systems will use ALOHA random access, while more sophisticated systems will derive their transmit burst times from a forward link carrier.

More sophisticated fleet management systems will provide messaging capabilities beyond simple position reporting. The next stage of complexity might add the transmission of pre-programmed messages to or from the vehicle. These might include routine messages tailored to a specific business eg "Pick up next load at customer X", or "phone for further instructions."

In general, messages other than position reports will originate at both the vehicle and dispatcher ends of the link. Both asset tracking and fleet management applications require two-way messaging in order to be truly effective, although the asset tracking system could be "transmit -only" in principle.

There are a variety of types of business within the road transportation sector which can use mobile satellite messaging. They include:

Long distance haulage
Less-than-load trucking
Just-in-time delivery services
High-value cargo
Perishable goods
Courier services
Temperature-critical services
Hazardous cargo

Factors which will influence the success of mobile satellite messaging in the road transportation sector include perceived value, and improved customer satisfaction. Systems will be judged by reliability of message delivery, message latency (real and perceived), reliability of equipment, ease of use by driver, terminal and air time charges, installation and service convenience, and most importantly one stop shopping for equipment, service, installation, billing and application software.

Mobile terminal costs will decrease from the present $3000-$4000 to under $1000 in the next 18 months. Fig (3) shows a Calian-manufactured

terminal developed for INMARSAT's Standard-D global mobile messaging service. Similar terrminals may be applicable for North American use.

It is believed that users may be willing to pay $50 -$100 per month per vehicle for air time.

For several years now fleet management and asset tracking have been operating in North America using cellular telephones, land mobile radio and mobile data networks such as RAM Mobile Data.

Mobile satellite messaging has the advantage of ubiquitous and seamless coverage but must be sensitive to air time charges in order to compete effectively. We can also expect to see hybrid satellite-terrestrial systems built. In these, terrestrial radio links may be used to carry the messaging in urban areas and/or where radio coverage is available and satellite links used in unserved areas.

The potential market for fleet management and asset tracking in North America is huge and is based on a population of over 10 million trucks.

c) Emergency Messaging Applications

In contrast to fleet management and asset tracking applications, where messaging tends to be periodic and relatively frequent, Emergency Messaging systems are designed to accommodate an extremely large user population, eg in the millions, with any individual user sending messages once or twice a year at the most. Typical users would be citizens who through age, infirmity, or fear, wish to provide themselves with the highest degree of protection against accident or incident while in their vehicle.

Emergency messaging can be used to call a variety of help including roadside repair service, police, and ambulance services.

By its very nature emergency messaging requires both a position-reporting capability and bi-directional transmission. The former allows the response unit where to dispatch the assistance, and the latter provides a channel to the driver to advise him of progress on dispatch of the requested assistance.

It may also be desirable to provide GPS positon reports to better than 100m accuracy in some circumstances. For instance, a disabled vehicle may be situated in a parking lot with several hundred other vehicles in close proximity. The response unit must isolate the specific vehicle in distress quickly and unambiguously. Some form of differential GPS is likely to be necessary in these cases, although it should not be concluded that each vehicle will be equipped with DGPS.

The satellite industry is watching closely the initiatives in emergency messaging by automobile manufacturers General Motors and Lincoln. GM offers a new optional cellular/GPS system called Onstar on its 1997 Cadillac models. Onstar units cost about $1000 US and cellular and other fees will add another $60 US cost per month.
Lincoln's Remote Emergency Cellular Unit (RESCU) system offers a touch console that confirms vehicle locations and has tow truck and ambulance icons. The RESCU system sells for $1995 US. Both systems are linked by radio to a response centre manned 24 hours a day.

If these systems prove popular automobile manufacturers may start to offer emergency satellite messaging systems as an OEM fit to lower priced vehicles at time of manufacture. As the number of units installed increases the price should fall drastically, perhaps to $500-750US to the car buyer. Users can expect to pay a low monthly subscription charge ($10?) but pay a significant fee, perhaps a few dollars, for each emergency message transacted. With a vehicle population of 80 million the North American market is one of the most attractive in the world.

Once the emergency satellite messaging system has passed the curiosity stage, designers will need to pay increasing attention to the cosmetics of their products. Users will want equipment which is unobtrusive, colour-coordinated with their vehicle, vandal and theft-proof and without unsightly wiring.

Clearly this type of business can be attractive to the service provider, but not necessarily as lucrative for the satellite owner/operator since very little space segment is needed to support a very large number of subscribers. Perhaps the real opportunities are for providers of response services such as vehicle repair services.

d) SCADA Applications

SCADA applications are typically implemented to provide telemetry or control of fixed, rather than mobile, sites. Representative applications would include electrical power grid load management, highway traffic management systems, managed billboards, and meter reading systems. The attractiveness of L-band mobile satellite systems for SCADA lies in their ability to provide consistent communications over wide geographical areas at much lower per-node costs than Ku or C-band VSAT systems.

SCADA systems can in some instances be uni-directional, particularly when used in a data broadcast mode. Most often however they will be bi-directional to permit end to end error checking of transmitted messages. This is essential in many applications.

Generic Terminal Design

A generic terminal design which will apply to many of the two way messaging applications described above is shown in Fig (4).

The antenna is typically a low gain (1-6dB) microstrip patch, 2-4 inches in diameter, with a low-noise amplifier (NF<1dB). The transmitter will probably be sized in the 0.1 to 1 W power range to support data rates of 100-1000 bps. Both transmitter and receiver will be frequency-synthesized using the new low cost synthesizer chips from the PCS market place. Modems will be primarily power-efficient and will normally include Forward Error Correction, an ARQ protocol, and interleaving to mitigate the effects of multipath-induced burst errors. For the foreseeable future, modems will be implemented using Digital Signal Processing techniques. GPS receivers will be provided as a near-essential option to the terminal. Based on these precepts the terminal excluding the antenna will be no larger than a pack of cigarettes and consume only a Watt or two of dc power.

Future Developments

The OmniTRACS system has had a relatively long product life (1988-96) in which to mature and return its development costs to investors. This fortunate situation is unlikely to continue. Today's new systems must provide an adequate return on investment over a much shorter product life cycle, even though product volumes will be much higher than in the past.

Many new satellite systems will be launched in the next three years and will provide intense competition for existing MSAT's. The new systems will be mainly LEO's and MEO's. They will provide a wide variety of services from vehicle tracking to high speed Internet access. Many of the systems will be global. Others will be regional. Terminals will no doubt be superbly engineered with custom integrated circuits being widely employed. Hand-held terminals for personal messaging and safety applications (see Fig 5) will emerge and be available to business, government and to the public at large.

Prices will be incredibly low compared with the past especially if the high volume applications take off.

So, what will the differentiating factors be?

We believe that user-friendly applications, good terminal cosmetics, low power consumption and excellent human/machine interfaces are the key to success for the terminal manufacturer. An imaginative and flexible approach to airtime charges, plus one-stop-shopping will be essential to the success of the service provider!

	Globalstar	Iridium	Oddessey	ICO
Orbit	LEO	LEO	MEO	MEO
No. of satellites	48	66	12	10
Frequency (GHz)	1.6/2.4	1.6	1.6/2.4	2/2.2
Access	CDMA	TDD/TDMA/FDMA	CDMA	TDMA
Coverage	Global	Global	Global	Global
Service Dates	1998	1998	1998	1999

	Orbcomm	Starsys
Orbit	LEO	LEO
No. of satellites	36	24
Frequency (MHz)	138/149	138/149
Access	FDMA	CDMA
Coverage	Global	Global
Service Dates	1995/97	1998/2001

Table 3 Near Future Satellite Systems

References

1) http://www.qualcomm.com
2) http://www.calian.ca

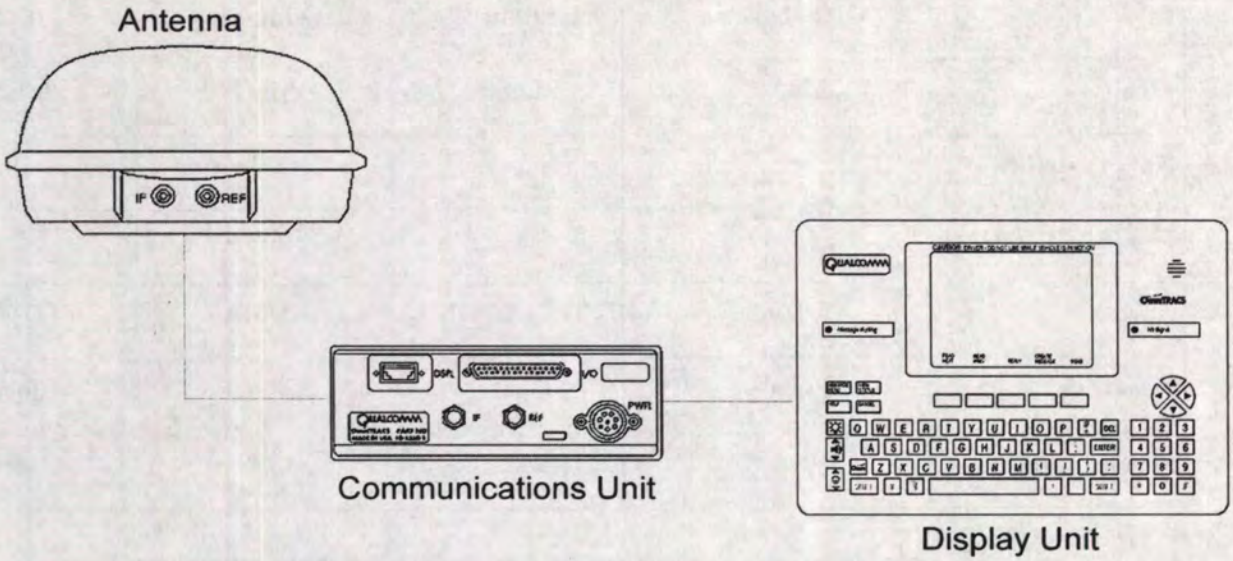

Fig 1. OmniTRACS System (1988-1996)

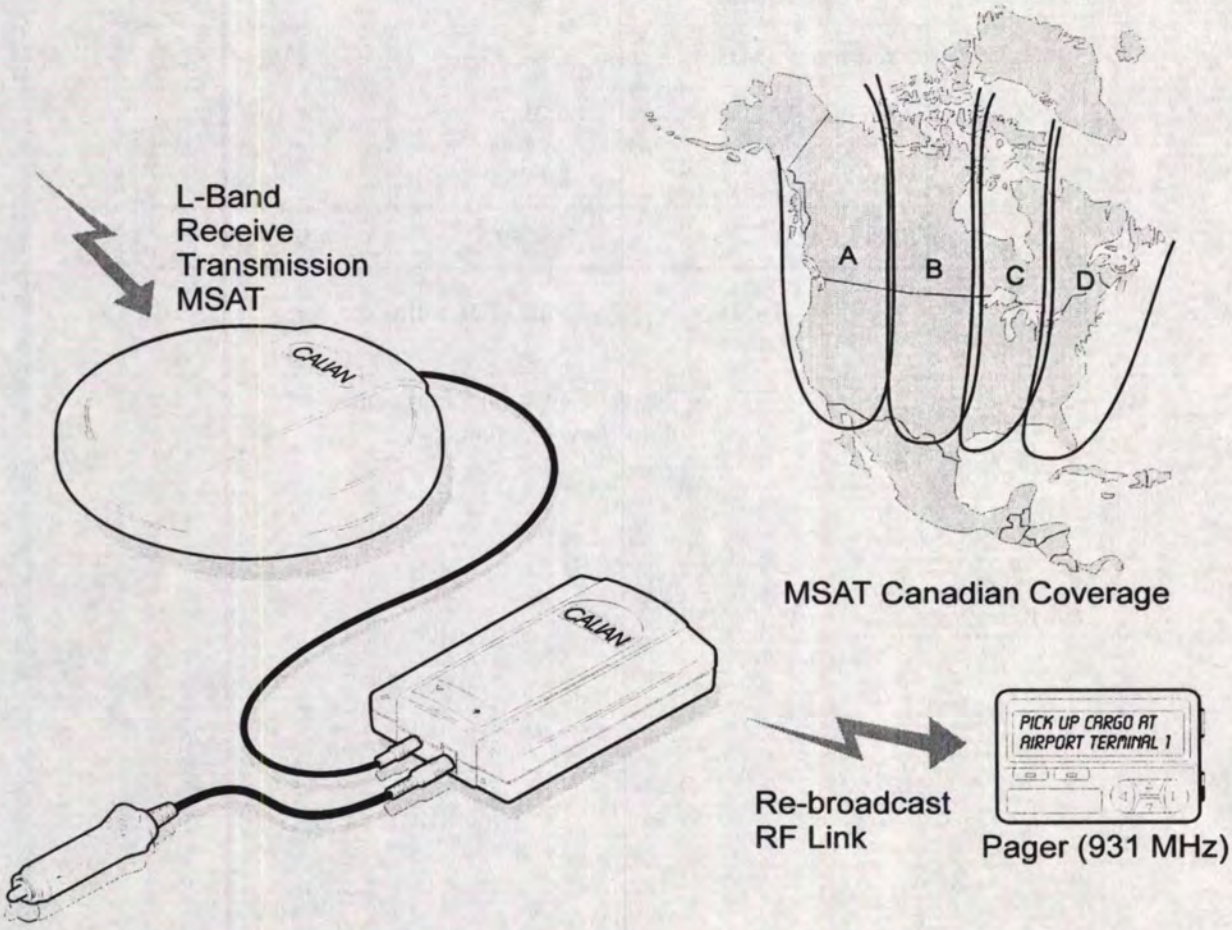

Fig 2. Calian 1-way SkyWave Paging Terminal for MSAT - 1996

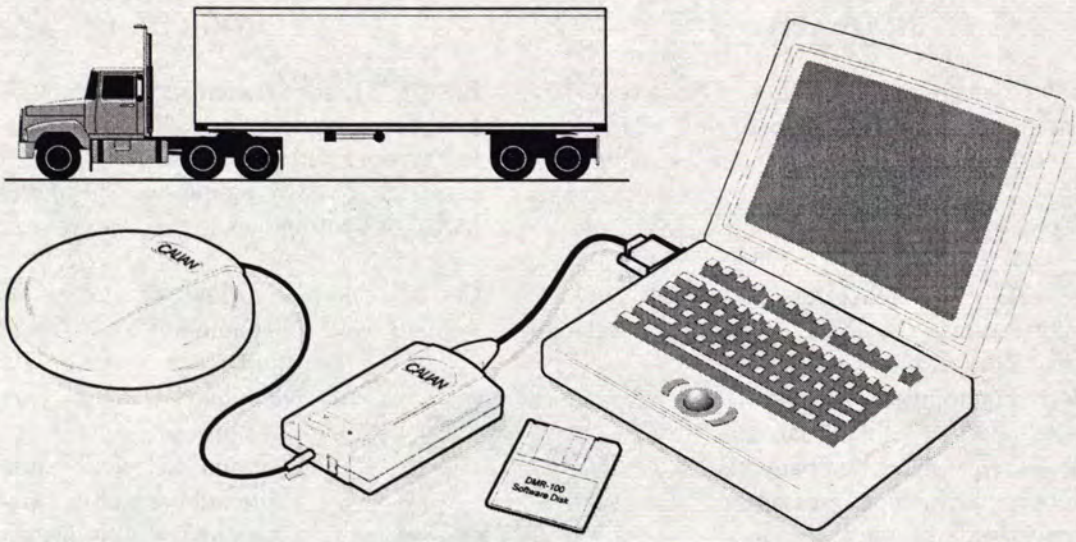

Fig 3. Calian Messaging Terminal for Inmarsat-D - 1997

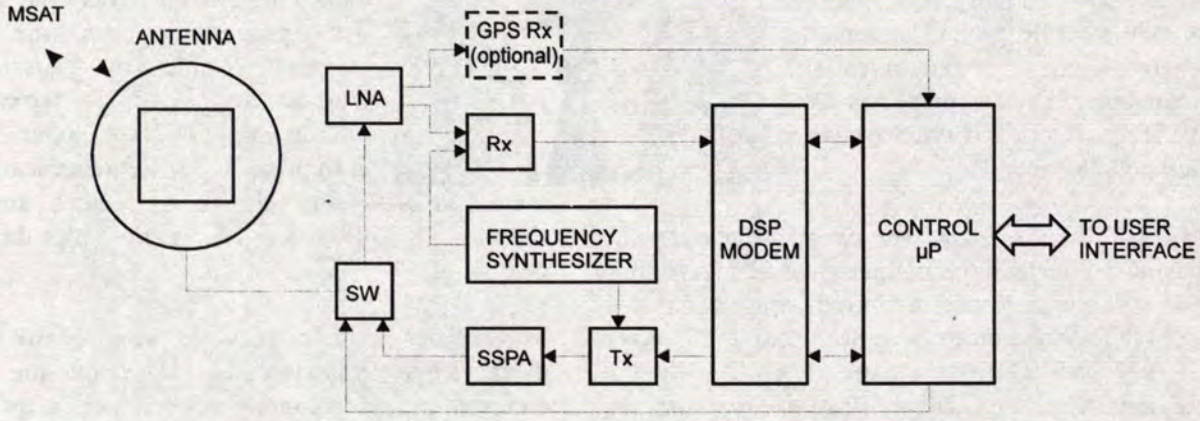

Fig 4. Generic Mobile Satcom Messaging Terminal

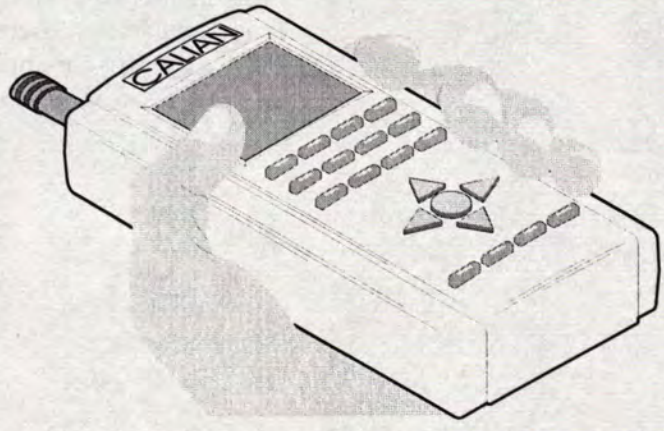

Fig 5. Future Concept Hand-Held Messaging Terminal

BIOGRAPHY

Larry O'Brien founded Calian Technology Ltd. in 1982 as a one-man consulting company, and for the past fourteen years has been responsible for strategic planning and overall business development.

Calian designs, manufactures and markets satellite communications systems, provides related technical outsourcing services and develops communication terminal products for mobile satellite applications. The company is developing low cost messaging terminals for use with the next generation communications satellites and is active in technical outsourcing on programs such as Radarsat. Calian also markets mobile satellite ground systems to international communications companies. The commune has sales of $58 million and employs over 400 people.

Mr. O'Brien has had over twenty-four years of business and technical experience in electronics and communications since graduating in physics from the Algonquin College School of Technology in 1972. Mr. O'Brien is currently co-chair of the Regional Economic Diversification Opportunities (REDO) committee. In 1994, Mr. O'Brien was elected the Chairman for the Canadian Advanced Technology Association.

BIOGRAPHIE

En 1982, Larry O'Brien fonde Calian Technologie Ltd., la société d'un consultant unique, et, pendant les quatorze dernières années, il est chargé de planification stratégique et de développement global des entreprises.

Calian conçoit, fabrique et met en marché des systèmes de télécommunications par satellite, fournit des services d'impartition technique connexes et met au point des produits de terminaux de communication pour les applications mobiles par satellite. La société produit des terminaux de messagerie à prix modique pour la prochaine génération de satellites de télécommunications et est active dans l'impartition technique pour des programmes comme le Radarsat. Calian met aussi en marché des systèmes terrestres mobile de satellite pour des entreprises de communications internationales. Son chiffre de ventes annuel s'élève à 58 millions $ et elle emploie plus de 400 personnes.

M. O'Brien possède plus de vingt-quatre ans d'expérience commerciale et technique en électronique et communications depuis qu'il a obtenu son diplôme en physique de l'école de Technologie du Collège Algonquin en 1972. M. O'Brien est présentement coprésident du Programme de diversification des occasions économiques à l'échelle régionale (ODÉR). En 1994, il est élu président de l'Association canadienne des technologies de pointe.

POSITIONING TECHNOLOGIES FOR ITS NAVIGATION SYSTEMS
TECHNOLOGIES DE LOCALISATION POUR LES SYSTEMS «ITS»

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ABSTRACT

The majority of the Automatic Vehicle Location and Navigation (AVLN) systems have flourished within the last decade as a result of the development of various positioning technologies such as the Global Positioning System (GPS) and other terrestrial systems such as paging, cellular and FM radio signals. AVLN system developers and integrators now have to consider a multitude of options regarding the positioning technology contained in their system. Positioning, communications and map databases are being integrated into complete systems solving specific problems of buyers. The authors have identified about 300 systems-products available worldwide (see the World Wide Web: http//www.navnet.com).

The paper gives an overview of the current positioning and navigation technologies. A description of the primary positioning and navigation devices used in AVLN is given. A numerical analysis of the different positioning techniques used in the different AVLN systems developed worldwide is also given. The paper shall serve as an introductory guide to those who intend to know about AVLN system positioning and navigation.

Positioning Technologies for ITS Navigation Systems

INTRODUCTION

AVLN systems are classified into four types: Autonomous, Fleet Management, Advisory and Inventory (1). Autonomous systems are stand-alone vehicles with an on-board positioning device and a map database. No communication link is available with the outside world. Fleet management systems, on the other hand, consist of fleets of vehicles linked to a control center via a communications link. The control center may be responsible for the transmission of the necessary information from the database to the vehicle on call. Generally, fleet management systems are for groups of vehicles controlled by a dispatch center such as police cars and ambulances.

An advisory navigation system is a blend of autonomous and fleet management architecture. It is an autonomous system in the sense that it is not controlled by a dispatch center, yet it is a part of a fleet that is being served by a traffic control center. Advisory system vehicles receive updated information regarding traffic and weather without the control center being able to identify them. Finally, an inventory system usually includes autonomous vehicles equipped with video or digital cameras to capture time and coordinate tagged site information necessary for road inventory or any other surveillance purposes.

Regardless of its type, an AVLN system encompasses some kind of a positioning and navigation device which may be anything from a wheel-mounted sensor to a satellite signal

processor. Discussed in the following sections are the principal types of positioning and navigation sensors and techniques used in the different AVLN systems developed worldwide. A detailed description of each of the positioning and navigation technologies with some illustrative examples of AVLN systems is given. That is followed by summary statistics on the number of systems employing each of the different techniques.

AVLN POSITIONING TECHNOLOGIES

Presented in the following sections are the primary positioning technologies used among the different AVLN systems. These techniques include dead reckoning, satellites, terrestrial radio-frequency and map-aiding.

Dead Reckoning

Odometers

Odometers are basically used to determine distance traveled over a period of time. The difference in distance traveled by a pair of wheel odometers over a period of time can be used to determine a change in heading. Taxis have been the largest users of precise vehicle odometers in the past, as their fares are often based on distance traveled. In this case a precise odometer had to be retrofitted to the vehicle as an after market product. Many of the new vehicles with anti-lock barking systems provide an output directly with no additional sensors required.

Odometers are used in singles or in differential mode. Single odometers are typically of the transmission type and are mounted where the speed odometer cable connects to the transmission. Distances are computed by observing the pulse count detected from speed odometer transmission output and by multiplying these pulse counts by a calibration value representing pulse counts per distance traveled. The calibration value tends to change quite slowly varying with velocity, tire pressure and the coefficient of friction of the tire to the road. Reverse motion is detected externally by connection to a back-up light switch.

Differential odometry, on the other hand, involves three odometers mounted on two wheels of the non-driven wheel pair measuring the traveled distance, heading change, and forward-reverse motion detection. Distances are computed by observing the number of pulses detected from targets affixed to, and equally spaced around, each wheel and by multiplying these pulse counts by a calibration value representing pulse counts per distance traveled.

Compass

Compasses have been used for decades for providing an absolute heading for marine and airborne applications. These applications typically operate in areas that are free from external magnetic disturbances. Once the system has been installed and calibrated, it then can be used with in-frequent calibration updates and adjustments. An electronic compass, which measures the direction of the vehicle in relation to the earth's magnetic field, gives information about the heading of the vehicle. An electronic fluxgate compass contains transducers that convert a magnetic flux into voltage. The compass heading can be used when other sources of heading are unavailable or unreliable; for example GPS-derived heading is interrupted or degraded by tall buildings or poor satellite coverage.

Compasses were installed in early AVLN systems by a number of companies. Great efforts were made to continuously calibrate these sensors to account for the often rapidly changing external effects. The sensors were satisfactory for rough navigation but proved unsatisfactory for mass market AVLN applications. Compasses are sensitive to external magnetic field disturbances such as bridges, railway tracks and overpasses. Spurious readings as large as 180° are therefore often encountered. Tests have shown the presence of large errors due to the operation of power windows and air conditioning. Accordingly, most AVLN system developers have abandoned using compasses in their systems. New low cost compass engines, however, are being used in aircraft and in

marine applications where external effects are minimal.

Rate Gyro

Most companies supplying dead reckoning solutions in today's AVLN market have either switched to rate gyros or are planning on it in the future, for angular velocity measurements. The basic requirements for a rate gyro for automotive applications are: mass production, low cost, resistance against environmental influences (e.g. temperature and vibrations), stability of all characteristics over time, high reliability and designed-in safety. The US manufacturers have typically been involved with large military or aviation contracts where accuracy, size and weight have been the prime factors. As military developments have declined in the past several years, these companies are now focusing their efforts on the civilian markets. The demands on accuracy are orders of magnitude less, however the demands on cost are also orders of magnitude less as well.

Satellite Positioning

GPS is the first truly global utility offering positioning and navigation information to land, marine and airborne users. Other satellite positioning systems include Geostationary Earth Orbit (GEO) satellites, Low Earth Orbit (LEO) satellites, Medium Earth Orbit (MEO) satellites and Highly Elliptical Orbit (HEO) satellites.

Global Positioning System (GPS)

GPS is a 24-hour, all-weather satellite positioning system available free of charge to all users. The system is owned and operated by the United States Department of Defense (DOD) at an initial cost of $15 Billion dollars to the US tax payer. The system comprises 24 positioning satellites enveloping the Earth at an altitude of approximately 20,000 kilometres transmitting signals downwards at 1.6 GHz (2).

With a GPS receiver, now costing as little as a few hundred dollars, you can receive data on the position of the satellites, measure the ranges to them, process the information, and compute coordinates and velocity vector (heading and speed) as frequently as every second (some high performance GPS receivers can compute positions at a rate of 10 Hz or higher). This capability has revolutionized the positioning and navigation market place and GPS related products have mushroomed all over the world to fulfill the needs of an expanding position-related industry, which in North America is conservatively estimated at $20 billion over the next decade.

There are some pitfalls to this panacea. First, GPS is a military system, hence it is viewed with a great deal of skepticism by the European community, who have been threatening for the past decade to launch a purely civilian positioning and navigation satellite system. Nevertheless, companies from all over the world have literally jumped on the bandwagon and have invested heavily in building GPS receivers and related products - albeit using a US military system. Secondly, the system accuracy is purposely degraded under the DOD action called Selective Availability (SA) which denies the full capability of the system to unauthorized users. The effect of SA is to degrade the ephemeris of the satellites, as well as dithering the satellite clock thereby adding unwanted errors - all of which seriously degrade the positioning accuracy. The standard GPS positioning service with the effect of SA provides horizontal positioning accuracy of 100 m and vertical positioning accuracy of 156 m 95% of the time.

To overcome the effect of SA, Differential GPS (DGPS) has been extensively used. DGPS improves the positioning accuracy to about 1 to 10 meters. This is achieved by setting up a reference (or base) station over a point of known coordinates to continuously compute the errors in the respective satellite measurements. The calculated measurement errors are then transmitted, along with the respective satellite ID, by a communication device to a remote user, who then uses them to correct their own ranges made at the remote site.

Differential GPS has been implemented in various forms over the last few years. Two distinct types of DGPS have been identified; namely, Local Area Differential GPS (LADGPS) and Wide Area

Differential GPS (WADGPS). Both LADGPS and WADGPS are typically pseudorange-based differential GPS implementations with positioning accuracy in the range of 1 to 10 meters (3). The leads to the question - *Who needs an accuracy of 1 to 10 meters* ?. Firms involved with regional and wide area tracking of trucks may not, but an ambulance service responsible for navigating to an address of a 911 emergency call (heart attack victim) does. Also, coordinate tagging of road related information such as curb-lines, catch basins, roadside obstructions, valves and the like need to be performed to an accuracy commensurate with DGPS standards. Geographic Information Systems (GIS) containing coordinate tagged data need DGPS. The agricultural industry are sold on this DGPS for scientific and precision farming. As users become more familiar with GPS they will naturally demand a higher accuracy.

In addition to LADGPS and WADGPS, during the last year a number of manufacturers have developed the Real Time Kinematic (RTK) technology using carrier phase observations. RTK typically requires dual frequency receivers to reliably fix the ambiguities and yield centimeter level accuracies. RT-20 technology has been developed using precise pseudroranges and carrier phase measurements using single frequency receivers. Accuracies in the order of 20 cm are achievable.

Global Navigation Satellite System (GNSS)

The Global Navigation Satellite System (GNSS) is a European project intended to become the navigation tool for air, land and marine in the 21st Century GNSS is intended to distinguish generic satellite positioning and navigation from GPS (and the Russian counterpart GLONASS) military owned system. In other words, when Europeans and Japanese address civilian based satellite positioning and navigation systems, it is to GNSS which they refer. This begs the question - *how then does GNSS differ from GPS* ? To answer this question, one must state first that there are two GNSS systems-GNSS1 and GNSS2; each are described immediately below.

GNSS1 is essentially GPS augmented with GEO communication satellites. The time frame given for the development of GNSS1 is 1994-99, while GNSS2 will be studied and analyzed over the period 1994-97, with its design and development taking place later; it would replace GNSS1 in about 10 to 15 years. GNSS2, in turn, would be a new satellite system yet backward-compatible with GPS. The reasoning behind this characteristic is to be able to use the millions of GPS receivers that will have already been deployed with GNSS2. In this way, the GPS along with its military control would thereby be by-passed - a worrisome problem for many nations.

GNSS is being spearheaded by a European Tripartite Group consisting of the following political and scientific parties (4): European Commission which is looking after the political and institutional matters; European Space Agency is responsible for the implementation; and Eurocontrol is charged with validation and certification of GNSS. Another large and important player in GNSS is the European Union Group of Institutes of Navigation (EUGIN). The institutes of navigation that are presently members are from France, Germany, Italy, Netherlands, Nordic countries and the United Kingdom. The role for EUGIN is to promote a decentralized ownership and regional operation of GNSS. A small number of autonomous-interoperating subsystems, owned and operated by major players from the Far East, Europe, USA and the Arab Nations is envisioned by this organization.

Geostationary Earth Orbit (GEO) Satellite Positioning Systems

Orbiting at altitudes of 36,000 kilometers in synchronization with the earth's rotation, GEO satellites remain approximately over the same locations on the earth's surface near the equator. Due to their vast distance above the earth, they require relatively large antennas at the earth mobile terminal to send and receive signals, making the equipment somewhat bulky. This technology is effective for AVLN applications that require wide-area coverage; however, the equipment and services are relatively costly. A typical Mobile Terminal (MT) is about 18"x12"x4" and weighs three or four pounds. Qualcomm and AMSC sell their MT's for about US$5,000.

Inmarsat, one of the first providers to enter the satellite business, offers worldwide coverage except in the extreme polar regions. Inmarsat employs four satellites with the following services: Inmarsat A/B, which handles voice , telex, and data: Inmarsat M, which handles voice and offers fax and data capability; Inmarsat C, which handles telex and data messaging; and Inmarsat E, which provides the EPIRB (emergency position indication radio beacon) distress signal. Inmarsat has also been used as an interim solution for those AVLN applications awaiting future communication satellite launches. Inmarsat has not offered inherent positioning, but they are launching new satellites that will offer a kind of quasi GPS service called *GPS Overlay*.

Another provider, AMSC, offers a service called Sky-Cell. Signals are carried in the L-band which operates on frequency of 1635-1600.5 MHz at 300 bits per second (bps) from the subscriber to the satellite and 1530-1559 MHz at 600 bps from the satellite to the subscriber. Coverage includes the continental Untied States with 200 miles of coastal water, Puerto Rico, and the Virgin Islands. AMSC does not offer inherent positioning yet, however, they plan to in the future. At the present their MT's are equipped to work with GPS receivers.

One of AMSC's partners, TMI communications, owns the MSAT satellite (yet to be launched), which is a twin of AMSC's Sky-Cell satellite; this will give each service provider a back-up system. Each backup can support as many as 3,200 radio channels.

AVLN systems that use GEO inherent positioning include Qualcomm's Omnitracs (and its French relative, Alcatel-Qualcomm's Euteltracs), TMI's Roadkit, and AMSC's Sky-Cell Fleet Management. These systems offer inherent positioning services but can also be interfaced to external positioning device (GPS sensors, for example) for more accurate positioning. Some other geostationary satellite communications-based systems without inherent positioning services that can accommodate GPS or other positioning sensors are the SNEC VTS (SNEC, France), GEC-Marconi's Star-Track, an airport vehicle tracker from GP&C (Sweden), and Rockwell's Satellite Communication System.

Low Earth Orbit (LEO) Satellite Systems

Although geostationary satellites offer solutions today, the spotlight has switched to a development of the future - the race to deploy full LEO constellations that will provide global, low powered, low cost, handheld communications. Unlike high-orbit geostationary satellites, LEOs orbit at distances of less than 2,000 kilometers.

The only LEO-based AVLN system ready for market is the Orbcomm system, which works in conjunction with its respective communications system. Many companies with AVLN systems claim to be compatible with future LEO networks. Orbcomm's plan calls for 34 satellites. Communications from satellite to subscriber is on a VHF channel at 137-138 MHz at 4,800 bps; from subscriber to satellite, communications are on VHF 148-150.5 MHz at 2,400 bps. Companies from 20 countries have signed up as service providers. Orbcomm's strategy is to convince its resellers to work with system integrators to develop end user systems.

Medium Earth Orbit (MEO) Satellite Systems

Medium Earth Orbit satellites are at altitudes of roughly 8,000 km. No MEO satellites have yet been launched, but at least two are in the planning stage, and both will offer inherent position and tracking services. A constellation of MEOs called Odyssey is in the design stage. Teleglobe and TRW are envisioning 12 satellites in space by the year 2000. Teleglobe claims that MEOs are the optimum constellation: lower power than geostationary; less satellites to provide global coverage than LEOs; overall more economical. Another constellation by Ellipsat called Ellipso will incorporate MEO and Highly Elliptical Orbit (HEO) technology.

Highly Elliptical Orbit (HEO) Systems

A constellation of HEOs, called Archimedes, has been designed by the European Space Agency. These satellites will have a 1,000 kilometers altitude at the perigee (near the earth) and 26,800 kilometers at the apogee (far from the earth). This

design is supposed to provide higher vertical angles to the satellite, which is good in urban canyons. The European Space Agency claims that HEOs will provide satisfactory angles in cities and have large enough capacity for television to be beamed into cars, and provide personal communications. However, some experts doubt this claim.

The Archimedes satellite system consists of a constellation of four satellites in 12 hour Molnyia orbits. Each satellite hovers for six hours per day over Europe at an elevation angle of greater than 70 degrees. By spacing the satellites in orbit planes 90 degrees apart, full 24-hour coverage is provided. By using HEO orbits, a high elevation angle line-of-sight path between the mobile user and satellite can be maintained, even at northerly latitudes where signal fade and blockage will disrupt transmissions to and from a GEO satellite. The system has the potential for mobile positioning service. However, it has not been decided whether or not the service will be offered.

Terrestrial Radio Frequency Based Positioning Systems

Loran-C

Loran-C user equipment has matured steadily during the past 20 years. Competitiveness among manufacturers specializing in land vehicle user products appears to be healthy and their equipment already satisfies most requirements in terms of cost, reliability, ruggedness, size and power consumption. Nowadays, reliable and accurate low power Loran-C receivers packaged on a 6 in. x 6 in. board can be procured for well below $1,000 in large quantities. The availability of such user equipment may well be the strongest point in favor of Loran-C today for land navigation users.

The use of the differential Loran-C (DLC) mode, where a monitor station installed at a known location in the area of interest broadcasts differential corrections, can improve the performance of Loran-C dramatically in areas where the conductivity is fairly constant and the topography relatively flat. The most suitable environment for DLC is evidently the marine one. Accuracies of 8 to 20 m have been confirmed by the U.S. Coast Guard. DLC for land navigation cannot, however, deliver the above performance except in areas relatively close to the monitor due to ground conductivity and spatial weather variation effects. The use of some of the above combinations would likely result in a level of accuracy of the order of 50 to 100 m.

Paging

Paging based systems are being considered more and more in the urban areas as an economical and efficient way of providing fleet management for multiple groups of end users. The reasons for its popularity are the low cost of two way paging, the convenience of both positioning and data communication, and the existence of paging systems which, with minor adjustment, can be quickly and inexpensively used in this manner. Below, a few systems are presented as examples of the way in which this technology is being implemented.

Airtouch Teletrac Systems Inc. of Garden Grove, California previously PacTel Teletrac Systems Inc. has developed a fleet management system, called *Fleet Director*, based on paging as its method of communication. The system was first introduced in 1992 and they are now marketing a second generation model. Airtouch is currently marketing both OEM and retrofit versions of its hardware which target commercial and government fleets as well as private consumers. They claim to be the largest provider of metropolitan based fleet location and information services in the world including cities like Los Angeles, Detroit, Chicago, Dallas, Houston and Miami with over 35000 users in these cities and over 5 million vehicles and messages per month. The company has Federal Communications Commission (FCC) licenses to operate in 140 of the largest US metropolitan areas.

Pinpoint Communications has also developed a fleet management system called ARRAY. This system was first introduced in 1992. Their only known current strategic alliance is with Westinghouse, USA. Pinpoint has obtained licenses from the FCC to operate in Atlanta, Baltimore, Boston, Dallas, Detroit, Fort Lauderdale, Houston, Miami, Minneapolis, Oakland, Philadelphia, Phoenix, San Diego, San Francisco, San Jose, St. Louis and Washington DC.

Fort Worth, St. Paul and Los Angeles are expected to be added soon.

In addition, Advanced Systems Research Party LTD. with Lend Lease Corporation LTD of Australia has developed a paging system based fleet management system. Advanced Systems Research Party is a division of British Aerospace Australia Ltd. The system is marketed under the name Quicktrak and was first announced in 1987. They are currently marketing a first generation system. The Quicktrak system was intended originally for fleet management but has spread into personal and home security in which alarms cannot be disabled by cutting phone lines, to monitor and report meter readings, or low inventory and faults in dispensing machines.

Finally, Galaxy Microsystems has developed an AVL system based on pager type technology. They were intending to run a pilot test program in Austin Texas with the assistance of Mark IV Eagle Signal, Austin Metro Group, the University of Texas Transportation Department and the Texas Department of Transportation.

Cellular

There are more than 24 million analogue cellular phone users in the United States alone. Therefore, Cellular based location systems must be considered. Most emergency response agencies are capable of determining the location of 911 call made by a telephone on a land-line network. However, there are no established systems that are capable of determining the location of a caller from a wireless phone. It is expected that by the summer of 1996 the FCC in the U.S. will require that all cellular phone providers know the position of a caller to within a quarter of a mile. If the FCC proceeds with this regulation, it is expected that Canada will follow. The emergency 911 market is driving the emergence of cellular positioning technology.

Because of its wide acceptance and coverage (for example, over 90 percent of the entire U.S. population and 60 percent of the geography), cellular technology has attracted significant interest in the AVLN marketplace as a convenient way to transmit data over the air. According to an Owner-Operator Magazine reader survey (Jan/Feb 95) of 3319 drivers throughout North America, in the trucking industry over 53% of owner-operators utilize a cellular phone for business purposes in their truck. Of those who do not own a phone, 85% are planning a purchase in 1995-6. Complete two-way voice (67%) is the highest rated single feature that owner operators want in mobile communication and information system. Most drivers (62%) expect to pay between $50 and $200 a month for a mobile communications system with complete voice and data capabilities.

Two types of cellular positioning calculations are used: Time Difference of Arrival (TDOA) and Direction Finding. The former uses time measurements from at least four receiving towers to define the intersection of three curves, which is the position of the caller. The second method uses at least two (but usually more) towers equipped with direction sensitive antennas which point in the direction of the incoming call. The intersection of two directions defines the position of the caller. For TDOA measurements it is very important to use narrow correlator technology to determine when the signal has actually arrived; because the signal is a distorted analogue signal, it is difficult to determine when the same part of a signal has arrived at different receiving towers. For both types of position determination, sophisticated filtering is used to distinguish between multi-path components of the signal.

An example of the Direction Finding type of cellular system is the Direction Finding Localization System (DFLS) by KSI, Annandale, Virginia, USA. The system is designed to calculate the location, speed and heading of a wireless phone caller to a 911 service. The Cell-Loc System by Cell-Loc, Inc. from Calgary Alberta, on the other hand, is a Time Difference Of Arrival (TDOA) system capable of achieving accuracies of under 120 metres. The hallmark of the Cell-Loc system is the super resolution technique used to combine multi-path elements of a signal and determine the precise time of arrival of the main element of the signal. For position determination, at least four different receiving towers are required, where four time of arrival measurements are made. These four time measurements define three hyperbolas. The

intersection of the three hyperbolas defines a position. For a position accuracy of 100 meters, the time measurements must be made to within microseconds . accuracy. Cell-Loc uses GPS receivers for timing at each cellular tower.

Amplitude and Frequency Modulation (AM and FM)

There was a great interest in this area of positioning technology in the late 1980s. This was because AM and FM based radio was used commercially everywhere and the modifications required to implement these systems was very cost effective. There is no longer much interest in this area because of several technological advances which have been made in the area of positioning such as GPS in particular. There is still some interest in this technology as far as a one way communications method to transmit traffic and parking information to vehicles.

Terrapin has developed and patented a chip set called PINS (Position, Information, and Navigation System) which can in incorporated in other communications products such as cellular phones. They have no currently marketed product and are looking to get their product incorporated into someone else's product. Terrapin is promoting it chip set as ideal for use in a wide variety of applications such as Mobile 911, vehicle navigation, stolen vehicle recovery and fleet management. The chip set is very inexpensive and is expected to be found in many applications in the near future.

The Volkswagen Company of Germany, on the other hand, developed an FM based locator system in 1989 called the Volkswagen FM. The company has been involve in the development of several other systems, one being the Autoscout by Siemens. This system was developed for use as a personal navigation unit.

Cambridge Research, in partnership with Lynxvale of the UK, has developed a system using terrestrial bases AM/FM radio signals. they are marketing this product in the UK as CURSOR. They are targeting fleet and container management, position monitoring of emergency vehicles and personnel, in-vehicle navigation and vehicle security as their primary markets. They did beta testing of the latest model in August of 1995.

Map-Aided Navigation

Address Matching

Often called geocoding, address matching is the process of determining a street address given a latitude and longitude, or vice versa. Most people do not know the coordinates of their destination, so to navigate to an address, the address must be converted to coordinates. Address matching requires street names and address ranges as attributes of the roads in a digital road map. The roads and intersections in a digital road map must be stored using a co-ordinate system that can be related to the coordinates output from positioning systems, such as WGS-84 ellipsoidal or UTM mapping plane coordinates. Given a latitude and longitude then, the nearest road is found. The address ranges are most often stored for links between two adjacent intersections. A particular address is found by linear interpolation between the address numbers of two intersections. Note that different address ranges must be stored for each side of the road.

Map Matching

The assumption behind map matching is that the vehicle is on a road. When a positioning system gives coordinates that not exactly on a road in the digital road map, the map matching algorithm finds the nearest road and 'snaps' the vehicle onto the road. As the vehicle travels, changes in direction and distance traveled are used to determine the shape of the route traveled, and this shape can be used in matching to the road network in the map. A good map matching algorithm relies on maps with high positional accuracy, generally better than 30 m to minimize incorrect road selections. Also, for map matching to be robust, the roads in the map must be topologically correct so that they reflect the real world. If a road traveled is not shown in the map, the algorithm will get confused since it will not consider the route valid.

Map matching is a pseudo positioning system which can return a position based on the coordinates and the azimuth of the road being traveled. There are times when the position

obtained by map matching is more accurate than that obtained by the positioning sensors themselves, so the map matched position can be used in the position determination algorithm, whether a filter or a weighted mean. In dead reckoning, where sensors are used to measure distance traveled and heading to compute relative change in position, map matching is critical to obtaining absolute coordinates.

Best Route Calculation

In the pre mission phase of vehicle navigation, a user may wish to plan the route and have assistance in determining the optimal route to travel. A digital road map coupled with a best route calculation algorithm can provide an optimal route based on travel time, travel distance or some other specified criterion. The results of the best route calculation would be turn-by-turn driving instructions from the initial location to the destination. Again, this is a function that requires a high level of map information.

Route Guidance

Once a route has been determined by the driver or the best route algorithm, the navigation system must guide the driver along the route. Route guidance can be given pre-mission or real-time. Pre-mission route guidance consists of a printout of door-to-door turn-by-turn driving instructions that include street names, distances, turns, and landmarks. Real-time route guidance is much more useful, and much more demanding in terms of software. As the vehicle travels, each position must be geocoded to a location in the digital road map so that the route guidance algorithm knows where the vehicle is in the route. As a turn or manouver approaches, the algorithm must alert the driver, with audible or visual signals, and then indicate when the manouver is to be performed. If all goes well, the vehicle will continue along the planned route. If the driver misses a turn or manouver, the position reported will result in a location that is off of the planned route. If this occurs, the route guidance algorithm must invoke the best route calculation algorithm to compute a new best route to get from the current location to the destination. Route guidance would then resume along the new route.

SUMMARY STATISTICS ON AVLN POSITIONING TECHNOLOGIES

The IVHS Navigation Systems Database v5.0c was used to produce the summary statistics of the count of AVLN systems developed worldwide using the primary positioning techniques shown in Table 1. The database contains information on 282 AVLN systems developed worldwide covering a wide range of aspects including general system information, company and contact names, addresses, phone and fax numbers, target market, positioning technology, mapping technology, communications and computer hardware and software.

Statistics show that 69% of the systems developed worldwide since 1975 to 1996 use GPS among their positioning sensors: 79% of North American systems, 54% of the Japanese systems, and 50% of the European systems. Dead reckoning techniques are prominent in Japan with a rate of 62% of the Japanese systems, whereas only 21% of the North American Systems use dead reckoning. Nevertheless, systems using dead reckoning in North America exceed those in Japan; 36 and 23, respectively. Dead reckoning systems constitute 33% of the worldwide total number of systems.

Terrestrial radio frequency positioning has been used more extensively in North America and Europe than in Japan; 14% of the North American and European systems use terrestrial radio frequency positioning, versus only 3% of the Japanese systems. Only one Japanese system has been reported to be using this technology. Map matching, on the other hand, is more popular in North America and Japan than in Europe. Eight North American 18 Japanese systems use map matching (10% and 49% of the respective total number of systems).

CONCLUSIONS

Many believe that GPS-based positioning is the end to all ITS navigation systems. Clearly, it is just the beginning as many alternative positioning technologies are emerging both of satellite-based and terrestrial-based. The most promising satellite systems are the LEOs while the most promising terrestrial positioning alternatives

are cellular and paging based systems. The reason for this is that they are two-way systems and have the positioning and communications functions combined into one unit with the same infrastructure.

Table 1 **Summary Statistics**

		GPS	Dead Reckoning	Terrestrial Radio Frequency	Map Matching
America	*Total*	139	36	25	18
	%	79	21	14	10
Japan	*Total*	20	23	1	18
	%	54	62	3	49
Europe	*Total*	32	32	9	13
	%	50	50	14	20
Other	*Total*	4	2	1	1
	%	67	33	17	17
Worldwide	*Total*	195	93	36	50
	%	69	33	17	23

A total of 282 AVLN systems from 1975 to 1996 reported

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BIOGRAPHIES

Mohamed Abousalem is a Senior Geomatics Engineer at NCS International Inc., Houston, Texas, USA. He obtained his B.Sc. in Civil Engineering from Alexandria University, Egypt, and M.Sc. and Ph.D. in Geomatics Engineering from The University of Calgary, Canada. Dr. Abousalem is
involved in the design and development of geomatics software as well as devising, documenting and implementing appropriate training programs for NCS staff and clients. His areas of expertise include GPS positioning and navigation system development, Kalman filtering techniques, statistical testing and quality control of integrated navigation systems.

Edward J. Krakiwsky is Professor of Geodesy and Vehicle Navigation, The University of Calgary. In 1979 he founded the Department of Geomatics Engineering, UofC. In 1992, he founded Intelligent Databases International Ltd. which is about to launch an online service on the internet called NavNET - one stop shopping for information on GPS, tracking, and navigation systems and products available worldwide. His traditional areas of expertise are in modeling, quality control and filtering in kinematic positioning and Automatic Vehicle Location systems. He has written one textbook; three electronic books on land, marine and air navigation systems; and published 80 scientific papers. Presently, he is a writer for GPS World and ITS World Magazines in the USA. Dr. Krakiwsky is a consultant to several national and international firms and governments.

HOMESTAR - A DIGITAL SATELLITE TELEVISION SERVICE FOR ALL CANADIANS

HOMESTAR - UN SERVICE DE TÉLÉVISION NUMÉRIQUE POUR TOUS LES CANADIENS

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ABSTRACT

Shaw DBS Ventures was established by Shaw Communications to provide satellite services to Canadian households. One of its first initiatives was the filing of a license application for a Direct-to-Home (DTH) digital satellite television service (HomeStar) with the Canadian Radio-Television and Telecommunications Commission (CRTC) on June 12, 1996.

If licensed, HomeStar will use fully addressable digital set-top technology to offer Canadians first-class picture and sound quality and service. Packages designed to maximize consumer choice will offer a broad range of conventional, specialty, pay and pay-per-view television and digital audio services in English, French and other languages such as Italian, Chinese and Inuit. With 77 of its 92 channels dedicated to Canadian programming, HomeStar will be distinctly Canadian.

HomeStar will also provide significant community benefits including: offering schools in remote and isolated areas of Canada free satellite receivers and educational programing; allocating two percent of its gross revenues to support the programming initiatives of Television Northern Canada if this proposal is accepted by the CRTC; and allocating an additional three percent of gross revenues to an independently administered production fund to assist Canadian programming.

By 2005 there could be up to 2 million DTH subscribers in Canada. Currently demand is being met by U.S. satellite services such as DirecTv and

RÉSUMÉ

Shaw DBS Ventures a été établie par Shaw Communications pour fournir des services par satellite aux domiciles canadiens. Une de ses premières initiatives a été de présenter une demande de licence pour un service de radiodiffusion directe à domicile (SRD) (HomeStar) au Conseil de la radiodiffusion et des télécommunications canadiennes (CRTC), le 12 juin 1996.

Si la licence est obtenue, HomeStar utilisera la technologie du « set-top » numérique entièrement adressable pour offrir aux Canadiens une image, une qualité sonore et un service de première classe. Des groupages d'émissions conçus pour maximiser le choix du consommateur offriront une vaste gamme de services audionumériques et télévisuels conventionnels, spécialisés, ainsi que des services de télévision payante et de télévision à la carte en anglais, en français et dans d'autres langues comme l'italien, le chinois et l'inuit. Avec 77 de ses 92 voies consacrées à la programmation canadienne, HomeStar sera incontestablement une entreprise canadienne.

HomeStar offrira également des avantages importants à la communauté : elle offrira gratuitement à des écoles des régions éloignées et isolées du Canada des récepteurs de signaux de satellite et une programmation éducative; elle affectera deux pour cent de ses revenus bruts au soutien des initiatives de programmation de Television Northern Canada, si cette proposition est acceptée par le CRTC; et elle affectera trois

Echostar. Despite this HomeStar believes that, when given the choice, consumers will prefer a truly Canadian alternative that showcases programming services reflecting our own culture.

autres pour cent de ses revenus bruts à un fonds de production administré indépendamment pour aider la programmation canadienne.

D'ici 2005, il pourrait y avoir jusqu'à 2 millions d'abonnés au SRD au Canada. À l'heure actuelle, ce sont les services de satellite américains comme DirecTv et Echostar qui répondent à la demande. Malgré cela, HomeStar croit que, lorsqu'ils auront le choix, les consommateurs préféreront une solution vraiment canadienne qui affiche des services de programmation reflétant notre propre culture.

HomeStar - A Digital Satellite Television Service for All Canadians

Introduction

As an active participant in the Canadian communications industry for over thirty years, Shaw Communications recognizes that a new and highly competitive era is emerging. In embracing competition, Shaw's long-term strategy is to provide a wide range of entertainment, information and communications services to all Canadians by the delivery method of their choice. We established Shaw DBS Ventures to provide satellite services. The HomeStar Direct-to-Home (DTH) application is one of its first initiatives.

In order to be competitive in the future, Shaw must invest in programming, in the delivery of programming services, and in new technology. HomeStar is but one of many competitive service offerings that comprise Shaw's core business of delivering communications, information and entertainment to Canadian homes. HomeStar will have a clear and unequivocal mandate to attract subscribers from all market segments -- including the existing cable base.

HomeStar

HomeStar's application was filed on June 12, 1996 and was heard by the Canadian Radio-Television and Telecommunications Commission (CRTC) on September 23, 1996. Utilizing the full addressability of digital set-top technology, HomeStar, if licensed, will offer Canadians the widest possible choice and control in the reception of programming services, delivered direct-to-home by satellite in both English and French.

HomeStar will be a nationally oriented, consumer-friendly service which will offer a viable competitive alternative to the rapidly expanding grey market and to all other competing delivery systems: cable, other DTH services, and alternative delivery systems such as MMDS and LMCS. As a real Canadian DTH service, HomeStar will strengthen the Canadian broadcasting system and further the objectives of the Broadcasting Act.

The three fundamental objectives of the HomeStar initiative are as follows:

1. HomeStar will offer a full range of program packages to **ALL** Canadians, no matter where they live, whether in remote areas or urban communities.

2. HomeStar will showcase licensed Canadian services. Our interactive on-screen program guide will highlight Canadian programming choices -- 77 of 92 channels will be dedicated to licensed

Canadian programming services.

3. HomeStar will give Canadians a credible, sustainable and attractive alternative to the grey market. We believe that when given the choice, Canadians will choose a Canadian DTH service.

We propose to launch the HomeStar service in 1997 and we will work with retailers of the HomeStar receivers to supply a range of program packages with broad appeal to our target market. We are confident that our service will be popular with Canadians and successful in the market.

HomeStar offers significant community benefits. First, we have committed to provide schools in remote and isolated areas of Canada with satellite receivers and a package of educational programs, free of charge, through HomeStar's "Home Room" initiative. Second, we propose to allocate two percent of gross revenues to support the programming initiatives of Television Northern Canada which is currently facing an uncertain future due to funding constraints. The remaining three percent of gross revenues would go to an independently administered production fund.

Programming

The heart of our service is its programming line-up. Canadians have made it clear that they want choice and control over their viewing options. HomeStar offers 14 different programming packages designed to maximize consumer choice.

HomeStar's program offering is distinctly Canadian. The entry level "National" package is designed to be a Canadian "life-line" service which will deliver Canada's national television networks, the parliamentary channel and this country's only aboriginal network. Subscribers will be able to select the most appropriate mix of program packages from a broad range of conventional, specialty and pay television services in English, French and other languages. In addition to providing national access for underserved linguistic and cultural minority communities, HomeStar will offer, from the outset, digital audio and multi-channel pay-per-view in both English and French. Table 1 summarizes HomeStar's proposed programming packages.

This packaging approach gives viewers maximum flexibility over their discretionary viewing options and provides Canadian services with a national window of exposure. For example, the National Plus tier will provide viewers with the Canadian national networks, a selection of Canadian independent stations and two of Canada's multicultural services, offered in English, French and bilingual versions. Viewers across Canada, from a BC logging camp to a prairie farm to Shediac, New Brunswick will be able to access the best of Canadian and U.S. network programming as well as a selection of independent services from major Canadian cities. Francophones in Dryden and Charlottetown will, for the first time, have the opportunity to view the complete range of niche programming services offered in Le Bouquet Spécialisé. Moreover, carriage of multicultural programming will provide members of Canada's cultural mosaic with national television services that are relevant to their unique linguistic and cultural needs.

Marketing

Consumers have expressed a desire for choice in service providers as well as greater flexibility in selecting the mix of services purchased. Strong demand for DTH service is already evident in Canada. As shown in the research filed with our application[1], DTH services could establish a market share in the order of 15 to 20 percent of television households. By 2005 there could be 1.7 million DTH subscribers in Canada. Some

[1] "HomeStar: An Application to the Canadian Radio-television and Telecommunications Commission for a Direct-to-Home Satellite Distribution Undertaking License", filed with the CRTC by Shaw Communications Inc., 12 June 1996.

Table 1 PROPOSED HOMESTAR PACKAGES

NAME	SERVICES	# SERVICES	PRICE
The National	CBC, CTV, SRC, CPAC TVNC, Program Guide/Le Navigateur 2 PPV Barkers (Eng. & Fr.)	7	$ 6.95
National Plus	CBC, CTV, SRC, CPAC TVNC, CIII, CITY, CITV, CFMT, NBC CBS, ABC, FOX, PBS, 2 PPV Barkers (Eng. & Fr.), Program Guide	16	$19.95
National Plus French	CBC, CTV, SRC, CPAC TVNC, TVA, TQS, RQ, CTEQ 2 PPV Barkers (Eng. & Fr.) Le Navigateur	11	$17.95
National Plus Bilingual	National Plus and National Plus Fr. 2 PPV Barkers (Eng. & Fr.) Program Guide/Le Navigateur	20	$25.95
Specialty Tier English	18 Cdn Specialty (inc. 6 new) 6 U.S. Specialty, 1 S/Stn Telelatino, Fairchild	27	$15.95
Le Bouquet Spécialisé	9 Cdn Specialty (inc. 2 new) Telelatino, Fairchild	11	$ 9.95
Specialty Tier Bilingual	27 Cdn Specialty (inc. 8 new) 6 U.S. Specialty 1 S/Stn Telelatino, Fairchild	36	$19.95
Pay English	TMN/SC Movie Max/Pix Family Channel, 4 S/Stns	7	$23.95
Volet TV Payante	Super Écran, U.S. 4 + 1	6	$16.95
Family Pay	Movie Max/Pix, Family Channel 4 S/Stns	6	$17.95
Digital Audio			$ 4.95
Homerun	**All English Services**	**49-PPV**	**$49.95**
Le Coup de Circuit	**All French Services**	**28-PPV**	**$34.95**
The Grand Slam/ Le Grand Chelem	**All Services**	**64-PPV**	**$59.95**
À la Carte	**Equivalent to The Grand Slam/ Le Grand Chelem**		$91.75
Pay- per-view (PPV)	English or French Movies and Events		$ 3.95 ea

estimates put this as high as 2 million. We are convinced that Canadians in every region of the country want access to a diverse menu of world-class programming services.

Currently the demand for DTH service in Canada is being addressed by grey market satellite services such as DirecTv and Echostar. Despite the inroads these services have made, we believe that, when given the choice, consumers will prefer a truly Canadian alternative that showcases programming services reflecting our own culture, while delivering first-class picture and sound quality and service.

Table 2
HomeStar Market Projections

	1998	2001	2004
Total average DTH subscribers (000s)	423	1,167	1,415
HomeStar market share	10%	25%	32.5%
Total average HomeStar subscribers (000s)	28	278	442

In preparing the marketing plan for HomeStar, we separated the potential DTH market into three categories -- the unserved market (households that are not currently passed by cable), those within cable territories who choose not to take cable service, and existing cable customers. Table 2 shows the projected Canadian DTH market and HomeStar's projected market share.

HomeStar is positioned to provide Canadian consumers with an exciting range of entertaining and informative satellite programming packages. HomeStar will be delivered by a distribution technology that is available to every Canadian and offers nearly 100 channels of Canadian and authorized U.S. television programming. Addressable digital technology permits consumers the flexibility to select and pay for only those program packages they want to view. Those who place a premium on signal quality will be rewarded with HomeStar's digital picture and CD quality sound.

The marketing of HomeStar will kick off with a national product launch followed by ongoing brand support and product promotion. Our business plan calls for a marketing budget of close to $10 million for the launch and first year roll out. Total marketing and sales expenditures during the first seven-year licence term are budgeted at more than $100 million, or over 10 percent of projected gross revenues. HomeStar will compete aggressively with all home entertainment service providers in Canada.

Satellite Arrangements

We have a number of viable satellite options which will enable the timely launch of our service. Our short-term options, pending migration to high-power DBS facilities, are as follows:

1. Securing space segment on Telesat's Canadian satellite facilities.
2. Alternatively, interim space segment is available to HomeStar in the U.S.

These short-term alternatives are credible and practicable solutions to accommodate Homestar's satellite capacity needs.

In addition to having a range of viable satellite options, HomeStar's DTH service is based on proven and reliable compression technology, utilizing satellite receivers that are being manufactured today.

Conclusion

In 1993, the Commission recognized the potential of direct-to-home satellite technology as a means of extending the delivery of broadcasting services to all Canadians, providing competition to the dominant providers of program distribution and serving as a made-in-Canada solution to the threat

of unauthorized DTH services in the Canadian market.

HomeStar's program packages and prices have been formulated with the goal of providing consumers with a truly Canadian choice. HomeStar will offer an attractive alternative to the grey market and competing delivery systems -- cable, MMDS and LMCS. Canadian viewers are sure to benefit as a result.

Approval of the HomeStar application will contribute to the fulfilment of the Government's policy of creating dynamic competition among DTH services and all other competing delivery systems. We are confident that we would be able to launch within six to nine months of a positive decision by the Commission.

HomeStar is ready, willing and able to offer Canadians a viable and sustainable Canadian alternative to the grey market. Our proposal offers Canadians the option of choosing Canadian programming supplied by a Canadian service and will stimulate competition among Canadian delivery systems. In so doing, there will be two winners: Canadian consumers -- who for the first time, will have choice in terms of both price and product -- and Canadian programmers, who will receive national exposure in all markets across Canada.

BIOGRAPHY

Dr. Mark Pezarro is President of Shaw DBS Ventures. Dr. Pezarro's responsibilities include overseeing Shaw's application for a new Canadian Direct-to-Home (DTH) service. Should a licence be granted, he will oversee bringing the service to market.

Dr. Pezarro has extensive business development, marketing, technical and research experience in the cable and multimedia sectors. He most recently served as Vice-President, Business Development & Research with a Montreal-based communications company. Dr. Pezarro holds a B.Sc. in Computer Science from the University of Calgary and a Ph.D. in Computer Science from the University of Cambridge.

BIOGRAPHIE

M. Mark Pezarro est président de Shaw DBS Ventures. Il est responsable, entre autres, de la surveillance de la demande de Shaw relative à un nouveau service canadien de diffusion directe par satellite (SRD). Si une licence est accordée, il supervisera l'entrée du service sur le marché.

M. Pezarro a une vaste expérience du développement des entreprises, de la commercialisation, technique et de recherche dans les secteurs de la câblodistribution et des multimédias. Tout récemment, il a rempli les fonctions de vice-président du développement des entreprises & de la recherche sur les entreprises au sein d'une société de communications basée à Montréal. M. Pezarro possède un B.Sc. en ordinatique de l'université de Calgary, et un Ph.D. en ordinatique de l'université de Cambridge.

VideoRoute™ BUSINESS BROADCAST SERVICE
VidéoRoute^MC LE SERVICE DE TRANSMISSION D'ENTERPRISE

Ted Hardy

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ABSTRACT

The Stentor Alliance has introduced VideoRoute™ Business Broadcast Service, North America's first public business television network. The service provides customers with a single one-way video channel and up to four associated one-way audio channels. Receivers are pizza sized dishes with a receiver/decoder about the size of a VCR. Applications include education, training, corporate communications and special events broadcasting. Access will be via a series of strategically located VideoRoute™ Serving Centres which will in turn have access to satellite up-links This is the first Stentor service offering to combine both terrestrial and satellite links. Encoded and compressed video and audio signals are transmitted at the low digital rates of standard MPEG digital technology. Additions to the basic service include the patented "One Touch™" system which is an interactive touch/response pad and microphone, to allow interactive question/answer sessions between, for example, instructors and students.

Video Route™ Business Broadcast Service

The Stentor Alliance, which comprises Canada's nine major telephone companies, has a reputation for breaking new ground in new communication services. The latest example is its 1996 introduction of VideoRoute™ Business Broadcast Service (VRBB), North America's first public business television network.

The operative word is "public" - many large companies already operate their own private broadcast networks. VRBB now makes it possible for an organization to buy services on an as-required basis, without setting up their own complete networks.

The digital, satellite-based system provides business and other organizations in Canada with a cost-effective way to transmit digital-quality audio/video broadcast presentations from customer-owned production studios to an unlimited number of receiving locations.

Stentor has targeted the service to a specific market niche for which market research indicates a significant pent-up demand: geographically dispersed companies and organizations. This is particularly true of companies based in the Toronto-Ottawa-Montreal triangle. Stentor anticipates that usage of the service will grow dramatically.

In terms of technology, the new service puts Canada out front in the expanding field of business broadcast communication. VRBB is the first Stentor service offering to combine both terrestrial and satellite links. It is also the first commercially available business television service in the world to conform with the new MPEG 2 (Motion Picture Experts Group) standard.

The service provides customers with a single one-way video channel and up to four associated one--way audio channels.

Customization

This arrangement allows for a high degree of customization. The multi-channel audio capability, for example, makes possible simultaneous English-French or multi-lingual translation. And broadcasters can tailor their "networks" of receiving sites, making individual presentations available to all, or just some of the total number.

For example a Canadian bank with, say, 1,600 branches across the country could beam training of rate-change broadcasts to a limited number of "spotlight" sites or to the whole network with transmissions staggered to fit different time zones.

The system is ideally suited for the delivery of business, educational, and other presentations to dispersed locations throughout Canada. Logical applications include the broadcast of executive speeches and other corporate announcements, training programs, product updates and communication of information to employees. Large retail stores can use the service for chain-wide broadcasts or to transmit programs to specific stores and departments. Manufacturers can use the system for training and product updates. The Ford Motor Company, for example, uses a similar private broadcast system to train mechanics and other personnel at some 6,000 locations.

Other natural customers for the service include educational institutions and school boards seeking to extend teaching programs to remote communities. Medical institutions can also make use of the service for diagnostic discussion, training, and other purposes.

The service can help doctors stay abreast of new developments without interrupting their practice. By installing a dish, a decoder/receiver, the physician can plug into continuing medical education programs after normal working hours.

One federal government department, Human Resources Development Canada (HRDC) is using VRBB to broadcast training programs to government employees dispersed across a 200 site nationwide network. In this case, HRDC combines "point-to-mass" broadcast with interactive, two-way audio communication between the sending and receiving sites using the patented interactive distance education OneTouch™ system.

HRDC recently won an award for Excellence in the Management of Information and Technology (provided by the Federal Government) for its use of VRBB.

Applications: The Top Ten

A recent North American survey shows the leading applications of business broadcast services to be:

- technical training
- management training
- sales training
- customer training
- employee communications
- retail product information
- corporate communications
- information networks
- special event broadcasts
- continuing education

Cost benefits

Geared to large, geographically dispersed organizations and for point-to-mass communication, VRBB compares favourably in cost with other broadcast services presently available in Canada.

VRBB's cost advantage is a function of its digital base. Bandwidth access costs money and analog broadcast services require more of it than their digital counterparts. Stentor's bandwidth-thrifty

Business broadcast benefits extend to every sector

VRBB opens up new opportunities for any organization that needs to communicate with widely-dispersed locations in Canada. For example:

Education: Broadcast audio-interactive presentations of classroom sessions and other teaching programs particularly to villages and other small settlements remote from Canada's urban belt. These communities lack both the student numbers and the tax bases to support local specialized instruction in many subjects. Central schools and education departments can use VRBB to close this city/country gap. In this setting, the service can be enhanced and made interactive by the addition of a patented interactive distance education system called "One Touch™". The system is comprised of an interactive touch/response pad and microphone, to allow interactive question/answer sessions between instructors and students.

Financial institutions: Weekly base-touching with regional offices on changes in interest rates and operational policies. In a stock exchange, for example, brokers would use their own receiving sites to receive continuously fresh, updated information on which to base advice to their clients.

Health: Updating and other distance medical training. VRBB service can be particularly helpful to doctors, nurses, and lab technicians in remote northern regions who cannot take time off to travel. It is possible to receive training programming in large auditoriums of hospitals, or directly at a doctor's home or office.

Manufacturing: Product training and new-product updates.

Police: Large geographically dispersed police organizations such as the RCMP and the OPP, can provide on-site training of constables including timely operational updates on law enforcement issues, and other communications.

Real estate: Sales training and weekly meetings to advertise new listings and provide sales updates.

Retail: Product updates, customer information, and employee training.

system makes it possible to transmit encoded and compressed video and audio signals at the slender digital rates provided by standard MPEG digital technology.

Also contributing to VRBB's cost advantages is the chain of delivery through which Stentor channels the broadcast, terrestrially and through space, from broadcast studio to receiving site.

Conventional systems require the customer to either install or be physically close to a large and costly uplink dish facility through which broadcast signals can be beamed to the satellite. Effectively this has limited the use of business broadcast to very large users or to customers in major cities where third-party uplinks are available.

Stentor has removed this obstacle by running its delivery chain through a network of several VideoRoute™ Serving Centres strategically positioned across Canada .

Getting started

At the originating end, the organization will need to install a broadcast studio, customized as required to meet its needs. The essential elements are audio, lighting, and video equipment, including cameras. Optional items include equipment for the broadcast of simultaneous translation.

The business broadcaster will also need to purchase local access to audio and video lines and switches to link the production studio with the nearest VideoRoute™ Serving Centre. Stentor Alliance members make this access available on either a full-time or ad hoc basis, depending on customer requirements. Included in the package price is the "backhaul" transport of the signal from the VideoRoute™ Serving Centre to the satellite uplink, the use of the satellite uplink itself, plus the associated satellite space segment.

At the receiving end, the customer will need to purchase:

- A small, pizza-sized, satellite dish plus an audio and video decoder. Depending on location, the installed price of this component ranges from $2,500 to $5,000.

- A standard television monitor.

- An integrated receiver/decoder to descramble the encoded signal. About the size of a standard VCR, this unit fits on the top of the television monitor.

The other cost item is service tariffs. VRBB Customers buy as much service as they need, in time blocks of 30 minutes minimum, with 15-minute increments as required. At current rates (see boxed items) a 60-minute broadcast originating in Toronto, Montreal or Ottawa costs $800. The rate is $1,000 from all other locations.
Stentor officials point out that in many instances the service offers a cost-effective alternative for multi-point delivery of information.

Duration (minutes)	Montreal, Ottawa, Toronto	Other locations
30	$500	$600
60	$800	$1,000

VRBB Pricing

The time charge for VRBB buys the customer the broadcast of encoded signals to an unlimited number of sites. George Leslie, Director Insurance Operations Training for Human Resource Development Canada, says "Our use of this service has made it possible for us to meet vastly expanded training responsibilities - and more importantly, to do so at a time when government budgets have been shrinking."

- It is important to understand that VRBB and video conferencing meet different needs in different ways:

- Videoconferencing for example provides two-way video communication - VRBB offers one-way video.

- Videoconferencing requires the use of the same equipment at all sites - VRBB does not.

- Finally, videoconferencing requires relatively costly terminal equipment compared with VRBB.

The bottom line: VRBB is the service of choice when two-way video is not a "must" and when the broadcaster needs to reach several locations.

In addition to cost-effectiveness, the digital-based Stentor system offers its customers signal quality visually and audibly superior to analog-based systems.

The system uses a sophisticated scrambling system to protect the confidentiality of broadcasts.

One-stop shopping

Stentor telephone companies are equipped and staffed to provide one-stop shopping in all these areas. The services include assistance to customers

in the design and construction of their studios and the design and equipping of receive sites. They will also custom-tailor the service itself-building in enhancements such as interactivity to meet the demands of the organization.

In addition to providing the network, Stentor hopes, through alliances with other suppliers, to provide one-stop shopping for hardware purchases, installation, and maintenance.

Session 3

SESSION 3: ROLE OF TERESTRIAL SERVICES IN A COMPETITIVE ECONOMY
SÉANCE 3: LE ROLE DES SERVICES AU SOL DANS UNE ÉCONOMIE CONCURRENTIELLE

Chair: Elisabeth Angus
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BIOGRAPHY

Lis Angus is Executive Vice-President of Angus TeleManagement Group, a telecommunications consulting and research firm based in Ajax, Ontario. She has been active in telecommunications since 1980. Ms Angus has conducted numerous telecommunications research and policy studies for government and private sector clients, and is co-editor of the monthly magazine *TELEMANAGEMENT.*

BIOGRAPHIE

Lis Angus est vice-président exécutive d'Angus TeleManagement Group, une firme de services conseils et de recherche en télécommunications située à Ajax (Ontario). Elle joue un rôle actif dans ce domaine depuis 1980. Elle a mené divers traveaux de recherche et études stratégiques en télécommunications pour le compte de clients des secteurs public et privé. Elle est rédactrice adjointe du mensuel TELEMANAGEMENT.

THE LOCAL LOOP OF THE FUTURE
LE CIRCUIT LOCAL DU FUTURE

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ABSTRACT

Local loop is a term used to identify the facility used by a telecommunications carrier to connect between its network and a customer location. Around the world, most local loops today are made of pairs of copper wires, typically in multi-pair cables located underground or on poles. For the most part, they belong to incumbent local telephone companies and were designed for voice telephony.
Now new technologies are available or emerging that enable higher bandwidths to be provided and that facilitate entry by new service providers.

The paper provides a high-level summary of the various available and emerging technologies and their applications, including copper loops, digital loop carrier, digital subscriber loop, fibre-to-the-curb, hybrid-fibre/coax and fixed wireless, and discusses technology strategies of interest to the various players in the local services markets of the future.

Local Loop of the Future

1. The traditional copper local loop continues to be widely deployed around the world.

In most countries, the dominant or only provider of local loops is the local telephone service provider. The local loop plant is usually designed and used for public telephone service, but also for dedicated voice, data and sound program connections.

Most local loops are comprised of pairs of copper wires, typically in multi-pair cables located underground or on poles. A loop connects between a telephone switch in a central office and a telephone instrument at the subscriber's location. The main components are illustrated in Figure 1.
The main components are:

- Pairs between the line terminations on telephone switch and the main distribution frame (MDF; a central location in an exchange office on which all outside cables are terminated).
- Distribution or primary cables from the main distribution frame to neighbourhood cross-connection cabinets.
- Feeder or secondary cables from the cross-connection cabinets to distribution points that are near subscriber locations.
- Drop wires from the distribution points to the point of entry into the subscriber's premises.
- Inside wiring within the subscriber's premises, and a telephone instrument.

Current to activate the telephone instrument flows from the telephone switch, through one wire, through the telephone instrument, and back through the other wire; hence the origin of the term "loop".

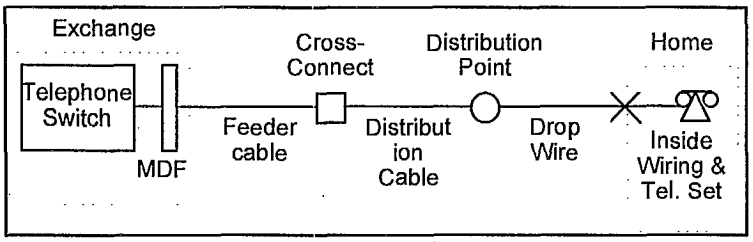


Figure 1-- Copper-pair local loop architecture.

1.1 Copper pairs are also used for other applications.

Although the basic copper-pair plant is designed primarily for switched telephony, copper pairs are also widely used for other applications, including the following.

- Basic-rate (144 kb/s) ISDN subscriber loops.
- Digital repeated lines at 1.544- or 2.048-Mb/s.
- Dedicated voice, data and sound program circuits.
- Telex subscriber loops, and burglar and fire alarm circuits.

2. Advances in technology are enabling service providers to respond to forces for change in the local loop plant.

There are several important forces for change in the local loop environment:

- Cable congestion near telephone exchanges.
- A desire to reduce the cost of new construction and rebuilds.
- Liberalization of markets, allowing entry by new providers.
- A dramatic increase in bandwidth needs.

The local loop plant of the future will be impacted by technology choices made by players to respond to these forces. We discuss them below under the following headings:

- To provide telephony and related services.
- To provide higher-bandwidth services.

3. Service providers have several options for providing telephone and related services.

The options available, under development or being discussed include the following:

- Digital loop carrier
- Remote line units
- Fibre/copper networks
- Rural fixed wireless access
- Urban fixed wireless access
- Hybrid-fibre/coax

3.1 Digital loop carrier technology substitutes multiplexed digital lines for copper feeder cables.

An illustrative example of digital loop carrier technology is shown in Figure 2.

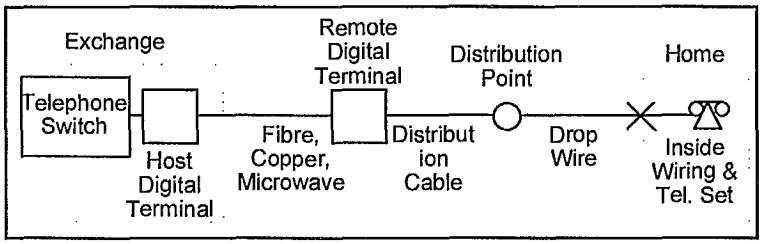


Figure 2 -- Digital loop carrier example.

A Remote Digital Terminal is placed in the neighbourhood, and is linked to a Host Digital Terminal at the switch over digital lines that can be on fibre, copper cable or microwave. Distribution cables and drop wires connect from the neighbourhood cabinets to the subscriber locations. Various sizes up to 96 or 120 subscriber lines are common.

Dedicated or demand-assigned links can be set up between the Remote and Host Digital Terminals, depending on traffic requirements. ISDN and data services can also be provided.

This arrangement can be more economical than the traditional all-copper equivalent in urban and suburban settings, and will continue to be deployed in greater numbers in the local loop plant around the world as new construction and rebuilds occur.

3.2 Remote line units are components of switches relocated to neighbourhoods, thus shortening loop lengths.

Where more subscriber lines are needed, a remote line unit is placed in the neighbourhood. The remote line unit is connected to and controlled by the host switch over digital lines, as illustrated in Figure 3. Sizes of up to 500 or 1,000 lines are available.

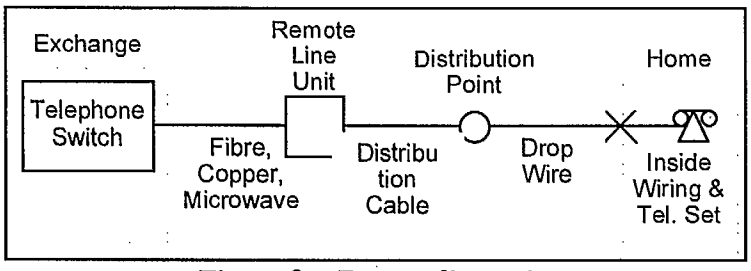


Figure 3 -- Remote line unit.

Remote line unit technology can be more cost-effective than traditional copper-loop technology in urban settings, and is being used by new entrants as well as incumbent telephone companies globally. Continued deployment of this type of technology can be expected.

3.3 Local fibre/copper networks will continue to be widely deployed by incumbents and new entrants.

Local loop networks based on fibre optic transmission systems and copper drops have been widely deployed by incumbent telephone companies and competitive access providers in many countries, and by cable television operators in the United Kingdom.

The first widespread local telephone operations by cable television operators were in the United Kingdom, using an "overlay" architecture where separate but parallel networks for telephony and cable television were deployed. In this architecture, often a high-speed digital fibre optic ring connects the telephone switch with hubs in the franchise territory, as illustrated for example in Figure 4.

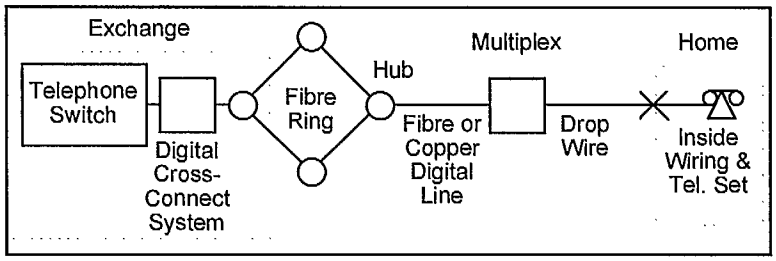


Figure 4 -- A representative cable telephony overlay architecture

Fibre optic or copper digital lines extend from the hubs to digital multiplexers located in the neighbourhoods (e.g., 480 lines) or at the distribution points (e.g., 30 lines), from which points copper-pair drop wires extend to the subscriber locations. This provides a dedicated voice channel to the telephone switch for each subscriber.

Such an architecture can be extended to provide a wide range of voice and data services to residences and businesses, by (a) adding multiplexers at the hub locations, for major centres, and/or (b) providing lower-speed rings between the hubs and the distribution points, as shown in Figure 5. Dedicated circuits for voice and data can be injected into the local network at the digital cross-connect system, and extracted at the hubs and local nodes.

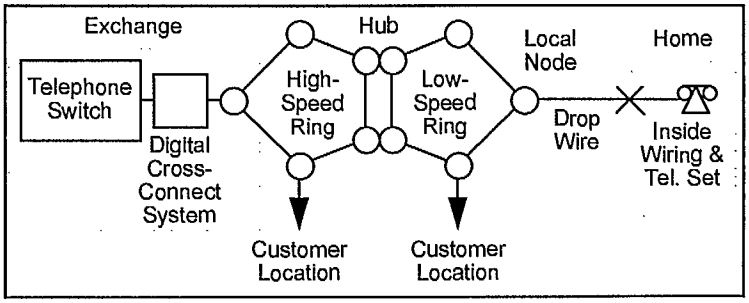


Figure 5 -- Local digital fibre-based network.

Architectures of this nature find application in areas of commercial concentration and where there are multiple-dwelling units, and are widely used by incumbent telephone companies and competitive access providers as well as by U.K. cable companies.

3.4 Fixed wireless access is becoming widely used in rural applications, and is beginning to be applied in urban applications.

Multi-channel fixed wireless is being deployed in rural parts of Canada and abroad. For example, in Figure 6, a radio base station is located at the telephone switch, or is located remotely and is linked back to the telephone exchange by a transmission link. The base station illuminates a service area in which remote radio stations are provided. At each remote station, one or several metallic subscriber loops can be connected. Local power is used or generated.

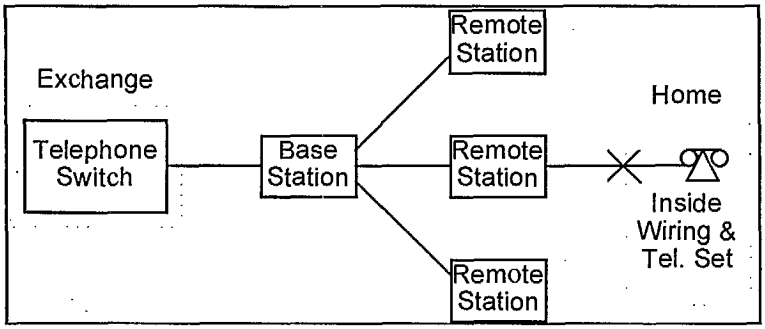


Figure 6 -- Illustrative rural point-to-multipoint fixed wireless access system.

When the switch or a subscriber has a call to make, the remote stations and base station contend for air time, which is often derived over a TDM/TDMA air interface. Some products support high-quality voice and voiceband data.

This type of technology can often be deployed more quickly, be more reliable and provide better quality than copper-cable or open-wire alternatives.

An alternative approach that is being widely deployed and used in developing countries is based on cellular mobile technology, adapted for the fixed wireless application. As illustrated in Figure 7, a cellular network without the mobility capability is deployed to cover the desired service area.

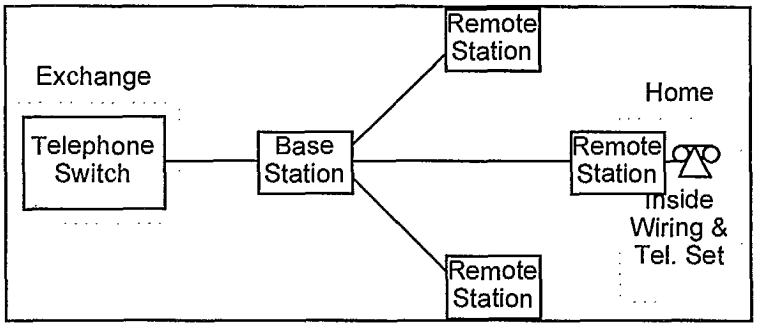


Figure 7 -- Fixed cellular.

Subscriber telephone instruments are connected to remote stations, which are essentially adapted cellular handsets fixed in or on the premises. Calls are handled like in a cellular network, but there are no handoffs and no roaming. Analogue and digital products are available.

With this technology, voice quality and data speeds are cellular-like. New voice codecs being developed for the cellular market promise voice quality comparable to wireline, and the additional delay due to processing within the codec is likely to reduce the effective mean opinion score by only about 0.1, so future deployments of this technology can have wide customer acceptance where low data speeds are sufficient for the market.

An important advantage to this technology is that it enables rapid deployment of service on an interim basis where demand exceeds the supply of conventional loops. A similar approach can be taken to integrate fixed and mobile services on a cellular network .

3.5 Urban fixed wireless has the potential to be competitive with wireline approaches.

While it is reasonable to deploy rural fixed wireless in urban settings for an interim period to meet immediate demand, the cost can be higher than with wireline alternatives. This is a consequence partly of handset, cell-site and switch complexity, which are optimized for higher-value less-dense mobile environments.

New technologies are emerging which are optimized for the local loop environment in terms of quality and cost. The first wide-scale deployment of this type of technology is happening in the U.K. Other technologies, such as PACS (personal access communication system) in the U.S., DECT (digital European cordless telecommunications), and Personal Handyphone (Japan) also have potential fixed wireless applications. High-quality low-delay voice, and data at voiceband rates, will be provided.

A critical challenge is to contain the costs of infrastructure and subscriber stations. Another important challenge in many countries is obtaining access to appropriate radio spectrum.

3.6 Hybrid-Fibre/Coax (HFC) technology trades bandwidth for cost to enable economical local telephony deployment.

An HFC network is a two-way linear broadband network using CATV technology, in which analogue fibres radiate from a headend or central office to fibre nodes in the vicinity of 200 to 2,000 homes, and coaxial cables extend thence to homes. Coaxial cable is combined with fibre because this is the most economical way to develop and distribute broadband power to multiple locations. Since this is a linear network, it can carry a mixture of analogue and digital signals of various types, including analogue television, compressed digital video, high-speed data and digital telephony.

The strategic importance of HFC is that it trades bandwidth for cost. Once the basic infrastructure is in place, it is feasible to introduce new services at minimal cost and with little interdependence with pre-existing services and technologies.

Products are available for digital telephony over HFC which are functionally similar to digital loop carrier. This architecture is illustrated in Figure 8.

Typical modern HFC networks provide a downstream band (i.e., to the subscriber) from 50 up to 750 MHz, and an upstream band from 5 up to 42 MHz; lower bandwidths are also common. Power for the coaxial amplifiers and for telephony

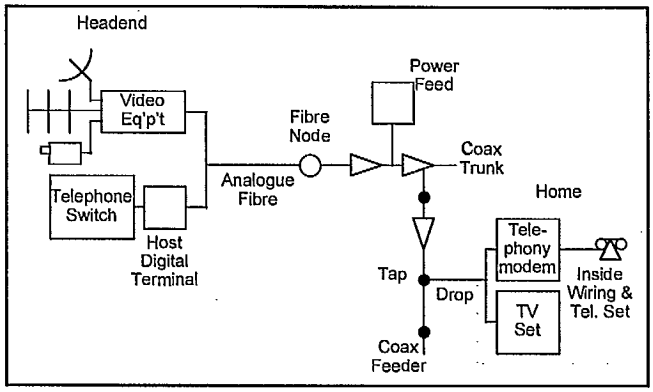


Figure 8 -- Telephony over hybrid-fibre/coax.

radio-frequency modems at the subscriber locations is inserted from the power grid at convenient locations.

Telephony is added to an HFC system typically in the following way. The telephone switch, which may be at the headend or some other, more central, location, is provided with an HFC-compatible Host Digital Terminal. Two-way telephony radio-frequency modems are provided at subscriber locations. The Host Digital Terminal and subscriber telephony modems interact over assigned spectrum on the HFC network.

The cost of adding telephony to a pre-existing HFC network is often competitive with available alternatives. With fibre nodes placed deep in the distribution network, upstream bandwidth capacity is not a problem.

Important considerations in deploying an HFC-based cable telephony system include:

- Controlling entry of impulse noise and extraneous short-wave radio-frequency signals into the upstream signal path, and ensuring that the upstream technology combats these interferences.
- Deploying appropriate standby power at the power-feeding locations.
- Deploying suitable operations support systems for remote monitoring and control.

Widespread deployment of HFC networks with video, cable telephony and high-speed data services have been initiated in the U.S. and Australia.

4. Service providers will also choose among several options for providing higher-speed services.

The technologies discussed in this paper up to now have been focused on reducing cost or plant congestion, providing more rapid deployment, or making it possible for new entrants without physical right-of-way to gain access to customers, for telephony and similar services.

There is, however, an increasing demand for local services of higher speed. The most immediate need is to respond to the large demand for high-speed access to the Internet. Also of importance are video distribution, video-on-demand and work-at-home.

In the search for high-speed markets, the telephone companies have an important strategic advantage, in that they have ubiquitous copper plant and a business relationship with most homes and businesses. They are working, however, to overcome the important strategic disadvantage inherent in the limited bandwidth of their loop plant. They are examining digital subscriber loop, fibre-to-the-curb, hybrid-fibre/coax and wireless technologies.

The organizations better placed technologically to respond to these higher-speed opportunities are the cable operators. They are progressively converting their one-way cable systems to two-way HFC, and are actively deploying cable modems.

Radio technologies such as MMDS and LMCS are only partly ready to enable new entrants to enter this market.

These technologies are briefly discussed below.

4.1 Digital Subscriber Line

Increasing the bandwidth capability of the existing plant is a high priority for telephone companies because of the immense sums and large construction delays that will be required for other two-way high-speed alternatives.

Although the existing copper-pair plant was designed for analogue voice with a frequency range of 300-3,400 Hz, it can be operated at significantly higher speeds under certain restrictions with Digital Subscriber Line (DSL) technology.

The restrictions involve limiting the loop distance depending on operating speed, removing loading coils (inductors that are sometimes added to extend the voice range of an analogue loop), and removing parallel pairs that are sometimes deliberately connected to the distribution cables in Canada and the U.S. to facilitate service provisioning.

The family of DSL technologies includes ADSL, HDSL, SDSL and VDSL. The differences and applications are summarized briefly below.

4.1.1 ADSL (Asymmetric Digital Subscriber Loop) allows video delivery and Internet access under limited conditions.

ADSL provides 1.5 or 2 Mb/s toward the customer on loops of 4.6 to 5.5 km in length, or 6.1 Mb/s on loops of 2.7 to 3.7 km in length. An extension to 9 Mb/s is under development. The telephone company provides equipment at the central office and the subscriber location, attached to the same copper-pair loop that is usable for ordinary telephone and basic-rate ISDN services.

Many major telephone companies in Canada and abroad have expressed interest in widespread ADSL deployment, and trials are under way. There are several important challenges to universal roll-out of ADSL, however.

- Many loops are too long to be used, e.g., only about 60 per cent of U.S. loops are short enough for 6.1 Mb/s service. Many of the long loops are in suburban locations which would likely also be early candidates for new high-speed services.
- About fifteen per cent of sufficiently-short loops require re-work to make them suitable.
- Arrangements for splitting the high-speed signal out from the home wiring require development.
- Harmful radiation at radio frequencies from aerial drop wires may be a problem.
- The current cost of $4,000 per line is too high

for a viable business plan.

4.1.2 HDSL (High-Speed Digital Subscriber Loop) provides bi-directional digital lines over a moderate distance.

HDSL is a stable technology that allows bi-directional 1.5 Mb/s lines to be provided over two pairs, and 2 Mb/s lines over three pairs. Although the distance is limited to 3.6 km, this is satisfactory in many instances for extending digital lines to businesses, for example.

4.1.3 SDSL (Synchronous Digital Subscriber Loop) will allow bi-directional digital lines to be provided over a single pair.

SDSL is a new technology just entering trial that will allow 1.5 Mb/s digital lines to be handled over only one copper pair at up to 3 km distance. This may be attractive as an HDSL replacement over shorter distances since it uses fewer pairs.

4.1.4 VDSL (Very-High-Speed Digital Subscriber Loop) will provide up to 51.84 Mb/s over short copper pairs.

VDSL is a new asymmetric technology under development that will provide up to 51.84 Mb/s to the subscriber over a 300 m copper pair, with 1.5 to 2.3 Mb/s toward the network. It would require fibre-to-the-curb deployment (see below), as well as new underground loops where aerial drops exist.

4.2 Fibre-to-the-Curb (FTTC) uses switched digital technology to provide bandwidth to homes.

FTTC is one possible long-term approach to the bandwidth bottleneck for new services being considered by some telephone companies. FTTC involves constructing digital fibre links from the telephone switch to the vicinity of 16 or 32 homes, where an Optical Network Unit would be placed. The fibre would carry video, voice and data in digital form (video could also be carried in analogue form, as in HFC). Telephony would be carried into the house on a twisted pair in analogue form. Data and video would be carried into the home in analogue form over a coaxial line, or VDSL could be used as mentioned above.

Among the complications is how to power the Optical Network Unit. Among the options being considered are: local mains feed with battery, a copper cable from the central office, and power fed back from the subscriber locations.

The overall cost picture for FTTC compared with major competing technology HFC is not yet clear. A major U.S. regional Bell operating company has announced its intention to roll out FTTC on a wide scale.

4.3 HFC's high-bandwidth linear transmission structure supports multi-service deployment.

HFC, including the addition of telephony, is described above in section 4.6. For high-speed data, cable modems are provided at subscriber locations that interact with a companion cable modem termination system at the headend.

HFC is the architecture of choice for new cable operator construction, and cable operators are re-working existing unidirectional cable plant to bi-directional HFC form.

For a telephone company, HFC requires a completely new network, therefore with a higher marginal cost than the cable operators face. Major HFC construction programs are in hand by some U.S. and Australian telephone companies. In one case, the copper plant is also being left in place for plain old telephone service.

4.4 Radio technology provides one-way bandwidth, but two-way support requires further development.

Radio technology enables telephone companies and other players to enter local one-way high-bandwidth services markets. Two technologies are interesting: Microwave Multipoint Distribution Service (MMDS) and Local Multipoint Communications Service (LMCS).

4.4.1 MMDS allows economical one-way video distribution over a local area, but two-way applications need the telephone network for a return path.

Fundamentally, MMDS is analogue UHF television technology transferred to the vicinity of 2 GHz and operated in a subscription environment.

Digital video compression is being applied to MMDS as it is to cable systems, thus significantly increasing the quantity of programs deliverable over MMDS.

Telephone companies and others have found this a suitable way of entering the "cable" business, and some demonstrations of providing high-speed data (using the telephone network for the return path) have been made.

Although there have been discussions about using MMDS as a basis for a local two-way service, and some demonstration trials, there is not enough bandwidth assigned to make this viable on a large scale.

4.4.2 LMCS will provide economical one-way wideband video distribution over a local area, the prospects for two-way are not clear.

LMCS is called LMDS (Local Multipoint Distribution Service) in the U.S. and MVDS (Multipoint Video Distribution System) in Europe. This is a service at 28 GHz (40 GHz in Europe) for which licenses were recently awarded in Canada. It will provide a very wide bandwidth to subscriber locations from numerous cells in limited areas. The first use will be for distribution of video entertainment.

There have been discussions about further development of this technology to provide two-way service for telephony and high-speed data. However, no products have emerged as yet, and it is not clear that it could be cost-competitive with other options.

5 The local loop of the future will be provided by a mixture of technologies.

The local loop plant is a mixture of technologies chosen to meet the various goals and constraints of the various players. We will continue to see a mixture of different technologies in the local loop plant, as technologies and markets develop.

Copper-pair loops will likely continue to be ubiquitous for some time to come, because of the immense investment they represent, their long asset life, and their continuing suitability for voice telephony.

Progressively over time, we can anticipate a shortening of copper loop lengths, as technologies like digital loop carrier continue to be rolled out where justified. Meanwhile, telephone companies will roll out ADSL technology where there is a market requirement and where permitted by the loop length and condition.

We will also see continuing deployment of networks based on fibre optic transmission systems where densities and service demands warrant, such as in areas of commercial concentration and to multiple-dwelling units.

The cable companies will continue to convert to HFC where needed for high-speed data and telephony services. Some telephone companies will continue HFC and FTTC deployments.

In developing countries, we will see continued deployment of traditional copper loop plant and digital loop carrier technologies. In addition, we can expect to see widespread deployment of high-capacity urban fixed wireless access technology, in addition to continuing growth in rural fixed wireless access.

BIOGRAPHY

Roger Hay is a Senior Consultant in Arthur D. Little's technology-based consulting section, where he helps leading organizations around the world lever technology for strategic benefit.

He has broad experience in network planning, business planning, systems engineering and standards development, in the fields of public telecommunications, cable television and mobile communications.

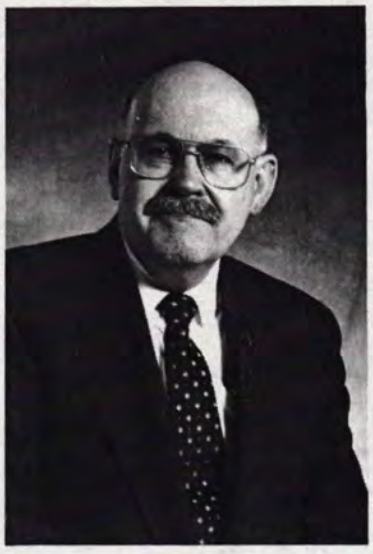
Mr. Hay holds the Bachelor of Engineering degree from McGill University, Montreal, and the Master of Business Administration degree from the University of Ottawa. He is a member of the Association of Professional Engineers of Ontario.

BIOGRAPHIE

Roger Hay est consultant principal à la section de consultation technologique chez Arthur D. Little's, où il aide des organisations de pointe du monde entier à tirer un avantage stratégique optimal de la technologie.

Il a une vaste expérience en planification de réseau, planification d'entreprise, ingénierie de systèmes, et normalisation, télécommunications publiques, câblodistribution et communications mobiles.

M. Hay a un baccalauréat en génie de McGill et une maîtrise en administration des affaires de l'Université d'Ottawa. Il est membre de l'Association of Professional Engineers of Ontario.



EVOLUTION OF THE WIRELESS LOCAL LOOP

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ABSTRACT

The emergence of competition in local access markets, the reallocation of hundreds of MHz of radio spectrum, and continued technological progress is driving a revolution in telecommunications: wireless access as the fundamental infrastructure for providing telephone service. The wireless local loop is penetrating environments in both emerging countries (for POTS) and in developed markets (where government deregulation has opened the door to new competitive local access providers). The recent spectrum auctions in the United States demonstrate the perceived value of the wireless connection to service providers. This paper presents an overview of wireless access requirements, radio/cellular evolution, and the technical enablers and design challenges for wide-scale provisioning of telephone services using wireless access.

RÉSUMÉ

L'émergence de la concurrence sur les marchés locaux de distribution, la réallocation de centaines de MHz du spectre radioélectrique, ainsi que les progrès technologiques continus entraînent une révolution dans les télécommunications : le réseau de distribution sans fil comme infrastructure fondamentale de la prestation du service téléphonique. La ligne d'abonné sans fil s'impose dans les environnements, autant dans les pays émergents (pour le service téléphonique traditionnel) que dans les pays développés (où la déréglementation gouvernementale a ouvert la porte à de nouveaux fournisseurs de réseaux concurrentiels locaux de distribution). Les récentes ventes aux enchères de bandes de fréquence aux États-Unis démontrent la valeur perçue de la liaison sans fil pour les fournisseurs de services. Le document donne un aperçu des exigences en matière de réseau de distribution sans fil, de l'évolution de la radio et de la radio cellulaire, ainsi que des outils techniques et des problèmes de conception concernant la prestation généralisée de services téléphoniques utilisant le réseau de distribution sans fil.

Evolution of the Wireless Local Loop

1. Introduction

The technology of the local loop has undergone little change since its inception over 100 years ago – from a single wire to twisted pair to a channel in a digital loop carrier [2]. Meanwhile tremendous technological advance has occurred in other areas of the telecom network, for example, in transmission and switching. In transmission, long–haul microwave radio and fiber optics have revolutionized capacity, performance and cost. In switching, digital technology has contributed to feature-richness, value-added services and capital and operations cost savings.

In the wireless industry, unprecedented demand for wireless equipment, both mobile and fixed, is driving down the cost of the underlying enabling technologies. Consequently, wireless technology is being pushed into non–traditional applications such as the local loop. Today, the cellular industry, barely fifteen years old, boasts over 80 million subscribers world-wide. Analysts predict a significant leap in that number by 1998, when three-quarters of the world's countries will have at least one cellular network. Today, the lion's share of the $500 billion global telephone business is generated by wired operators, however, massive migration from wireline to wireless systems will occur over the next decade [3].

Be it a developing or a developed economy, traditionally the most costly component of the network to build and the least cost–effective to maintain has proven to be the local access distribution network. The scope of investment required to build and maintain copper-based networks has created physical and technical barriers to entry and has made high penetration rates for basic telephone service available only to industrialized cities and nations of the world.

Wireless access can overcome many of the investment and build-out hurdles associated with copper-based outside plant. In emerging markets, this makes the provision of basic telecom-munications service feasible. In developed markets, the lower cost of implementing a wireless access solution can level the playing field for start-up local access providers. With a cost-per-subscriber in the range of US$700 to $3000, the required investment is more than competitive with the US$1000 to $5000 cost-per-sub (dependent on terrain and urbanization level) in the wireline domain.

2. Wireless Access Requirements

There is significant variation in the characteristics of the local loop. This is particularly evident in developing countries, from the perspective of teledensity and loop length. Urban and suburban applications require high capacity to support hundreds (and sometimes thousands) of telephone subscribers per square kilometer. Villages and towns, on the other hand, often isolated from major population centers, may support only a few hundred subscribers. Rural areas present a further unique environment, with small clusters of perhaps a few lines each in very isolated pockets.

In addition to topography and teledensity, other factors differentiate network applications; for example, service set, performance and quality objectives. On a network basis, solutions must satisfy cost and build–out timing objectives. Some of the required infrastructure may already be in place and can be reused. There may be mandated air or network interface standards. Terrain and climate can influence the optimal wireless solution choice.

In many cases, wireless can offer lower life-cycle cost, flexibility in network design and faster deployment than traditional copper-based outside plant. Most of the cost of constructing wireline loops is associated with the vast, branching network of copper cable that connects to individual homes. In fact, the last few hundred meters of distribution copper may account for more than 50 percent of the total cost of the local loop (Figure 1). This is particularly true in rough terrain, in the case of rehabilitation of distribution networks, or where subscriber density is very low.

Most of the capital cost associated with the construction of a wireless network is 'electronics'.

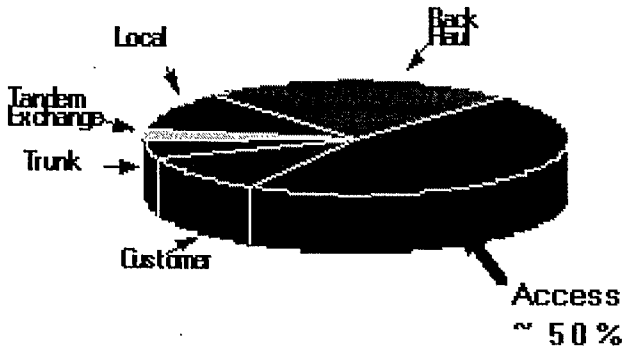

Figure 1: Typical Wireline Network Cost Breakdown

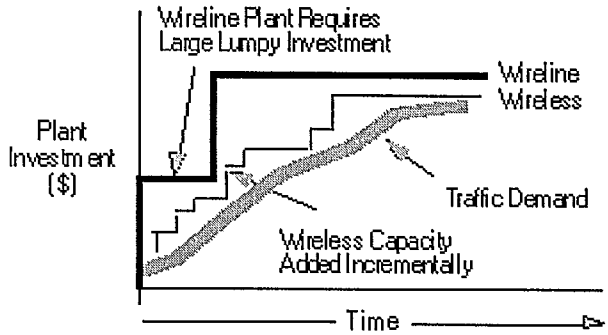

Figure 2: Wireless vs. Wireline Infrastructure Cost

By contrast, in a copper network, significant cost is incurred for cable material and construction/labor, whose costs are not decreasing nearly as quickly over time as 'electronics' costs. The comparable element for the wireless solution -- cell sites -- brings a significant advantage over the cost for deploying copper distribution networks. Overall, this can decrease the cost of deploying a network by as much as 50% over that of a wireline implementation.

Operational cost savings represent another advantage over copper-based access. The elimination of copper distribution/drops reduces operations costs due to fewer trouble reports, dispatch and repair activities. Nortel studies have shown that wireless loops can reduce operating expense by as much as 25 percent per subscriber per year. A reduction in installation and operating costs, coupled with capital cost savings, results in lower life-cycle costs for wireless access systems.

Inherently, wireless access is more 'forgiving' to uncertainties in subscriber demand forecasts. "One of the great difficulties in planning the installation of loop cables over the years has been the uncertainty of the timing and location of future demand for services" [4]. Wireline infrastructure requires 'lumpier' investment which is exposed to uncertainty in demand. In the past, a telephone company over–provisioned --for "just-in-case" growth -- since expansion in already–established neighborhoods is prohibitively expensive. With wireless access, incremental investment can more closely track subscriber demand, resulting in faster payback and reduced financial exposure to over–provisioning.

Customers waiting for telephone service represent an opportunity cost. Therefore, rapid deployment is critical to the business case. As evidenced in the cellular industry, wireless systems can literally be installed in a matter of weeks as opposed to months -- or even years -- with copper-based access. This accelerates returns which can then be reinvested to further building out network capabilities.

In addition to achieving low life-cycle cost, the ability to meet projected teledensity requirements and rapid time-to-deploy, a wireless system must provide acceptable performance (voice quality, delay, blocking, reliability). Furthermore, the system must support the appropriate service-set (voice, fax, data), and should have the option to interwork with the mobility network if this is a commercial requirement. Finally, the ability to integrate wireless systems with in-place infrastructure (e.g. switching, transport) is a significant economic advantage.

Key input parameters to the design of a wireless network are teledensity (over time) and subscriber usage (e.g. Erlangs per subscriber). These variables establish the traffic density that the wireless system must support. The availability and quantity of spectrum, channelization of the particular radio access technology, the extent to which frequencies can be re-used (N), and cell-size influence the traffic carrying capacity of a wireless access system.

3. Deregulation and Competition

Perhaps the most significant factor challenging copper in the local loop is the emergence of true competition in the previously monopolistic local telephone market. The recent radio spectrum auctions in the United States demonstrate the extraordinary value a network operator perceives in being able to eliminate local access charges to reach a customer's home. A significant part of an alternative long-distance carrier's operating costs (up to 40%) are the access charges paid to the established local exchange carrier. There is significant pressure to repatriate those costs into a form under direct control of the operator.

The result has been a massive planned investment in Personal Communication System (PCS) infrastructure, and a race to bring true competition to local telephone access. Mandatory Local Number Portability (LNP) will remove the last major operational hurdle for consumer acceptance. While PCS brings additional (mobility) features beyond the traditional local loop, there are many applications where PCS will simply operate as a fixed wireless access methodology. Even here it will benefit from the economies of scale and continued research and development afforded by the larger market.

New spectrum assignments around the world are fostering this competition. In North America, the 1900 MHz band is being cleared for PCS use, and the 28 and 38 GHz bands are targeted for point to multipoint broadband fixed wireless services. In the U.K., competitive access provider Ionica is licensed to operate its Fixed Radio Access system in the 3.5 GHz band. Spectrum in the 10 GHz range has also been made available in the U.K. and is being considered for use on the European continent. In all areas, this additional spectrum will lead to increased competition, applications and services.

4. Radio Technology Evolution

Reduced cellular terminal cost and increased network capacity have fueled tremendous growth in the wireless industry. In the past decade, the cost of a cellular telephone has been reduced by more than an order of magnitude, its internal volume has shrunk dramatically, and handset weight has fallen 50% every two to three years. On the network side, use of smaller cells, coupled with the introduction of multiple-access digital cellular technology has increased the traffic carrying–capacity of cellular networks by orders of magnitude. Today, digital wireless technology can support several thousand subscribers per square kilometer at network costs 40 to 50 percent below previous generation analog–based wireless systems.

Traditionally, cellular systems have been designed and optimized for high-speed mobile applications with relatively high power and large cells. Mobile environments require careful consideration of multi-path propagation, frequency dispersion and multi-user interference impairments. Although these anomalies also exist in fixed wireless access systems, they are generally easier to deal with since they are less time-varying or random as compared to the mobile application. Fixed wireless applications do need to consider and compensate for

RF channel obstruction/interference;
short term (e.g. atmospheric) fluctuations; and,
long-term fluctuations, such as new building construction.

Also, RF coverage to antennas and hand-sets located indoors can be impaired by the construction material of the building itself.

Many techniques can be used to provide good voice quality and performance in a fixed application. Directional antennas improve Carrier-to-Interference (C/I) ratios. Diversity in time (e.g. interleaving), space (e.g. multiple antennas), or frequency enhances the integrity of the system. Power control and discontinuous transmission minimizes noise level within the environment. Dynamic/quasi-static channel assignment algorithms may be used to further enhance C/I and performance.

There are many RF technologies which can be applied to the wireless access application (see Table 1). Some systems such as IS-54 TDMA and GSM have evolved from the cellular mobile

	IS-54 TDMA	GSM	Ionica FRA	DECT
Voice Bit Rate (kbps)	8/4	13	32	32
Channel Bandwidth (kHz)	30	200	300	1720
Duplex Method	FDD	FDD	FDD	TDD
Channel Bit Rate (kbps)	48.6	271	512	1152
Frame Duration (ms)	40	20	5	10
Power Control	Yes	Yes	Yes	No
Omni Cell Range (km)	>30	>30	>16	<1
Frequency Re-use (N)	12/7/4	7/3	7/4	n/a

Table 1: Wireless Access Technology Options and Attributes

domain, where in the past, low bit rate codecs have been used in the face of:

limited spectrum;
the need for higher system capacity; and
pressure to continually reduce equipment cost on a per subscriber basis.

Wireless access systems are also evolving from lower power applications. The Ionica Fixed Radio Access (FRA) is a 10-channel TDMA system specifically designed for wireless access in a 'fixed' application. That system delivers wireline voice quality and many other enhanced voice/data services. DECT (Digital European Cordless Telephone) is a low-power wireless technology currently being evaluated for fixed wireless access applications.

5. Impact of New Services on Wireless

The expectations of the marketplace will of course have an impact on the roll-out of wireless services as customer expectations continuously compare wireless offerings to their wireline siblings.

In competitive markets, consumers of wireless services will be unrelenting in demanding audio quality equal to wireline access. Acceptance of digital technologies in the local loop will be tied directly to the audio quality delivered by the vocoder. Improvements here will also address capacity issues, as will new access methodologies such as Code-Division Multiple Access (CDMA). Audio quality is less of an issue in emerging markets, since in many cases there is no existing high-quality wireline benchmark for comparison.

Un-tethering customers from wired connections also introduces new issues that simply did not exist in the wireline domain. Fraudulent usage has spurred development of Advanced Intelligent Network (AIN) features that dramatically improve the real-time tracking and cross-checking of user access.

By far the most explosive growth category for communications in the past few years has been fax/data/internet access. This translates into an enormous second-and-third-line opportunity in homes and offices. Again, this will push wireless technology to greater spectral efficiency. The next step in wireless evolution is now appearing in the form of high bandwidth Local Multipoint Communication Systems (LMCS), incorporating the traditional local loop into a high bandwidth service that can accommodate video and high-speed data access.

6. Technology Challenges - Wireless Access

The categories of equipment in a wireless access system are wireless subscriber units, cell-site/base radio, backhaul, and switching/network. The key drivers in wireless subscriber unit technology will continue to be low-cost, high-reliability and further miniaturization. In addition, the challenge is to increasingly provide wireline-like voice quality, performance, and feature-sets. Longer-life, more-efficient battery technology needs to be aggressively pursued.

Multi-channel RF access technologies (TDMA, CDMA) increase the traffic carrying capacity of access radio systems. High-speed digital signal processing (DSP) techniques and software-

definable radios are yielding further advances in radio flexibility, performance, size, and cost. Vocoder technology is progressing rapidly to attain higher and higher levels of voice quality with less throughput.

Radio resource management, and improved Operations, Administration and Maintenance (OAM) are redefining performance and provisioning rules on the network side. Clever dynamic channel assignment methods, powerful diversity schemes and handoff algorithms, and effective dynamic power control methodology reduce co-channel and adjacent channel interference resulting in higher network capacity and performance. Sophisticated fault detection, isolation, performance monitoring, and automatic commissioning and calibration subsystems are adding flexibility and operations efficiency in wireless networks. Wireless network test-beds and simulators are used to evaluate the capacity/performance and OAM tradeoffs of the various radio resource management options.

Integrated circuit technologies will continue to be key for future wireless communications. Superior performance, lower cost, smaller size and reduced power consumption are the key drivers for the various IC technologies being evaluated. Filter and interconnect devices, both direct and dual conversion transceiver architectures, and an array of mixers and power amplifier topologies are under examination in the context of power handling, noise figures, and power consumption.

Silicon and gallium arsenide (GaAs) semiconductors exhibit different performance parameters as a function of frequency. This influences the choice of circuit topologies and transceiver architecture. RF, IF, and baseband filter research is ongoing. In addition, interference suppression and spectral shaping have been evaluated under various digital modulation formats. Finally, packaging technologies, including chip on board (COB), tape automated bonding (TAB), and flip-chip mounting techniques are being evaluated.

Especially for developed areas with existing wireline access, wireless systems require more cost-effective, less-obtrusive antennas. Adaptive electronic antennas that automatically optimize C/I will further increase capacity and performance of wireless networks and enhance the aesthetics of the installation.

Higher network capacity through use of smaller cells increases backhaul infrastructure cost since more sites need to be interconnected to the switch. Backhaul systems must be carefully designed in the context of existing and evolving physical plant -- twisted pair, coax, fiber, and radio -- to achieve optimum cost structures.

Intelligent network functionality and high–performance network processing and signaling allow the transfer of subscriber data across the PSTN/AIN (Public Switched Telephone Network / Advanced Intelligent Network), and cellular (IS-41, GSM) networks. This ensures transparency of service to subscribers across both wireless and wireline networks -- essential to delivering innovative services and accurate, customized billing records.

7. Convergence and the Wireless Local Loop

As service providers for telephone, television and data (internet) access converge, there is increasing pressure to merge all of these services onto a single access medium. In parallel with this convergence, technology and economics are pushing all of these communications to a digital format.

Bandwidth (in both wireline and wireless systems) has always been a limiting resource. However, this has driven -- and will continue to drive -- the development of technology to overcome the limitations of the access medium. For example,

Wireline data communications in the last decade has seen modem speeds increase by a factor of almost 50 (1.2 kbps to 56 kbps), with little or no change to the wireline local loop;

In the last ten years, data communications in a wireless mobile environment have gone from 600 bps to 19.2 kbps within existing 25 kHz channel allocations;

Digital compression techniques for television now deliver up to fourfold increases in the

capacity of a 6 MHz channel that previously carried an analog signal;

Cellular telephony using digital TDMA techniques has tripled the capacity of initial analog channel allocations, with further increases on the way as more efficient vocoders and access methodologies are implemented.

On the wireline side, the "Local Loop" has already been merged with the delivery of communication services (voice, data and video) on a single link to the home (coaxial, fiber, ADSL twisted pair). The technology is now available to put this on a digital broadband wireless link (MMDS, LMCS), again incorporating the capacity for the local loop.

These broadband systems represent a formidable option for a network operators or its competitor [5]. The system could be the functional equivalent (if not superior) to a high speed twisted pair drop in a Fiber-to-the-Curb system, offering such services as switched video and interactive traffic.

8. Conclusions

The "evolution" that the local loop takes will to some extent be dependent on the environment where it is located. Emerging markets, where POTS is the entry level service requirement, will benefit from a simple deployment of digital-cellular based systems. New access methodologies, such as CDMA, with improved spectral efficiency and voice quality will accommodate foreseeable growth.

Competitive Local Exchange Carriers (CLECs) in deregulated markets will use a traditional (POTS) wireless local loop solution to build a valid business case for a start-up operation. The broadband wireless case -- integrating voice, data and video -- can bring an enhanced solution to areas where cable-television services did not exist, or where deregulation now permits competition.

Wireless access has begun to play an integral role in telecommunications networks. Lower life-cycle costs, faster deployment, and greater flexibility in network design enhances the service provider's business case. There is tremendous diversity in access networks in terms of telephone density and coverage area, requiring a family of wireless access products to meet specific needs.

With respect to technology evolution, low-cost subscriber units approaching wireline audio quality, performance and feature-set are penetrating the market. In addition, continued efforts in multi-channel RF access (e.g. TDMA, CDMA), high-speed DSP, voice codecs, silicon/GaAs semiconductors, powerful radio resource management techniques, and high-performance intelligent networks are further enhancing network cost structures and performance. Broadband wireless technologies are taking the convergence of voice, data and video to the next logical level.

Acknowledgments

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BIOGRAPHIES

Michael Hayes graduated from Barry University with a Masters in Telecommunications Management and is currently completing his Doctorate in Computer Science at Nova University. He joined Bell Canada in 1976 in Outside Plant Forecasting and Regulatory Reporting, moving in 1983 to Northern Telecom's cable division supporting the manufacturing process. In 1985 he migrated to Northern Telecom Sales and Marketing region for the Caribbean and Latin America where he worked in Network Engineering and Network Planning for nine years. Currently, Michael is Director of Wireless Proximity Market Development based out of Richardson, Texas; he has global responsibility for Fixed Wireless Access.

Kevin LeBlanc spent 11 years with Motorola's Land Mobile Products Sector, progressing through System and Project Engineering, Proposal Management and Sales for two-way radio systems. He joined Nortel's Fixed Wireless Access Applications group in 1996. He holds a Bachelor's degree in Electrical Engineering from McGill University.

BIOGRAPHIES

Michael Hayes a obtenu une maîtrise en gestion des télécommunications de l'université Barry et est en train de faire son doctorat en ordinatique à l'université Nova. Il s'est joint à Bell Canada en 1976 au service de Prévisions et de réglementation des réseaux extérieurs, est passé en 1983 à la division de la câblodistribution de la Northern Telecom, appuyant le procédé de fabrication. En 1985 il a été muté à Ventes et marketing, Northern Telecom, région des Antilles et de l'Amérique latine, où il a travaillé à l'Ingénierie de réseau et la Planification de réseau pendant neuf ans. Actuellement, Michael est directeur de l'Expansion des marchés pour le sans fil Proximity, qui opère à partir de Richardson, Texas; il a la responsabilité générale du réseau de distribution fixe sans fil.

Kevin LeBlanc a passé 11 ans dans le secteur des produits mobiles terrestres de Motorola, d'abord à System and Project Engineering, puis à Proposal Management and Sales pour les chaînes de poste émetteur-récepteur. Il s'est joint au Groupe, Applications réseau de distribution sans fil de Nortel en 1996. Il possède un baccalauréat en génie électrique de l'université McGill.

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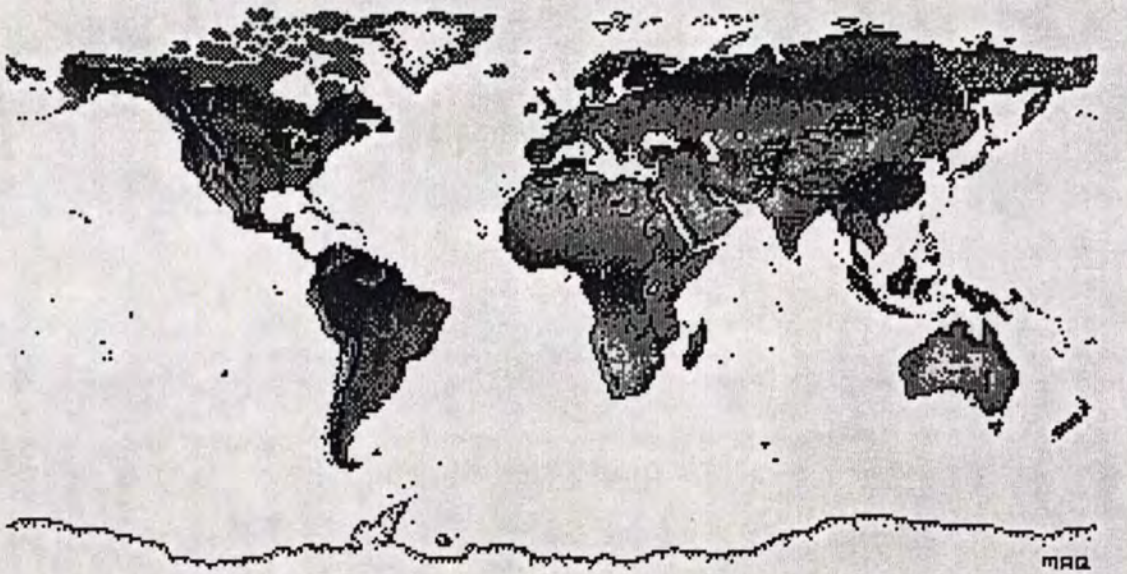
Evolution of the Wireless Local Loop

Creating World-Class Wireless Access Infrastructure...



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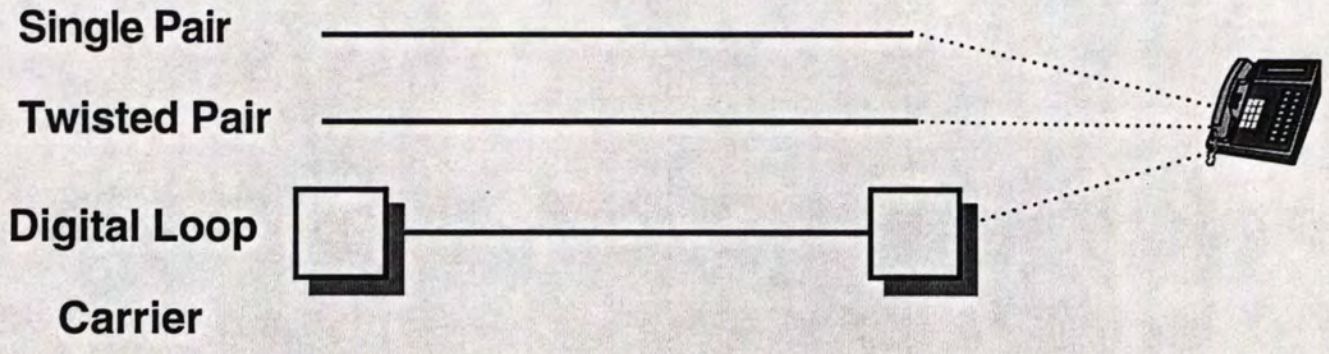
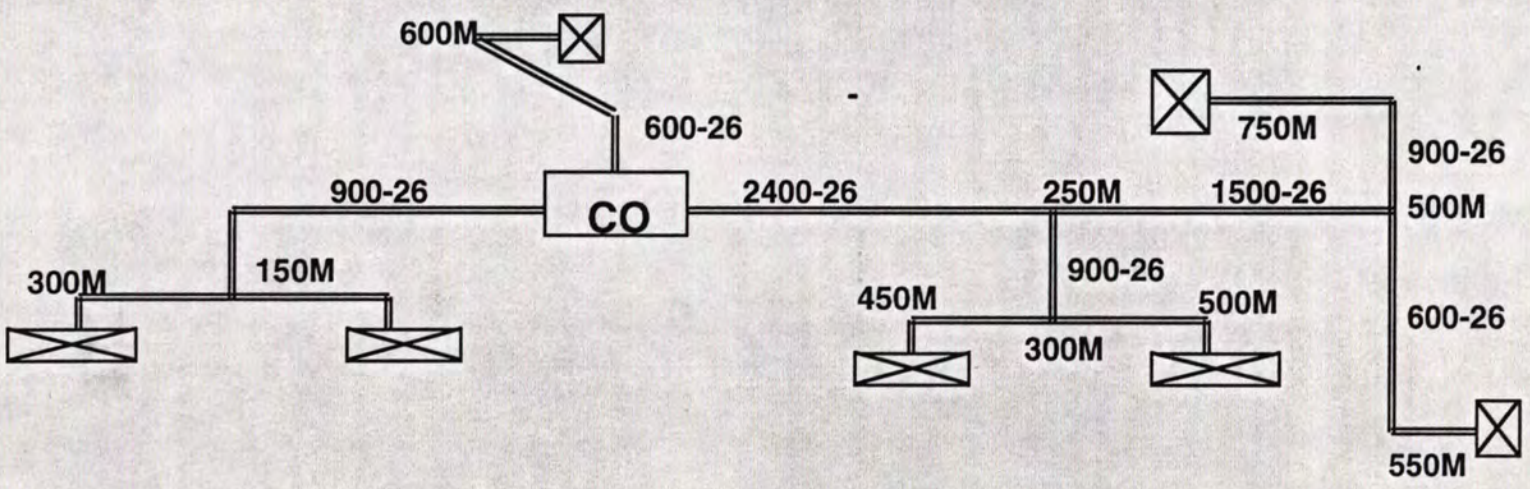
Spectrum 20/20 1996
"Dollars and Sense"

November 21, 1996
Ottawa, Ontario, Canada

The last hundred years

NORTEL
NORTHERN TELECOM





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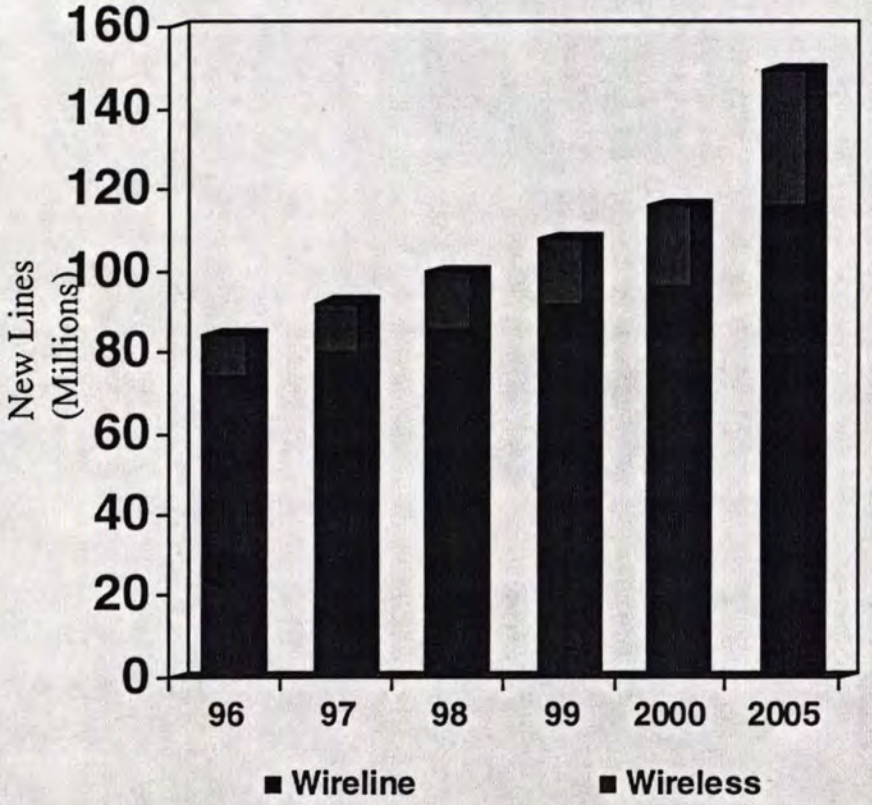
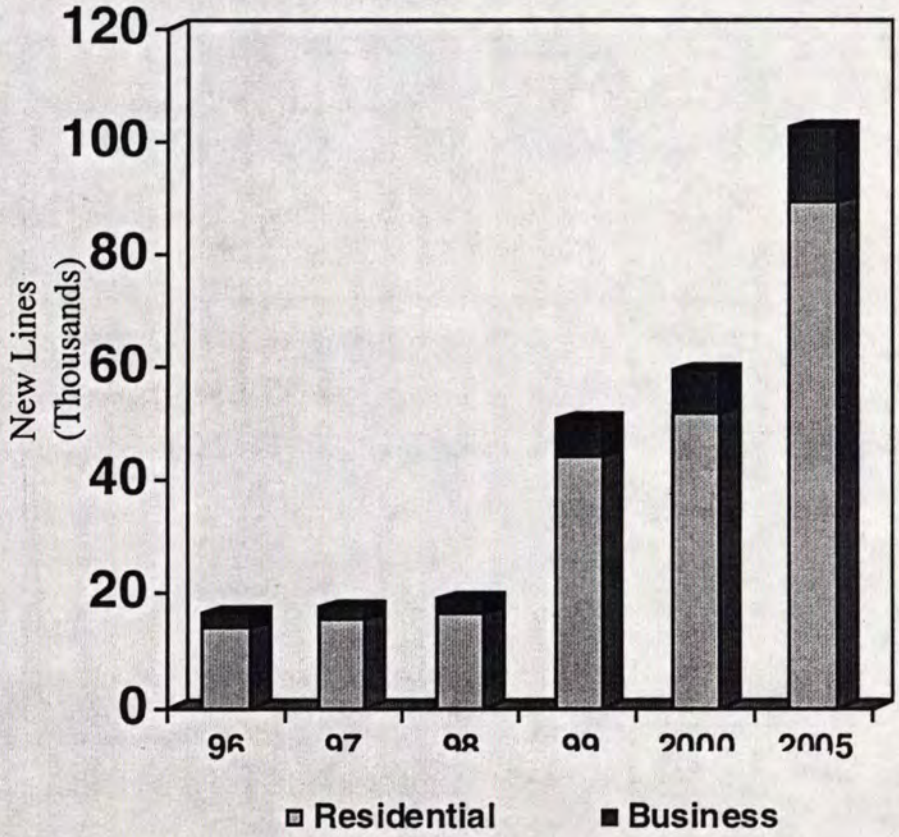
Global Market Forecasts - 1996-2000 and Beyond

Global



Canada



Source:: MTA-EMCI, Ovum Reports

Market directions

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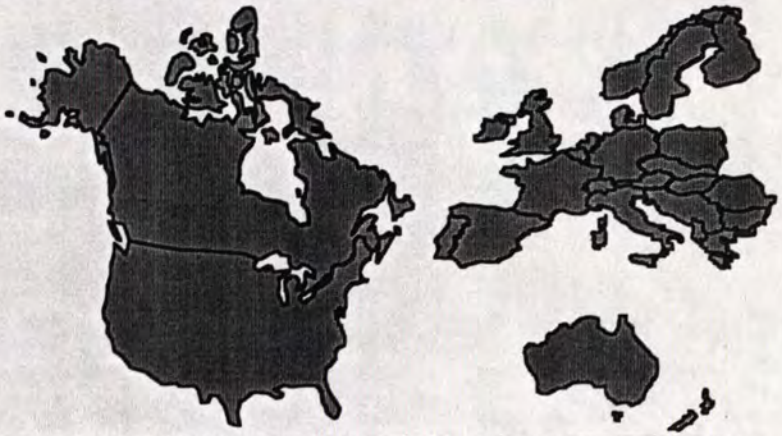
- WLL began as solution where no telephone service existed at all
- Wireless more cost-effective than wireline due to low pop. densities
- Characterized as "Fixed"
  No mobility requirements
- Target Market: POTS

Developed World



- Low Pop. Density applications in developed countries: POTS
- Applications in Dense Pop. areas:
  - Wireline and Wireless operators
  - Catalyst towards service and technology convergence

What is changing now

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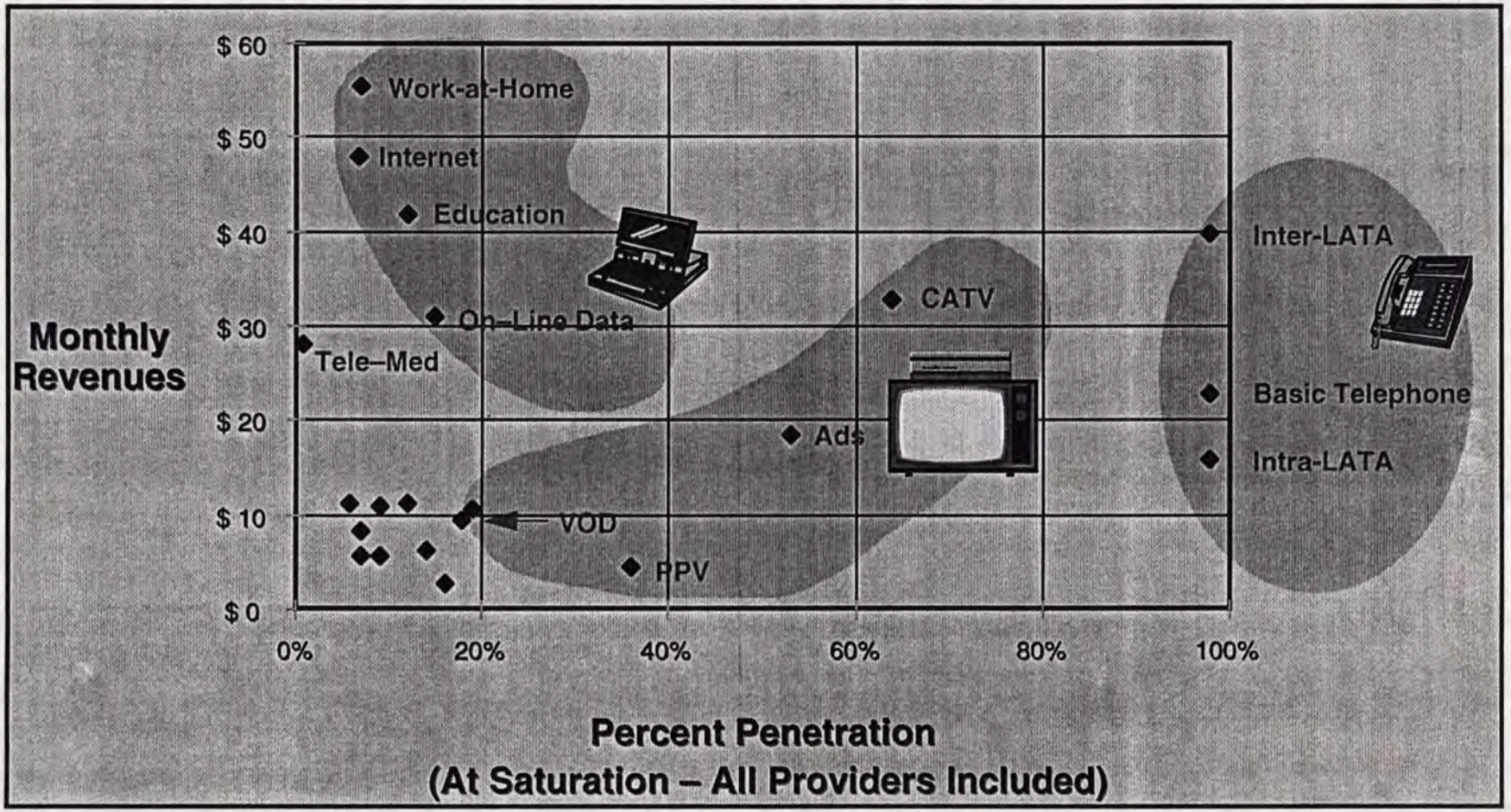
Residential/Business Access
Where is the new business?



Source: U.S. Market Analyses

Services and Applications

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END-USER SEGMENTATION - BY DELIVERY INTERFACE & APPLICATION

"MOBILE" VOICE & DATA

- Private
- Public
- Paging
- LS Fax
- LS Data
- Alarms
- Telemetry
- *LS Internet*

- PMR
- CMRS
- Satellite

Portable/ Mobile & Cordless

II. *"WIRELINE EQUIVALENT" SERVICES, RELIABILITY & QUALITY*

POTS VOICE

- Downtown
- Urban
- Sub-Urban
- Rural
- Isolated

- party line
- single line
- multi-line
- multi-unit

Telephones, Answering Machines, Cordless Phones, Fax machines, PCs

POTS FAX

- Fax m/c
- PC
- Server

- 9.6 or less
- 9.6 - 19.2
- *19.2-28.8*
- *>28.8*

Fax Machines, Modems, Voice / Fax / E-Mail Systems, PCs

POTS MODEM

- Modem
- PC
- Server

- 9.6 or less
- 9.6 - 19.2
- 19.2-28.8
- *>28.8*

- CS Data
- PS Data
- Internet

POTS SPECIAL

- Key System
- PBX
- Payphone
  - Public
  - Private
- Alarms
- Telemetry

- single line
- multi-line
- multi-unit
- T1 / E1 (incl fract.)

Key Systems, PBX's, Integrated Voice / Fax Mail Systems, Modem Servers, PC-based Call Centres, etc

ISDN BRI

- Modem
- PC
- Server
- ISDN TA

- 9.6 or less
- 9.6 - 19.2
- 19.2-28.8
- *>28.8*

- File xfer
- Videoconf
- Internet

LEASED LINE

- Voice PW
- Modem
- PC
- Server

- 9.6 or less
- 9.6 - 19.2
- 19.2-28.8
- *>28.8*

- T1 / E1 (incl fract.)

Special Data, ISDN and Server / Mux Devices, PCs

III. BROADBAND

- B'cast TV
- CATV
- Multi-T1/E1
- DS-3

- Entertainment
- Videoconf
- Telephony
- *Interactive Vid*
- *Internet*
- *Graphics*
- *HS Data*

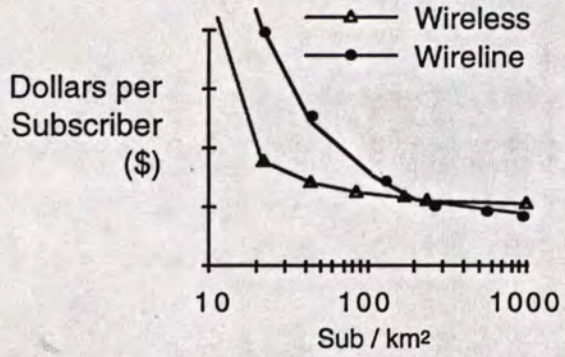
Televisions, PCs, Set-top Boxes, Decoders, etc

END-USER SEGMENTATION - BY TERMINAL EQUIPMENT & TECHNOLOGY

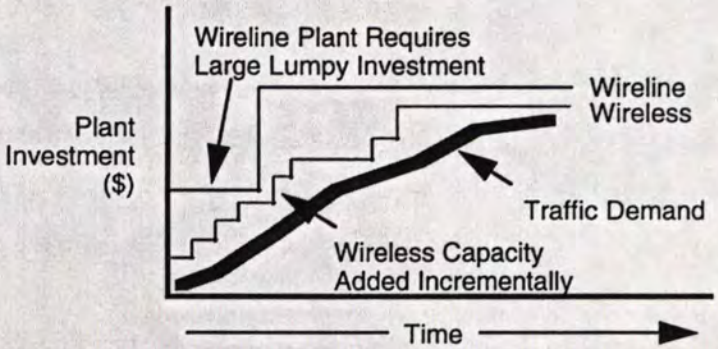
Global Market Drivers

NORTEL
NORTHERN TELECOM

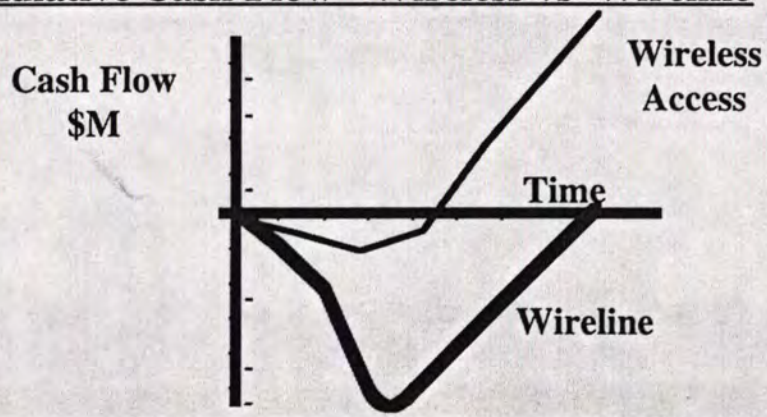
Low Capital Cost



Flexible Network Design



Cumulative Cash Flow - Wireless vs Wireline



New wireline vs new wireless economics

Time to Market

Time to Turn Up Systems

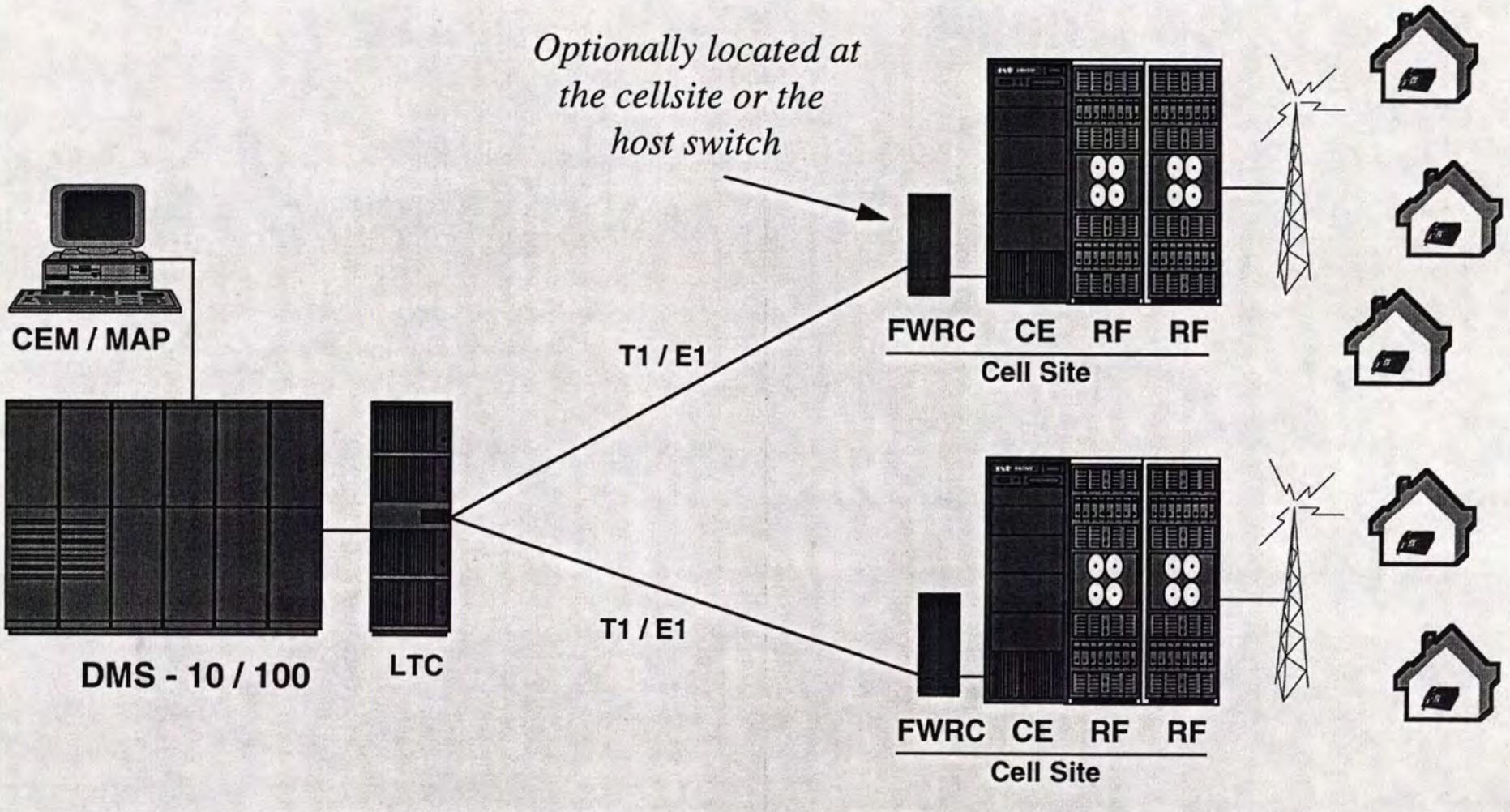
Wireless — Months

Wireline — Years

= Faster Payback

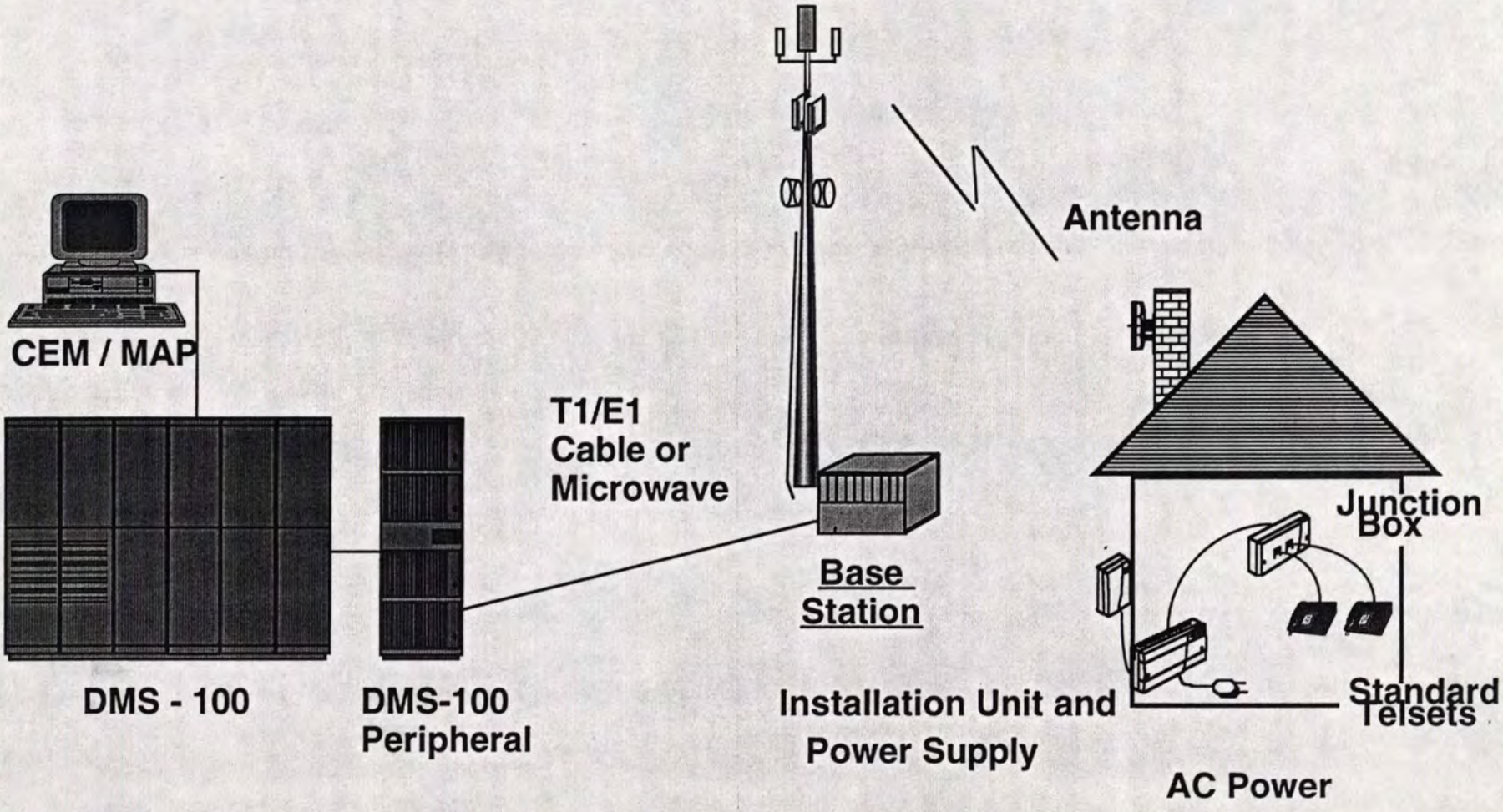
NORTEL
NORTHERN TELECOM

Proximity T400/T800 - DMS



NORTEL
NORTHERN TELECOM

Now Fixed Wireless Access
(eg. Proximity I - 3.5 GHz)



Bandwidth Requirements

NORTEL
NORTHERN TELECOM

Broadcast Television

+

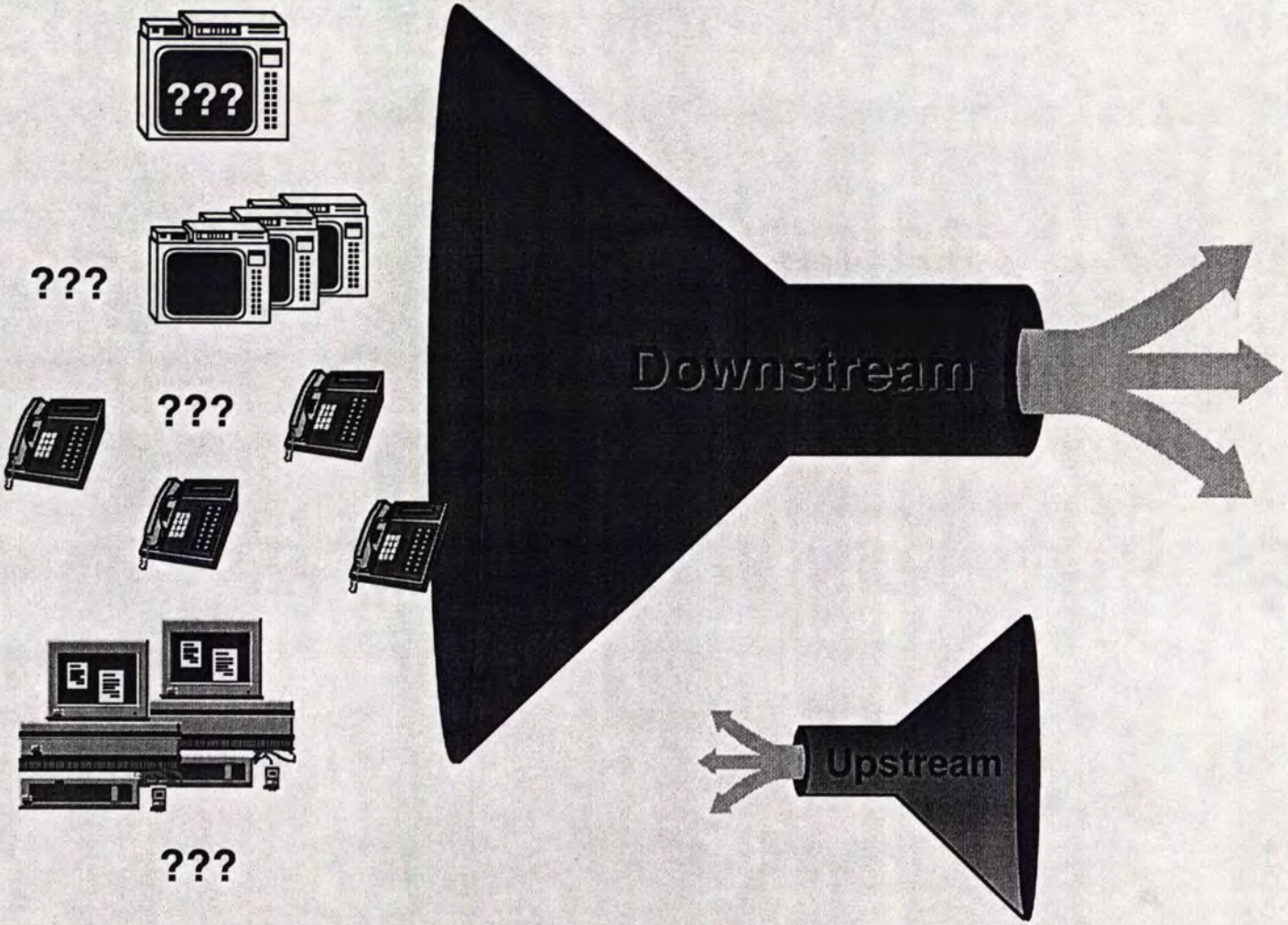
Premium Video

+

Voice

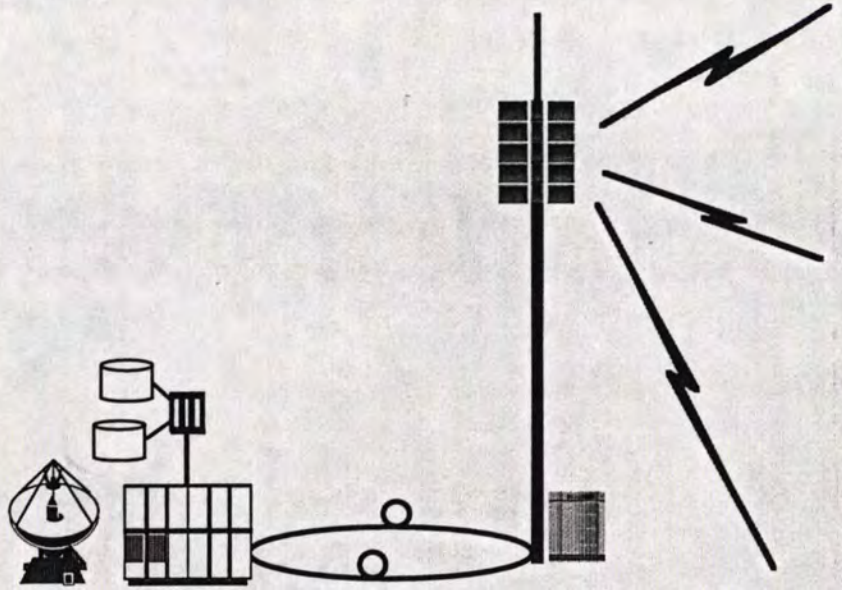
+

Data



Bandwidth: A Hypothetical Year-10 View

NORTEL
NORTHERN TELECOM

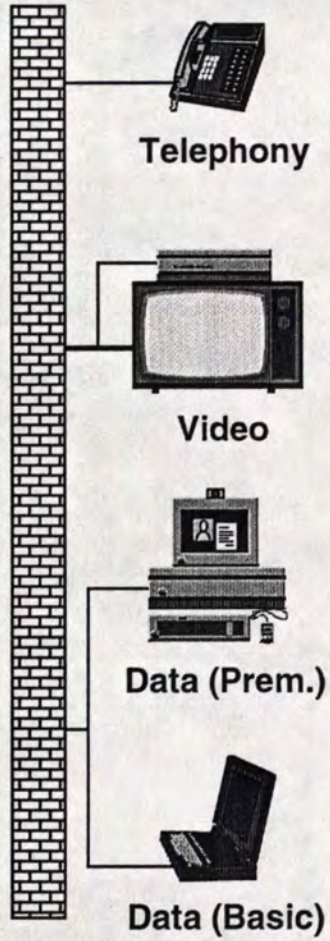


Downstream

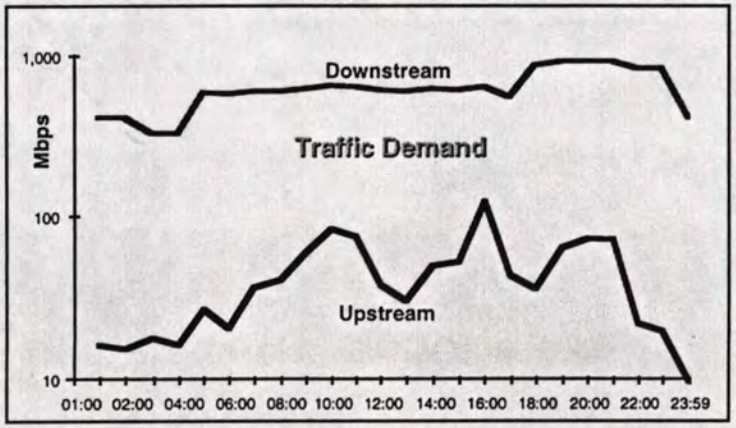
≈300 Mb/s
(Broadcast TV)

700 Mb/s
(Voice, Data, VOD)

120 Mb/s
Upstream

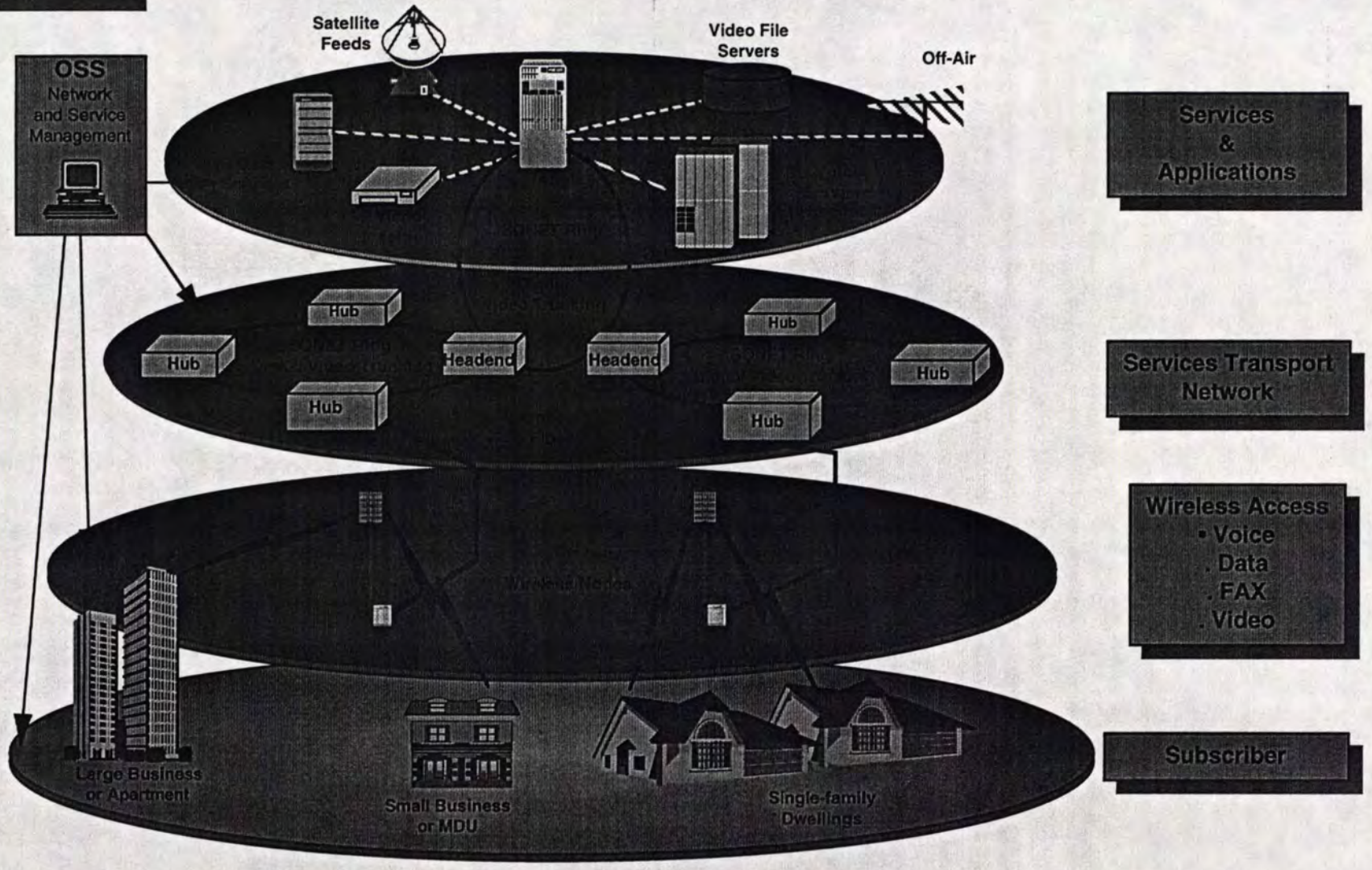


Business / Residential
(single, multi-tenant), SOHO



Wireless Layered Architecture

NORTEL
NORTHERN TELECOM



NORTEL
NORTHERN TELECOM

- Loss of 2nd line business
- L.D. Revenue erosion
- Carrier Access Tariff revenue erosion
- Temporary/Seasonal Service revenue erosion
- Operation Cost Saving - opportunity cost
- Modernization revenue - opportunity cost

NORTEL
NORTHERN TELECOM

The Opportunity to "Brand, Bundle and Bond"

- Build/ Leverage Brand Franchise
- Accelerate Modernization / Urbanization
- Reduce "churn rate" of customers
- Increase G.O.S. / Quality of Services
- Increase Revenue per account
  - ✶Increase value, additional services
- Simplify the Customers Life!

SPECTRUM 20/20 1996 PROGRAM
WORKING WIRELESS - A COST BENEFIT JUSTIFICATION
JIM BALSILLIE - RESEARCH IN MOTION

INTRODUCTION

It is indeed a pleasure to be here. I looked at the biographies of those presenting today and the number of advanced technical degrees achieved by just about everyone but me. So I quickly concluded that I had better talk about something I understand, and speak about it in relatively layman's terms.

In wireless, customers intuitively understand the complexities of their own cost:benefit analysis. As suppliers of wireless services and technologies or policy makers in this area, if we want to catalyze adoption of wireless in the workplace, we need to deeply understand the costs, the benefits and the alternatives.

Today, I will present the current and emerging network options for wireless teleworking and compare their individual attributes that are relevant for a cost: benefit analysis.

WHY ALL THE FUSS?

The utility of wireless teleworking is as obvious as it is inherently compelling.

Deliver the wireless services and you get the market. And there are lots services to deliver today:

- full duplex voice conversations
- voice messaging
- data messaging
- client-server communications
- file-transfer/ document management
- personal information management (PIM) with synchronization
- electronic financial transactions and banking
- automated vehicle location (AVL) and intelligent transport system (ITS)

Along with these services today is the future goal of wireless image delivery and even multimedia.

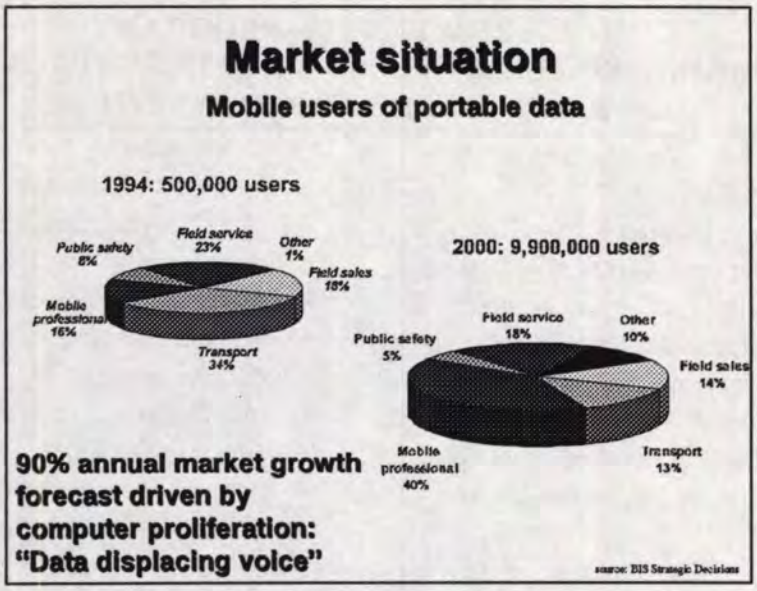
No matter which expert you ask, all assessments conclude that the target market is well worth the effort. If you reviewed recent industry studies, you will notice that there exists consensus that the market will grow to at least 10 million users by the year 2000 sustained growth in penetration is expected to continue thereafter for a long period of time.

"Wall Street analysts say that penetration for wireless personal communications, especially advanced messaging services, will eventually be 160%," said Hector Ruiz, Executive Vice President for Motorola's Messaging / Paging Group.

New Wave May 1996

"The move to integrate the Internet and wireless communication is a growing trend in the industry," said James Barksdale, president and CEO of Netscape Communications Corp. "The Internet is a logical extension to wireless communications," Barksdale said in his keynote address here. "I see wireless and Internet augmenting each other."

PC Week April 1, 1996



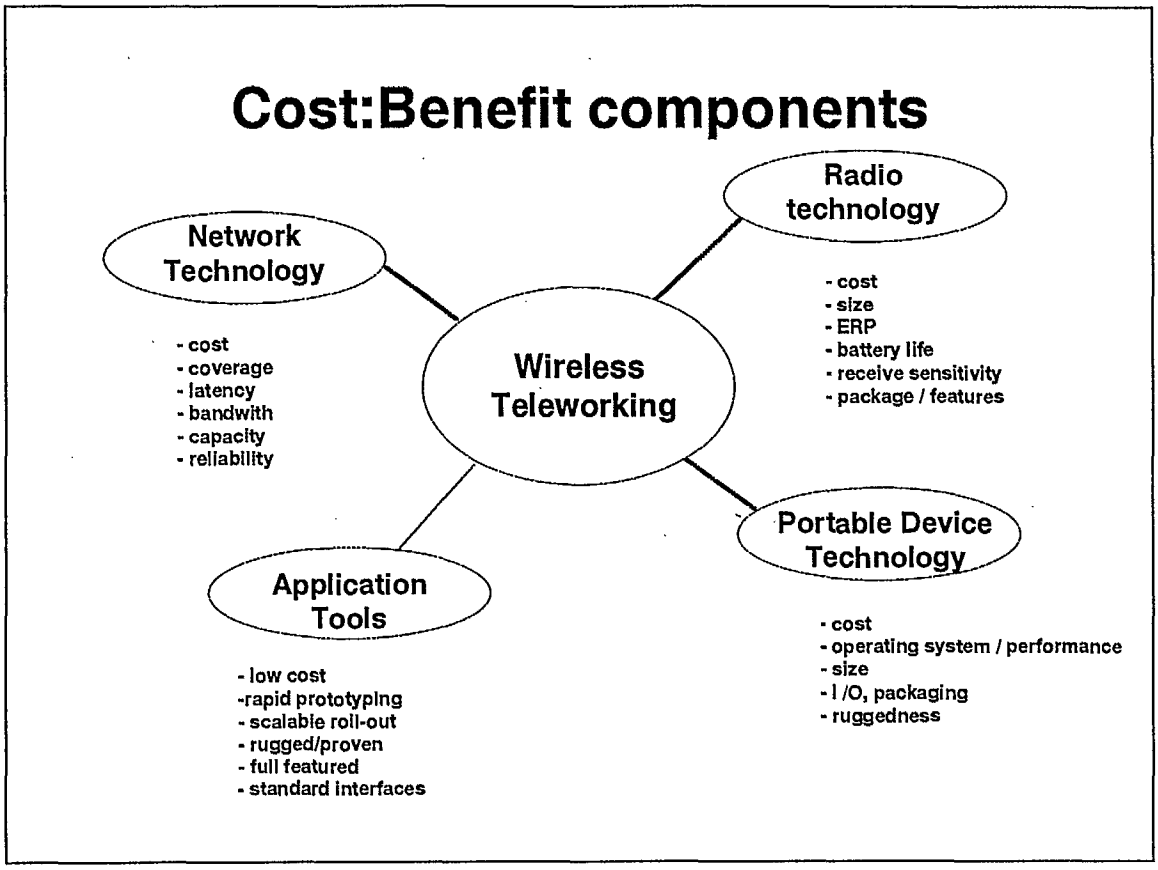
WIRELESS TELEWORKING DEFINED

I am defining potential wireless teleworkers as people who are mobile or frequently away from their workplace and who also have time-sensitive information and communication needs. In this definition, the common denominator is the need for the person to be *"always on and always connected"*. Take one step from this common denominator and you have substantial variations in the parameters of technical and economic requirements in each application niche. These parameters include: bandwidth, latency, coverage, terminal I/O, size, battery life, fixed costs, usage costs, information access, service bundles, etc.

Note that I am not addressing the wireless local loop here because I believe that it is mainly for fixed station applications that are not remote. Also, I am not including wireless LAN's or campus LAN's for much the same reason.

COST: BENEFIT DEFINED

When you telework wirelessly, you experience a system. I have separated the benefit deliverables that a customer interprets and values when working wirelessly. These deliverables are objectively measurable and able to be compared when assessing your options. Of course, the costs always weigh in against the benefits. In this system, you experience four main components: a network, a radio, a portable device and applications/tools. Each component has benefit characteristics that it offers and the threshold of acceptability of each characteristic varies with each user. However, make note that a threshold exists and in many wireless teleworking markets the threshold of acceptability is very high indeed. Noting the quote below, certain market requirements are so clear and defined, they might as well be the law.

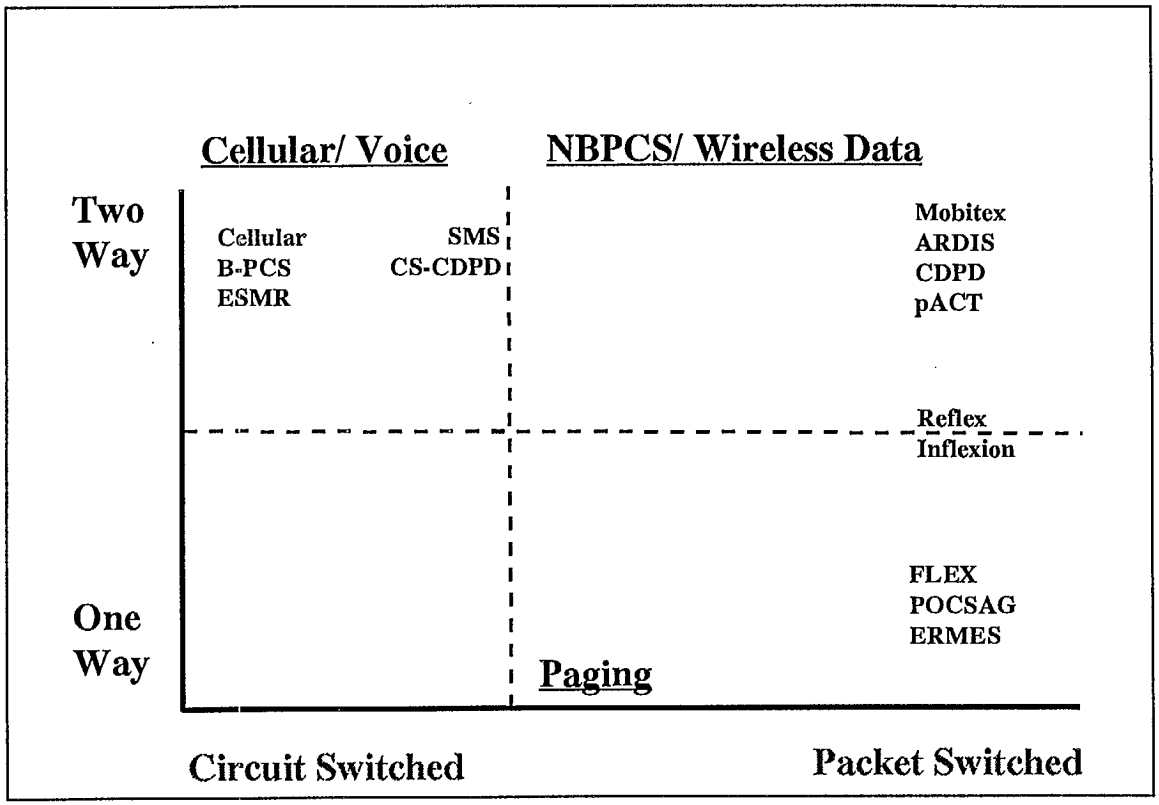


WIDE-AREA WIRELESS NETWORK OPTIONS

When a customer buys a wireless service, they are experiencing the inherent technical and economic attributes of the wireless network that their service operates on. I try to categorize the network options by two characteristics: circuit-switched or packet-switched and one-way or two way. This demarcation naturally separates most wide area wireless networks by their most basic technical and economic distinctions. When this is done, the various networks nicely segment into cellular/B-PCS, wireless data/N-PCS, and paging.

"In digital cellular radio, the system requirements are defined. Meet those requirements or fail! Good sensitivity, low spurious signals, and timing requirements are legal specifications. Power supply current, (talk and standby time) cost, time-to-market are 'soft' requirements. Do not be fooled. The market place will decide."

Paul C. Davis, AT&T Bell Labs February 7, 1996



Now I will summarize the relative cost:benefit attributes of the three primary segments in the chart below. What is important in this analysis is that each of these network categories possesses a distinct set of economic and technical attributes that we can map to the application and service requirements of a specific customer. These comparisons do indeed have many shades of grey between them and all are actually implementing new advanced technologies. However, the inherent differences are difficult to deny.

Beyond technology, the great advantage of cellular/B-PCS is that most people have circuit switched voice to begin with so the radio is already paid for.

Thus, the strategy for voice networks is often to add circuit-switched "computing" or "short messaging" capabilities on top of the existing voice service. However, this free ride on the voice business can only take you so far technologically. At the other end of the spectrum, paging offers a very cost effective low end service of "cheap beeps". While a very attractive entry point, this too can only take you so far technologically. Between the add-on strategies of cellular voice and low cost strategies of paging lies the wireless data/N-PCS sector: distinctive in its technical attributes yet chronically facing the up-front capital challenge that voice and paging networks cause with their first mover status.

RELATIVE COST: BENEFIT ATTRIBUTES

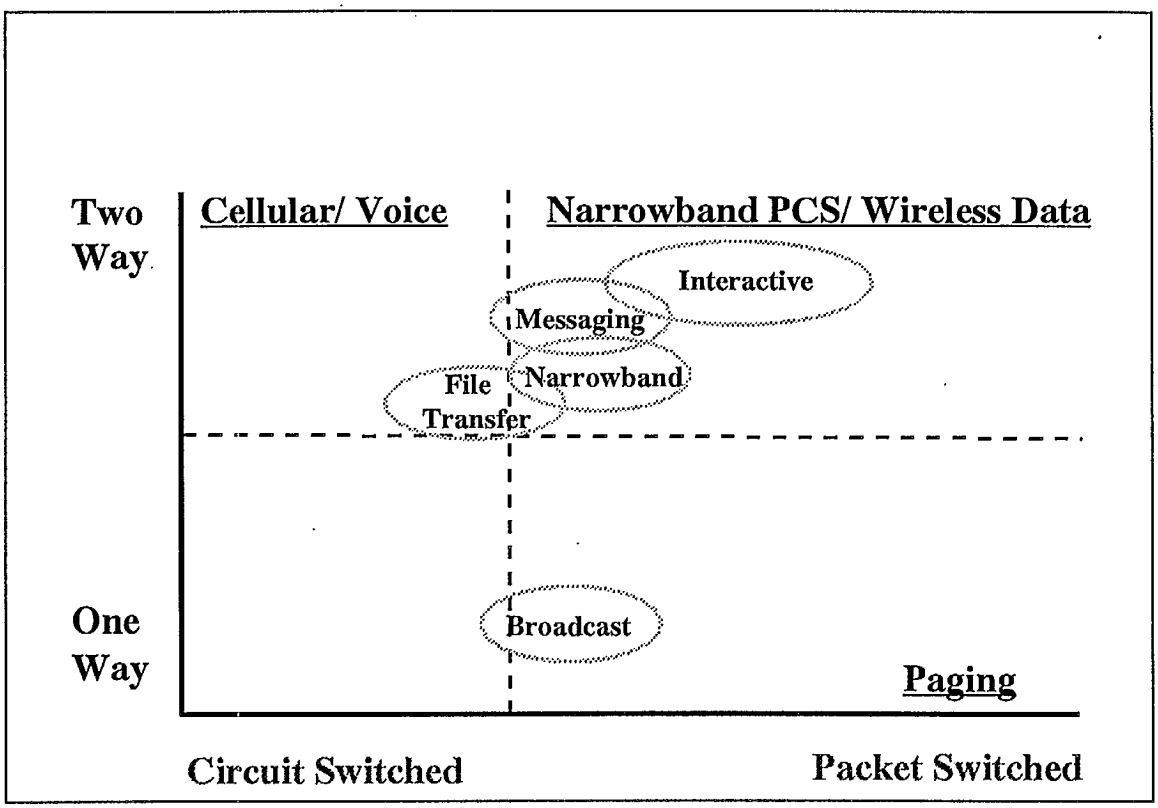
	Cellular/ B-PCS	Wireless Data/ N-PCS	Paging
Device Sizes	small	small	very small
Full Duplex /Circuit (continuous two-way)	yes	no	no
Spectral Efficiency			
- cellular	yes	yes	no
- packet switched	no	yes	yes
Battery Life	moderate	long	very long
Bandwidth	large	moderate	small
Infrastructure Costs	high	moderate	low
Store and Forward	no	yes	no
Device Prices	medium	medium	low
Air Time Prices	high	medium	low

Satellite is an important wild card in this analysis. While it is currently a higher cost remote coverage service, there are many exciting satellite plans in varying stages of implementation. These include Iridium, Orbcomm, TMI/AMSC, Odyssey, Teledesic, OCI and many others. Important differences and open issues include: service availability, bandwidth, capacity, costs, link budgets and devices. It is my strong belief that no one should underestimate the potential impact satellites will have in the wireless teleworking marketplace nor the risks of missed timelines and unmet performance expectations.

WIRELESS TELEWORKING APPLICATIONS BEYOND VOICE

True wireless teleworking is now at an exciting stage of emergence and adoption. Beyond traditional voice or paging, and file transfer using data over cellular, new classes of applications are taking hold.

These applications are centered around accessing information and two-way messaging. It is important to state again that no one network can meet all application requirements, and different protocols materially alter many critical application performance requirements. However, beyond a circuit-switched voice call, it is clear that the wireless data / N-PCS network segment is positioned to best serve the teleworking marketplace based on the technical attributes of the segment and the costs of that spectrum usage. Think of low cost companion devices that fit in your shirt pocked, last for one month, store-and-forward voice and data messages and are linked, via the Internet, to information repositories you need access to and you pay only for the information sent/received. Or think of sub-notebooks with PC card radios that are *always on, always connected* to your office while your PC is in suspend mode. Now the application utility broadens.



CONCLUSION

When you offer wireless teleworking services, the customer is experiencing a system consisting of a network, radio, computing device, and application software. The core benefits offered can be clearly determined using objective technical and economic measurements. For implementing wireless teleworking within the current suite of possible technical deliverables over the next five years, the market is settling for two core requirements: Circuit-switched voice and always on, always connected messaging/information access. The benefits of each are clear and distinct. While there exists considerable uncertainty about protocols and the application device form factor, one element is certain: wireless data and narrowband PCS are positioned to play a leading role in this equation.

REFERENCES

1. Hector Ruis, "Narrowband PCS/Wireless Data", New Wave, May 1996,
2. James Barksdale, "Narrowband PCS/Wireless Data" PC Week, April 1, 1996
3. "Market Situation", BIS Strategic Decisions
4. Paul C.Davis, "In digital cellular radio," AT&T Bell Labs, February 7, 1996

PERSONAL BIOGRAPHY
JAMES L. BALSILLIE

BUSINESS EXPERIENCE:

1992-1996 **RESEARCH IN MOTION LIMITED** **WATERLOO, ONTARIO**
Chairman & Partner
Direct strategy, business development and finance for Canada-based and owned wireless data communications radio developer. Profitably grew sales by 900% in the past three years, with over 95% of sales to export markets. Negotiated strategic alliance with **COM DEV**. Received **1995 CATA** Award for Outstanding Product Achievement. Received **CANARIE** funding for Wireless Internet Connectivity.

1989-1992 **SUTHERLAND-SCHULTZ LIMITED** **KITCHENER, ONTARIO**
Executive Vice President and Member of the Board of Directors
Profit and loss responsibility for Engineering/Products Group with 130 employees and $20 million annual revenues. Grew profits by 75% with twelve technology licenses with large U.S.-based controls manufacturers. Received Canada Award for Business Excellence (Innovation).

Chief Financial Officer for Sutherland-Schultz Limited, an $80 million Engineering/Construction company. Participated in all aspect of sale of company to European investors.

1988 **PRUDENTIAL-BACHE SECURITIES** **NEW YORK, NEW YORK**
Senior Associate, Investment Banking
Participated in transactions totaling over $300 million. Determined appropriate structures and negotiated with sellers and sources of financing.

1984 -1987 **ERNST & YOUNG** **TORONTO, ONTARIO**
Senior Associate, Strategy Consulting Group
Provided strategy services to entrepreneurial/technology companies.
Senior Accountant, Entrepreneurial Services Group
Performed financial and operational audits for a variety of emerging businesses. Prepared financial forecasts and business plans for several technology companies.

EDUCATION:

HARVARD GRADUATE SCHOOL OF BUSINESS ADMINISTRATION BOSTON, MASS.
Awarded Master of Business Administration. Tutored finance and managerial economics. Received fellowship for Canadian studying at Harvard.

ONTARIO AND CANADIAN INSTITUTES OF CHARTERED ACCOUNTANTS
Awarded Chartered Accountant designation and admitted to the Ontario and Canadian Institutes. Served as President of the Chartered Accountants Students Association of Ontario (5,000 members).

UNIVERSITY OF TORONTO (TRINITY COLLEGE), TORONTO, ONTARIO
Awarded Bachelor of Commerce Degree (Economics Major) with Distinction. Received award for highest standing in finance and three academic scholarships. Named Athlete-of-the-Year.

COMMUNITY:

Founding Member of Atlas Group of Waterloo Region High Technology Companies. Board Member of Kitchener-Waterloo Symphony Orchestra. Past Board Member of Kitchener Economic Advisory Committee, Waterloo Region Industrial Coalition, City of Waterloo COMPARE Committee (Committee on Municipal Productivity and Revenue Enhancement), Waterloo Region Social Planning Council, Conservative Business Association of K-W and Trinity College (Finance).

PERSONAL:
Married with two children. Enjoy public affairs and sports.

CHALLENGES AND OPPORTUNITIES FOR CANADIAN MANUFACTURERS OF DAB EQUIPMENT
DEFIS DÉBOUCHÉS POUR LES FABRICANTS CANADIENS D'ÉQUIPEMENT «RAN»

Stephen Edwards

Vice-President, Corporate Engineering & Technology
Rogers Broadcasting Limited
36 Victoria Street
Toronto, ON, M5C 1H3
416 864-2130

Introduction

Good morning, ladies and gentlemen. It's a pleasure for me to be with you today to talk about DAB, or Digital Audio Broadcasting, and the challenge and opportunities it presents for Canadian manufacturers.

Radio, as with every other communications medium, has recognized that its survival in the future is reliant on a move to digital technology. I'm sure it will come as a surprise to many of you that such a technology has been under development for over ten years. The R&D phase of this technology is almost complete, and deployment planning is well underway.

The official launch of DAB is scheduled for September of 1997 in Europe, at which time regional and national radio services will be available to over 130 million people, and retail outlets will have stock of receivers from about 20 European, and Japanese manufacturers. We are planning to launch DAB in Canada at the same time, in Montreal, Toronto, and Vancouver.

A potential worldwide market for transmitting equipment, receivers, and services provides some exciting opportunities for Canadian manufacturers but, as with any new technology, there are also some significant challenges.

This morning, I will be giving you some background information on DAB, and an overview of the technology then moving to the specific opportunities and related challenges. Finally, I will be looking at some of the companies already involved, both Canadian and international, and at their current product lines.

Background

In 1986, the European Council of Ministers agreed to fund a program to be known as Eureka 147, which had the goal of developing a digital transmission technology for radio broadcasting. In the 10 years since that decision, almost $100 million dollars has been committed, and the outcome has been so successful that not only will the technology be used virtually worldwide for digital radio, it also provided much of the technology base for digital television transmission in Europe.

The original project partners numbered 14, including the British, French, and German state broadcast organizations, several research institutes, and a number of major manufacturers including Philips, Thomson, and Bosch.

The project proceeded smoothly from original technology demonstrations in the late 80's, to agreement on international spectrum allocation in 1992, to completion of the European and world

standardization process in 1995. Today, we find ourselves on the threshold of commercial implementation.

In 1994, the project was opened to membership by companies worldwide who wished to contribute to the development of the technology. There are now 25 additional members including 12 Japanese receiver manufacturers and a Canadian organization known as Digital Radio Research Incorporated, or DRRI, an organization which undertakes digital radio research and development projects on behalf of its co-founders, Canada's public and private broadcasters.

From our first involvement with Eureka 147 DAB in 1990, Canada has been at the forefront of the development process, widely recognized for contributions such as the first technology demonstrations outside of Europe in 1990, the world's first C-band radio transmissions in 1991, a key role in worldwide spectrum allocation in 1992, an important demonstration of the technology in Mexico City in 1993, sponsorship of an International Symposium on Digital Radio in Toronto in 1994, and completion of all national regulatory and frequency planning processes in 1995; again, a world first.

Many, many countries worldwide are moving towards the implementation of DAB, with Europe and Canada at the forefront. Europe is working towards a formal launch coinciding with the IFA consumer electronics exposition in Berlin in September of 1997, by which time DAB transmitter facilities will provide coverage to over 130 million people in a dozen countries and receivers from at least 12 Japanese and European manufacturers will be on retailers' shelves.

In the interim, promotional trials are underway across Europe. Germany alone is spending over 100 million D-marks to establish transmission facilities and to subsidize the distribution of some 20,000 receivers to early adopters.

We are planning to coordinate our official launch here in Canada with the European launch so as to maximize the impact. By next Summer, we expect to see most public and private broadcasters transmitting DAB signals in Montreal, Toronto, and Vancouver and thereby providing coverage to about one third of Canada's population.

Key to our roll out strategy is close coordination with receiver manufacturers and retailers that will see lots of on-air advertising, in-store promotions, and one-on-one alliances between broadcasters and receiver manufacturers.

Our general roll-out strategy is to introduce DAB in the order of market size, to maximize broadcaster participation at the time of introduction in each market, and to cover only the central core of each market initially - a circle with a radius of about 40 kilometers.

We see DAB as a replacement technology for AM and FM, with the transition taking place over perhaps 15 years. In the early years, programming on the analog and corresponding digital service will be essentially identical. New services such as subscription programming - concerts, perhaps - and enhanced services such as location-specific traffic reports and specialized business reports will be introduced as the number of receivers in the marketplace increases. Coverage also will be increased over the years as the market expands.

Overview of the Technology

Having looked at the development and introduction aspects of DAB, I would now like to take a few moments to consider the underlying technology.

The essence of the Eureka 147 technology is the use of coded orthogonal frequency division multiplexing or COFDM. In this case, a set of 384 orthogonal carriers occupying a 1.5 Megahertz wide channel is used to transport a gross data rate of 2.3 Megabits per second within a sequence of 24 millisecond frames. A number of techniques such as energy dispersal, convolutional encoding, time interleaving, frequency interleaving, and the use of a guard interval all contribute in making the system extremely robust in a fully mobile environment. The use of a guard interval between data symbols also allows, for the first time in broadcast history,

the use of multiple transmitters on the same frequency in the same coverage area without interference. This feature also allows mixed satellite and terrestrial broadcasting in the same band, to the same receiver. Auxiliary transmitters cn be used to provide complete coverage in urban areas where the direct satellite signal is obstructed.

As a point of interest, the European digital television system currently under development will use the same technology extended to some 6,816 carriers occupying a 7 Megahertz channel, transporting a net data rate of about 18 Megabits per second.

At the level of the ISO transport layer, the Eureka 147 system allows for the distribution of up to 64 services per 1.5 Megahertz channel with individual data rates in multiples of 8 kilobits per second. Each service can be either in a streaming mode or a packetized mode with individually addressed packets as small as 24 bytes. In Canada, each radio station will be assigned one-fifth of the data capacity of a 1.5 Megahertz channel, providing a data rate net of error correction of about 256 kilobits per second. We expect that 192 kilobits per second will be used for transporting the program service and program associated data, and the remaining 64 kilobits per second will be used for unspecified auxiliary data applications.

If this very brief technical description has confused rather than enlightened you, you may be interested in accessing via the Internet the entire 271 page official ETSI specification ETS300401. The internet address is www.kp.dlr.de/DAB.

The Opportunities

So, what does all of this add up to? An opportunity to participate in the complete replacement of the transmission and reception infrastructures of radio broadcasting worldwide. Given that it is estimated that there are about 75 million radio receivers sold each year just in North America and that they are tuned to about 12,000 radio stations, the existing market is clearly not insignificant.

However, it is really the new applications and new services that DAB makes possible which lead to the most exciting opportunities. DAB will allow radio to move from being a single-dimensional music and companionship service to being a multi-dimensional multimedia service offering a broad range of entertainment and information customized to suit the needs of each individual listener. It would take another hour just to describe the range of programming possibilities, not to mention that the Internet's HTML protocol is fully integrated into the Eureka 147 specification, so that a radio receiver could become an addressable mobile internet terminal, and an interactive one at that if combined with a cellular telephone.

DAB receivers will be essentially very powerful computers implemented on a single chip. These receiver chips will be integrated into a wide variety of communications and entertainment systems rather than being single-purpose radio receivers crunched out in the identical millions. This immediately presents opportunities for smaller, specialized Canadian companies. Rather than having Canadian receiver designs limited to a few high-end audio firms such as Magnum Dynalab and Fanfare, we might see PC card receivers offering multiple wireless audio and date services from ATI, Matrox, or Advanced Gravis. Delco sees huge opportunity in automotive systems incorporating DAB. GPS, cellular, and intelligent vehicle highway systems. Other Canadian automotive suppliers may see similar opportunities. On the services side, Cancom has already started focusing on the integration of their satellite-to-truck data services with DAB. Leitch Technologies could well apply their conditional access expertise to DAB.

There are many similar opportunities for Canadian suppliers in transmission systems, and there are already a number of manufacturers involved. I mentioned earlier that DAB allows multiple transmitters in the same coverage area. The most important application for this unique capability is to provide coverage using off-air pickup and retransmission in difficult areas such as subway tunnels, and in areas obstructed by mountains or

buildings. G and A Telecom in Montreal is developing a range of specialized gap-filler transmitters, which integrate filters, attenuators, preamplifiers, power amplifiers, antennas, and power supplies in one compact package.

Other manufacturers such as Wavesat in Montreal, Unique Systems in Toronto, and Larcan in Oakville have developed DAB filters, upconverters, and power amplifiers. At least one company has licensed the baseband technology and is preparing to manufacture COFDM encoders. Tiltek, here in Ottawa, manufactures a complete line of L-band antennas.

The international market, of course, is where much of the sales potential lies. The potential is based on both the larger market sizes abroad, and the strong competitive position of Canadian manufacturers. Through a combination of favourable exchange rate differentials and higher European labour and material costs, our manufacturers enjoy, in some cases, a two-to-one price advantage.

In summary, then, DAB presents a wide range of opportunities for Canadian firms in service development, receiver system development, and in transmission hardware development. These opportunities, though, are not without risk.

The Challenges

There are a number of significant challenges yet to be overcome on the road to DAB implementation and success for Canadian companies. Some relate to the basic acceptance of DAB in the marketplace, some relate to the situation in the United States, and some relate to the ability of Canadian manufacturers to remain competitive.

Regarding the latter, the size of the potential market is impressive, but so is the competition. Will a strengthening Canadian dollar significantly weaken our ability to compete? Is our marketing adequate to gain attention on the world stage? Can our R&D efforts match those of much larger and longer-established international competitors? I think we can be optimistic on all these counts.

The Americans are more of a puzzle. More and more it appears that their political system is simply not suited to the adoption of clear technical standards. In the same way that the digital television issue is complicated by incompatible technical, political, and industrial agendas, so the issue of DAB in the U.S. has seen a litany of hidden agendas, misinformation, unreasonable expectations, and short-term thinking. The National Association of Broadcasters or NAB reversed its early endorsement of Eureka technology using the L-band as a result of pressure from some FM group owners who candidly admitted that their goal was either to prevent the advent of DAB, or, failing that, to adopt a system that favoured FM.

Following this, the U.S. became the only country not supporting the world-wide allocation of L-band spectrum from DAB. At this time the NAB officially supports so-called In Band On Channel approaches to digital radio but, after disastrous results from laboratory tests organized by the Electronic Industries Association and subsequent withdrawal from related field testing, those proposals have little credibility. In contrast, the Eureka 147 system performed almost flawlessly in both lab and field tests, and it is being seen more and more as the only viable alternative. In my view, the U.S. will ultimately adopt Eureka DAB in the L-band, probably within a few years.

The last area of challenge I spoke of is, in my view, by far the most serious. We have had great success so far in verifying the Eureka 147 technology, in securing spectrum, and in frequency and regulatory planning in Canada. As we move towards implementation, however, we effectively lose control of the process. We will be reliant on individual broadcasters to implement transmission facilities, on receiver manufacturers to provide receivers in a timely and cost-effective manner, and, ultimately, on the consumer to find the advantages of DAB sufficiently compelling that he will purchase a receiver. None of these are to be taken for granted. The radio industry in Canada has experienced poor profitability in recent years, so capital is not easy to come by. As well, although receivers will definitely be marketed in large

numbers in Europe, manufacturers will have to look at the size of our market versus the cost of packaging, marketing, and supporting receivers here. Finally, having good technology has never guaranteed success in the consumer marketplace.

Broadcasters are aware of these challenges, and the CAB's Digital Radio Roll-out Committee is hard at work dealing with them. On the broadcaster side, plans have been developed to make it easy for broadcasters in Montreal, Toronto, and Vancouver to establish transmission facilities. It was announced at the recent CAB Convention in Edmonton that there are commitments by eight broadcasters to establish DAB facilities for 15 radio stations in Toronto by mid 1997. If, as expected, CBC and others who expressed interest also participate, then more than 20 of the 25 Toronto radio stations will be on the air in digital. Similar developments are expected in Montreal and Toronto. We are also in close touch with several of the key receiver manufacturers who have indicated that their commitments would be conditional on broadcaster commitments, so we have good reason to be optimistic there, too.

Finally, marketing plans are being developed that will see joint manufacturer/retailer/broadcast promotions and alliances, with lots of free air-time, on-site broadcasts, and other initiatives aimed at convincing consumers to commit.

Conclusion

Will we achieve our goal of establishing DAB as the replacement technology? I believe without reservation that we will, although it is difficult to predict the pace of acceptance. The technology is superb, the benefits are clear, Europe is heavily committed, and the Americans are moving in the right direction. The Government of Canada has provided superb cooperation both nationally and internationally and I believe that their recognition of the potential opportunities for Canadian manufacturers was a major factor leading to that support. I am personally convinced that DAB will ultimately be successful in replacing AM and FM in Canada, in the U.S., and around the world, and that Canadian manufacturers will share in that success.

BIOGRAPHY

Steve Edwards is Vice-President, Corporate Engineering & Technology for Rogers Broadcasting Ltd. He is also widely involved in broadcast industry activities, including being a Director of the CAB and chair of the CAB's Engineering and Technology Council. His activities have included heavy involvement in all national and international aspects of DAB for the past seven years.

BIOGRAPHIE

Steve Edwards est vice-président des services intégrés d'ingénierie et de technologie de Rogers Broadcasting Ltd. Il est aussi très actif dans le domaine de la radiodiffusion, y compris comme directeur de l'ACR et président du conseil technique et technologique de l'ACR. Au cours des sept dernières années, il a participé à toutes les activités de RAN à l'échelle nationale et internationale.

Bell *Mobility*

Speech

MASTERING THE MULLIGATAWNY:
Wireless Communications and Customer-Driven Convergence

Notes for Remarks
Randall J. Reynolds
Senior Vice-President, Market and Network Development
Bell Mobility

to the Spectrum 20/20 Conference
Ottawa, Ontario

November 21, 1996

Check Against Delivery

Good morning.

A couple of weeks ago, as I was thinking about what to say today, it was one of those awful fall days -- cold, dark, not quite raining and not quite snowing -- you know the type.

And as I drove to a luncheon commitment, I thought, "Man, this is not a day for fancy French cuisine, or a light salad. This is the kind of day you want to take comfort in a big bowl of stew . . .

. . . a concoction like grandma used to make with every known food group in the icebox -- and then some. A dinner that, without question, is greater than the sum of its parts, guaranteed to chase away the deep, dark, dank November in your soul.

In a way, stew is everything I want to talk about today: for what is stew but the convergence of the full range of foods in a simple-to-use and ultimately satisfying mixture that makes you feel better beyond its nutritional value.

And what is technological convergence but the bringing together of the full menu of technologies, applications, and services in a simple-to-use format that offers the customer a potful of value, however that consumer defines value.

I want to talk today about convergence from three different points of view -- that of the customer, who is of course, paramount; that of the industry, which has to deliver not only to customers but also to shareholders; and that of the regulator, who has significant input in what, in the end, shows up in the customers' hands.

But I also want to be very clear about what the wireless industry brings to the mix -- and I can tell you it is more than just a little spice.

To date the convergence debate has focused largely on the competition between the telcos and the cablecos to offer converged services to the home.

Even as we talk, we are seeing the first manifestations of this in places like the U.K., where Cable and Wireless and Videotron are offering combined telephony and cable television.

The same bundle of services is being offered in Virginia by Jones Cable -- with very high penetration rates in the targeted markets.

But with great respect for the work that is going on to deliver convergence to the home, it makes for a rather thin stew.

That's because there is even greater potential in delivering convergence to the individual.

Because if we look at the totality of communications needs for an individual, they include mobility.

And it is in that context that we see the personal user as the power driver behind true convergence.

It is the personal user whose expectations and needs will drive the development of the truly intelligent network because it is the personal user who -- even today -- presents the most varied appearances to the network.

It is the personal user who is also the power driver of value added features -- one voice-mail box that covers home, car, office and trail; personal number services that simplify keeping in touch. . . and so on . . . and so on . . .

. . . Anywhere . . . any time.

And it is this personal user, frankly, that makes the wireless component of the convergence stew so piquant, so interesting from a functional perspective.

But before I get too carried away with my wireless advocacy, let me just say that, from our perspective, convergence isn't about technology and whether cable, wireline or wireless will win.

It isn't even about the regulatory environment.

It is about the battle for customer relationships -- which companies can win the hearts and minds of consumers . . . and do it for the long haul.

So that's where I'll start -- with the customer point of view.

In brief, that view today is that things are becoming more, not less, complex.

The market is filled with the babel of messages about cable, telephone, pagers, satellite phones, death stars and Internet servers.

Customers' mail boxes are filled with bills from the same constellation of service providers -- and their desks stuffed with user manuals for all the different devices we use to get our information.

And each of those manuals takes the customer to a different customer service organization.

Internet access is coming at us from internet service providers, telcos and in "Waves" from cable companies.

Even just in the wireless world, we sell such a profusion of products that it sometimes looks like we want people to load down their belts with pagers, fill their pockets with cell phones and mobile fax machines, and top off their RVs with satellite dishes.

No wonder they're screaming for simplicity.

No wonder they want integration of services.

A recent study by Washington-based MTA-EMCI reported 32 per cent of consumers want local and long distance phone service bundled; another 21 per cent want a long distance and wireless bundle; and 20 per cent want local wireline and wireless service in one place.

Fully one person in seven surveyed was interested in a much fuller package, offering local phone and long distance, cable TV, cellular, paging AND Internet access. Now that's a thick, nourishing stew!

The industry response is interesting and instructive.

AT&T in the U.S. is bundling in with its local service a 15-cents-a-minute rate for long distance anywhere in the country. It's also marketing direct TV.

MCI, for its part, has sold more than a half million pagers through its long distance telemarketing group.

Primeco -- one of the most advanced PCS providers in North America -- announced earlier this month the start of PCS service in 16 U.S. cities, service that includes state-wide long distance.

I can't mention that Primeco launch without pointing out that Primeco's service is based on a CDMA network, technology that, some critics have hinted, might not be ready for some time.

Looks like it's ready.

Digital PCS -- at least as envisioned by Bell Mobility -- is itself convergence technology, driven by the powerful needs of the personal user.

Digital PCS phones will be able to do the work of pagers and data terminals, just as computers can and will do the work of telephones, radios and televisions, . . . and telephones will be doing the work of data terminals and computers.

We're not there yet, but were seeing the first forays into the field.

Nokia's 9000 model PCS phone -- on the market today -- also acts as a PDA, a personal digital assistant, enabling users to talk, get e-mail, send faxes and access the Internet without wires.

For the last month, we've come to know about a proto-PCS fellow called MiKE who ingeniously enables users to receive text messages while on a voice call -- and allows one-to-many broadcast voice to boot.

Not quite all in one, but that's the direction.

And Microcell -- another recipient of a 2 GHz licence -- has said it will launch its first service in Montreal in about a week.

But there is more to this than simply the convenience of dealing with one device and one customer service organization -- as critical as those are.

What's more exciting is that people who turn to wireless are high revenue users who demand greater functionality.

They're sophisticated users who are driving growth that is much more dynamic than the growth in wireline.

And . . . ultimately . . . they are driving convergence.

Consider some data: In terms of the growth in the number of minutes used, wireless is far outstripping wired networks -- 43 per cent compounded annual growth rate for wireless compared to just over three per cent for those other guys.

Observers estimate that by the end of this century -- just three years away -- about half the calls in the world will involve at least one wireless device.

As for the industry here in Canada, we've experienced growth at about 35 per cent a year over the last few years. We're moving from just under 11 per cent penetration in Canada today to 40 per cent by the year 2005.

That's 10 million people . . . Not quite a phone in every pocket, but . . .

Obviously many things are fueling this growth, not the least of which is the technology's exploding ability to deliver terrific new applications to people.

But the growth of wireless is also -- and probably fortuitously -- tied to the evolving lifestyle, at least in the western world.

In North America and Europe -- as any demographer from David Foot on down will tell you -- we're becoming a more mobile and splintered civilization in which the ability to communicate while on the move is not just a nice-to-have convenience but a must-have productivity, safety and convenience tool.

With more double-income families . . . more single parent families . . . fewer stay-at-home moms and more latch-key kids -- our lives are demanding ubiquitous communications.

And as we move along the convergence continuum, that ubiquity applies to all of our communications facilities.

Imagine the value of being alerted automatically in your office, or your car, when your 12-year-old son gets home from school and logs onto the Internet.

Imagine the value when -- and it may not be too far away -- we can include global positioning in a two-way pager so that when little Susie forgets to check in when she gets home alone from school, you can track where she is -- even if she's sneaking off to the mall.

It's in that sense that the personal user is the driver of convergence -- not because the technology can, but because the human need to stay in touch is real.

And that need must be met anywhere, any time, any way.

The phone works in the car, on a plane, in the city, country or out on the tundra. And it works as more than a phone.

Any customer can walk through any of a number of doors to enter this convergence world.

And that's why the battle over customers is not a technological one, but a service relationship one.

One of the first things people point to when they talk about a customer relationship is brand.

Isn't it interesting that the number 2 wireless brand in Canada last week willingly entered an agreement in which it substantially alters its brand to accommodate a U.S. partner.

To us, the Cantel AT&T deal demonstrates the value in bundling -- and the opportunity to offer new bundled packages is a big part of the agreement.

We've always thought that, and will continue to do what we need to do to retain our brand leadership position.

The customer relationship is also built on service -- not only understanding their expectations today but also identifying their latent needs to develop applications for tomorrow.

In the end, from the customer point of view, we need to deliver a single point of contact, simpler ways to manage all their communications needs -- customized to markets as small as one.

We need to build an intelligent network that enables the customer to move beyond the somewhat mundane single bill, single device model and to a focused, personalized function model.

For our part, we've reorganized the whole Bell Mobility business in the face of these realities. For our first decade, we organized by technology -- with separate companies for cellular, paging, air-to-ground, mobile radio and so on.

This summer, we changed to focus sales and marketing on customer segments -- selling our whole portfolio of technologies to clearly identifiable groups of customers.

And we've begun work to get a better handle on who our customers are and what they want. We've always gathered giga-bytes of data; the challenge now is to translate that into customer intelligence that enables us to provide even better service . . . and cement the strongest customer relationships.

It is a challenge that faces the whole industry, and that brings me to the second perspective I want to touch on today: the industry view.

We share the view of some observers that the communications industry in Canada will rationalize down to three or four major players.

They will be challenged and supported by a substantial array of niche players who drive application development and spur competition.

But at the centre will be the big guys: the Bell group, AT&T and its affiliates, Sprint and its courtiers . . . and perhaps a yet-to-emerge fourth group.

It's happening all over. Look no further than British Telecom and MCI, or Cable & Wireless and Global One.

These are the organizations that have the resources and the expertise to deliver convergence on a number of fronts.

These are the integrated organizations that can realize the efficiencies of cross-marketing.

In wireless and long distance, for instance, the single biggest cost of business is acquisition cost -- over 25 per cent of the total operations expenses.

With strong brand presence, a full range of offerings wrapped up in a single, highly efficient point of contact across all the technologies, the integrated companies can amortize that cost of acquisition more effectively.

Plus we can focus on where the real profit is: retention.

There's been a great deal of work done in the last few years to show the contribution of customer retention to the bottom line. I won't take the time to review it in depth, because you're probably familiar with it.

But the bit of data that always catches my attention is one cited by Frederick Reichheld in the Harvard Business Review. Companies can boost profits by almost 100 per cent, he wrote, by retaining just 5 per cent more of their customers.

That's a pretty good return on investment.

What better way to retain customers than by meeting more of their needs, selling them more product and servicing their accounts -- regardless of technology -- through a single point of contact.

That single point of contact, of course, is a two-way street. For the more services you sell a customer, the more intelligence you gain about his preferences and needs across the entire communications spectrum.

That provides unprecedented opportunities for customer support and contact. And the better that contact, the lower the churn rate. A happy cycle of success.

We are becoming somewhat blasé about the wonders of communications, but there are still two billion people in the world who have never made a phone call.

And many of those people are in our own back yard. And example. When we launched mobile satellite service in January, Minister Manley here in Ottawa chatted by satellite phone with an elder of a village north of the Arctic Circle.

It was only the second time in his life that the elder had ever talked on a phone -- the first time was the day before when they were testing it and he was astounded by the power he held in his hand.

Those who witnessed the event got a new appreciation of how big and diverse this country is . . . and a poignant reminder of the potential of the technology we work with every day.

So the economics of the industry, plus the drivers of investment, will push towards more convergence, to take advantage of the efficiencies of integration, recognizing the critical importance of brand and loyal customer relationships.

And that brings me to the third and final ingredient in the convergence stew: the regulatory view.

In this context -- and it is a context enlivened by last week's Cantel AT&T announcement -- the preferred industry *modus operandi* is clear: Let the customer choose.

Let me expand upon that point.

This fall two University of Toronto professors -- Frank Mathewson and Michael Trebilcock -- conducted an extensive study on competition and regulation in the Canadian wireless industry.

The professors reviewed the competitive environment in the industry and the state of current and proposed regulation -- including initiatives on interconnection, resale, equal access, and joint marketing.

Among many conclusions they came to, Mathewson and Trebilcock found that the wireless sector in Canada is competitive today, an environment that should be nurtured through reliance on market forces instead of inefficient and costly regulation.

Resale, they said, will naturally occur as a result of market forces and there is evidence to suggest that mandatory resale -- which "amounts to the enforcement of uniform pricing" -- would be less efficient.

They also noted that "restrictions placed on incumbent firms in the cellular/PCS market in an attempt to facilitate entry of new firms are misguided" because they reduce future incentives to invest.

"Without proof of market failure," they write, "regulation results in inefficient resource allocation and a consequent reduction in wealth."

In other words, let the customer choose. Let the customer choose the carrier. Let the customer choose the reseller. Let the customer choose -- and in fact help to develop -- the application. Let the customer choose the bundle of services she wants to pay for.

We say welcome to the competition, for in the end it is consumers who win.

But we also say let's encourage true competition.

If we open up precious spectrum to new carriers, we say don't tie the hands of incumbents just because they've been in business for a decade or more.

If we think resale is a viable element of the mix, then let's allow resale to happen naturally -- not force it artificially.

But let's also enable companies to create alliances and use their partnerships to offer customers what they want, including bundles of services that are customized to meet their needs across the entire communications universe -- wired and not.

Clearly, the Cantel AT&T deal puts a new cat among the pigeons when it comes to bundled services.

As of today, AT&T, through its Unitel acquisition and last week's announcement -- like Sprint with its long distance business and its investment in Microcell -- are in a position to provide wireline and wireless services which Bell Mobility and Bell Canada cannot.

We hope this development will convince regulators that the time has come to allow Canadian companies also to align themselves and be full service providers of telecom services. That would mean Bell Canada and Bell Mobility would be free to compete fully by presenting a single face to the market.

As of last Friday, things seem to have started changing for the better.

That day, the CRTC approved an application to allow Bell Mobility to sell its Liberti phones in Bell Canada's Phone Centres -- the first variance from a very strict prohibition on joint marketing.

We applaud the regulator for this decision which we see as a first step in redressing the balance being set by the global nature of our industry.

And we look to government and the CRTC to continue down that road.

To us, the expectation that Canadian companies could align themselves to be full service providers is not just a commercial interest argument.

It reflects the increasingly global nature of the industry and speaks to the need to have a truly Canadian choice, not only for Canadian consumers, but also for Canadian job-seekers.

We have become used to having the best telecoms services in the world -- including wireless. The Yankee group has said that the wireless networks in Canada deliver to their customers better coverage, better quality and at a better price than Americans get from their carriers.

What we need is a platform from which to turn that expertise into a Canadian player that can compete against the biggest in the world.

As with the evolution of anything, the future of convergence is unpredictable. No one can say with certainty what new applications will be developed, or which ones will catch the market's imagination.

In fact, there is plenty of evidence that my convergence stew has many more ingredients that I've not had time to throw in the pot.

For instance, take the recent licence process for Local Multipoint Communications Services or LMCS.

Dialogue Canada Multimedia -- the consortium of which Bell Mobility was a member -- brought together Canadian know-how . . . a team of software specialists, creative multi-media types, content suppliers, network operators, even organizations that are best known for that ancient technology known as newspapers.

Is convergence just us -- just cable, wired and wireless? Not a chance.

New stuff's being added to the pot all the time.

The implication of that is that, in such a fluid environment, we have to be flexible. We must have the ability to innovate in the way we organize the business, develop products, and approach the market.

If we allow the industry the flexibility and forbearance it needs to get on with the job, we can build an industry that will not only provide Canadians with the leading products and services they need, but also enable Canadians to sell our expertise to the world -- with all the wealth creation that export activity can generate.

In an environment of such volatility and promise, we need to ensure that the regulatory climate encourages innovation by the communications industry -- and specifically in that I include the wireless sector, pioneers and new players alike.

Market participants should be free to develop the alliances that suit their purposes on terms they find commercially viable and which they believe will distribute value to their customers . . . and shareholders.

Let the customer choose.

For it is through competition that we will provide value for the most important people in the industry -- the customers, people like you and me who want choice, convenience, simplicity, value . . .

. . . people who want to take comfort that we will make a stew to chase away the dark of poorly understood and massively complex technology and nourish the spirit of real communications, in any form, in any place, at any time.

BIOGRAPHY

Richard Barth is the Director, Telecommunications Strategy and Regulation in Motorola's Corporate Government Relations Office in Washington, D.C. His responsibilities primarily involve developing and maintaining working relations with the U.S. Government's Executive Branch in order to facilitate Motorola's businesses worldwide. He manages a team that works closely with U.S. government agencies, especially the Federal Communications Commission, that deal with spectrum and telecommunications regulatory issues. He also is developing a broader strategic program to deal with other telecommunications issues, such as encryption policy and export controls. He is responsible for developing and implementing the company's policies towards, and role in, the National and Global Information Infrastructures (NII and GII).

Prior to his present position, Dr. Barth handled international trade and technology policy issues in Motorola's Washington office. Before that, he was on the National Security Council staff in the U.S. Executive Office of the President for over three years following a career that included various other trade- and technology-related positions in the Commerce and Treasury Departments.

Barth's doctorate is in inorganic chemistry and he is married, with two children, residing in the District of Columbia.

INFORMATION SECURITY: WHAT DOES THE CUSTOMER WANT? SECURITÉ DE L'INFORMATION: QUE VOULAIT LE CONSOMMATEUR?

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ABSTRACT

Information security is a far more complicated issue than the popular press would have one believe. There are aspects of security that everyone, including governments, acknowledge should be very strong. There are other aspects of security that cause government to object strongly to their widespread use because of concerns that terrorism, drug running and other societally objectionable acts could be protected from police monitoring. Bridging the gap in the perceived needs of the governments and private sector in this arena has proved elusive.

The issue must first be analyzed to determine which aspects of security concern governments and why. The private sector should apply its resources, then, to determining if there is some way of giving the government what it needs, access, while protecting private citizens and the security needs of individual businesses. This has been made more difficult because of the hype that has taken over the issue of information security.

The hope is that this paper will help bridge this gap in perspectives and thereby lead to a more focused effort to fix the problem rather than continue to engage in non-productive hyperbole.

Information Security: What Does the Customer Want?

I. Introduction

Over the past three or four years, as the Internet has exploded, as we finally figured out how to have MACs and PC's talk across networks, and as hard drive storage expanded only slightly faster than software demands, one issue has proven especially divisive: the security and privacy of these systems.

Few talk of security issues related to the web without immediately talking about narrowly defined lines drawn in the sand by both sides in this debate. Generally, many in the private sector seems stuck on the view that the governments of the world are out to undercut the revolution that will take us all the final steps to nirvana. You have only to read a few pages in *Wired* magazine before you will find another Netizen highlighting the latest supposed government violation of our basic rights.

For better or worse, this debate is not just centered in the US and a few other countries like Canada that are viewed as information haves, as opposed to the 90% of the world's population that hasn't even seen a laptop. In China the government is rolling out new rules on information access as fast as they spot new threatening sites on the web. In Singapore, it is said that the government is monitoring its citizen's activities on the web and

blocking out web sites deemed seditious or dangerous to public morals. And to top it all off, the frightening news came out on Halloween that Myanmar, or Burma to those of us born in the first half of this century, has imposed criminal penalties on web browsing should you happen to trip into a site containing such information as the GDP of that nation.

But let's focus back on the real issues of security in the information age and what problems companies and government officials should be trying to resolve.

II. Drivers for Information Security

An important element of information security is that networking capability has given us significantly larger and new security challenges, especially on the largely public world wide web component of the Internet. With stand alone computers in the period of 1950 through the late 1980's, security was largely a matter of preventing an individual inside an organization from creating mischief on that particular computer. With the advent of truly effective and global networking, you get a whole new dimension of security issues. Witness the Scandinavian hackers who altered the CIA's home page.

Customers, certainly individuals, but particularly businesses, are encouraging the increased use of these networks to conduct daily business in a company or to deal with suppliers and/or external customers. In any of these relationships, that have at their core an economic element, security protections are essential. When Boeing developed its 777 aircraft as a global exercise in teamwork, only good security on their network allowed them to trust this new concept for designing aircraft in far less time than had ever been accomplished before.

It has oft been said that the "killer app" of the Internet will be electronic commerce. Why drive to the mall, when the mall exists on your home Mac? I'm not exactly sure which of the many definitions of electronic commerce will be this "killer app," but which ever one it is, it will be dependent on elements of security that are increasingly available on the Internet. Mastercard and Visa are actively pursuing the need for confidence in the Internet when you load in your credit card number, and the only certainty I have is that these very resourceful private enterprises will succeed, even if they have to tone down the level of security on the system in order to gain governmental approvals needed for a world wide system.

As these kinds of applications spread and reach out to more and more individuals, at home or in the office (a distinction that is rapidly disappearing) all of the legitimate participants will want good security.

III. The Multiple Dimensions of Security

At Exhibit I is a chart developed by Motorola to help highlight the multiple dimensions of the security issue as it applies to all aspects of the information industry: computers, telecommunications, software, hardware, the Internet and any other aspect of this thing dubbed the Global Information Infrastructure, the Information Society or any other term describing these networks of networks.

This chart must be examined closely to see which aspects of security apply to which applications sought by users of the various inter and intra nets that add up to what we call the world wide web. As you will see on the chart, the first aspect of this complicated issue of security is that there are applications that require quite specific security to meet the consumer's intended use of his or her information appliance. For example, most companies and many individuals want to have authentication of the user before their laptop logs into their network from some remote site, whether for creating slides for a presentation, retrieving email or typing up a contract. This simple aspect of security is generally part of the log on procedure that in most corporate networks helps prevent the theft of corporate secrets. No one objects to this type of security, be it ever so strong, and the US government at least is investing major funds in using such schemes, and even more advanced ones including bio traits like finger prints or voice

recognition, to ensure that the information on a government computer is protected from unauthorized access. Clearly, in this, as in other cases the corporate world and governments share the same objectives for information security.

But let's dig a little deeper. Take another issue related to security: data file encryption. Look at the General working through the night at home on a battle plan who is run over by the trash truck on the way to work. Or the corporate general counsel who spends a week negotiating a deal to buy a major competitor and has a memory lapse as to which former wife's name he used to create a password and loses access to the contract? In both cases, if not they themselves, their higher management wants to have some way of retrieving the data on their computer. Again, governments and companies share the same objectives, although they may actually want differing strengths of computer security.

Quickly review the other aspects of security that are listed on this chart, and you will see that there are similar needs for both governments, organizations and individuals for good security. Both corporations and government want non-repudiation of an email or electronic transmission, whether Visa card transactions or orders to deliver a diplomatic note. Both corporations and government want certification or validation of the identity of the other party to a transaction, again whether a military order or an order to a supplier to deliver another 20,000 axles to a Ford plant in Toronto. Across the spectrum of security issues, both government and the private sector share nearly identical objectives for information security.

IV. Will the Customer Get What the Customer Wants?

In Motorola, we are finding increasing, customer-driven requirements for security that are easy to solve technologically, but which generate government concerns. Our high end pager customers who want stock quotes and an ability to respond to their broker and buy shares through the same paging device, are but one example of the need to address customer needs. Encryption of the content of the message as well as certified identification and non-repudiation, are all essential elements of the transaction.

Similarly, we are now providing cable modems that will allow your TV cable to your home also to be used as a phone line or to link to the Internet, while still delivering excellent TV reception. These signals need to be encrypted because of the fact that the systems are basically constructed like party line phone systems in order to allow for economical implementation. The users - large cable operators who are risking millions to bring home these systems - chose 56 bid DES as their solution for privacy and security. Unfortunately, that security-driven decision for the US market resulted in a non-exportable product. Clearly the customer's needs have been foiled by government, with attendant harm to inter-operability and mass production savings. Interestingly, a Japanese firm can build to the US user's standard and export to the US or other destinations freely. US competitors must build to the user's specifications for the US market but, until now at least, they cannot export the 56 bit DES product and must down rate it to a 40 bit implementation. What marketing gambit do you expect from the Japanese firms when they compete against US firms in countries such as India? "Buy American or buy security."

V. The Great Divide - Government versus Users!

Despite all the similarities of need for security by both government and the private sector, as identified above, there is one issue that divides the private sector and their governments. That issue is of course wiretapping or surreptitious monitoring of other activities such as faxes, emails and the like. Most companies don't want to get anywhere near monitoring their employees in the same way that the governments around the world are demanding access to their citizens - and in many cases foreign citizen's - transactions that threaten some essential aspect of that society.

There are those who object sheerly and absolutely

to such activities by government. But there are many who respect the legally limited need of governments to engage in this activity. But the hype on the issue basically leaves many thinking that governments want to prevent the use of strong security measures whether or not the private sector needs or demands them.

On the government side, they do not universally accept the evidence of demand as compelling.

Let's again go back to Exhibit I. On Exhibit I there is really only one aspect of security that has led to this perceived enormous gap between governments and their private sectors. That issue is confidentiality. It is largely overlooked in the media hype on this issue, focusing on rights and terrorists, that governments have for years allowed many types of security to be as strong as they can be devised.

VI. Conclusions

The minefield of emotions that have made encryption front page news is thus largely based on disagreements on only one aspect of security. Governments are now increasingly insisting on some type of access, often referred to by the term key escrow, as a technology solution to this problem.

Motorola, and some other companies, believe that there is a market for key recovery, key access or, again, that most hated term of all, key escrow systems. These terms really all refer to the same technologies, but they each have different connotations, with gradations of anxiety tied to each. But that market will in fact be limited to certain security applications, especially data file storage and retrieval.

In order to serve that market, we have announced that we will work to make these technologies available. The market, however, not governments, will decide whether key access technologies and capabilities meet customer needs or not.

Regardless, I would close by noting that there are some end to end encrypted transactions, such as simple telephone calls and police two way radio systems, that will evolve toward increasingly stronger encryption and for which there is no role for key access capabilities. I submit that our challenge for the next several years is convincing governments that these types of systems have a valid place in the international marketplace without key access.

Exhibit I Customer Needs **Needs and Types of Security Vary**

Example Market Segments	Financial Transactions	Data Services	Entertainment	Government/ Public Safety	Medical/ Healthcare	Cellular/ Telephony
Customer Needs	Trusted Payment	Service Access	Copyright, Ordering, Payment	Emergency Access	Privacy	Billing
Authentication	●					●
Authorization			●			
Availability		●		●		●
Data Integrity	●	●			●	
Confidentiality				●	●	
Non-repudiation	●					

Session 4

SESSION 4: SPECTRUM ECONOMICS
SÉANCE 4: LES ASPECTS ÉCONOMIQUES DU SPECTRE

Chair: Roger Poirier

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BIOGRAPHY

Roger Poirier is President and CEO of the Canadian Wireless Telecommunications Association (CWTA), a Trade organizations representing the wireless telecommunications industry in Canada. Its members include Canada's cellular companies, paging operations, personal communications carriers, mobile satellite and mobile radio operators from coast to coast.

Mr. Poirier is also a past President of the Radio Advisory Board of Canada, a government advisory group on spectrum and telecommunications policy.

Prior to joining CWTA in 1993, Mr. Poirier was Senior Vice President with the Canadian Cable Television Association (CCTA) and was responsible for Technology, Telecommunications and Planning. Prior to joining CCTA, Mr. Poirier's early career, 1972-1982, was with the Federal Department of Communications occupying senior positions in stwandards development affecting broadcasting and cable television.

Roger Poirier holds bachelors and masters degrees in electrical engineering from the University of New Brunswick.

BIOGRAPHIE

Roger Poirier est président et chef de la direction de l'Association canadienne des télécommunications sans fil, une association corporative représentant l'industrie des télécommunications sans fil au Canada. Parmi ses membres, citons les entreprises de radio cellulaire du Canada, de téléappel, de communications personnelles et les exploitants du service mobile par satellite et de radio mobile d'un océan à l'autre.

M. Poirier fut aussi président du Conseil consultatif canadien de la radio, un groupe consultatif gouvernemental sur la politique du spectre et des télécommunications.

Avant de se joindre à l'Association canadienne des télécommunications sans fil en 1993, M. Poirier fut premier vice-président de l'Association canadienne de télévision par câble (ACTC) où il était chargé de la technologie, des télécommunications et de la planification. Auparavant, M. Poirier avait amorcé sa carrière, de 1972 à 1982, au ministère fédéral des Communications, où il a occupé divers postes supérieurs en normalisation de la radiodiffusion et de la câblodistribution.

Roger Poirier détient un baccalauréat et une maîtrise en génie électrique de l'Université du Nouveau-Brunswick.

PROPOSED MARKET-BASED MECHANISMS FOR SPECTRUM MANAGEMENT / MECHANISMS DE GESTION DU SPECTRE PROPOSÉS EN FONCTION DU MARCHÉ

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ABSTRACT

In June 1996 the UK Government published a White Paper "Spectrum Management: into the 21st Century". This announced that legislation on spectrum pricing will be introduced when parliamentary time is available. This paper outlines the key policies to change from spectrum management based on regulation, to a regime using a combination of regulation, spectrum pricing and a spectrum efficiency scheme.

The paper also draws on two consultants' reports on "The Economic Impact of the Use of Radio in the UK" and a "Study into the Use of Spectrum Pricing". The first report estimated that in the UK use of the radio spectrum contributed over £10bn a year to GDP, which is more than 1½ per cent of the total. It also provides efficiency gains and consumer surpluses for users of between £7bn and £11bn per annum. The second report outlined proposals for implementing spectrum pricing. This informed the pricing examples given in the White Paper.

The procedures proposed for setting administrative pricing are explained with examples given for mobile radio applications. The White Paper assumes that for mobile radio the value per MHz for national coverage ranges between £240K and £640K. The charges for an individual mobile radio licence will depend on the band width used; the area sterilised by the transmissions; and the degree of sharing with other users. Examples of charges

RÉSUMÉ

En juin 1996, le gouvernement du R.-U. a publié un livre blanc, « Spectrum Management : into the 21st Century », qui annonçait que la législation sur l'établissement des prix des bandes de fréquence serait adoptée lorsque le calendrier des travaux du Parlement le permettrait. Ce document décrit les principales politiques destinées à passer de la gestion du spectre basée sur la réglementation à un régime utilisant à la fois une réglementation, l'établissement des prix des bandes de fréquence et un plan de rendement spectral.

Le document s'inspire également des rapports de deux consultants sur les incidences économiques de l'utilisation de la radio au R.-U., et sur une étude de l'utilisation de l'établissement des prix des bandes de fréquence. Le premier rapport indique qu'au R.-U., l'utilisation du spectre radioélectrique a rapporté plus de 10 milliards de livres sterling par année au PIB, soit plus de 1½ pour cent du total. Il génère également, pour les utilisateurs, des gains d'efficience et des surplus du consommateur de l'ordre de 7 milliards à 11 milliards de livres sterling par année. Le deuxième rapport décrit les propositions concernant la mise en oeuvre de l'établissement des prix des bandes de fréquence, et renseigne sur les exemples d'établissement des prix donnés dans le livre blanc.

Les procédures proposées pour l'établissement des prix administratifs sont expliquées par des exemples d'applications de la radio mobile. Le

are: a taxi firm with 20 mobiles operating in London for a 2x12½ KHz channel the current fee of £250 will increase to £650; and for a cellular company with a national 2x200 KHz channel, the current fee of £28,800 will increase to £177,000.

The paper concludes that the economic case for getting the maximum efficiency from the radio spectrum is compelling. In order to achieve this, appropriate spectrum management tools are required, along with a well-informed strategic plan for the use of the spectrum over time.

livre blanc suppose qu'en ce qui concerne la radio mobile, la valeur par MHz pour ce qui est de la couverture nationale, se situe entre 240 000 et 640 000 livres sterling. Les frais pour chaque licence de radio mobile dépendront de la largeur de bande utilisée; de la zone stérilisée par les transmissions; et du partage avec les autres utilisateurs. Voici des exemples de frais : pour une compagnie de taxis possédant 20 radios mobiles exploitées à Londres, les frais passeront de 250 livres sterling à 650 livres sterling pour une voie 2x12½ kHz; pour une compagnie de téléphone mobile cellulaire utilisant une voie nationale 2x200 kHz, les frais actuels de 28 800 livres sterling augmenteront à 177 000 livres sterling.

Le document conclut que les motifs économiques d'obtenir un rendement maximal sont convaincants. Pour atteindre cet objectif, des outils appropriés de gestion du spectre sont nécessaires, de même qu'un plan stratégique éclairé concernant l'utilisation du spectre au cours des ans.

PROPOSED MARKET-BASED MECHANISMS FOR SPECTRUM MANAGEMENT

Introduction:

This paper is based on the policies outlined in the White Paper "Spectrum Management: into the 21st Century" (Reference 1) published on 17 June 1996. I will also draw on the analysis undertaken to support the preparation of the White Paper. In particular, two consultant studies on "The Economic Impact of the Use of Radio in the UK" and "Study into the Use of Spectrum Pricing" (References 2 and 3).

Spectrum value:

The topic for this session is the value of the spectrum. There is now a growing realisation that the radio spectrum is a very valuable resource. In 1995 the UK Radiocommunications Agency published a study on the economic impact of radio. This concluded that, on a conservative basis in 1993/94, radio contributed over £10bn a year to the UK's gross domestic product (GDP). This is more than 1½% of total GDP. The breakdown of this contribution is shown in Fig.1 below:

Fig 1 Contribution to GDP 1993/94

	(£m)
Private Business Radio*	
200+	
Cellular telephony	1,200
Fixed Links	80+
Satellite	
950	
Broadcasting	6,800
Other	600
Total	10,000+

* Formerly Private Mobile Radio

The contribution from cellular telephony is likely to be significantly higher now, as user growth rates are averaging about 50% per annum. The broadcasting contribution is also likely to rise as a result of developments in this market, including the introduction of digital services. The contribution of radio to UK GDP is therefore likely to continue to increase in absolute terms and as a proportion of the total.

Radio also leads to efficiency gains and consumer surpluses for users. The economic impact study suggested these were between £7bn and £11bn per annum. This estimate is prepared on a different basis from the contribution to GDP and so the two numbers cannot simply be added. The breakdown of the contribution is shown in Fig.2 below:

Fig 2 Economic benefits to radio users 1993/94

Efficiency Benefits:	
Private Business Radio	£450-2,250m
Fixed links	£100- 400m
Satellite	
positive	
	£550-2,650m+
Consumer Surplus:	
Cellular telephony	£3-5000m
Broadcasting	£3,000m+
	£6-8,000m+

These levels of economic activity also translate into employment, which was estimated at more than 300,000 jobs. The industry is currently assumed to be generating about 1,000 jobs a week.

The above figures demonstrate that effective management of the spectrum can make a significant contribution to the economy, as well as providing social, cultural and scientific benefits. The spectrum also has vital applications for defence and a range of emergency services. Demand for spectrum is growing rapidly as a result of growth in existing services, and the need for new services. These processes are driven by the flexibility and cost effectiveness of radio and the desire to now undertake in the mobile environment activities which were previously considered as fixed services.

The use of regulation for spectrum management:

Traditionally, spectrum has been managed by purely regulatory means. In the UK, the main spectrum management legislation has changed little since the original Wireless Telegraphy Act in 1904, the dawn of the age of radio. Spectrum has been assigned on a "first come, first served" basis, subject to various technical criteria, with licence fees charged at the level of the administrative costs of spectrum management. In almost all cases this is well below the value of the spectrum. This distorts the market and can lead to some or all of the following consequences:

(i) spectrum is not assigned to the highest value user or use and investment decisions are distorted;

(ii) rather than being market driven, spectrum management decisions are imposed by administrations, often on the basis of incomplete information and uncertainty about future trends;

(iii) administrative procedures for changing spectrum allocations and assignments are slow, retarding desirable technical progress and market development;

(iv) users have little incentive to give up unused or under-used spectrum or to invest in more spectrum efficient technology. This creates a self-perpetuating vicious circle of shortage and hoarding; and

(v) regulation imposes hidden but sizeable compliance costs and denies users the right to make informed choices.

Spectrum Pricing White Paper:

A consultation document on the future management of the radio spectrum was issued in 1994 (Reference 4). The responses to this showed a general consensus on the need for reform. There was acceptance of the principle of administrative pricing but concern about the general use of auctions. The results of the consultation and the further consultancy studies were considered by the UK Government and the decisions announced in the spectrum pricing White Paper "Spectrum Management: into the 21st Century" (Reference 1), presented to the UK Parliament on 17 June 1996.

The White Paper stated the UK Government's intention to introduce legislation, when parliamentary time is available. The main purpose of the legislation will be to allow licence fees to reflect more closely the value of spectrum. It will also contain provisions to increase the security of licensees and make provision to give financial assistance to radio users in order to accelerate desirable changes in spectrum usage.

The market based spectrum management tools that will be introduced via the legislation are considered in more detail below.

Auctions:

Auctions have important advantages of economic efficiency, transparency and speed. They also allow users themselves to value the spectrum directly. Examples of where it is envisaged that auctions could be used are:

- for national or regional services where there are more well-qualified applicants then can be accommodated in the spectrum available;
- to promote the release of analogue broadcasting spectrum; and
- to select a spectrum management organisation for a block of spectrum.

In response to the concerns expressed during the earlier consultation, the White Paper makes clear that auctions are not suitable for all circumstances. In particular, where there is a large number of relatively low value licences to assign, auctions would be impracticable and the associated cost could exceed the value of the spectrum. As a result, there are no plans in the UK to auction individual private business radio (formerly known as private mobile radio) or fixed links licences.

The NERA/Smith report (Reference 3) outlined options for conducting auctions. These are not considered in this paper, as other countries have practical experience of auctions.

Administrative pricing:

Spectrum that is not subject to auctions will be subject to administrative pricing. This will complement the regulatory spectrum management tools and be driven by spectrum management requirements, not revenue raising. Higher charges will therefore be focused on services and parts of the country where there is, or is likely to be, insufficient spectrum to meet demand.

Administrative pricing requires fees to be set at an appropriate level in circumstances where there is not a true market from which the value of spectrum can be determined. The fee needs to be set at a level which maintains a balance of the supply and demand for spectrum.

In competitive markets, the price of a commodity is generally equal to the marginal value of the goods or service consumed. A number of ways of estimating the marginal value or opportunity cost of spectrum were considered. These include:

- revenue of the organisation using the spectrum resource;
- profitability of the spectrum using activity; and
- cost of the next best alternative (radio or non-radio technology, alternative service or frequency bands).

The revenue approach was rejected, as it does not give a reliable indication of the value of the spectrum. For example, a firm with a greater revenue per MHz could value spectrum less than others if the use of radio only contributed a relatively minor part of its activities. The profitability of spectrum using activities was also considered inappropriate because of the problems of obtaining data. The approach of the next best alternative was therefore adopted.

To determine the administrative price, assumptions need to be made on the least cost practical alternative. For example, for users of private business radio the options include, narrow band technology, moving to a different band, or an alternative service such as public access mobile radio. The last of these was selected in this case.

This process generates a value of spectrum for each class of service subject to increased charges. For example, the White Paper assumes the marginal value per MHz for mobile services ranges between £240K and £640K. The charge to be made for a licence takes account of the marginal value of the spectrum and other factors. For mobile radio these include:

- spectrum used (bandwidth);
- the area sterilised by the transmission and within which re-use of the frequency is not possible; and
- the degree to which the channel can be shared with other users assessed on the basis of the number of mobiles. The number of mobiles is only a rough indicator of actual use and the RA is developing more sophisticated alternatives.

As the objective is to balance supply and demand, higher charges based on the marginal value will only apply in areas of congestion. For mobile radio in the UK the White Paper assumes these to be the regions of London, Birmingham and Manchester. National or regional charges may be derived based on assumptions about the area covered and the re-use of frequencies possible. Examples of possible charges based on the proposals in the White Paper are given in Fig. 3 below.

User	Spectrum	1995/96 Fee	New Fee
Taxi Firm 20 mobiles	2 x 12.5 kHz	£ 250	£250 or £650*
Electricity Co. 2000 mobiles	2 x 12.5 kHz 3 National Channels	£18,000	£ 48,000
Cellular Co.	2 x 200 kHz	£28,800	£177,000

Fig 3 Examples of charges for mobile radio

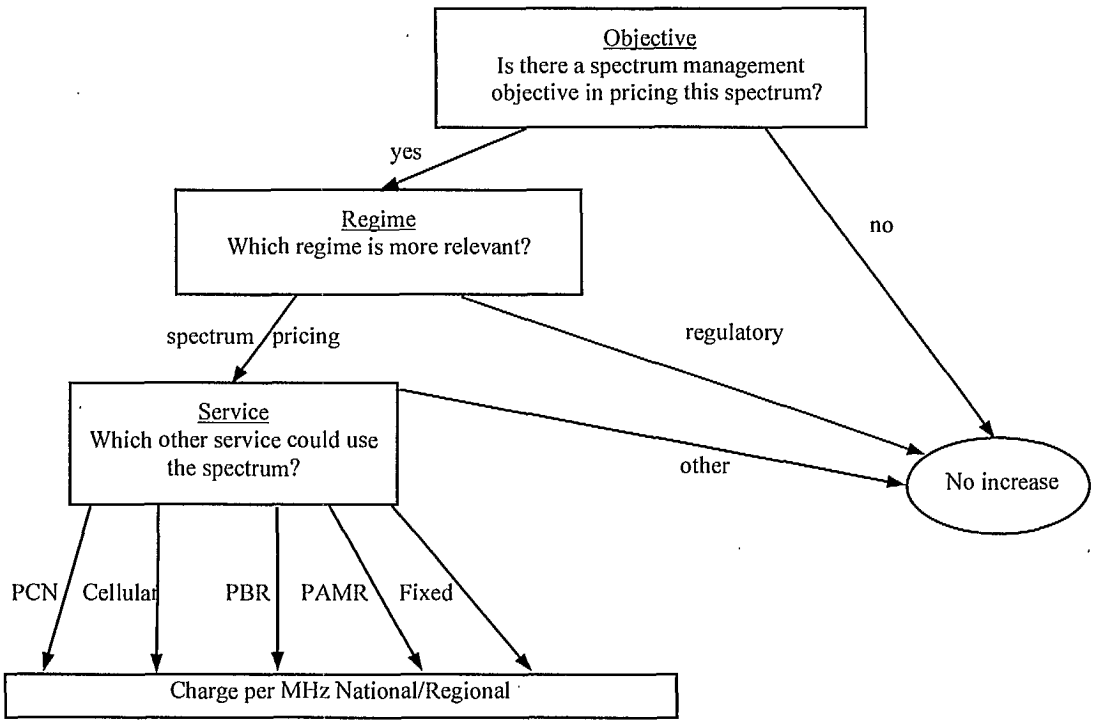
* London, Birmingham and Manchester

Affordability:

It is important that the above charges do not have the effect of pricing users out of spectrum. They therefore need to be sustainable by users, including small businesses. In the case of taxi firms with twenty mobiles operating in an area of congestion, the increase represents about £0.40p per taxi per week following full implementation of the higher charges. This needs to be seen in the context of a total revenue of about £500,000 and an annual radio system cost of £5,000. In the case of the regional electricity company the use of radio represents a very small part of their total business. Total revenue would be in the order of £1.4bn and annual radio system costs about £1.7m. Turning to cellular telephony, it is forecast that the present four operators (including the two PCN operators) will by the year 2000 have a combined turnover of over £3.8bn and 10 to 14 million subscribers.

The pricing proposals in the White Paper are subject to a consultation period which has just closed. Careful consideration will be given to all comments and suggested amendments and it is likely that some changes to the pricing structure

Fig 4 Pricing public sector spectrum



will be made in the light of this. The new fees will be introduced via secondary legislation, so final decisions will not be taken until the primary legislation has been enacted.

Public sector users

A key element of the proposals in the White Paper is that the private and public sector should pay for spectrum on a comparable basis. However, this will only apply to administrative pricing, as it would not be appropriate for the public sector to bid in auctions. The concept of the least cost practical alternative cannot be used in many cases in relation to Government Departments, for example, where MOD use spectrum for weapon systems. It is therefore proposed that the value of spectrum for the public sector will be determined on the basis of which other service could use a particular frequency band. The process of setting the fees for each frequency band is outlined in Fig.4 above:

Spectrum efficiency scheme:

It is intended that the legislation for spectrum pricing will also include a provision to give financial assistance to radio users in order to accelerate desirable changes in spectrum use. For example, payments could be made to assist users to move to alternative frequencies in order to clear a band for a new application or higher value service. Payments could also encourage users to re-equip with spectrum efficient technology before existing equipment is fully depreciated.

All payments under the scheme will need to be justified on value for money grounds. In most cases, the benefits will be the result of accelerated change in spectrum use. Where this involves clearing a frequency band for a new service, very large economic benefits can be achieved. For example, the economic impact study (Reference 2) considered the consequences if the UK personal communications networks (Orange and Mercury One-2-One) had been delayed by two years. It was

estimated that by 1999 the impact would have been a loss of £410m a year GDP, 7600 jobs and £2.5bn a year of consumer benefit. These net losses to the overall economy would have been caused by delays to investments in the new system and reduced competition to the original two cellular operators.

Spectrum allocation:

It is not intended at this stage to extend the role of spectrum pricing to the allocation of spectrum. However, it is believed that the analysis of the economic benefit of different potential allocations of spectrum and the values derived from spectrum pricing should be used to inform decisions both at national and international level.
Currently, allocation decisions are predominantly made on technical grounds. However, the economic impact study (Reference 2) demonstrates that allocation decisions can have a significant impact on wealth creation, competitiveness and jobs. Now that hard choices are having to be made between competing demands for spectrum, it is important that the economic consequences are taken into account.

Economic analysis can inform allocation decisions in two ways. The first is by analysing the economic impact of the alternative uses. In doing this, account needs to be taken of a range of economic indicators, as they may not all point in the same direction. For example, figures 1 and 2 show that private business radio makes a relatively small contribution to the UK's GDP but generates large efficiency gains and consumer surpluses. Conversely, broadcasting makes a large contribution to GDP but relatively smaller efficiency gains and consumer surpluses. It is therefore necessary to consider a range of economic indicators in considering allocation decisions. This will not only help a balanced decision to be made but maintain diversity in the market place and promote competition.

The second way in which economic factors can inform allocation is by considering the relative administrative price for different services. The pricing models in the White Paper work within current allocation decisions. As the objective is to balance supply and demand, the size of existing allocations will affect the marginal value of the spectrum. Therefore, discontinuities in price across allocation boundaries within the same area of the spectrum can provide a useful indication of the need to adjust the respective allocations. For example, the administrative price for fixed link services in the 1-2 GHz regions is only about a tenth of that for mobile radio applications. This suggests that encouraging fixed services to use alternative frequencies, or technologies, in order to release additional spectrum for mobile radio would bring economic benefits.

It is not suggested that allocation decisions should be taken purely on economic grounds, as particularly at the international level they tend to be too strategic in nature to be left entirely to market forces. However, spectrum managers should take account of the economic consequences of allocation decisions. In order to inform this in the UK, the Radiocommunications Agency will be undertaking a rolling programme of economic impact studies.

Longer term plans:

In the UK, it has been decided not to legislate at this stage for a secondary market in spectrum. The introduction of spectrum pricing it seen as a necessary first step in order to bring supply and demand for spectrum more into balance. Once this has been achieved, conditions will exist for an orderly market in spectrum. This could include the auctioning of blocks of spectrum for commercial management. It is possible to foresee a situation in which commercial spectrum management organisations have freedom to price spectrum according to market conditions and licences are freely tradeable on a secondary market.

Under such a market for spectrum there would still be a requirement for central regulation in order to:

- oversee compliance with international obligations;
- ensure national security and that essential

services have sufficient spectrum to meet their operational requirements;

- prevent anti-competitive practices and monopolies;
- regulate the conduct of spectrum management organisations to ensure that they do not abuse their positions as monopoly suppliers; and
- maintain the diversity of radio use, including scientific, cultural and social applications.

Conclusions:

This paper outlines the proposals in the UK to move from a spectrum management regime which relies solely on regulation, to one which uses the combined tools of regulation, spectrum pricing and a spectrum efficiency scheme. The new tools would be used singly or in combination, taking into account their effectiveness and the respective value for money on a case by case basis. Legislation is required before the new powers could be exercised.

The current regulatory regime strongly favours existing licence holders. However, the RA is not only required to manage the spectrum for existing users but also has, at the same time, to find spectrum for new applications and deal with the tail of old services, which can persist over a long period. With the rapidly increasing demand for radio spectrum, the time taken to achieve spectrum management objectives must be reduced.

The economic case for extracting the maximum efficiency from the radio spectrum is compelling. The proposals for administrative pricing in the White Paper would result in a total increase in fees of about £80 million. On the basis of the benefits outlined in figures 1 and 2 a modest increase in the efficiency of the use of the radio spectrum will lead to quantifiable benefits many times greater, plus further unquantifiable gains that could amount to £ billions. In order to obtain the highest possible benefit, spectrum managers need the right tools and a good understanding of the current and future demands for spectrum. Based on this, a strategic plan for the use of the radio spectrum over time can be prepared and implemented.

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Reference 3: "Study into the Use of Spectrum Pricing"
Radiocommunications Agency, June 1996
Internet: http://www.open.gov.uk/radiocom/rahome.htm

Reference 4: "The Future Management of the Radio Spectrum"
Radiocommunications Agency, March 1994

BIOGRAPHY

John Reynolds graduated with a Bachelor of Science degree in marine technology from the University of Wales in 1975. His early career included working as a navigating officer with P & O and undertaking research on ship design and navigation and control systems.

He first worked for the UK Radiocommunications Agency in 1989, as Head of Mobile Radio Licensing. He then moved to the Cabinet Office, where he was responsible for briefing the Prime Minister on international science and technology issues and the environment. This was followed by a period as a Director of the Laboratory of the Government Chemist.

He rejoined the Radiocommunications Agency as a Director in February 1996. He heads the Bill Team and his first task was to prepare and publish the White Paper "Spectrum Management: into the 21st Century". Now he is focusing on preparing for the legislation outlined in the White Paper and taking forward the new policies for spectrum pricing within the Agency.

BIOGRAPHIE

John Reynolds a obtenu un baccalauréat ès sciences en technologie marine de l'université de Wales en 1975. Au début de sa carrière, il a travaillé comme officier de navigation à P & O et a entrepris des recherches sur la conception des navires ainsi que sur les systèmes de navigation et de commande.

Il a travaillé pour la première fois au Radiocommunications Agency du R.-U. en 1989, comme chef de la délivrance des licences de radio mobile. Il est ensuite passé au Bureau du Conseil des ministres, où il était chargé d'informer le Premier ministre sur des questions scientifiques et technologiques internationales ainsi que sur l'environnement. Par la suite, il a été directeur du Laboratory of the Government Chemist.

Il est retourné au Radiocommunications Agency en qualité de directeur en février 1996. Il dirige la « Bill Team » et sa première tâche a consisté à rédiger et à publier le livre blanc « Spectrum Management : into the 21st Century ». Il s'attache maintenant aux préparatifs concernant la législation décrite dans le livre blanc, et fait avancer les nouvelles politiques d'établissement des prix des bandes de fréquence au sein de l'organisme.

SPECTRUM PRICING
L'ÉSTABLISSEMENT DU PRIX DU SPECTRE

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ABSTRACT

This is an extraordinary time for the Federal Communications Commission (FCC), the telecommunications industry and all countries involved with spectrum issues. As your Minister of Industry, the Honourable John Manley, has pointed out "We are witnessing an explosion of new technology that will have billions of dollars worth of impact on the world economy."

As spectrum managers, our job at the FCC has become even more challenging as we try to accommodate existing and new technologies and services, and, turn to more market-based approaches for managing the spectrum. An important market-based approach the U.S. is pursuing is the use of auctions. My paper will cover the FCC spectrum auction experience.

Spectrum Pricing

The U.S. Spectrum Auction Experience

In 1993, a communications revolution occurred in the United States that will forever impact the use of radio spectrum. This revolution wasn't a new invention or an important technological break through. It was a law.

In the Omnibus Budget Reconciliation Act of 1993, Congress gave the FCC authority to auction the radio spectrum. Since then, auctions have played an important part in the development of telecommunications services in the United States and have raised significant revenue. In fact, the FCC has granted hundreds of licenses and raised over $21 billion dollars for the U.S. Treasury using its auction authority. Auctions have provided the FCC with a new regulatory tool -- To ensure that licenses are awarded to those parties who value them most highly, and, therefore can be expected to introduce valuable new services to the public in the most rapid and efficient manner.

Background: Congress authorized the FCC to use competitive bidding procedures or "auctions" to award certain electromagnetic spectrum licenses, when the licenses or uses of the spectrum will involve or are likely to involve subscription-type services. That is, the new licensee will receive compensation from subscribers in return for providing the communications service. Congress also required the FCC to promote the following objectives in designing its auction procedures: 1) the development and rapid deployment of new technologies, products, and services for the public, including those in rural areas; 2) promote economic opportunity and competition, and ensure that new and innovative technologies are readily accessible to the public by avoiding concentration of licenses and disseminating them among a wide variety of applicants, including small businesses, rural phone companies, minorities and women; 3) recovery for the public of a portion of the value of the spectrum resource and avoidance of unjust enrichment; and, 4) efficient and intensive use of the spectrum.

Auction Benefits: Using auctions has enabled the FCC to improve and speed the existing FCC licensing process. Before auctions, all radio frequency licenses were given away for free through comparative hearings which were costly and slow for applicants, as well as for the FCC staff. In the mid-eighties, the FCC tried a lottery system for some cellular licenses. Unfortunately, some of the lottery winners did not construct the systems authorized by those licenses. Instead, those lottery winners resold their license in after-market transactions, gaining a financial windfall. Lotteries thus, often delayed the initiation of service to the public and deprived the public the value of the spectrum.

Using auctions to award licenses has enabled the FCC to speed the licensing process. By example, it normally took two years or longer -- from the initial application to granting of the license -- with the more traditional comparative hearing process. Lotteries took well over a year to complete on average, and initiation of service was further delayed while lottery winners negotiated to transfer their licenses to entities truly interested in providing service.

The new auction process enables the winning bidders to bring new and innovative services to the marketplace more quickly. An example of how auctions speed technology to the market is demonstrated by comparing the following time lines. The average time from a cellular hearing to award of the license was 26.3 months. The average time from a cellular lottery to award of the license was 15.7 months. In the A/B block PCS auction the time was significantly reduced from the completion of the auction to licensing of 4.1 months. This is a fraction of the licensing time which the more traditional licensing methods require. This shortened period of time significantly reduces administrative workload upon the applicant and the FCC staff.

Other important auction pluses include: (1) stimulating the number of new entrants in the bidding competition, (2) enabling the FCC to make new business opportunities available on a fair value scale for sellers and buyers, and (3) encouraging creation of new jobs which in turn will spur economic growth.

Auction Designs: Since receiving its auction authority, the FCC has experimented with a number of auction designs and methods. The FCC has tried both the traditional oral outcry auction design and a never-before-tried auction design --the *simultaneous* multiple round auction.

Oral outcry auctions are familiar to most of us. An auctioneer stands at the front of a room, opens bidding on the first item and continues to auction items sequentially until the last item is sold. Bidders are generally present in the auction room and are able to increase their bids until the item is sold. The oral outcry method may be appropriate for spectrum auctions where there is little interdependence among the value of the licenses being auctioned (i.e., the value that a bidder will place on a particular license has little to do with the value of another license).

Although the simultaneous multiple round auction design had never been used outside of laboratory experiments, the Commission determined that this auction method offered several important advantages over other auction methods where license values are interdependent. In simultaneous multiple round auctions, all interdependent licenses are put up for bid at the same time, and bidders have an opportunity to bid on as many licenses as they desire in successive discrete bidding rounds. Bidding generally remains open on all licenses until there are no new valid bids on any of the licenses being auctioned. Activity rules are used to ensure that bidders do not hold back from bidding until they see what values other bidders place on the licenses. In this regard, simultaneous multiple round auctions generate the maximum amount of information for bidders concerning license values and facilitate the award of the licenses to the bidder(s) who value them most highly. In addition, this auction method enables bidders to pursue efficiency enhancing back-up bidding strategies as more information becomes available about license values.

Simultaneous multiple round auctions are conducted electronically using an automated auction software program. Bidders may place their bids from remote locations either via computer or telephonically. In this regard, bidders are provided with maximum flexibility to place bids from their offices without being forced to remain in Washington for the duration of the auction.

Participation in auctions is pretty straight forward. Each party whose initial application to participate in an auction has been accepted by the Commission must remit an upfront payment in order to be eligible to bid at the auction. This payment is necessary to ensure that only serious bidders participate in FCC auctions and to provide a source of funds from which the Commission may collect any bid withdrawal or default penalties. The amount of the upfront payment applicable to each license is determined prior to each auction, and a bidder's maximum eligibility to bid in the auction is determined by the amount of its upfront payment. If a bidder is the winning bidder for a license(s), its upfront payment is retained and applied to their down payment on the license(s) won. If a bidder is not the winning bidder on any licenses, and has not incurred any bid withdrawal or default penalties, the upfront payment is refunded.

Strategies used by bidders vary as much as the dollars they bid. Some companies have formed partnerships with like services, others have formed partnerships with complimentary services, while others have used other innovative funding schemes. In addition to raising substantial funds, auctions have enabled us to move quickly on the licensing of newer technologies, including wireless. In fact, many of the winning bidders so far, have been comprised of businesses with existing holdings in the wireless industry. Ten auctions have been completed and one is currently open.

FCC Auction Results: The first new service to be auctioned by the FCC was the Personal Communications Systems (PCS) in July, 1994. PCS is an example of an important new technology that expands the meaning of the word wireless by allowing wireless to take advantage of mobile, ancillary fixed communications and other interconnecting technologies. The FCC created PCS so that innovative services could be developed. We also gave tremendous technical flexibility to the PCS licensee, to serve as a stimulus to technical innovation.

Narrowband PCS can be used to provide new services such as voice message paging, two-way acknowledgement paging in which a subscriber can receive a message and transmit a response back to the sender, and other data services. The FCC auctioned ten nationwide licenses to provide Narrowband PCS in the 900 MHz band and awarded another through the pioneer's preference program. Five of these licenses are 50/50 KHz paired (two-way), three are 50/12.5 KHz paired, and two are 50 KHz unpaired.

To give you an idea of the first PCS auction in dollars and cents: twenty nine bidders were qualified to bid, each submitted a minimum upfront payment of $350,000 in advance, and the auction closed after 47 rounds, with bids for the ten licenses totaling $617,006,674. Number of days from the start of the auction to granting of the licensed was approximately 200.

In addition, the U.S. Government received an additional $33,300,000 for the nationwide Narrowband PCS license that was awarded prior to the auction pursuant to our pioneer's preference program. All of the nationwide Narrowband PCS licenses have been granted. Winners of the nationwide Narrowband PCS licenses were authorized to provide service over all 50 states, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, American Samoa, Guam, and the Northern Mariana Islands.

The Interactive Video Data Service (IVDS) auction was also held in July, 1994. The FCC used the oral outcry design in this auction. IVDS is a two-way communications service that can be used in conjunction with other wireline and wireless services, and, may be interactive. IVDS can be delivered through broadcast and cable television, microwave, or direct broadcast satellite

technologies. When it is available, it will be offered on a subscription basis.

The FCC also anticipates that IVDS will assist in providing affordable interactive television services such as home banking, home shopping, and educational and pay-per-view programming on a commercial basis. To access these systems, wireless or coaxial devices not unlike cable converter boxes would likely be used in conjunction with hand-held remote controls.

594 IVDS licenses in the 218-219 MHz band were auctioned. More than 95% of all IVDS licenses were won by small businesses or businesses owned by members of minority groups or women who were able to take advantage of the special provisions for designated entities discussed above. The FCC auctioned all 594 licenses within two days for almost $215 million dollars. Licenses have been granted to all of the IVDS bidders that satisfied the applicable payment deadlines and whose applications were not contested.

In late 1994, the FCC auctioned 30 regional Narrowband PCS licenses. Twenty-eight bidders qualified to bid. The regional Narrowband PCS auction was the first to use a new computerized auction system that allowed bidders to participate in the auction either on-site at the FCC's auction headquarters or from remote locations via computer or telephone.

The auction closed after 105 rounds of bidding. This auction also provided special opportunities for small businesses and women and minority bidders in the form of bidding credits and installment financing. Eleven of the 30 licenses were won by small businesses owned by members of minority groups or women. The total revenue from this auction was $394,835,784. All of the regional Narrowband PCS licenses have been granted.

On December 5, 1994, the FCC began its first auction of licenses to provide personal communications services in the 2 GHz band (Broadband PCS). Broadband PCS encompasses a variety of mobile and/or portable radio services - using such devices as small lightweight, multifunction portable phones, portable fax machines, and advanced devices with two-way data capabilities -- that are expected to compete with existing cellular, paging and other land mobile services. As a new competitor, broadband PCS is expected to bring new communications services to the American public in a more affordable manner.

A total of 99 licenses were auctioned. Thirty bidders qualified to bid in the auction. The auction ended on March 3, 1995, lasting 112 rounds that were conducted over more than three months. Eighteen bidders won licenses. The December Broadband PCS auction did not include special provisions for women and minority-owned businesses. The major trading areas Broadband PCS auction generated more than $7.7 billion for the U.S. Treasury (including revenue to be collected from the pioneer's preference winners). All of the winners have been granted their licenses.

The Direct Broadcast Satellite (DBS) auction was held in January 1996. DBS transmits or retransmits its signal by space stations and are intended for direct reception by the public. The FCC auctioned two DBS construction permits. The first permit, for the use of 28 channels in the 110 degree west orbital location, was awarded after 19 rounds with a winning bid of $682.5 million. The second permit, for use of 24 channels in the 148 degree west orbital location,was awarded after 25 rounds with a winning bid of $52.3 million. The 110 degree west orbital location offers full nationwide coverage, while the 148 degrees west orbital location offers coverage for most of the U.S. with the exclusion of parts of the East Coast.

DBS is a direct-to-home satellite service that permits delivery of digitally-compressed audio and video signals to individual households by means of an 18 inch dish receiving antenna. Thus, while DBS is expected to be a competitor to cable, the service is not limited to the traditional model of providing multi-channel video programming. DBS services offer packages of satellite television and radio programming that include virtually all of the basic and premium cable programming services, certain television broadcast signals, substantial "out-of-market" sports programming, and a wide

range of pay-per-view movies. The auction of the DBS construction permits should result in greater price competition and more programming options for viewers. Currently, approximately 1.2 million households subscribe to DBS service. This compares with 62 million cable television households, and 96 million broadcast television households in the United States. Analysts estimate that the potential market for DBS could reach well over 10 million subscribers.

Multipoint Distribution Service (MDS) is often referred to as wireless cable and uses microwave transmission and signals to offer delivery of video programming using MDS or Instructional Television Fixed Service (ITFS) channels. The MDS auction was held earlier this year and brought in over $216 million dollars.

Specialized Mobile Radio (SMR) provides dispatch, voice and data services to commercial business and other users and will be the subject of a future auction.
How have so many diverse technologies been able to enter the marketplace and provide revenue to the United States government? A lot has to do with the forward looking rules and policies that we are creating at the FCC.

Spectrum Policy and Competition

The demand for access to and use of the radio spectrum is growing at an extraordinary rate. Administrations within governments responsible for radio regulation are being faced with difficult decisions to determine which parties and services should receive the benefits associated with having access to this important resource. In the United States, we are increasingly relying on market-based approaches, such as auctions, to help us make these decisions. We believe our experiences can provide some useful guidance for others. We recognize that the whole world is rethinking communications policy. In the United States and in Canada, as in many other countries, there has been tremendous change in the use of the spectrum and the way it is managed. The past, when communications policy was usually about government-owned or favored monopolies and simple engineering solutions, is over. Instead, competition and innovative technologies are spurring the new communications revolution of the 21st century.

Our Chairman Reed Hundt often urged that other countries allow greater competition in their provision of communications services, and has stated on several occasions that a competitive market will generate far more benefits for nation's citizens than a monopoly market. Other countries -- including Canada, the United Kingdom, the Russian Federation, Australia and Mexico, are also undertaking studies to examine the relationship between economics and spectrum management, and in so doing, are looking at market-based approaches.

President Clinton talks about building a bridge to the 21st century. Some of us in this room know how to construct the links -- broadcast stations, cellular towers, satellite communications and other hardware. The bridge we build must be able to hold the traffic of the future. It must include flexible regulations, laws, and policies to anticipate new and changing technologies. It must reduce roadblocks that inhibit competition and keep services from the marketplace. And, it must offer stimulus to create healthy competition both nationally and internationally.

Industry Canada sums it up nicely when they state that through their reliance on market forces they expect to better achieve their objectives of "Maximizing the benefits to society generated by the spectrum resource and ensuring an appropriate return of resource rent to the public." Our auctions are helping us to provide similar objectives.
If all countries, developed and lesser developed, can work together to build a bridge that connects the best examples of spectrum management to "dollars and sense" parity, then we will all be winners. And, the bottom line will have been reached -- To ensure a future with a strong global telecommunications highway -- where the cars represent diverse telecommunications services, and, -- the riders represent both the businessperson and the citizen (you and I) empowered with opportunity to achieve personal and global goals in the years ahead.

BIOGRAPHY

Bruce Franca is Deputy Chief of the Office of Engineering and Technology at the Federal Communications Commission. Bruce joined the FCC as an engineer in 1974. He has held positions in the FCC's Private Radio Bureau, the Office of Plans and Policy, and the Mass Media Bureau. He has been Deputy Chief of OET since 1987. Before joining the FCC, Bruce worked for the Naval Ship Research and Development Center in Annapolis, Maryland, the Naval Electronics Laboratory Center in San Diego, California, and the Naval Applied Science Laboratory in Brooklyn, New York. Bruce is a graduate of Pratt Institute in Brooklyn, New York and has done graduate work in electrical engineering at the George Washington University in Washington, DC.

REVENUE EQUIVALENCE, THE WINNER'S CURSE AND AFTERMARKET SALES IN AUCTIONS

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ABSTRACT

A classic result in auction theory, the Revenue Equivalence Theorem suggested that auctioneers need not be too concerned about effects of the design of an auction on the revenues it would raise. Many apparently different auctions often generate the same average revenues from sales. This result has often been thought to fail in auctions where winner's curse like effects are present. Furthermore, after auction conditions such as the opportunity to use a spectrum to generate revenues in a downstream market or the opportunity to retrade the spectrum right itself may create an environment with winner's curse effects. This paper argues that in many circumstances, the winner's curse effects are absent. Even when they are created by these features, they pose concerns mainly for private bidders and not necessarily for auction designers. The laudable intentions of the Government of Canada to allow aftermarket sales in licenses should not be affected by the concern for winner's curse effects that these sales may create.

RÉSUMÉ

Un résultat classique de la théorie des enchères, le Revenue Equivalence Theorem, semble indiquer que les commissaires-priseurs ne doivent pas se préoccuper outre mesure des effets de la conception d'une vente aux enchères sur les revenus qu'elle générera. Un grand nombre de ventes aux enchères apparemment différentes génèrent souvent les mêmes revenus moyens. On a souvent pensé que ce résultat n'était pas atteint dans les ventes aux enchères où des effets du genre winner's curse sont présents. En outre, les conditions qui suivent une vente aux enchères, comme la possibilité d'utiliser des bandes de fréquence pour générer des revenus dans un marché aval ou la possibilité de retrade les bandes de fréquence peut créer un environnement où les effets du winner's curse se font sentir. Ce document soutient qu'en de nombreuses circonstances, les effets «winner's curse» sont absents. Même lorsqu'ils sont présents, ils posent un problème principalement pour les soumissionnaires privés, et pas nécessairement pour les concepteurs de la vente aux enchères. Le gouvernement du Canada, qui a l'intention de permettre les ventes aftermarket de licences, ne devrait pas se préoccuper des effets winner's curse que ces ventes peuvent créer.

Revenue Equivalence, the Winner's Curse and Aftermarket Sales in Auctions

When the United States' Federal Communications Commission (FCC) announced in 1993 its intention to sell radio spectrum at public auction, it solicited expert advice from auction experts around the world to help it design the appropriate auction mechanism. Auction theory had developed out of the application of a combination of the mathematical tools of game theory and probability theory. An enormous amount of theoretical research had been devoted in the 1980's precisely to this question of what would be the best way for a seller to sell an object at auction and theorists were eager to apply these insights to a concrete policy problem (some popular references for results in auction theory are Milgrom (1987), McAfee and McMillan (1986), Milgrom and Weber (1982)). John McMillan, the auction consultant for the FCC observed that for the first time, arcane concepts such as order statistics, Bayesian-Nash equilibrium and incentive compatibility constraints were to be heard in the corridors of power in Washington. (McMillan (1994)).

Among perhaps the most prevalent and evocative phrases that arose was the notion of the winner's curse. This concept derives from a problem of selection bias that is generated by the fact that winning bidders are the most optimistic bidders and it played an important role in both the characteristic of the ascending bid type mechanism selected by the FCC and in the bid determination process of the participants in the auction. Recently, another remarkable concept has become widely discussed. The late Canadian economist, William Vickrey, was awarded the Nobel prize in economics for his work illustrating the surprising fact that for some environments, the average revenues raised at auction are typically the same independent of the type of auction used to sell objects (Vickrey (1961)). These two concepts have often been linked since it is sometimes implicitly or explicitly assumed that one of the environments that is NOT covered by Vickrey's result is indeed an environment characterized by winner's curse effects. In this discussion, I want to illustrate that the two notions are independent. Revenue equivalence can hold even in the presence of winner's curse effects. The possibility of aftermarket sales, either through downstream sales of a product that uses the auction good as an input, or retrading of the auction good itself, do not necessarily create winner's curse like effects. Even when these effects are present, they may not overturn the revenue equivalence result.

This conclusion is important both for public policy reasons and for private firms who are participating in such auctions. If we are in an environment where revenue equivalence holds, then the auctioning body may be confident that its choice of auction design is relative innocuous in terms of revenues raised. As a result, it may choose its auction mechanism on the basis of criteria other than revenues. For example, some auction designs work better than others to discourage collusive bidding, other designs expose bidders to less risk while other designs yet again offer greater simplicity to participants in the determination of optimal bidding strategies. From a bidder's perspective, a private firm which finds itself in an auction with strong winner's curse effects, must follow a much more sophisticated and complex bidding strategy than it would if it were in an auction without these features.

What is the Winner's Curse?

The winner's curse is mainly the consequence of a statistical sampling problem. Suppose that there are two firms each considering the same risky investment and each of whom are equally capable of performing the project. However, the two firms may differ concerning their opinions about the profitability of the project because they may have access to different information. For example, to make things as simple as possible, suppose that the project can be a winner or a loser with equal probability, and suppose that each firm has conducted a study to attempt to learn more about its chances. The studies, like all such studies, unfortunately, are not perfect -- they only yield partially reliable conclusions. Again for concreteness, suppose that when the project is indeed profitable, then two out

of three times, a study will conclude (correctly) that the project is good and one out of three times the study will conclude (falsely) that it is bad. Similarly, when the project is bad, then two out of three times, it will conclude it is bad and one out of three times, it will conclude it is good.

Notice that in this type of world, a firm which receives a good report from its studies will tend to revise its estimates that the probability that the project is good, upward (more exactly, from 50% to 67%), though, it will never become completely certain about the project's worth. Similarly, if the report is bad, it will revise its estimate downward. In both cases, the company is behaving correctly given its information -- it is making statistically efficient use of its data. Nevertheless, if the company had access to information from similar studies from another firm, it would definitely be able to make valuable use of this additional information. Suppose that conditional on the true value of the project, the probability that the report of the study of the other firm is good or bad is also exactly as above. Then, if the original firm were to learn that there was another report that was good, it would revise its estimates again, in this case upward and so on. Of course, most firms would like to keep their information private if at all possible, and, so, companies do not always have the luxury of relying on these other reports.

This is where the relevance to auctions comes in. Auction theory tells us, intuitively enough, that more optimistic bidders tend to bid higher than less optimistic bidders. This implies that when you know something about your opponent's bid, you also learn something about his level of optimism and thus his information. And, further, the more you can know about this bid, the more you can infer about his private information. If it turns out that a firm wins at an auction, at the very least, it has learned that all its rival bidders were less confident than it was and if it is able to observe more precisely the actual final bids of its opponents it may learn even more. In auctions where firms can observe their opponents' bidding behavior, this option gives them additional flexibility to alter their own bidding behavior in light of this information in the course of the auction and this flexibility can have a tendency, on average to lead them to bid more aggressively.

What are important features of these types of environments? While the general answer is somewhat complex, the example suggests two important features are required for a winner's curse effect to arise:

> A1) Firms enjoy statistically different information initially about the project;
> A2) Although firms may differ in their estimates of the value of the project, if they were to know all the relevant information, they would tend to value it similarly.

This latter feature is sometimes referred to as a common value component.

What is Revenue Equivalence?

A general result in auction theory tells us that the less private information there is in an auction, the less revenue goes to the bidders and the more goes to the seller. A consequence is, that in environments that sometimes include the so-called common value environment I described in the example, auctioneers will do better in auctions such as open ascending bid auctions where bidding behavior is mutually observable rather than in other auctions such as sealed bid auctions. More formally, what is needed is the condition that

> B1) The amount any bidder expects to pay in any auction depends only on the bidder's bid and not on his private information.

From a public policy perspective, this feature is the critical characteristic in terms of determining whether the revenues an auction raises depend on which type of auction is chosen to sell the good. This is the well-known result that is connected to the research of the most recent Nobel prize winner, William Vickrey, known as Revenue Equivalence. Fix an auction environment. Within any class of auction types such that feature B1) holds, the expected revenues generated by all auctions in this class is the same.

This result when it was first discovered appeared to suggest that auctioneers need not worry themselves about what type of auction to choose in terms of revenues and therefore could use

other criteria by which to select an auction design. Subsequently, it became better understood which are the types of environments which do NOT satisfy B1). A common example that was often put forward as such a case, was precisely the winner's curse type cases. Furthermore, since the presence of downstream markets appeared to provide a natural explanation for why characteristic A2), the common valuation feature, it has often been argued that whenever this downstream market is present, i) winner's curse-like effects are present and ii) auction designers who are concerned about raising revenues should select auction types with the intent to mitigate these effects.

After Auction Conditions and Common Values Properties:

A) Do the downstream revenues generate by spectrum licenses create common values?

The question of whether or not a given auction has common value features has often focussed on the sources of the values that firms place on the items purchased. For example, if the only source of firm differences in profits come from firm specific efficiencies in using the license to provide services, then one might believe that condition A2) fails. In the case of PCS licenses, however, it seems fairly clear that all firms who are pursuing spectrum licenses care about one element of profits in a very similar manner -- that element, of course, is the revenues generated by the service. For all firms, revenue enter into profits in pretty much the same way. If estimates about the value of the license vary mainly because of the randomness in the revenues that can be generated, then it would seem that condition A2) is satisfied. Firms care equally about an important random element in the value of a license -- that is, the revenues that can be generated by providing PCS to the public.

While the potential for revenues may be highly uncertain in this new field, more attention needs to be paid to whether condition A1) is also satisfied. That is, do firms really differ in any significant way in their estimates about the revenues that are going to be raised by the license up for sale? Since many of the serious bidders will be veteran telecommunications firms, there may be good reasons to believe that their estimates about the future revenues, since they are based on effectively the same available data, will also be effectively the same. In terms of the example, at the beginning of this paper, this would be as if, for whatever the true value of the project, whenever the researchers of one firm get an imperfect prediction about its profitability, researchers in the other get exactly the same prediction. In such a case, firms do not care about each other's predictions because they know already what it will be from looking at their own. In such cases, winners' curse effects are not present. If this is correct, then there are no strong implications either for additionally sophisticated bidding behavior on the part of bidders. Bidders need only focus on their own private information in constructing their optimal bids. Neither are there any revenues reasons for preferring one auction design over another one. A policymaker can focus on other criteria in coming up with an auction design. (R.Preston McAfee and I explore this issue further in current research, Vincent and McAfee (1996)).

Part B: Does License Resale Create Common Values?

Another feature common to many auctions is the fact that the objects sold at an auction may themselves be sold later in secondary markets. This issue has important policy implications. If participants at an auction were able to predict perfectly their ability to use the licenses that are for sale and if auctions worked perfectly, then the matter would likely be moot. The most efficient firm would typically win at the auction and there would never be an incentive to attempt to retrade the license. Unfortunately, even the most astute of bidders can make mistakes, and the best laid plans of the best operated firms can often go awry. In auctioned licenses, as in all economic goods, markets offer society the chance to improve upon a suboptimal allocation.

Industry Canada and the CRTC in recent rulings have indicated a willingness to allow spectrum licenses to be traded (Industry Canada (1996)). This development is highly welcome. In an environment which can change rapidly and unpredictably, any initial allocation of licenses may prove after the fact to have been suboptimal. Incumbent firms may find that the new service does not fit their portfolio of products, outside firms may discover hitherto unperceived sources of efficiencies that merit their ownership of the

spectrum resource. Even a well-functioning auction cannot fully guard against these subsequent developments. A relatively free aftermarket in spectrum licenses serves as a safeguard which offers participants an valuable source of flexibility.

But if licenses can be and might be retraded does this not also produce a common value element that will have implications for the best choice of auction mechanism? And, further, should this possibility dampen a government's willingness to allow secondary market resales? The answer to the first question is, again, "Not necessarily" and to the second, "Almost surely, not". The reason why one might at first blush believe that an active secondary market creates common value elements is that since all winners of the license at auction will have access to the price available in the secondary market, this access provides for all bidders a common source of valuation. Condition A2) mentioned above is satisfied. However, it is important to note, first, that if the after the fact value that firms placed on the license were truly identical and firms only differed in their initial information about the object's ultimate worth, then we would see no trade in an aftermarket. Trade will only occur if there are some inherent, firm specific advantages that motivate the trade. Suppose that all the reasons for trade come from these types of differences. Then, the reason we might see secondary market activity is simply that the initial guesses that firms have at the time of the auction even though rational at the time, proved over time to be misplaced. Other firms who were less optimistic, in fact turn out to be more efficient and therefore better end-users of the license.

Preston McAfee, Wendy Takacs and I (1996) have examined this question in the context of auctions of quota licenses in Australia and New Zealand where active markets in quota licenses were present. In that paper, we show that although the prospect of being able to retrade in a secondary market affects bids, we also show that they do so in a way that is independent of the type of auction chosen to sell the quotas. That is, winner's curse like effects are present in this environment, but these effects, on their own, do not overturn the revenue equivalence result. There remain a large class of auctions which will raise similar revenues on average. The implication is that private firms who participate in auctions with resale, ignore the presence of a secondary market at their peril. However, policymakers may well be free to choose the actual auction mechanism on the basis of other criteria without adversely affecting the revenues that will be generated for the public purse.

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BIOGRAPHY

Daniel R. Vincent earned his Ph.D. in Economics at Princeton University in 1987. Before that, he was a Rhodes Scholar at Merton College, Oxford. He has taught at the J.L.Kellogg Graduate School of Management at Northwestern University and also at the California Institute of Technology. He is currently Associate Professor of Economics at the University of Western Ontario, in London, Canada. His research has focussed on applications of game theory to economics in particular analyses of auctions and bargaining. Recently, he has published work focussing on both theoretical and empirical applications of auctions. He has served as a consultant to American Personal Communications and to Ameritech for the FCC Spectrum auctions. He has also provided consulting services to TELUS in its response to recent Industry Canada requests for comments on auctioning of spectrum in Canada.

BIOGRAPHIE

Daniel R. Vincent a obtenu son Ph. D. en économique à l'université Princeton en 1987. Auparavant, il a été boursier de la fondation Cecil Rhodes au Merton College, Oxford. Il a enseigné à la J.L.Kellogg Graduate School of Management de l'université Northwestern et au California Institute of Technology. Il est actuellement professeur agrégé d'économique à l'université Western Ontario, à London, Canada. Ses recherches ont porté sur les applications de la théorie des jeux à l'économique, et plus particulièrement sur les analyses des ventes aux enchères et de la négociation. Il a publié récemment un ouvrage portant sur les applications théoriques et empiriques des ventes aux enchères. Il a rempli les fonctions de consultant auprès de American Personal Communications et de Ameritech concernant les ventes aux enchères des bandes de fréquence du FCC. Il a également fourni des services de consultation à TELUS lorsqu'Industrie Canada lui a demandé récemment de faire part de ses commentaires sur la vente aux enchères du spectre du Canada.

GLOBALIZATION OF SERVICES
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Merrill R. Shulman
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BIOGRAPHY

Merrill Schulman has been active in the Communications Industry since 1974. From 1974 until 1989 he was the managing partner of VIP Communications Ltd. of Winnipeg, Manitoba, Canada. In 1989 he formed Shulman Communication Inc., providing telephone order processing services to a wide range of clients in Canada and the United States. SCI also provides consulting services to the wireless industry.

Mr. Shulman returned to the RCC industry as a service provider in January of 1992, with the formation of Integrated Messaging Inc. IMI develops and provides a complete range of advanced messaging services. Integrated Messaging Inc. is Canada's leading direct response call centre service bureau, serving clients throughout Canada and the United States.

Mr. Shulman has served as President of the RadioComm Association of Canada (RAC), Vice President of the Radio Advisory Board of Canada (RABC) and is a member of the Board of Directors of the Communications Research Centre (CRC) in Ottawa. Mr. Shulman served as Chairman of the Board of RadioComm, now the Canadian Wireless Telecommunications Association from 1993-1995. He is currently a member of the Economic Innovation Council of Manitoba and the Manitoba Information Highway Advisory Council.

He has represented the Radio Common Carrier industry before the Standing Parliamentary

BIOGRAPHIE

Merrill Schulman est actif dans l'industrie des communications depuis 1974. De 1974 jusqu'en 1989, il est associé de gestion de VIP Communications Ltd. de Winnipeg (Manitoba) Canada. En 1989, il crée Shulman Communication Inc., qui traite les commandes téléphoniques pour une vaste clientèle canadienne au Canada et aux États-Unis. SCI fournit aussi des services de consultation à l'industrie des communications sans fil.

En janvier 1992, M. Shulman revient à l'industrie des radiocommunications comme fournisseur de services avec la création de Integrated Messaging Inc. IMI met au point et fournit une gamme complète de services de messagerie de pointe. C'est le premier façonnier de centre téléphonique de réponse directe du Canada, avec une clientèle répartie à travers le Canada et les États-Unis.

M. Shulman fut président de l'Association RadioComm du Canada (ARC), puis vice-président du Conseil consultatif canadien de la radio (CCCR) et il est maintenant membre du conseil d'administration du Centre de recherches sur les communications (CRC) à Ottawa. De 1993 à 1995, M. Shulman fut président du conseil d'administration de RadioComm, devenue l' Association canadienne des télécommunications sans fil. Il est présentement membre du Comité de l'innovation économique et de la technologie du Manitoba et du Conseil consultatif de l'autoroute de l'information au Manitoba.

Committee of Communications and has appeared on numerous occasions before the Public Utilities Board of Manitoba and the CRTC on various Telecom issues.

Mr. Shulman was the Chairman of the Canadian Industry Advisory Committee on Public Cordless Telephone Service under the auspices of the Radio Advisory Board of Canada and Industry Canada. In 1991, Mr. Shulman was appointed by the Government of Canada, to serve as a member of the Task Force on the Economic Regulation of the Prairie Telephone Companies.

Mr. Shulman is currently President of Integrated Messaging Inc. in Winnipeg, Manitoba, Canada.

Il a représenté des entreprises de radiocommunications devant le Comité parlementaire permanent des Communications et s'est présenté à de nombreuses occasions devant le Public Utilities Board of Manitoba et le CRTC pour débattre de diverses questions de télécommunications.

M. Shulman fut président du comité consultatif de l'industrie canadienne sur le service téléphonique public sans cordon, sous les auspices du Conseil consultatif canadien de la radio et d'Industrie Canada. En 1991, il est nommé par le gouvernement du Canada au sein du Task Force on Economic Regulation of the Prairie Telephone Companies.

M. Shulman est présentement président d'Integrated Messaging Inc. de Winnipeg (Manitoba) Canada.

CONVERGENCE: SIMPLICITY FOR THE CUSTOMER
LA CONVERGENCE: LA SIMPLICITÉ À LA PORTÉE DU CONSOMMATEUR

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BIOGRAPHY

Randall J. Reynolds is Vice President, Market & Technology Development. He leads the corporation's activities in developing new product and service capabilities encompassing both the business development and technology development activities. He is also responsible for network operations, and is President of Bell Mobility ARDIS.

Previously he was Executive Vice-President and Chief Executive Officer of Bell Mobility Paging Inc.

Mr. Reynolds has an engineering degree from Queens University and an M.Sc. from the Massachusetts Institute of Technology.

BIOGRAPHIE

Randall J. Reynolds est vice-président, Développement commercial et technologique. Il dirige les activités de l'entreprise en concevant de nouveaux produits et de services englobant à la fois le développement d'entreprise et le développement technologique. Il est aussi chargé de l'exploitation de réseau et est président de Bell Mobilité ARDIS.

Il avait auparavant été vice-président exécutif et chef de la direction de Bell Mobilité Pagette Inc.

M. Reynolds possède un diplôme en génie de Queen's University et une maîtrise en sciences du Massachusetts Institute of Technology.

Copies of Mr. Reynolds paper will be provided at the Session