

QUEEN
QC
454
.R3
S64
1992

Radio Advisory Board of Canada
and
Department of Communications

Conseil consultatif canadien de la radio
et
Ministère des Communications

Symposium Proceedings

A Spectrum 20/20 1992 Symposium on the Radio Spectrum **TRANSITIONS**

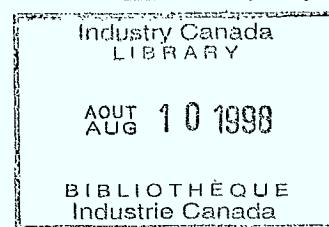
Colloque sur les fréquences radio
Spectre 20/20 1992

Les actes du colloque

September 23, 24 and 25 1992
Toronto, Ontario

Les 23, 24 et 25 septembre 1992
Toronto (Ontario)

Canada



QC454
R3
S64
1992
~~1995~~

Radio Advisory Board of Canada and Department of Communications

Spectrum 20/20 1992

PROCEEDINGS

A Symposium on the Radio Spectrum

September 23, 24 and 25, 1992
Toronto, Ontario
Canada



Conseil consultatif canadien de la radio et Ministère des Communications

Spectre 20/20 1992

COMPTE RENDU

Colloque sur les fréquences radio

Les 23, 24 et 25 septembre
Toronto (Ontario)
Canada

QC454

R3

S64

1992

TOUR

TABLE OF CONTENTS

DESCRIPTION	PAGE
What is the RABC?	iv
Welcome Messages:	
RABC President	v
Minister of Communications	vii
RABC Members & Committees	ix
Program Outline	x
Spectrum 20/20 Committee Members	xix
Abstracts and Papers:	
Session #1	1.1.1
Session #2	2.1.1
Session #3	3.1.1
Biographies	

TABLE DES MATIERES

DESCRIPTION	PAGE
Qu'est-ce que le CCCR?	iv
Allocution de Bienvenue:	
Président CCCR	vi
Ministre des Communications	viii
Membres et comités CCCR	ix
Programme générales	xiv
Membres et comités du Spectre 20/20	xix
Résumés et Rapports:	
Séance #1	1.1.2
Séance #2	2.1.2
Séance #3	3.1.3
Biographies	

WHAT IS THE RABC?

The Radio Advisory Board of Canada (RABC) is a non-profit association of some two-dozen organizations which are concerned with the use of the radio spectrum. These in turn represent the users of radio communications and related service providers, manufacturers, and professional societies.

There are nearly 2,000 organizations, 10,000 radio amateurs and 30,000 members of professional societies represented by the member organizations of the RABC.

The Board's purpose is to consult and advise the Department of Communications (DOC) on behalf of industry on the development, management, and regulation of radio services in Canada.

QU'EST-CE QUE LE CCCR?

Le Conseil consultatif canadien de la radio (CCCR) est une association à but non lucratif réunissant plus d'une vingtaine d'organismes qui s'intéressent à l'utilisation du spectre des fréquences radioélectriques. Ces organismes, pour leur part, représentent les utilisateurs et les fournisseurs de services de radiocommunications, des fabricants et des associations professionnelles.

Les organismes membres du CCCR représentent, quant à eux, près de 2000 organismes, 10 000 radioamateurs et 30 000 membres d'associations professionnelles.

Le Conseil représente l'ensemble de l'industrie auprès du ministère des Communications et a pour mandat de consulter et de conseiller ses représentants sur le développement, la gestion et la réglementation des services de radiocommunications au Canada.



WELCOME MESSAGE FROM THE RABC

BY

ERNIE WELLING
Radio Advisory Board of Canada

It gives me great pleasure to welcome you to the Spectrum 20/20 Symposium in Toronto.

This is the third time that the Radio Advisory Board of Canada (RABC), an industry advisory group, has joined with the Federal Department of Communications (DOC) to present this unique forum on the use of the radio spectrum.

Our program clearly shows why this regular forum has developed. Technology applications that rely on spectrum, new services, growth in old services and changes in regulatory climate are all reasons for maintaining regular dialogue among spectrum managers. In addition this year we have the impact of the recent World Administrative Radio Conference to consider.

It is a busy and informative program which I am sure will be of great value to you, as well as the opportunity to make professional and international contacts.

It's good to have you with us.

Ernie Welling
President
RABC.



ALLOCUTIONS DE BIENVENUE

Par

ERNIE WELLING

Conseil consultatif canadien de la radio (CCCR)

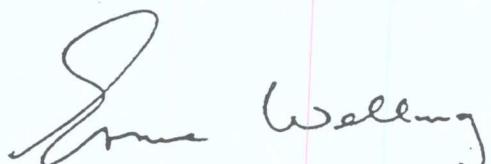
Je suis très heureux de vous souhaiter la bienvenue, ici à Toronto, au symposium Spectre 20/20.

C'est la troisième fois que le Conseil consultatif canadien de la radio, un groupe consultatif de l'industrie, se joint au ministère fédéral des Communications pour offrir cette tribune unique concernant l'utilisation du spectre des fréquences radioélectriques.

Notre programme montre clairement pourquoi ce symposium est devenu une rencontre régulière. Les applications technologiques qui reposent sur le spectre ainsi que les nouveaux services, la croissance des anciens et les changements du climat réglementaire sont autant de raisons de maintenir un dialogue régulier entre les gestionnaires du spectre. De plus, cette année, nous devons envisager les retombées de la Conférence administrative mondiale des radiocommunications.

Le programme du symposium est chargé et riche en information. Je suis persuadé qu'il sera très précieux pour vous et que vous trouverez l'occasion d'établir des liens professionnels et internationaux.

Je me réjouis de votre présence parmi nous.



Ernie Welling
Président
CCCR



WELCOME MESSAGE
FROM
THE HONOURABLE PERRIN BEATTY, P.C., M.P.
Minister of Communications

As world economies turn toward renewal, the telecommunications sector and computer technology are recognized as the high-technology engines for growth and competitiveness into the 21st century. Canadians can take tremendous pride in our long and progressive history of technological innovation which has placed us strongly within the global economy.

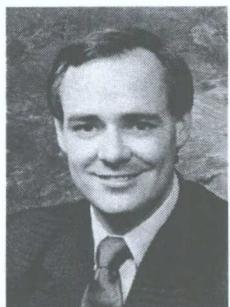
Canada is a world leader in telecommunications and spectrum management. Our history as pioneers in this field goes back to the invention of the telephone at Brantford, Ontario, in 1874, and the first radio broadcast, made by an Ontario native in 1906. In 1973, Canada became the first country to employ satellites for domestic communications. To-day, we are proud to add to this legacy with a new digital audio broadcasting and personal communications services, for which we lay the groundwork at gatherings like Spectrum 20/20 and the recent WARC '92.

The Spectrum 20/20 theme of "Transitions" reflects the dynamic process of growth, change and innovation that will take us to the year 2000 and beyond. I am delighted to see speakers from the industry and from government sharing their insights and ideas on the changing nature of spectrum demands. This sort of communication benefits everyone.

I extend my warmest greetings to the delegates from across Canada and the world who are meeting in Toronto for Spectrum 20/20. I am pleased that Communications Canada has been able to support this significant event, and it is my sincere hope that Spectrum 20/20 will be a valuable and productive experience for all who have the privilege to be involved.

A handwritten signature in black ink, appearing to read "Perrin Beatty".

Perrin Beatty
Minister of Communications



ALLOCUTIONS DE BIENVENUE

Par

L'HONORABLE PERRIN BEATTY
Ministre des Communications

Alors que nous assistons au renouvellement de l'économie mondiale, il est d'ores et déjà reconnu que les secteurs de la technologie informatique et des télécommunications seront au XXI^e siècle les moteurs de la croissance et de la compétitivité. Nous pouvons être très fiers, en tant que Canadiens, de nos nombreuses innovations technologiques qui nous permettent aujourd'hui de jouir d'une position solide au sein de l'économie mondiale.

Le Canada est non seulement un chef de file mondial dans les domaines des télécommunications et de la gestion du spectre, mais également un pionnier dans ces sphères d'activité. En effet, c'est à Brantford (Ontario) que fut inventé le téléphone en 1874 et c'est un Ontarien qui réalisa la première radiodiffusion en 1906. De plus, le Canada est devenu en 1973 le premier pays à utiliser des satellites pour ses communications internes. Nous sommes fiers d'ajouter à ce passé glorieux de nouveaux services de communication personnelle et de radiodiffusion numérique, que nous mettons en oeuvre lors de réunions comme Spectre 20/20 et la CAMR '92, qui s'est tenue récemment.

«Transitions», le thème du colloque, reflète le processus dynamique de croissance, de changements et d'innovations qui nous mènera à l'an 2000 et au-delà. Je me réjouis que des conférenciers des milieux industriel et gouvernemental puissent échanger leurs perceptions et leurs idées sur l'évolution des télécommunications. Ce genre d'échange bénéficiera à chacun d'entre nous.

Je souhaite la plus chaleureuse bienvenue aux délégués de tout le Canada et du monde entier qui se rassembleront à Toronto à l'occasion de Spectre 20/20. Je suis heureux que Communications Canada ait pu appuyer la tenue de cet événement d'envergure. J'espère que Spectre 20/20 sera une expérience très productive pour tous ceux qui auront le privilège d'y assister.

Perrin Beatty
Ministre des Communications

RABC MEMBERS & COMMITTEES/CCCR MEMBRES ET COMITÉS

MEMBERS

Canada Post Corporation
Canadian Amateur Radio Federation Inc.
Canadian Association of Broadcast Consultants
Canadian Association of Broadcasters
Canadian Broadcasting Corporation
Canadian Cable Television Association
Canadian Centre for Marine Communications
Canadian Electrical Association
Canadian Petroleum Association
Canadian Radio Relay League Inc.
CellNet Canada
Computer & Telecommunications Services
Ministry of Government Services
Government of Ontario
Electrical & Electronic Manufacturers Association of Canada
Engineering Institute of Canada/Canadian Society for Electrical Engineering
Institute of Electrical & Electronic Engineers
Metropolitan Toronto Board of Commissioners of Police
Ministry of Culture and Communications of Ontario
Municipal Electric Association
National Defence
Ontario DX Association
Radiocom Association of Canada
Railway Association of Canada
Royal Canadian Mounted Police
Stentor
Teleglobe Canada
Transport Canada
TV Ontario (The Ontario Educational Communications Authority)
Unitel Communications Inc.
Western Canada Telecommunications Council

EXECUTIVE COMMITTEE

Broadcasting Committee
Cordless Telecommunications Committee
Electromagnetic Compatibility Committee
Land Fixed & Mobile Committee
Marine Committee
Radio Relay Committee

MEMBRES

Association canadienne de l'électricité
Association Radiocom du Canada
Canada Post Corporation
Canadian Association of Broadcast Consultants
Canadian Petroleum Association
CellNet Canada
Centre canadien des communications maritimes
Computer & Telecommunication Services
Ministry of Government Services
Government of Ontario
Défense nationale
Fédération des radio amateurs canadiens inc.
Gendarmerie royale du Canada
Institute of Electrical & Electronic Engineers
L'Association canadienne des radiodiffuseurs
L'Association canadienne de télévision par câble
L'Association des chemins de fer du Canada
L'Association des manufacturiers d'équipement électrique et électronique du Canada
L'Institut canadien des ingénieurs la société canadienne de génie électrique
La ligue canadienne de la radio amateur
La société canadienne de génie
Metropolitan Toronto Board of Commissioners of Police
Ministère de la culture et des Communications de l'Ontario
Ministry of the Solicitor General O.P.P.
Telecommunications Project
Municipal Electric Association
Ontario DX Association
Société Radio-Canada
Stentor
Teleglobe Canada
Transports Canada
TV Ontario (l'office de la télécommunication éducative de l'Ontario)
Unitel Communications Inc.
Western Canada Telecommunications Council

COMITÉ EXÉCUTIF

Comité sur la radiodiffusion
Comité sur le brouillage électromagnétique
Comité sur les réseaux de relais hertziens
Comité sur les services radio mobiles marine
Comité sur les services radio terrestres fixes et mobiles

PROGRAM

WEDNESDAY, 23rd SEPTEMBER

18:00-21:00 REGISTRATION

19:00-21:00 WELCOMING RECEPTION

THURSDAY, 24th SEPTEMBER

8:00 REGISTRATION

8:30-8:50 Welcome Addresses

Ernie Welling, President, Radio Advisory Board of Canada (RABC)
Michael Binder, Acting Deputy Minister, Department of Communications (DOC)

8:50-9:30 Opening Address

Key-note Speaker

"Will There Be Bit Police?"

Nicholas Negroponte, Director, MIT Media Lab, Cambridge, Massachusetts.

9:30-12:00 SESSION #1 - TRANSITIONS, POST WARC-92

This session will cover issues and application perspectives resulting from the WARC '92 conference.

Session Chair

Nisar Ahmed, Director General, Engineering Programs Br., DOC, Ottawa, Ontario.

9:30-10:00 1-Canadian Perspectives on WARC'92

Robert W. Jones, Director General, Radio Regulatory Br., DOC, Ottawa, Ontario.

10:00-10:30 2-USA Perspectives on WARC'92

Jan Witold Baran, Ambassador, US delegation WARC '92; Partner, Wiley, Rein & Fielding, Washington, D.C., U.S.A.

10:30-11:00 REFRESHMENTS

11:00-11:20 3-Future Deployments in Personal Communications Services

Michael H. Callendar, International Chairman-CCIR Task Group 8/1; Senior Member, Technical Staff-MPR Teltech Ltd., Burnaby, British Columbia.

- 11:20-11:40 4-Mobile Satellite Services in Canada**
Orest S. Roscoe, V.P. Engineering, Telesat Mobile Inc., Ottawa, Ontario.
- 11:40-12:00 5-Future Deployments in DAB and HDTV**
David L. Garforth, Director, Transmission and Distribution Department, Canadian Broadcasting Corporation, Montreal, Quebec.
- 12:00-14:00 LUNCH**
- Guest Speaker**
The Hon. Perrin Beatty, Minister DOC, Ottawa, Ontario.
- 14:00-17:00 SESSION #2 - TRANSITIONS: INTERNATIONAL PERSPECTIVES AND A WIRELESS SOCIETY**
This session will address various international perspectives on radio spectrum applications.
- Session Chair**
Peter J. MacLaren, Assistant Vice President, Business Development, Northern Telecom Wireless Systems Inc., Ottawa, Ontario.
- 14:00-14:30 1-Restructuring of ITU and VGE Recommendations**
Gary C. Brooks, Chairman, IFRB, International Telecommunications Union Geneva, Switzerland
- 14:30-15:00 2-Future Directions and Deregulation of Spectrum Management in Japan**
Yoshihiro Ishida, Director, Office of Telecommunications Standards, Telecommunications Policy Bureau, Ministry of Posts & Telecommunications, Tokyo, Japan
- 15:00-15:30 3-Terrestrial Digital Transmission of Audio-visual Signals**
Bertrand Sueur, Dept. Head, Digital Terrestrial Broadcasting, Centre Commun d'Etudes de Telediffusion et Telecommunications (CCETT), Rennes, France
- 15:30-16:00 REFRESHMENTS**
- 16:00-16:30 4-Market-Driven Initiatives - New Zealand Experience**
Ken McGuire, Manager, International Radio Policy, Ministry of Commerce, Communications Division, Wellington, New Zealand
- 16:30-17:00 5-Towards a Wireless Society**
Lloyd V. Kubis, Vice President and Director of Government Relations, Motorola Canada Ltd., North York, Ontario.

18:30-19:30 RECEPTION

19:30-? BANQUET

"Whistle While You Work"

Alvin Law, President, AJL Communications, Regina, Saskatchewan.

FRIDAY, 25TH SEPTEMBER

9:00-12:00 SESSION #3 - EMERGING TECHNOLOGICAL DEVELOPMENTS

This session will cover new technologies, applications, and where the spectrum utilization is heading, including futuristic applications.

Session Chair

David Lyon Executive Director DOC - Ontario Region, Toronto, Ontario.

9:00-9:30 1-Communications is Being Personal

Peter J. MacLaren, Assistant Vice-President, Business Development, Northern Telecom Wireless Systems Inc. Ottawa, Ontario.

9:30-10:00 2-Radio Propagation Coding and Modulation Considerations for Indoor Wireless Communications

Dr. Robert W. Breithaupt, Interim President, Communications Research Centre Ottawa, Ontario.

10:00-10:30 REFRESHMENTS

10:30-11:00 3-Future Developments in Satellite Technologies

John T. Feneley, Director, INMARSAT & Radio Matters, Teleglobe Canada Inc. Montreal, Quebec.

11:00-11:30 4-Emerging Technologies for Fixed Services

Roger T. Poole, Vice President of Network Services, Unitel Communications Inc., Toronto, Ontario.

11:30-12:00 5-Vision 2000

Edward M. Strain, President, Vision 2000 Inc., Ottawa, Ontario.

12:00-14:00 LUNCH

Luncheon Speaker

Ms. Jocelyne Côté-O'Hara, President & CEO, Stentor Telecom Policy Inc. Ottawa, Ontario.

14:00-16:00 SESSION #4 -ACCOMMODATING THE CHANGES

This will be a panel session to debate substantive issues regarding policies, evolving technologies, changes to standards and regulations.

Session Chair

Lloyd V. Kubis, Vice President and Director of Government Relations, Motorola Canada Ltd., North York, Ontario.

Panel Members:

Raymond J. Carnovale, Vice President, Engineering, Baton Broadcasting Inc. Scarborough, Ontario.

George A. Fierheller, Chairman & CEO, Rogers Cantel Mobile Communications Inc. North York, Ontario.

Michael T. N. Fitch, Executive Director, US Delegation, WARC'92, US • Department of State, Washington, D.C., U.S.A.

David Mulcaster, Acting Assistant Deputy Minister, Research & Spectrum, DOC Ottawa, Ontario.

Paul Racine, Assistant Deputy Minister, Communications Policy, DOC Ottawa, Ontario.

John Roth, President, Northern Telecom Wireless Systems Inc. Mississauga, Ontario.

16:00-16:05 SYMPOSIUM CLOSING

Ernie Welling, President, RABC

PROGRAMME

MERCREDI 23 SEPTEMBRE

18 h - 21 h INSCRIPTION

19 h - 21 h RÉCEPTION DE BIENVENUE

JEUDI 24 SEPTEMBRE

8 h INSCRIPTION

8 h 30 - 8 h 50 Allocutions de bienvenue
M. Ernie Welling, Président, Conseil consultatif canadien de la radio
(CCCR)
M. Michael Binder, Sous-ministre par/int. Ministère des
Communications (DOC)

8 h 50 - 9 h 30 Discours inaugural
Y aura-t-il une escouade du numérique?
M. Nicholas Negroponte, Directeur, MIT Media Laboratoire,
Cambridge (Massachusetts)

9 h 30 - 12 h SÉANCE NO. 1 - TRANSITION: SUITES DE CAMR 92
Séance portant sur les dossiers et sur les applications possibles, à la
suite de CAMR 92

Président
M. Nisar Ahmed, Directeur général des Programmes techniques,
Ministère des Communications, Ottawa (Ontario)

9 h 30 - 10 h 1-Point de vue canadien sur CAMR-92
M. Robert W. Jones, Directeur général de la Réglementation des
radiocommunications, Ministère des Communications, Ottawa (Ontario)

10 h - 10 h 30 2-La perspective américaine sur CAMR 92
M. Jan Witold Baran, Ambassadeur, délégation américaine à CAMR 92
Partner-Wiley, Rein and Fielding, Washington (D.C.)

10 h 30 - 11 h PAUSE

11 h - 11 h 20	3-Applications futures des services de communications personnelles M. Michael H. Callendar, Membre principal du personnel technique, MPR Teltech Ltée.; Président international, Groupe de travail 8/1, CCIR, Burnaby (C.B.)
11 h 20 - 11 h 40	4-Services mobiles par satellite au Canada M. Orest S. Roscoe, Vice-président, Ingénierie, Telesat Mobile Inc., Ottawa (Ontario)
11 h 40 - midi	5-Mise en oeuvre future de la RAN et de la TVHD M. David L. Garforth, Directeur du Service des transmission et de la distribution, Société Radio-Canada, Montréal (Québec)
midi - 14 h	DÉJEUNER Conférencier invité L'hon. Perrin Beatty, Ministre des Communications, Ottawa (Ontario)
14 h - 14 h 30	SÉANCE NO. 2 - TRANSITION: LA FUTURE «SOCIÉTÉ SANS FIL» VUE DE DIFFÉRENTS PAYS Cette séance porte sur diverses perspectives internationales des applications du spectre radio. Président M. Peter J. MacLaren, Vice-président, int. Northern Telecom Wireless Systems Inc., Ottawa (Ontario)
14 h - 14 h 30	1-Restructuration de l'UIT y compris les recommandations du Groupe d'expert volontaires (GEV) M. Gary C. Brooks, Président, IFRB, Union internationale des télécommunications, Genève (Suisse)
14 h 30 - 15 h	2-Déréglementation de la gestion du spectre et orientations futures au Japon M. Yoshihiro Ishida, Directeur, Bureau des affaires relatives aux fréquences internationales, Bureau des communications, Ministère des Postes et des Télécommunications, Tokyo (Japon)
15 h - 15 h 30	3-La diffusion numérique de terre des Signaux Audiovisuels M. Bertrand Sueur, Chef, Radiodiffusion numérique de Terre, Centre commun d'études de télédiffusion et de télécommunication (CCETT), Rennes (France)
15 h 30 - 16 h	PAUSE

16 h - 16 h 30	4-Les initiatives tributaires du marché - l'expérience en Nouvelle Zélande M. Ken McGuire, Gestionnaire de la politique internationale de la radioélectrique, Division des communications, Ministère du commerce, Wellington (Nouvelle Zélande)
16 h 30 - 17 h	5-Vers la société sans fil M. Lloyd V. Kubis, Vice-président et Directeur des affaires extérieur, Motorola Canada Canada Ltd., North York (Ontario)
18 h 30 - 19 h 30	RÉCEPTION
19 h 30	BANQUET Conférencier invité Whistle While you Work M. Alvin Law, Président, AJL Communications, Regina (Saskatchewan)

VENDREDI 25 SEPTEMBRE 1992

9 h - midi	SÉANCE NO. 3 - L'ACTUALITÉ: NOUVELLES TECHNOLOGIES Cette séance porte sur les nouvelles technologies, les nouvelles applications et sur la direction vers laquelle évolue l'utilisation du spectre, y compris les applications futuristes.
	Président M. David Lyon, Directeur exécutif, Région de l'Ontario, ministère des Communications, Toronto (Ontario)
9 h - 9 h 30	1-Les télécommunications prennent un caractère personnel M. Peter MacLaren, Vice-président, int., Prospection commerciale, Northern Telecom Wireless Systems, Inc., Ottawa (Ontario)
9 h 30 - 10 h	2-Facteurs liés à la propagation radio, au codage et à la modulation, dont il faut tenir compte aux fins de la transmission sans fil à l'intérieur des immeubles. M. Robert W. Breithaupt Ph.D., Président intérimaire, Centre de recherches sur les communications, Ottawa (Ontario)
10 h - 10 h 30	PAUSE

10 h 30 - 11 h	3-Progrès futurs de la technologie des télécommunications par satellite M. John T. Feneley, Directeur, INMARSAT et radiocommunications, Téléglobe Canada Inc., Montréal (Québec)
11 h - 11 h 30	4-De Nouvelles technologies pour services fixes M. Roger T. Poole, Vice président des réseau, Unitel Communications Inc., Toronto (Ontario)
11 h 30 - midi	5-Vision 2000 M. Edward M. Strain, Président, Vision 2000 Inc., Ottawa (Ontario)
midi - 14 h	DÉJEUNER Conférencier invité Mme Jocelyne Côté-O'Hara, Présidente et chef de direction, Stentor politiques publiques Télécom Inc., Ottawa (Ontario)
14 h - 16 h	SÉANCE NO. 4 - QUE FAIRE, FACE AT TOUS CES CHANGEMENTS? Panel-discussion sur différents sujets de fond (dont certains portent à controverse) politiques, grands dossiers, initiatives, normes, règlements etc. Président M. Lloyd V. Kubis, Vice-présidentet Directeur des affaires exterieure, Motorola Canada Ltée., North York (Ontario) Panélistes: M. Raymond J. Carnovale, Vice-président, Ingénierie, Baton Broadcasting Inc., Scarborough (Ontario) M. George A. Fierheller, Président-directeur général, Rogers Cantel Mobile Communications Inc., North York (Ontario) M. Michael T.N. Fitch, Directeur exécutif, délégation américaine, CAMR 92, Département d'État du gouvernement des É.-U., Washington (D.C.) M. David Mulcaster, Sous-ministre adjoint intérimaire, Recherche et spectre, Ministère des Communications, Ottawa (Ontario) M. Paul Racine, Sous-ministre adjoint, Politique des communications Ministère des Communications, Ottawa (Ontario)

M. John Roth, Northern Telecom Wireless Systems Inc., Mississauga
(Ontario)

16 h - 16 h 5

CLOTURE

M. Ernie Welling, Président, CCCR

ORGANIZATION/ORGANISATION

Steering Committee/Comité directeur

Ernie Welling, Chairman/président
Nisar Ahmed
Felice Diamente
Robert W. McCaugher
Douglas Sward
David Kelley
David Warnes
Fernand Leger

Organizing Committee/Comité d'organisation

Ted Campbell, Chairman/président
Alex Sophianopoulos
Marg Coll
Felice Diamente
David Kelley
David Warnes
Bill Cosway
Elizabeth Sweetnam
Marnie Atkinson

Program Committee/Comité de programmation

Robert W. McCaugher, Chairman/président
Felice Diamente
Douglas Sward
David Kelley
Murray Hunt
Fernand Dubois
Lloyd Kubis

ABSTRACT

Will There Be Bit Police?

By

PROF. NICHOLAS NEGROPONTE
MIT Media Laboratory

All forms of broadcasting undeniably will be digital, including those broadcast media we usually do not consider as such, like books, newspapers and magazines. To date, becoming and being digital have been driven largely by interests in signal fidelity and bandwidth conservation. In the future, the impetus will come from new services and programming opportunities for broadcasters and consumers alike.

Broadcasters will be in the bit radiation business. Within a given piece of spectrum, broadcasters should be able to radiate bits of any sort, which are reconstituted at the receiving end in a variety of different ways rarely needed in real-time. At night, broadcasters might use most of their bits per second to deliver one or two audio streams, along with a gaggle of personalized newspapers. During the weekday, some of those same bits might be used for television and papers. On a Saturday afternoon, a local high school football game might necessitate allocating some spectrum by the broadcaster to high definition images.

Currently, the United States is reviewing four 20 megabit per second HDTV systems. In the unlikely event that one of these is chosen and 20 megabit licenses are thereafter issued, what clear thinking broadcaster would use those 20 megabits for HDTV all the time? Using that bandwidth to deliver four channels of broadcast quality NTSC already sounds like a better idea -- for both the broadcaster and the consumer. Dynamically allocating it appears even wiser from the perspective of good business and new services alike.

Will broadcasters be allowed to do that or, will there be **Bit Police?**

RÉSUMÉ

Y aura-t-il une escouade du numérique?

Par

PROF. NICHOLAS NEGROPONTE
MIT Media Laboratoire

Toutes les formes de diffusion seront sans conteste numériques, y compris les moyens de diffusion que nous ne considérons pas ordinairement comme tels, par exemple les livres, les journaux et les revues. Jusqu'ici, la fidélité du signal et l'économie du spectre ont été les facteurs déterminants dans l'adoption de la technologie numérique. À l'avenir, l'impulsion viendra davantage des possibilités sur le plan de la programmation et des nouveaux services, tant pour les diffuseurs que pour les consommateurs.

Les diffuseurs s'occuperont de transmission binaire. Dans une portion du spectre donnée, les diffuseurs devraient pouvoir transmettre des bits multiples, reconstitués à la réception de différentes façons et rarement nécessaires en temps réel. La nuit, les diffuseurs pourraient utiliser la plupart de leurs bits par seconde pour produire une ou deux suites audio de même qu'un groupe de journaux personnalisés. Les jours de semaine, certains de ces mêmes bits pourraient servir à la télévision et aux récepteurs de téléappel. Le samedi après-midi, la diffusion d'un match de football d'une école secondaire locale sur écran haute définition pourrait exiger l'attribution de quelques fréquences par le diffuseur.

À l'heure actuelle, les États-Unis étudient quatre systèmes de TVHD dont le débit est de 20 mégabits par seconde. Si, dans l'éventualité peu probable où l'un de ces systèmes était choisi et que des licences soient par la suite délivrées pour des systèmes à 20 mégabits, quel diffuseur sensé utiliserait en permanence ce débit pour la TVHD? L'utilisation de cette largeur de bande pour la transmission sur quatre voies de qualité NTSC semble déjà une meilleure idée, tant pour le diffuseur que pour le consommateur. L'attribution dynamique semble la solution encore plus logique, du point de vue d'une saine gestion des affaires comme de celui de la prestation de nouveaux services.

Les diffuseurs jouiront-ils de cette latitude, ou y aura-t-il une escouade du numérique?

SESSION 1

TRANSITION, POST WARC - 92

SÉANCE 1

SUITES DE CAMR 92

ABSTRACT

Canadian Perspectives on WARC-92

By

**ROBERT W. JONES
Department of Communications**

Canadian preparations for, and participation in, WARC-92 were detailed and included extensive sectoral representation from many Canadian business and user groups. The World Administrative Radio Conference was attended by over 1400 delegates from 127 of the ITU's 166 member nations and by observers from 31 international and regional organizations. The WARC was held in Torremolinas, Spain from February 3 to March 3, 1992. The Final Acts contained substantial reallocations of radio frequency bands and many new regulatory provisions. Some decisions of the WARC are in effect now. Most will come into effect on October 12, 1993 and some will come into effect only after this date. The advancement of Canadian radiocommunication interests in the rapidly changing, post-WARC environment will require continuing strategic thinking and effort by both industry and government in Canada.

RÉSUMÉ

Point de vue canadien sur CAMR-92

Par

ROBERT W. JONES
Ministère des Communications

Le Canada s'est préparé soigneusement en vue de la CAMR-92 à laquelle il a participé activement; à cette occasion, de nombreuses entreprises canadiennes et beaucoup de groupes d'utilisateurs ont fourni un apport considérable représentant le point de vue de différents secteurs. Plus de 1 400 délégués de 127 des 166 pays membres de l'UIT et des observateurs de 31 organisations régionales et internationales ont assisté à la Conférence administrative mondiale des radiocommunications. La CAMR a eu lieu à Torremolinas, en Espagne, du 3 février au 3 mars 1992. Les actes finals contenaient des réattributions substantielles des bandes de fréquences radioélectriques et de nombreuses nouvelles dispositions réglementaires. Certaines décisions prises lors de la CAMR sont maintenant en vigueur. La plupart seront mises en application le 12 octobre 1993 et certaines autres seront mises en oeuvre seulement après cette date. La promotion des intérêts du Canada en matière de radiocommunications dans ce contexte marqué par l'évolution rapide qui caractérisera la période subséquente à la CAMR exigera une réflexion stratégique et des efforts constants aussi bien de l'industrie que de l'administration fédérale au Canada.

ABSTRACT

WARC-92 - An American Perspective

By

**JAN WITOLD BARAN
Wiley, Rein & Fielding**

There is consensus in the USA that WARC'92 was generally a success but there are warnings about changing dynamics of spectrum allocation. Also, as the reorganization of the ITU is completed later in 1992, WARC meetings may become a biannual event. As it has been 13 years from the last WARC, many new issues and services such as PCS(FPLMTS) need to be defined, and LEO's, EVA etc. require spectrum allocation.

The US objectives for WARC were 1) promote global allocation for introduction of new technologies, 2) retain maximum flexibility for future domestic allocation decisions, and 3) protection of some services as a matter of national policy.

The President and other leading politicians, as well as high level industry leaders fully support US interest in spectrum issues and WARC, mainly for global marketing and the interest from some sectors for auctioning of spectrum.

There is a new disorder in the world as a result of collapsed alliances, mainly with the new Russia and the European community not properly defined. It will take some time to determine the impact as to the definition and requirements for spectrum allocation and management.

In light of these various changes, trends and attitudes, the US sees some development in the areas regarding US/European cooperation, international telecommunication policy, the impact of NAFTA and the great battle within the wireless consumer arena.

RÉSUMÉ

La perspective américaine sur la CAMR-92,

Par

JAN WITOLD BARAN
Wiley, Rein & Fielding

Aux États-Unis, on reconnaît généralement que la CAMR 92 a été un succès dans l'ensemble, mais qu'il existe des signes avant-coureurs au sujet du changement de la dynamique de l'attribution des fréquences du spectre. De plus, lorsque la réorganisation de l'UIT aura été terminée plus tard en 1992, les rencontres de la CAMR pourront avoir lieu tous les deux ans. Comme treize années se sont écoulées depuis la conférence précédente, beaucoup de questions et de services, comme les services de communications personnelles (FSMTPT), ont besoin d'être définis. En outre, divers services, dont les services par satellite sur orbite basse et les services EVA, ont besoin de fréquences du spectre.

Les objectifs des États-Unis pour la CAMR étaient les suivants : 1) promouvoir l'attribution mondiale de fréquences pour l'introduction des nouvelles technologies; 2) conserver le maximum de latitude pour les futures décisions touchant les attributions nationales; 3) protéger certains services au nom d'une politique nationale.

Le président et d'autres politiciens éminents des États-Unis ainsi que des dirigeants industriels de haut niveau appuient entièrement l'intérêt des États-Unis relativement aux questions du spectre et à la CAMR, principalement en ce qui concerne le marketing mondial, ainsi que l'intérêt manifesté par certains secteurs pour la mise aux enchères des fréquences du spectre.

Il existe un nouveau désordre dans le monde par suite de la rupture des alliances, principalement parce que la nouvelle Russie et la Communauté européenne ne sont pas adéquatement définies. Il faudra quelque temps pour déterminer les répercussions de ces ruptures sur la définition et les besoins de l'attribution et de la gestion des fréquences du spectre.

Compte tenu de ces diverses modifications, tendances et attitudes, les États-Unis voient une certaine évolution dans le domaine de leur coopération avec l'Europe, de la politique internationale sur les télécommunications, des répercussions de l'ALENA et de la lutte acharnée à l'intérieur des services grand public sans fil.

WARC-92 -- AN AMERICAN'S PERSPECTIVE

Jan Baran

Several months have passed since the conclusion of the 1992 World Administrative Radio Conference (WARC) in Spain. During that time, a consensus has developed in the U.S. that the Conference was a reasonable success. Global allocations of radio spectrum were agreed to by the international community to permit the introduction of new technologies into the new world order. While WARC appears successful in terms of results and by comparison to other more problematic multilateral negotiations, such as GATT and the so-called Earth Summit, there are warnings from WARC about the changing dynamics of spectrum allocation.

First, I note that this was the last WARC of its kind, the previous major WARC being in 1979. The International Telecommunication Union (ITU) will be reorganized at the end of 1992. If member nations adopt the changes to the ITU treaty as expected, WARCs will be held every two years. This should promote smoother and more timely decision-making in conferences that will last days, instead of weeks. This type of regularity will place greater burdens on some countries; particularly the United States, which must institutionalize further its international communications policies and activities.

More regular, hopefully less intense WARCs, are in part a concession to the increasing development of wireless communications technology. WARC-92 addressed a numbing array of services that required new spectrum allocations, including digital radio broadcasts from satellites, windprofiler radars, mobile voice and data services from low earth orbiting satellites (LEOs), extra vehicular activity (EVA) communications by astronauts, and more. The agenda for WARC-92 began as a collection of issues left over from the WARCs of the 1980s, but kept growing through the 1990 Administrative Council meeting of the ITU. U.S. domestic proceedings indirectly affected WARC right up to the last minute. For example, the U.S. Federal Communications Commission (FCC) in January 1992, announced rulemaking which could result in significant displacement of fixed microwave users in the band 1.8-2.2 GHz in anticipation of next generation mobile telephony or PCS (personal communications systems). PCS, which Europe refers to as Future Public Land Mobile Telecommunications Systems (FPLMTS), is a service that yet has to be defined, but was on the WARC-92 agenda and required international attention and agreement.

New radio technology also has changed attitudes and geopolitics. Satellite dishes and fax machines have convinced most political leaders that telecommunications is now a trade and development issue; not a technology that can be confidently controlled or even suppressed.

The most recent proof of that is the May 20, 1992, edition of the New York Times which reported on the prevalence of mobile phones used by anti-government protesters in Bangkok, Thailand. The Times called the uprising the "cellular phone revolution."

In this environment, the United States developed its overall objectives for WARC-92. The first immediate objective was to promote needed global allocations in order to allow for the introduction of new technologies. In the commercial field, the spectrum allocation for handheld mobile phone service from LEOs was our number one goal. Our second objective was to retain maximum flexibility for future domestic allocation decisions. The best example of this consideration was the land mobile allocations (FPLMTS). Finally, like all other countries, there were a few existing services which we had to protect as a matter of national policy, such as aeronautical telemetry in the L-band and defense users in the 14.5-14.8 GHz band.

These overall objectives were formulated as a result of a complex preparatory process in the U.S. Our multitudinous private sector interests participated in a lengthy FCC comment procedure which coincided with a much less public process for U.S. government spectrum users. The parallel procedures resulted in private-public consensus on all but one issue (digital broadcasting services) and produced the formal U.S. positions which were submitted to the ITU in August of 1991. By November, the 53 U.S. delegates were chosen.

The process that I have just described is the traditional U.S. preparation. It involves hundreds of what I call government and private sector "spectrum junkies." It is more decentralized than it appears. The participants represent scores of government agencies, dozens of radio-based services, and thousands of private companies. There is no one individual actually in charge. There are institutional, historical, and practical reasons for that.

U.S. international communications policy-making is trifurcated among the FCC, the Department of Commerce, and the Department of State (excluding semi-autonomous interests such as military defense and intelligence or the U.S. Trade Representative). The senior levels of U.S. government historically do not pay attention to WARCs or radio spectrum. In years gone by, U.S. senior officials thought that a gigahertz is a type of South American dance.

This time, however, there was attention from the highest levels of government. For example, when President Bush travelled to Japan and other Pacific nations last December, he included in his entourage the chief executives of Motorola and TRW. Both companies had major interests in spectrum and WARC. Vice President Quayle also was interested in and supported the development of so-called Big LEO telephony systems. His support is significant by virtue of his leadership of the Space Council and the Council on Competitiveness, in addition to his being Vice President. I believe that the growing importance to U.S. international trade of spectrum-related industries means that such high-level attention is likely to continue if not increase.

Another reason that governmental officials are paying more attention to spectrum is its potential for government revenue. The auctioning of spectrum, or as the Bush administration puts it, "competitive bidding," is attracting bipartisan interest. In June, Senators Daniel Inouye, a Democrat, and Ted Stevens, a Republican, proposed legislation that would provide for experimental auctioning of 30 megahertz of spectrum reassigned from government frequencies, to private commercial use. And, in the current and past sessions of Congress, the sale of governmental spectrum has been proposed by numerous legislators including Senate Republican leader Bob Dole as a means of financing other unrelated new government programs (although I sadly note that none of these proposals were for deficit reduction).

Another new feature of the '92 WARC was the evidence of the New World Order, which I think is sometimes more appropriately referred to as the new world disorder. This, of course, can be a multiple play on words. First, there is some disorder in the New World, meaning the Americas. Like elsewhere, the Americas have experienced dramatic political transitions and have embraced the privatization rage. All of which has changed, favorably, relations among Western Hemisphere nations.

There is also a new disorder in the world as a result of collapsed alliances. WARC-92 was marked by an absence of North v. South or East v. West tensions. The former Soviet Union is gone. Extraneous political issues, such as the attempted expulsion of Israel from the ITU's 1982 Nairobi Plenipotentiary Conference, were nowhere to be seen. Instead, the tensions seem to be between trading partners and potential markets.

To me, the most challenging and unsatisfactory relationship was that between the United States and Europe. Transatlantic alliances, formal and informal, are longstanding and valued by the U.S. I myself am a naturalized U.S. citizen whose family immigrated from Europe. Consequently, I personally had looked forward to productive, friendly, and mutually beneficial negotiations. Notwithstanding presumed goodwill on both sides and extensive multilateral and bilateral consultations before and during WARC, the U.S. concluded WARC with a belief that its negotiations with Europe were unproductive, if not useless. Why?

Well, first there was the practical problem of defining Europe. The Committee on European Post & Telecommunications (CEPT) represented 32 administrations who conducted themselves in lockstep at the WARC. They were a cohesive bloc, although they didn't like to be referred to as such. To us Americans, Europe was like a World War II battleship; large and impressive. But like a battleship, not easily maneuvered. Consequently, it did not seem that there was any flexibility in European positions. This is not surprising since arriving at a common position for 32 sovereign states takes time and is not easily changed.

The U.S. also was uncertain as to who spoke for Europe. The able representatives of CEPT did not (and perhaps could not) specify where within Europe there were differences of opinion and who was a stumbling block to agreement. At the same time, U.S. consultations with individual country delegations were time-consuming and usually ended with deference to CEPT positions and demands for U.S. flexibility.

There was also the perplexing presence of a delegation from the European Community. Who were they representing? Often the tensions between EC and CEPT delegates were palpable. Obviously, modes of negotiation between the U.S. and Europe (assuming Europe insists on behaving as a multinational bloc) must be improved before future WARCs if there are going to be more productive negotiations.

In the absence of such improvements, I expect that the U.S. will step up its consultations with the rest of the world which, in fact, was the impetus for adoption of all major allocations at WARC-92. It was the support and leadership of nations such as Indonesia, Morocco, and Brazil which ensured the allocations for Big LEOs and Little LEOs. Why were the Europeans opposed? Let me quote to you the following published opinion from the senior vice president of Loral-Qualcomm:

In Europe they [say that they] do not like mobile satellite services and everyone is going to have a cellular phone at hand. I have a different view, that is probably not so generous. I believe that the United States caught Europe flat-footed by three to five years in technology and I believe that there was an effort to slow it down, in order to catch up. They have committed billions of dollars to cellular technology. They were not just going to move off that basic type of technology and its services very easily, while the U.S. and other teams were promoting a satellite-based system. This newer entry would erode their market not only in Europe, but worldwide.

Regardless of the accuracy of this opinion, it underscores an area of existing and growing trans-Atlantic suspicions. The economic competition between North America and Europe is intense and geared towards two of the world's largest and most lucrative markets. It is difficult enough to negotiate spectrum agreements through technical considerations and existing services. Now the two continents will be increasingly caught up in issues of global competitiveness.

I suggest that in light of these trends and attitudes we may see the following developments:

- U.S. and European cooperation will increasingly depend on the pace of privatization in Europe and the rate at which both sides of the Atlantic open their markets to foreign service providers and manufacturers. These trends would create a larger private sector role, larger regulatory needs and more interdependence.
- The U.S. government must evaluate the manner in which it formulates and implements international telecommunications policy. The time is here for a more streamlined and better coordinated official approach to these multifaceted technical, economic and trade issues.
- I believe that there will be greater consultation among the nations of the Americas. The North America Free Trade Agreement represents the emerging reality of regional unified markets. Geography and modern attitudes in much of South America point towards increased alignment of spectrum uses. While there is no likelihood of a bloc developing such as Europe, there will be greater regional coordination at future WARCs.

- The great battle within the wireless consumer telecommunication arena will be between terrestrial and satellite-based mobile services. How will PCS develop along with an Iridium type system? Will Europe need mobile satellite telephony in addition to transeuropean cellular? How will the rest of the world use these technologies, and who can afford them?

These are just a few of the questions and developments that lie around the corner. They will affect domestic decisions and future international conferences. The only things that appear certain are that demand for precious radio spectrum will continue and that the international society of spectrum regulators will be very busy.

Jan W. Baran
Wiley, Rein & Fielding
1776 K Street, N.W.
Washington, D.C. 20006
Phone: (202) 429-7330
Fax: (202) 429-7207

ABSTRACT

Future Deployments in Personal Communications Services

By

MICHAEL H. CALLENDAR
MPR Teltech Ltd.

The World Administrative Radio Conference (WARC) of the International Telecommunications Union (ITU), in March 1992, identified global bands 1885-2025 and 2110-2200 MHz for Future Public Land Mobile Telecommunications Systems (FPLMTS), including 1980-2010 and 2170-2200 MHz for the mobile satellite component.

The potential for all FPLMTS radio interfaces to be in the same band provides a strong incentive to try and maximize the commonality between the satellite and terrestrial components of FPLMS. This would simplify multi-mode mobile equipment and also greatly increase the utility of FPLMTS for the provision of basic telecommunications needs in under-developed regions of the world.

Extension of both voice, video and data telecommunications to a person/machine "anywhere - anytime", as envisaged by FPLMTS, rather than to a place will have a dramatic effect on the way we live, and on the organizations which currently provide these services.

The basic structure for FPLMTS can be provided by a system architecture which evolves from present-day fixed and mobile networks toward the goal of world-wide communications mobility for people wherever they may be, at home or away, in planes, trains, cars, ships etc.

Truly seamless operation of these future wired/wireless telecommunications networks will only be achieved through the same process used for today's wired networks, i.e. through ITU global standards.

The paper outlines some of the international standards work in this area currently being carried out by CCIR/CCITT, in particular that of CCIR Task Group 8/1 (formerly IWP 8/13) on FPLMTS, and introduces the concept of "flexible standards" to speed up the process and leave room for technology development.

The paper also stresses the importance of adapting these new "mobile" technologies to become an effective means for improving the quality of telecommunications throughout the world and ensuring that global wireless access is as seamless as the world networks are today.

RÉSUMÉ

Applications futures des services de communications personnelles

Par

MICHAEL H. CALLENDAR
MPR Teltech Ltée

La Conférence administrative mondiale des radiocommunications (CAMR) de l'UIT qui s'est tenu en mars 1992 a établi que les bandes mondiales 1 885-2 025 MHz et 2 110-2 200 Mhz seraient utilisées pour l'exploitation des futurs systèmes mobiles publics terrestres de télécommunications (FSMPTT), les communications mobiles par satellite étant assurées dans les bandes 1 980-2 010 Mhz et 2 170-2 200 MHz.

Il sera beaucoup plus intéressant de maximiser les points communs entre les communications par satellite et les communications de Terre des FSMPTT lorsque toutes les liaisons radio de tels systèmes se feront dans la même bande. Cet arrangement simplifiera le matériel mobile multimode et rendra le recours aux FSMPTT beaucoup plus attrayant pour répondre aux besoins de télécommunications fondamentaux dans les régions sous-développées du globe.

Les FSMPTT, qui permettront de transmettre des communications vocales, des images et des données directement à une personne ou à un appareil peu importent le moment et le lieu et qui vont reléguer aux oubliettes le principe des communications avec un poste fixe, auront un effet révolutionnaire sur notre mode de vie actuel et sur les organisations qui assurent maintenant ces transmissions.

La structure de base des FSMPTT peut être assurée au moyen d'une architecture de système qui, à partir des réseaux fixes et mobiles actuels, évoluera pour atteindre l'objectif visé, acheminer des communications par des systèmes mobiles mondiaux auxquels les utilisateurs auront accès qu'ils soient chez eux ou à l'extérieur, en avion, en train, en auto, en bateau ou ailleurs.

Si l'on veut faire de ces futurs réseaux câblés et non câblés de véritables ensembles «monocoques» ou sans raccords, il faut impérativement procéder comme pour les réseaux câblés actuels : demander à l'UIT d'adopter des normes mondiales.

Le document fait état de quelques-uns des travaux de normalisation que le CCIR et le CCITT réalisent actuellement dans ce domaine, notamment les travaux que le groupe d'action 8/1 du CCIR (autrefois le GTI 8/13) effectue sur les FSMPTT et présente le concept de «normes flexibles» pour accélérer le processus et laisser de la place pour le développement de la technologie.

Le document insiste en outre sur l'importance d'adapter ces nouvelles technologies «mobiles» pour en faire des outils qui permettront d'améliorer efficacement la qualité des télécommunications internationales et pour que les interconnexions d'accès aux réseaux mondiaux sans fil soient aussi peu perceptibles que celles des réseaux câblés actuels.

FUTURE DEPLOYMENTS IN PERSONAL COMMUNICATIONS SERVICES

Mike Callendar

I. BACKGROUND

There are at least seven incompatible analogue cellular systems currently operating around the world. New digital cellular and cordless standards have been defined in Europe, North America and Japan which operate in a number of different frequency bands. [1][2][3][4]

There is some commonality between these various second generation digital wireless access systems, e.g. the use of Time Division Multiple Access (TDMA) in cellular and Time Division Duplex (TDD) in cordless.

Cellular is rapidly moving from vehicular to portable terminals, with most new units being hand-held. Cordless phone technology is becoming available in offices (Wireless PABX) and public areas (Telepoint) so the utility of a low power cordless unit is increasing.

Cellular and Cordless technologies can be expected to converge with others such as paging and mobile data to form integrated third generation multi-media wireless networks.

Standards are being developed in IEEE802.11 for Wireless Local Area Networks (WLAN's) with data rates up to 20 Mbit/s and the potential for packetized voice, to serve moving devices such as notebook computers and factory robots. These new WLAN's could revolutionize premises area distribution by combining PABX and LAN functionalities and also improve our working efficiency.[5]

The Rutgers University Wireless Information Network Laboratory (WINLAB) is studying third generation systems based on Metropolitan Area Networks (MAN's) as a backbone for interconnecting flexible wireless access ports with more conventional fixed telecommunications networks. [6]

Bellcore have proposed a wireless local loop concept which provides Universal Digital Portable Communications by using the ever increasing distributed intelligence of the fixed network to control routing of calls to and from the various low power radio ports.[7]

Trials of several Spread Spectrum/Code Division Multiple Access (CDMA) wireless access systems are currently underway in North America. [8][9]

Considerable research is also being carried out in Japan on many aspects of Personal Telecommunications (PT). [10][11]

The Research into Advanced Communications in Europe (RACE) program is studying the requirements to provide a Universal Mobile Telecommunication System (UMTS) which consists of a federation of individual mobile and cordless services all working to a common standard. The key elements are standardization of a flexible high-bit-rate radio interface and the provision of supporting functions within the public fixed network. [12]

A number of mobile satellite systems are in service or have been proposed, using geostationary, highly inclined elliptical or low earth orbits, which promise to complement terrestrial systems and play an important role in reaching people or machines "any where - any time". [13][14][15]

Global Personal Telecommunications represents a logical evolution from these satellite systems and many of today's essentially regional or local radio-based mobile services such as cellular, mobile data, cordless phones and paging.

Hopefully all these technologies can be made to appear to converge from a user's perspective, through common standards and where necessary multi-mode terminal equipment, offering the possibility of various universal pocket communicators, some of which may include notebook computer capabilities as well.

There is little doubt that users appreciate untethered access to telecommunications services, and it has been estimated that half the access to global telecommunications will be wireless by the year 2000. [16]

The concept of a personal number by which one can be reached "any where - any time" is both attractive and also a little disconcerting. To make these exciting new "personalized" communications services acceptable the customer must have control, e.g. who can reach him/her and what communications device (wired/wireless) is most suitable at any given time.

II. PERSONAL TELECOMMUNICATIONS (PT)

PT involves providing an essentially transparent connection linking the various necessary wired and/or wireless networks so that a practical range of "personalized" telecommunications services can be automatically provided to people on the move, wherever they may be.

The concept of a "service profile" for each user, which can be dynamically updated and available independent of where service is obtained, is a key part of PT.

Since the majority of PT will eventually originate and/or terminate in some form of wireless device it is logical for the wired networks to provide many of the supporting functions for wireless access systems (FPLMTS) and for wired network standards to be adapted to the needs of FPLMTS.

It is likely that, because of limitations inherent in both wired and wireless personal service, customers will need to move between these systems. There is therefore a requirement for an integrated design approach to all aspects, e.g. wired/wireless, of PT service development.

PT is not a new concept [17], there have been many different visions of future personal and mobile telecommunications, but in spite of the many variations some common factors emerge:

PT is a service concept, which will evolve mainly from existing radio-based services such as cellular, cordless, paging etc., and will use existing and planned fixed and mobile infrastructures to the greatest extent practicable.

Wired and wireless networks must together provide a **seamless service that the customer can easily control**.

The majority of PT will eventually have a wireless rather than a wired link to the person.

The **service quality** should, wherever possible, be comparable to that of existing wired services, e.g. for wireless this implies better than 99% coverage with less than 1% blocking.

Radio system architectures significantly different to today's cellular systems will be required, with increased use of adaptive control techniques and distributed intelligence.

III FUTURE WIRELESS ACCESS REQUIREMENTS

FPLMTS involves more than just personal telecommunications, since a flexible digital radio link can obviously be used as a wireless local or wide area network for communications between machines, e.g. for vehicular/robotic monitoring and control, PC to host communications etc. There is also considerable current interest in vehicular location and traffic safety communications of an automatic nature which could potentially be part of FPLMTS services.

Wireless access systems will be expected to provide digital services covering a wide range of bit rates and error ratios. Mobile radio systems today tend to be designed with fixed parameters which are usually determined by worst case conditions, this results in reduced capabilities under good conditions and better than required performance for most of the users most of the time. [18][19]

It would be desirable, for example, to be able to offer higher bit rate services in areas where radio conditions are suitable rather than be limited to bit rates associated with worst case conditions.

This suggests that system parameters such as the gross channel bit rate (and possibly therefore channel bandwidth) and channel coding and modulation schemes should be adapted in relation to the size and propagation characteristics of the cell, much as power levels are adapted in today's cellular systems. [20][21]

The future range and combination of both packet and circuit switched services required at any instant in a given cell is expected to vary considerably, and hence an efficient adaptable access and control scheme is needed to optimize the available radio transmission resources. [22]

Acceptable response times for various voice, data and video services will vary from less than 1 second in the case of interactive data communications to many minutes for some status reporting traffic.

Broad categories of traffic can thus be identified: voice, video, time-sensitive data and non time-sensitive data. This suggests that for optimum smoothing of the peak load within an integrated voice, video and data network a number of separate queuing and prioritizing strategies should be considered.

It could also be advantageous to include the ability to modify the services offered under peak loading conditions, e.g. reduce the voice coding rate and/or restrict wideband data services. [23]

Adaptive schemes have the potential to significantly increase the capacity and/or performance of future wireless access systems at little increase in cost or complexity.

IV. FUTURE TRENDS IN STANDARDIZATION

The traditional approach to standardization has been to precisely define all the details of a specific interface to ensure reliable operation of equipment from various manufacturers. The disadvantage of this approach in the rapidly changing technology world of today, when most

parameters are software determined and potentially highly flexible, is that standards can be very restrictive. This is further increased by the length of time needed to agree on a given standard.

The challenge in any standards work is to define things completely enough for reliable operation without restricting future enhancements that cannot be specified at the time.

The key to ensuring future enhancements is to consider that some parameters can be variables under system control rather than fixed values defined in the specification. This type of "flexible standard" would allow service and product differentiation as well as incorporation of future technology developments.

Cellular standards today have at least one variable under system control, e.g. mobile transmit power, and also have allowed for both a full and half rate speech codec. Additionally there are a number of classes of mobile unit, e.g. hand-held and vehicle units with different maximum power levels.

It is technically possible to down-load specific software to a mobile so that it can perform in the way in which the service provider would like in a specific environment, e.g. picrocell, microcell or macrocell etc., this would also open up the possibility of improved speech coding algorithms to keep pace with this rapidly advancing technology.

We are thus moving towards defining "platforms" which can be capable of many different functions, many of which could not be envisaged by the standards experts. This is somewhat similar to defining the operating system, e.g. DOS/UNIX, and leaving the actual hardware and software with considerable flexibility.

The fixed network has also been moving in this direction with the Intelligent Network (IN) concept in which services can be developed on many platforms throughout the network, and the Asynchronous Transfer Mode (ATM) in which a flexible "bearer" is defined which is capable of carrying almost any service.

In FPLMTS the hand-held unit represents a major system constraint because of the limited battery power available. Thus DSP's allowing great flexibility are generally replaced with custom IC's which draw significantly less power, so it will be challenging to define flexible standards for this application.

It is my hope that flexible standards can be defined for FPLMTS to allow room for technology development and manufacturer and service provider differentiation as well as to speed up the standardization process.

A number of digital wireless access technologies, such as satellite, cellular, cordless, mobile data and wireless LAN, will be extensively deployed in the 1990's and will to some extent compete for the same customers. A specification which incorporates adaptation to cover a number of these requirements would be a very attractive proposition.

V. FIXED APPLICATIONS OF WIRELESS ACCESS

The application of mobile radio techniques to the provision of service to essentially fixed locations, usually where there is no existing wired infrastructure, is within the scope of Task Group 8/1. This is the result of requests to CCIR from developing countries for study of how emerging mobile systems may be adapted to meet their basic telecommunications needs.

Radio-based wireless access to the fixed telecommunications networks is predicted to become progressively more cost competitive with the various wired alternatives. It is therefore likely that an increasing percentage of fixed traffic will originate and/or terminate in some form of wireless device.

Since phone service penetration in developed countries is close to 100% it is easy to forget that two thirds of the world's population does not even have access to a telephone.

There are many countries now trying to rapidly upgrade their telecommunications networks, wireless technologies in addition to being increasingly cost effective offer the further advantages of rapid and flexible deployment in urban as well as rural areas.

Telecommunications play an important role in economic development and investments in wireless telecommunications infrastructures throughout the world can be expected to grow dramatically as this technology provides an increasingly cost effective solution to this important global requirement.

[24][25][26]

VI ROLE OF THE INTERNATIONAL TELECOMMUNICATION UNION (ITU)

The International Telecommunication Union (ITU), which is responsible for telecommunications standards and spectrum management world-wide, has both regulatory and technical organizations.

In the regulatory area the International Frequency Registration Board (IFRB) keeps track of frequency assignments that have international significance, and World Administrative Radio Conferences (WARC's) are organized to update the Radio Regulations, thus sharing the radio spectrum

between the many competing services and administrations. The International Telegraph and Telephone Consultative Committee (CCITT) advises the ITU on "wired" telecommunications requirements, and the International Radio Consultative Committee (CCIR) advises on radio related, i.e. "wireless", requirements.

The ITU has played a key role in the evolution of "seamless" global telecommunications through its wired and wireless technical standards bodies CCITT and CCIR. An international call may involve many different transmission technologies, e.g. satellite, fibre, microwave point to point radio, copper etc., and a number of telecommunications carriers but the user is uninterested and generally unaware of these details. The customer is however very concerned with the ease of use (seamlessness), the quality of the various services and their cost.

Many Administrations and Regional organizations are currently studying the requirements for future telecommunications with people on the move, including a growing focus on PT. In order to avoid solutions that are limited in scope to regional areas and conditions it is important that studies on an international scale be rapidly carried out in a single forum. CCIR and CCITT represent this forum in the framework of the ITU.

VII. SPECTRUM ALLOCATIONS FOR PERSONAL TELECOMMUNICATIONS

Cellular and cordless frequency allocations are presently different in the three ITU regions, and generally do not correspond directly with the ITU spectrum recommendations for primary mobile status in all three regions. This is clearly not optimum for future global personal telecommunications.

The ITU organizes general WARC's, dealing with all spectrum requirements for all services, every 15 to 20 years. The last one was in 1979 and there may not be another one this century. Specialized WARC's have been held in the intervening periods to deal with the requirements of specific services.

The World Administrative Radio Conference (WARC) of the ITU in March 1992 identified global bands 1885-2025 and 2110-2200 MHz for FPLMTS, including 1980-2010 and 2170-2200 MHz for the Mobile Satellite component.

The potential for all FPLMTS radio interfaces to be in the same band provides a strong incentive to try and maximize the commonality between the satellite and terrestrial components of FPLMTS. This would simplify multi-mode mobile equipment

and also greatly increase the utility of FPLMTS for the provision of basic telecommunications needs in under-developed regions of the world.

The various National Administrations can be expected to subsequently allocate spectrum for the various components of FPLMTS in a coordinated manner according to their own specific priorities.

VIII. CCIR TASK GROUP 8/1 PROGRESS

At the end of 1985, long before Personal Telecommunications (e.g. PCS, PCN, UMTS, FPLMTS, UPT etc.) was a popular topic, CCIR formed a group called Interim Working Party 8/13 to study the requirements for Future Public Land Mobile Telecommunication Systems (FPLMTS). This group has identified what services can potentially be delivered by radio and what spectrum is needed to ensure reasonable quality and cost for these services. This work formed the basis of the FPLMTS part of the CCIR technical input to WARC-92.

IWP8/13, now called Task Group 8/1, has also studied the adaptation of mobile technologies to the provision of basic telecommunications, e.g. wireless distribution and local access, particularly for the needs of developing countries.

Over 30 Administrations and 10 International Organizations, presently participate in the work of Task Group 8/1.

Five FPLMTS Recommendations, a general one and detailed ones covering FPLMTS Services, Architectures, Satellite Operation within FPLMTS and Adaptation to the Needs of Developing Countries, have recently been approved by Study Group 8 under the new fast approval process and should shortly be available from the ITU.

Additional Draft Recommendations in areas such as FPLMTS Network and Radio Interfaces, Quality of Services, Network Management and Security are currently being prepared in collaboration with CCITT, some of which should be ready for the Study Group 8 meeting in early 1994.

It is hoped that early performance results from the many different second generation wireless access systems (GSM, CT2, CT3, DECT, Digital AMPS (IS54), Japanese Digital Cellular and Cordless standards, CDMA trials etc.) will assist the work of Task Group 8/1 on the definition of third generation wireless access standards for the year 2000.

IX. OTHER ITU PERSONAL TELECOMMUNICATIONS ACTIVITIES

CCITT, through its various study groups, has developed many mobile-related recommendations in such areas as numbering plans, location registration procedures and signalling protocols.

The wired networks are becoming more "intelligent" and will soon be able to deliver services based on a "personal telecommunications number", i.e. Universal Personal Telecommunications (UPT), to a person's chosen access point (wired or wireless) rather than to a fixed location.

A CCIR/CCITT Joint Experts Working Meeting on UPT and FPLMTS was held (June 4-8th 1990) in Vancouver, Canada, to assist the coordination of standards development in wired and wireless PT.

There have been many subsequent joint activities between CCIR Task Group 8/1 and CCITT experts in areas such as Services, Mobile Traffic Studies, FPLMTS Architectures and Low Bit Rate Speech Coding, usually in conjunction with planned CCIR/CCITT meetings. This has lead, for example, to a close alignment between the FPLMTS architecture recommendation and the CCITT Intelligent Network (IN) recommendations; such close cooperation is essential to the cost effective global delivery of these new PT services.

X. CONCLUSIONS

The basic structure for FPLMTS can be provided by a system architecture which evolves from present-day fixed and mobile networks towards the goal of world-wide communications mobility for people wherever they may be, at home or away, in planes, trains, cars, ships etc.

Truly seamless operation of these future multi-media wired/wireless telecommunications networks will only be achieved through the same process used for today's wired networks, i.e. through ITU global standards.

Now that 230 MHz of common world-wide spectrum has been identified by WARC-92 for FPLMTS it is necessary to keep a global focus on the development of the required wired and wireless telecommunications standards so that the universal pocket communicator can become a reality.

It is important that we use this chance to adapt these new "mobile" technologies to become an effective means for improving the quality of telecommunications throughout the world and to ensure that global wireless access is as seamless as the wired networks are today.

ACKNOWLEDGEMENTS

The support from the working members of Task Group 8/1, who have developed many of the ideas expressed in this paper, is gratefully acknowledged.

REFERENCES

- 1 Mallinder, B. J. T., "An Overview of the GSM System" DMR-III 12-15 October 1988, Copenhagen, Denmark.
- 2 Ochsner, H., "DECT - Digital European Cordless Telecommunications" IEEE VTC, 1-3 May 1989, San Francisco, USA, pp. 718-721.
- 3 Raith, K., Uddenfeldt, J., "Capacity of Digital Cellular TDMA Systems" IEEE Transactions on Vehicular Technology, May 1991, pp. 323-332.
- 4 Kinoshita, K., et al, "Development of a TDMA Digital Cellular System based on Japanese Standard" IEEE VTC, 19-22 May 1991, St. Louis, Mo., USA, pp. 642-645
- 5 Rypinski, C.A., "IEEE 802.11 Standards for RLAN" Virginia Tech Symposium on Wireless Personal Communications, 3-5 June 1991, pp. 3.1-3.7.
- 6 Goodman, D.J., "Second Generation Wireless Information Networks" IEEE Transactions on Vehicular Technology, May 1991, pp. 366-374.
- 7 Cox, D.C., Arnold, H.W., Porter, P.T., "Universal Digital Portable Communications: A System Perspective" IEEE J S A C, Special Issue on Portable and Mobile Communications, June 1987, pp. 764-773.
- 8 Schilling, D.L., et al, "Spread Spectrum for Commercial Communications" IEEE Communications Magazine, April 1991, pp. 66-79.
- 9 Gilhousen, K.S., et al, "On the Capacity of a Cellular CDMA System" IEEE Transactions on Vehicular Technology, May 1991, pp. 303-312.
- 10 Nakajima, A., et al, "Intelligent Digital Mobile Communications Network Architecture for Universal Personal Telecommunications (UPT) Services" IEEE VTC 19-22 May 1991, St Louis, Mo, USA, pp. 83-87.
- 11 Tanaka, K., et al, "Signalling Architecture for Microcell Communications Systems" IEEE VTC, 19-22 May 1991, St Louis, Mo., USA, pp. 240-244.
- 12 Grillo, D., MacNamee, G., "European Perspectives on Third Generation Personal Communications Systems" IEEE VTC, 7-9 May 1990, Orlando, Florida, USA, pp. 135-140.
- 13 Phillips, R.O., Wright, D., "Complementarity between Terrestrial and Satellite Mobile Radio Systems" DMR-III, 12-15 September 1988, Copenhagen, Denmark.

- 14 Callendar, M.H., MaLatchy, A., "Future Public Land Mobile Telecommunication Systems - A Canadian Perspective" DMR-II, 14-16 October 1986, Stockholm, Sweden, pp. 12-17.
- 15 Reinhart, E.E., "Mobile Communications" WARC-92 Special Report, IEEE Spectrum, February 1992, pp. 27-29.
- 16 Ross, M.H., "What is Personal Communications" NCF, 2-4 October 1989, Chicago, Illinois, USA, pp. 859-868.
- 17 De Brito, J.S., "Personal and Mobile Communications" IEEE ICC, June 14-18 1981, Denver, Colorado, USA, pp. 57.1.1-57.1.3.
- 18 Dornstetter, J., Verhulst, D., "Cellular Efficiency with Slow Frequency Hopping: Analysis of Digital SFH900 Mobile System" IEEE J S A C, Special Issue on Portable and Mobile Communications, June 1987.
- 19 Acampora, A.S., Winters, J.H., "A Wireless Network for Wideband Indoor Communications" IEEE J S A C, Special Issue on Portable and Mobile Communications, June 1987.
- 20 Maseng, T., Trandem, O., "Adaptive Digital Phase Modulation" DMR-II, 14-16 October 1986, Stockholm, Sweden, pp. 64-69.
- 21 Steele, R., "Deploying Personal Communications Networks" IEEE Communications Magazine, September 1990, pp. 12-15.
- 22 Goodman, D.J., Wei, S.X., "Factors Affecting the Bandwidth Efficiency of Packet Reservation Multiple Access" IEEE VTC, 1-3 May 1989, San Francisco, USA, pp. 292-299.
- 23 Callendar, M.H., "International Standards for Personal Communications" IEEE VTC, 1-3 May 1989, San Francisco, California, USA, pp. 722-728.
- 24 Murty, B.S., "A Phone in Every Village" Telecommunications Research Center, Department of Telecommunications, India, 1987.
- 25 Canas, A. F., "The Socio-Economic Impact of Telecommunications in Costa Rica" 5th World Telecommunications Forum, October 1987, Geneva, Switzerland.
- 26 Saunders, R.J., Warford, J.J., Wellenius, B., "Telecommunications and Economic Development. A World Bank Publication".

ABSTRACT

Mobile Satellite Services in Canada

By

OREST S. ROSCOE
Telesat Mobile Inc.

Telesat Mobile Inc. is making excellent progress toward implementing a mobile satellite communications system in Canada. All of the major contracts for the network elements are in place. These include contracts for the MSAT satellite, launch services, network control system, feederlink earth stations, and mobile terminals. Launch of the satellite is scheduled for the second quarter of 1994, with operational service commencing in the third quarter. MSAT will be launched into geostationary orbit at 106.5 degrees west longitude. It will have an aggregate EIRP in excess of 57dBw, making it the highest powered mobile satellite launched or planned to date. MSAT will be capable of serving hundreds of thousands of mobile terminals providing circuit-switched voice and data services and packet-switched data services. Access to the public switched telephone and data networks will be via a small number of feederlink earth stations. A large scale network control system will manage the allocation of the satellite capacity to the network of mobile and feederlink earth stations. A comprehensive portfolio of services is under development to meet needs identified through extensive market research. These include services for wide area fleet management, remote asset management, and mobile offices and mobile telephones in areas which cannot be reached cost effectively by terrestrially based systems.

RÉSUMÉ

Services mobiles par satellite au Canada

Par

OREST S. ROSCOE
Telesat Mobile Inc.

Télésat Mobile Inc. fait d'excellents progrès en vue de la mise en oeuvre d'un système mobile de télécommunications par satellite au Canada. Tous les principaux contrats relatifs aux composantes du système ont été conclus, notamment en ce qui a trait au satellite MSAT, aux services de lancement, au système de coordination du réseau, aux stations terriennes qui assureront les liaisons de connexion et aux terminaux mobiles. On compte lancer le satellite au deuxième trimestre de 1994 et débuter le service opérationnel au troisième trimestre. Le satellite MSAT sera mis sur orbite géostationnaire à 106,5° ouest. Sa p.i.r.e globale, qui sera supérieure à 57 dBW, en fera le satellite le plus puissant, actuel ou prévu, du service mobile. MSAT pourra desservir des centaines de milliers de terminaux mobiles. Il assurera des services de transmission de la voix et des données avec commutation de circuits et des services de transmission de données avec commutation par paquets. Quelques stations terriennes assureront les liaisons de connexion avec le réseau téléphonique commuté public et les réseaux de données. Un grand système de coordination du réseau gérera l'attribution des voies de satellite aux stations mobiles et aux stations terriennes de connexion. Une vaste gamme de services sont actuellement élaborés pour répondre aux besoins dégagés par une étude approfondie du marché. Il s'agit notamment des services suivants : systèmes à grande étendue de gestion de parcs de véhicules; services de gestion à distance des biens; et services de bureaux mobiles et de téléphones mobiles dans les régions qui ne peuvent pas être desservies économiquement par les systèmes de Terre.

MOBILE SATELLITE SERVICES IN CANADA

Orest S. Roscoe

Telesat Mobile Inc. (TMI) is progressing on schedule toward implementing a mobile satellite communications system in Canada. The contract for the MSAT satellite with Spar Aerospace, teamed with the Hughes Aircraft Company, commenced in December, 1990, and delivery is scheduled for March, 1994. Manufacturing of all units is nearly complete and assembly of both the payload and bus subsystems is underway. Integration of the payload and bus will commence at the David Florida Lab in February, 1993, with completion of testing and final acceptance scheduled for the end of March, 1994. A contract for launch services is in place with Arianespace, with launch scheduled for the second quarter of 1994.

A contract for the Communications Ground Segment (CGS) portion of the MSAT network was awarded to the Westinghouse Electric Company of Canada early this year and work started on May 1. The CGS comprises the Network Control System, a Feederlink Earth Station, and a packet-switched Data Hub. Volume supply arrangements for Mobile Terminals (MTs) have also been made with the Westinghouse Electric Corporation, and similar arrangements will be made shortly with another supplier. Both suppliers are required to supply at least 100,000 MTs each by the end of 1995 to meet forecast demands from both the Canadian and U.S. markets.

The Canadian MSAT network is being developed as part of a North American system. Telesat Mobile Inc. is cooperating with the American Mobile Satellite Corporation (AMSC) to implement a two-satellite system to serve both Canada and the United States. Common specifications for both the space and ground segments of the MSAT network have been developed jointly by both companies. The two satellites will be capable of providing mutual in-space back-up to each other, and will be augmented with more satellites as traffic warrants. Each satellite will be operated individually by each company, but through a Joint Operating Agreement between them the companies will provide common services to users, including wide-area national and continental roaming capability.

The services which will be provided via the MSAT system include a full range of circuit-switched and packet-switched voice, data and facsimile transmission services to land, maritime, and aeronautical mobile terminals. Some of these services will be fully interconnected to the public switched telephone and data networks and will offer many of the features customarily available to public network users. Others will be available as private network services and will offer features which are unique to private networks.

SPACE SEGMENT

Telesat Mobile's MSAT satellite will be launched into geostationary orbit at 106.5 degrees west longitude. It is a large satellite, based on the Hughes Aircraft Co. HS 601 bus, which is three-axis stabilized. Its principal parameters are listed in Table 1. Lift-off weight is 2514 kilograms when loaded with 10 years of stationkeeping fuel. End-of-life solar array power is 3.15 kilowatts, with 2.5 kilowatts required by the communications payload. Figure 1 illustrates the satellite, which is 21 metres in length tip-to-tip of the solar arrays and 19 metres edge-to-edge of the antennas.

The NOC will carry out the administrative functions associated with management of the total MSS system. This includes the registering of MTs with their attributes, setting up conditions so that properly authorized MTs may access the system, the recording of system usage for billing purposes and the accumulation of network performance records to aid in long-term system planning.

Within the circuit-switched portion of the network, the provision of DEMAND PERIOD circuits to and from MTs is carried out by a Network Control Centre (NCC) and the portions of the Feederlink Earth Stations (FESS) and MTs that are associated with the signalling channels through which the assignment of circuits and other network control functions are exercised. One or more Group Controllers within the NCC assigns satellite circuits to meet customer requirements at a calling rate of up to 70 calls per second. All interfaces within the NCS will be in accordance with a specified network standard.

Because bandwidth and power are valuable and limited, the available satellite circuits are formed into pools large enough to ensure high circuit usage efficiency. The various customer networks within the NCS will use circuits from circuit pools on an as-needed basis.

The signalling system provides a method for mobile terminals to access the NCS for the exchange of channel assignment and network management information among all the elements of the NCS. The signalling system serves the anticipated number of mobile terminals and provides the required response for setting up calls. One or more signalling channels will be needed in each beam of each satellite.

Mobile Terminals

A wide variety of mobile earth terminal types will be able to operate with MSAT. Generally these will be compact and low cost because of the high power channels available. It is anticipated that they will have antenna gains in the range of 7 to 12 dBic and corresponding G/Ts of -17 to -12 dB/K. Mobile terminal EIRP will be about 13 dBw. 4.8 kbps digitally encoded speech using a Multi-Band Excitation algorithm will be carried in a single channel per carrier mode. This method of voice coding has been found to perform well in a mobile satellite environment and will be used initially, with QPSK modulation.

A modular architecture has been specified for the mobile terminals, illustrated in Figure 6. The three functional units are an Antenna Unit (AU), a Tranceiver Unit (TU), and an External Interface Unit (EIU). It is expected that there will be several designs for AUs, depending on the application, within the parameters outlined above. There will also be a range of EIUs, also depending on applications and the types of external devices required. However, the design of the TU should be common for all MTs produced by each manufacturer, permitting the TU to be produced in volume with attendant cost efficiencies.

A basic terminal will offer circuit-switched service and will employ a telephone handset as the user device. A full-featured terminal will offer both circuit-switched and packet-switched service and will support all of the devices required to fulfill more elaborate needs, including telecopiers, printers, computers, keyboards and data displays. The target price for the basic terminal, in volume production, is in the range of \$1500 to \$2500, with the price of a terminal with more user devices being increased by the price of the devices.

Communications Subsystem

MSAT uses Ku-band between the satellite and fixed, feeder-link earth stations which are interconnected to terrestrial networks, and L-band between the satellite and mobile terminals. Thus the transponder is configured as a Ku-band to L-band forward repeater providing communications from a feederlink earth station to a mobile terminal and an L-band to Ku-band return repeater for communications in the return direction. Mobile-to-mobile communications necessitates a double hop link. A small amount of capacity for Ku-band to Ku-band connections among feederlink earth stations for control purposes is also provided.

The communications subsystem features separate L-band transmit and receive antennas with 5 metre by 6 metre unfurlable reflectors, each fed by 23-element arrays of cupped dipoles. The antennas provide six circularly polarized elliptically shaped spot beams over the service areas, as illustrated in Figure 2. The entire 29 MHz of spectrum allocated to the mobile satellite service is accessible in each beam. This permits maximum flexibility in coordinating spectrum for each beam. The directivity of the antennas provides sufficient isolation between the Canada-U.S. east and west beams and between the Canada-U.S. centre and the Alaska-Hawaii beams to permit spectrum re-use. The narrow spot beams in combination with high power L-band output amplifiers result in an aggregate EIRP of 57.3 dBw, in excess of 9 dB more than any other mobile satellite planned to date.

The range of communications capacity of the satellite for voice service is between 1000 to 2000 assignable channels, depending on the mix of terminal types in use. Depending on traffic characteristics, this capacity will be able to support from 100,000 to 200,000 mobile terminals for voice or the equivalent in data traffic. Typically a voice channel can be expected to support several thousand mobile terminals operating in a packet-switched data mode.

The bandwidth and power available on MSAT will be subdivided into one-way channels of various bandwidths and power levels. Generally, forward and return link channels will paired to support two-way communication. A symmetrical channel pair forms a circuit. Pairings may be asymmetric for provisioning of asymmetric services such as packet switched data and to support signalling. Circuits may be used for DEMAND PERIOD or for FULL PERIOD circuit switched services. DEMAND PERIOD circuits are used on a call-by-call, as needed basis. FULL PERIOD circuits are devoted to a long term particular use.

GROUND SEGMENT

Network Control System

A block diagram of the MSAT Network Control System (NCS) is shown in Figure 5. A Network Operations Centre (NOC) will manage and control all the resources of both the space and ground segments. A NOC will coordinate the frequencies to be used in each beam and will allocate blocks of satellite circuits to Control Groups or to Data Hubs. The NOC also allocates blocks of satellite bandwidth and power to customers such as the commercial aviation community, who may wish to operate their own mobile satellite system. The NOC receives and acts upon requests for pre-emption of frequencies if required for aeronautical safety services. In responding to the flight safety requirements, the NOC may need to reconfigure the frequency band to be used by each satellite in each beam and so advise the Group Controllers (GCs).

Extensive market research was carried out to determine applications which could be best satisfied with the MSAT bearer services. Eight principal applications were identified as those with the greatest appeal and which would cause customers to buy MSAT services during the early years of service availability. These can be grouped into a portfolio of Customer Services as indicated in Table 2.

The Mobile Fleet Management service is a command and control service supporting direct communications with fleets across North America. Both voice communications and data messaging are required, as well as position reporting, data reporting from on-board sensors, voice mailbox, telecopier service, and broadcast messaging. Key market segments are for-hire trucking, private fleets, bus lines, utilities fleets, railroads, barges, and maritime fleets.

The Remote Fixed Asset Management service serves a family of applications and is considered either a key part of a valuable asset protection system or a data communications tool. Typical applications include financial transactional services (ATM & POS) to remote and rural sites, environmental and industrial information gathering and reporting, asset and process monitoring and status reporting, and interactive on-line telemetry and control.

The Mobile Telephony service allows subscribers to place and receive telephone calls from anywhere to anywhere in North America. Interconnection will be available with the PSTN and the cellular networks as well as with other MTs on the MSAT network. Fixed remote residences will also be served. Mobiles will be able to operate not only on the MSAT network but also on the cellular network while in cellular coverage.

CONCLUSIONS

Implementation of both the space and ground segments of the MSAT network is well underway in Canada. The contract for the satellite is more than 50% completed and is on schedule. The ground segment is very comprehensive in design and has been specified thoroughly. Implementation is in progress. A modular mobile terminal architecture has been specified to permit the most complex component, the transceiver unit, to be common to all mobile terminals and thus manufactured in high volumes. Considerable attention is being given to the development of services with end-to-end applications designed to meet user needs, based on extensive market research.

REFERENCES

- (1) E. Bertenyi, "The MSAT Spacecraft of Telesat Mobile Inc.", Canadian Aeronautics and Space Institute Sixth Conference on Astronautics, Ottawa, Ont., Canada 19-21 November, 1990
- (2) N.G. Davies and B. Skerry, "MSAT Network Architecture", Proceedings of the Second International Mobile Satellite Conference, Ottawa, Ont., June 17-20, 1990.
- (3) N.G. Davies and O.S. Roscoe, "The Provision of Mobile Satellite Services in Canada", Canadian Journal of Electrical and Computer Engineering, June, 1990.
- (4) O.S. Roscoe, "Implementation of the MSAT Network in Canada", 42nd Congress of the International Astronautical Federation, Montreal, Canada, 5-11 October, 1991.

For further information:

O.S. Roscoe,
Vice President, Engineering
Telesat Mobile Inc.
1145 Hunt Club Road
Ottawa, Ontario, Canada K1V 0Y3

Tel: (613) 736 6728 Fax: (613) 736 4548

ABSTRACT

Future Deployments in DAB and HDTV

By

**DAVID L. GARFORTH
Canadian Broadcasting Corporation**

WARC '92 represents a watershed for the broadcasting industry, both nationally and internationally. This conference puts into place one of the final components, i.e. spectrum capacity, required by the broadcaster to provide complete digital delivery of new services to the consumer.

This paper will attempt to address the results and some of the implications of WARC '92 from a service perspective, including Digital Radio Broadcasting (DRB), Wide RF-Band High Definition Television Broadcasting, HF Broadcasting as well as indirect efforts on terrestrial Digital Television Broadcasting (formerly ATV). Some of the issues which will be addressed include; service modelling and spectrum planning; policy and strategic issues; regulatory considerations and industrial issues.

Broadcasters will now have the capacity to compete with other service providers on an equal basis for audience share. Specifically, the new DRB spectrum allocation will permit the organized migration of conventional analogue radio services to digital. Wide RF-band HDTV services provided by satellite for the future can be planned with fewer limitations. Further, the UHF-TV bands will accommodate terrestrial Digital Television Broadcasting along with conventional NTSC services, thereby providing a defacto allocation for this former service.

RÉSUMÉ

Mise en œuvre future de la RAN et de la TVHD

Par

DAVID L. GARFORTH
Société Radio-Canada

La CAMR 92 constitue un tournant pour l'industrie de la radiodiffusion, tant au Canada qu'à l'étranger. La Conférence a mis en place l'un des derniers éléments (c.-à-d. l'attribution de fréquences) nécessaires à la prestation, par les entreprises de radiodiffusion, de nouveaux services entièrement numériques aux consommateurs.

Le présent document expose les résultats de la CAMR 92 ainsi que certaines de ses répercussions sur les services offerts : radiodiffusion audionumérique (RAN), télédiffusion à haute définition à large bande, radiodiffusion HF. Il traite également des répercussions indirectes de la CAMR 92 sur la télédiffusion numérique de Terre (anciennement connue sous le nom de télévision de pointe). Le document aborde notamment les questions suivantes : modélisation des services et planification du spectre, politiques et stratégies, réglementation et enjeux industriels.

Les entreprises de radiodiffusion seront dorénavant en mesure de livrer une concurrence d'égal à égal aux autres fournisseurs de services pour obtenir leur part d'auditoire. Par exemple, les nouvelles fréquences attribuées à la RAN permettront la migration ordonnée des services radio analogiques classiques vers un service numérique. Il y aura moins de restrictions en ce qui concerne la planification des futurs services de radiodiffusion TVHD à large bande par satellite. En outre, les bandes TV-UHF permettront d'assurer à la fois la prestation des services de télédiffusion numérique de Terre (TNT) et des services NTSC classiques, ce qui constitue une attribution de fait de fréquences aux services TNT.

Future Deployments in DAB and HDTV

David L. Garforth

1. Introduction

Due to the length and complexity of its agenda, the limited period of time afforded to deliberations, the existing political environment, the commercial implications of some of its issues, as well as the importance of its results, WARC-92 is now considered to be a major success for the ITU.

For Canada, the Conference represents an impressive achievement, considering that all major objectives were met and, in some cases, exceeded. The major triumph for broadcasters was without a doubt the allocation for Digital Audio Broadcasting in the 1.5 GHz range and to a somewhat lesser extent, the allocation for the Satellite Broadcasting of HDTV in the 17.5 GHz range. In both cases, Canada arrived at the Conference almost alone with its Proposals which were at odds with the U.S.A, Europe and Japan. Further, Canada played a pivotal role in the discussions leading to the final compromise.

WARC-92 marks the beginning of a new era for broadcasting, where digital transmission, bit-rate reduction techniques and multimedia delivery will play key roles.

2. WARC-92's Results - Broadcasting Matters

The principal results, Digital Audio Broadcasting (DAB), Satellite HDTV and HF broadcasting are summarized and discussed in this section.

2.1. Digital Audio Broadcasting (BSS and BS)

Digital Audio Broadcasting (DAB), also called Digital Radio Broadcasting or DRB, is a new radio service designed to improve upon existing AM and FM sound broadcasting services in the areas of: technical sound quality; service reliability and availability; programming and coverage flexibility; spectrum and power efficiency; receiver flexibility; as well as provide new business opportunities for the broadcaster.

DAB was designed to deliver digital high-quality sound to vehicular, portable, and fixed low-cost simple receivers in a power and spectrum-efficient manner, addressing specifically the multipath and shadowing propagation effects experienced in

a mobile reception mode. The system which enables the use of on-channel retransmitters opens the door to new approaches in coverage planning. The coverage provided by the main transmitter (the latter being located in space for the satellite service or on the earth for the terrestrial service) can be improved through the use of terrestrial co-channel gap-filters and/or coverage extenders. This concept can also be used to reduce the required power of the main transmitter, maximizing frequency re-use. Multiple transmitter configurations and even cellular-type coverage is also possible.

One of the major challenges for DAB was to allocate a suitable frequency band(s) for this service. Before WARC-92, there was no spectrum directly available for DAB. To determine an appropriate portion of the spectrum was a difficult task, as all the bands under consideration (broadcasting and non-broadcasting) were extensively used, thus requiring the displacement of existing services. Bands across the VHF and UHF range, from the low-VHF-TV Band to S-Band (2500 MHz), were examined for DAB.

Important decisions on these issues were taken at WARC-92 with the agreed allocation on a worldwide basis of the band 1452-1492 MHz to the broadcasting-satellite service (BSS) and the broadcasting service (BS) for Digital Audio Broadcasting.

A number of Administrations, who were not in a position at that time to be satisfied with this generally agreed allocation, obtained through "in country footnotes" additional allocations at 2310-2360 MHz (U.S.A. and India), and at 2535-2655 MHz (12 countries in the far east, among them, Japan and the Russian Federation).

All these new allocations are co-primary with existing primary allocations. Through footnotes, the use of these new allocations is limited to Digital Audio Broadcasting and is subject to Resolution COM4/W relating to the introduction of BSS (Sound) and complementary terrestrial broadcasting in these newly allocated bands. The Resolution calls for the convening of a Conference, preferably not later than 1998, for the planning of the satellite component of the service and the development of procedures for the co-ordinated use of the terrestrial part. The Conference will also review the sharing situation in these bands.

In advance of the Conference, BSS (DAB) systems may be introduced in the upper 25 MHz of this allocation, subject to a special procedure to protect existing services. The terrestrial DAB service may be introduced during this interim period subject to co-ordination with Administrations whose services may be affected.

Before WARC-92, several European countries were considering the implementation of DAB on an interim basis in the VHF bands allocated to the broadcasting service, while ensuring the protection of existing stations. Resolution COM5/10 addresses the difficulties of introducing terrestrial DAB in the VHF bands. Further, to accommodate the concerns of these European countries, it requests that the subject of terrestrial VHF DAB for Region 1 and interested countries in Region 3, be included on the agenda of a future conference.

2.2. Broadcasting Satellite Service for High-Definition Television

Taking into account the Plans for the Broadcasting-Satellite Service in the 12 GHz band for conventional television, Resolution 521 (WARC ORB-88) asked for new BSS allocations for wide RF-band High-Definition television on a worldwide basis. WARC-92 began its work with three main proposals on this question: the 17 GHz band as promoted by Canada and Brazil; the 21 GHz band supported by CEPT and the 24 GHz band suggested by the U.S.A. and Japan.

Although there was a definite majority for the 21 GHz proposal (except in Region 2), a consensus was almost reached on the 17 GHz band approach. In the end, the Conference opted for Regional allocations. The 17.3-17.8 GHz band was allocated in Region 2 to BSS-HDTV, while the 21.4-22.0 GHz band was allocated in Region 1 and 3 for the same purpose. While these allocations will not become available until April 1, 2007, it is possible that BSS-HDTV could be implemented prior to that date, provided it protects existing services.

Feeder links for the BSS allocation in Region 2 will be accommodated in the following FSS bands: 18.1-18.4 GHz; 24.75-25.25 GHz; and, 27.5-30.0 GHz. Regulatory provisions were adopted for the sharing of the 17.3-17.8 GHz band between BSS-HDTV downlinks and feederlinks of the 12 GHz BSS, as well as FSS systems in the 17.7-17.8 GHz.

Finally, Resolution COM5/3 was adopted, requesting a Conference to revise (or modernize) the BSS Plans of Region 1 and 3 in the 12 GHz bands in light of studies carried out in the CCIR. This Resolution responded to the need to increase the efficiency and flexibility of the Region 1 and 3 Plans. It may also facilitate the accommodation of BSS-HDTV requirements in the 12 GHz bands in countries where the high-rainfall climatic zones would seriously limit the use of the higher BSS-HDTV allocated bands.

2.3. Shortwave (HF) Broadcasting

The question of new spectrum for HF broadcasting as well as more efficient use and equitable band access were important issues at the Conference, particularly for developing countries.

A total of 790 kHz of additional spectrum in the range 5900 kHz to 19020 kHz was allocated for the purpose of HF Broadcasting. An amount of 200 kHz is below 10 MHz and the remaining 590 kHz is above 10 MHz. The extended HF frequency bands are allocated on a worldwide basis, but are subject to the following regulatory provisions:

- the use is limited to single-side band emissions as per footnote 521A;
- the use is subject to planning procedures of a future WARC as per footnote 521B;
- the allocation will become available on April 1, 2007 as per Resolution COM5/7.

Resolution COM4/A recommends that the next competent WARC considers the possibility of advancing the date for the cessation of double-side band emissions from 31 December 2015 (HFBC-87) to an earlier date. In addition, Resolution COM4/B recommends that Administration takes practical steps to eliminate HF broadcasting outside the bands allocated for that purpose.

Finally, COM4/8, recommending the convening of a WARC as soon as possible to plan the HF broadcasting bands, was adopted.

3. Impact of the Results of WARC-92 on Broadcasting Services

The essence of these WARC-92 results for broadcasting is that they will allow proven (i.e. DAB) and emerging (i.e. HDTV and DTV) technologies to develop into real broadcasting services. The path is now laid for system development and standardization, as well as service planning and introduction.

3.1. The Planning and Introduction of Digital Audio Broadcasting

The new 1452-1492 MHz allocation to BSS and BS will enable the implementation in Canada of the mixed terrestrial/satellite approach for DAB, with the following advantages:

- highly spectrum-efficient approach as both satellite BSS and terrestrial BS DAB services use the same frequency band;

- local, sub-national, national and even international broadcasting (perhaps with lower quality levels) DAB program services could be provided in the same band and a common receiver could be used by the consumer/public for all services. The mixed approach would enable this at an economical price, but each country or service providers would have the option to implement it or not;
- the common receiver and common frequency band would also benefit the receiver manufacturers who could optimize their design and production, and provide a cheaper receiver. Worldwide or regional markets would also be possible;

This concept was introduced by Canada in the ITU during the course of the CCIR JIWP 10-11/1 Preparatory Meeting in Sydney, Australia in November, 1990. [1]

A gradual phase-in approach would enable Canada and its neighbouring countries to custom design the manner in which DAB will be introduced, taking into account existing (fixed in Canada and aeronautical telemetry in the U.S.A.) services.

The WARC-92 40 MHz allocation is of sufficient bandwidth to permit, in most countries, all the existing AM and FM stations to convert to DAB as well as new DAB satellite services. In the case of Canada alone, this is true. Additional terrestrial spectrum, however, might be required by the U.S.A. if they decide to implement DAB in the WARC-92 allocated 1452-1492 MHz band.

While the WARC-92 decisions have given a clear indication of which frequency band should be used for DAB in the long-term internationally, they do not prevent the introduction, in the short term, of DAB in other broadcasting bands. The VHF broadcasting bands (TV or FM) considered by some European countries for terrestrial DAB are not considered a good solution for the orderly introduction and long term viability of this service, unless a significant part of these bands (i.e. 20 to 50 MHz) are re-allocated to DAB. As far as the additional S-Band allocations in the U.S.A., Japan, India and elsewhere, even if they were made available without sharing constraints, (which is not the case now) they would represent a very expensive option for DAB, and provide limited coverage flexibility. In summary, these bands would not be able to accommodate the service objectives and requirements of DAB and would seriously limit the development and flexibility of the service. [2]

Rational spectrum planning is therefore required to better direct the system/hardware development and the implementation of the service, preferably in a single common band, which is now possible with the 1452-1492 MHz allocation. After considerable studies and discussions, taking into account the service requirements and applications of DAB, the interests of the public and broadcasters, as well as long-term impacts on the radio-frequency spectrum, it is believed in Canada that the optimum approach for the implementation of this service appears to be the mixed terrestrial/satellite service in the above band.

In regards to implementation timing, field tests and demonstrations of prototype DAB technology have been carried out in Europe, Canada and in the United States. Under test conditions, the Eureka-147 DAB (MUSICAM/COFDM) equipment demonstrated the feasibility and practicality of DAB in the VHF and UHF bands, including the 1400-1500 MHz range. Industry and public reaction to the trials in Canada and Europe has acknowledged the need, public interest, and demand for this new broadcast service.

The CCIR has already approved two similar draft Recommendations (one for BSS and the other for BS) specifying the technical and operational characteristics DAB systems should have. Three standardization processes are taking place almost simultaneously, internationally in the CCIR, at ETSI in Europe, and at the EIA in the U.S.A. It is expected that standard for a DAB system will be selected near the end of 1993 or early 1994.

In Canada, there are plans for experimental DAB stations operating in the new WARC-92 allocated band, in the 1992-1993 time frame. Service planning studies and frequency allotment exercises have started for both the terrestrial and satellite components of the DAB service. Frequency coordination with neighbouring countries and preparations for the WARC called by Resolution COM4/W will soon begin.

It is expected that the terrestrial DAB service will begin soon after 1995 if receivers are widely available, and the satellite DBS-DAB service could take form in the 2000-2005 time frame if not sooner.

3.2. Planning and Introduction of Terrestrial Digital Television

During the preparations leading to WARC-92 and at the Conference itself, the interest of the developed countries in

the potential benefits of new broadcasting technologies such as DAB was strongly manifested. Whereas DAB will enable the radio broadcasting industry to stay competitive and allow it to meet the needs of the consumer/public in the 21st century, a similar technology is also being developed for the television industry.

Developments towards an HDTV broadcasting service have occurred in the area of satellite broadcasting but also in North America in the area of terrestrial ATV. Digital processing and coding of images in general, have steered HDTV development in the direction of digitally-based systems.

There is now significant interest in Europe and in the United States for a terrestrial digital television broadcasting service which would have several of the benefits provided by DAB. The prime candidate frequency band for this future terrestrial digital TV broadcasting service (originally called ATV in North America) is the UHF-TV band (470-806 MHz). This band will therefore have to accommodate at some point in time both conventional TV as well as digital TV.

Now that a home outside the UHF-TV band has been found for DAB as a result of WARC-92, terrestrial digital television has a de-facto allocation in the UHF-TV band.

In regards to implementation timing, a standard is expected in the 1993-1994 time frame. Experimental stations could begin operation in 1995 or before.

3.3. Planning of Satellite Broadcasting of High-Definition Television

The WARC-92 allocation for BSS-HDTV provides Canada with increased flexibility for the implementation of broadcasting satellite service of HDTV. The 17.3-17.8 GHz allocation in Region 2 will accommodate the long term requirements (in 10 to 15 years) for the broadcasting of studio quality HDTV by satellite. In the short term, Canada has the option to use the 12 GHz either for conventional TV, narrowband HDTV or even wideband HDTV.

Studies are in progress in the CCIR towards standards for various applications of HDTV broadcasting. Once standards are selected, Canadian broadcasters will begin planning the development of the service in a manner that will best meet the future needs of the Canadian public.

4. Section 4: Transitions for Digital Audio Broadcasting

4.1. Technical Issues

Allotment Planning

Given that WARC-92 agreed to allocate, on a world-wide basis, the spectrum extending from 1452-1492 MHz, one of the key activities that has to be undertaken this year in Canada is the development of Digital Audio Allotment Plan.

As most are aware, the Canadian proposals in preparation for WARC-92 were predicated on a service model that afforded the broadcaster a maximum of service and implementation flexibility, the mixed terrestrial/satellite service model. The approach is based on both the terrestrial and satellite broadcasting Digital Audio services being implemented in the same spectrum, thus facilitating the use of single receivers, common coding and modulation standards and seamless service integration. However, this approach requires a sufficient amount of spectrum being allocated in order to be effective.

To this end, studies undertaken both during the course of the WARC and afterwards indicated that the 40 MHz allocation, although less than the Canadian proposal of 76 MHz, represented a sufficient "critical mass" of spectrum to permit the introduction of both services in Canada. Using the specific worst-case example of south-eastern Ontario, the most spectrum-congested area in Canada, all existing AM and FM assignments currently in operation could migrate to Digital Audio with sufficient capacity remaining to accommodate new service offerings. However, in the event the United States decides to implement Digital Radio services at the 1452-1492 MHz allocation sometime in the future, negotiations would have to be undertaken between Canada and the U.S. on a bilateral basis to extend the allocation below the lower 1452 MHz limit.

Having established the essential viability of the allocation under worst-case conditions, the next task to be addressed is the development of national allotment plan for Digital Radio services in Canada. This activity has been undertaken under the auspices of Canada's Joint Technical Committee for Advanced Broadcasting, or JTCAB, via its Frequency Allotment Planning Group. This Group, acting as industry consultants to the Department of Communications, is charged with the responsibility to develop allotment plans for both DAB and Advanced Television Services.

Such allotment planning must be based on system performance criteria, such as: required minimum service field strength; determination of signal availability as a function of both time and location; various station classes; receiver co-channel and adjacent channel performance; etc. A great deal of study and experimentation will be required to develop representative values for these factors that will contribute to the development of an efficient Digital Radio allotment plan.

Audio Source Coding and Channel Coding/Modulation Standards

The world-wide allocation for DAB facilitates the standardization of a common system standard for this service, including both audio source coding and channel coding/modulation schemes. Such system standardization would also provide obvious benefits to equipment manufacturers and the consuming public. The importance of the issue was recognized at the 1992 Seventh World Broadcasting Unions Conference in Mexico where a recommendation to strive for a common system standard was unanimously adopted. A special Ad-Hoc Inter-Union Working Group was established to work towards this objective.

In regards to international standardization activities, the only system that has been recognized to date as satisfying CCIR Study Group 10 and 11 requirements is the Eureka 147 system. Eureka 147 is composed of the world-wide ISO standard MUSICAM audio source coding and COFDM channel coding. Other competitive systems may be developed and tested during the course of the current CCIR study period, however a great deal of resources and effort will be required in the remaining timeframe to do so.

It should also be noted that the choice of an audio source coding standard has important ramifications in the areas of: ability to provide variable bit-rate service and variable quality levels; integration into leased networks; bandwidth-on-demand, etc.

4.2. Policy/Strategic Issues

Replacement Service

The CBC views DAB technology as a replacement service for conventional AM and FM broadcasting and not a third tier of service to the Canadian public. There are important policy and regulatory implications of this approach.

With increasing competition for audience share posed by such alternative technologies as compact disks, cable-delivered digital audio services and digital compact cassettes, DAB is essential for the long-term viability of the radio broadcasting industry in Canada.

The transition to digital service will be driven in large part by the availability and penetration of consumer receivers and by the financial resources required for implementation. This transition phase is expected to be protracted and will require extensive a priori planning and regulatory cooperation.

Ownership/Coverage

With its inherent system multiplexing capability, DAB has the potential to dramatically alter conventional broadcasting and distribution infrastructures, not the least of which are the issues of transmitter ownership and coverage areas.

Broadcasters will have to ascertain on a market-by-market basis whether there are strategic or technical advantages in owning the transmitting station and leasing spare capacity to other broadcasters or whether simply leasing is the more viable approach. These considerations will be complicated by the coverage afforded by the multiplexed station versus others which could potentially be available or constructed.

Other ownership-related factors to be assessed include:

- the possibility of establishing limited-partnership consortia with other broadcasters and interested parties in order to pool capital resources to build facilities;
- the degree of integration between the terrestrial and satellite broadcast services;
- the costs of maintaining older radio broadcast equipment and systems while new DAB systems are being introduced;

Satellite Issues

The next generation of Canadian satellites should be designed to accommodate broadcasters' planned DAB satellite services. This is particularly important given: the nature of the WARC-92 allocation, being co-primary for both Broadcasting and Broadcasting-Satellite Services; the geographic size of the Canadian landscape and location of smaller less-populated communities; and, the nature of the mandate of public broadcasters to service their audiences.

4.3. Regulatory Issues

DOC/CRTC

By far some of the greater impacts of DAB will not be felt by broadcasters or the listening public, but to the Canadian regulatory community.

The regulatory issues include:

- co-siting arrangements and ownership requirements;
- regulation of frequency and programme slot assignment;
- regulatory definition of market and coverage area, including the potential obligation to duplicate conventional AM and FM coverage;
- licensing requirements, including the requirement to develop new Broadcast Procedures and Rules;
- allowable AM/FM and DAB simulcasting period;
- programme content requirements;

4.4. Industrial/Economic Issues

Manufacturing Base

DAB offers unique opportunities for Canadian entrepreneurs and manufacturers who could offer licensed equipment and services for this new technology. This leadership will hopefully continue with the establishment of a Canadian manufacturing base for DAB-related equipment. These activities should be actively pursued by industry and supported by government initiatives.

Receiver Base Development

The key to the successful implementation of DAB at the new world-wide allocation lies in the availability of inexpensive receivers. It is essential to have a high penetration of receivers in Canada, and hopefully internationally, in order to assure the long term use of the band. Once a system standard is established, efforts should be made to have manufacturer produce Digital Radio receivers, either as stand-alone radio or in combination with AM, FM, CD and DCC units.

5. Section 5: Transitions for Terrestrial Digital Television or Advanced Television

5.1. Industry Standardization Activities

As most are aware, there has been a great deal of activity in the United States in recent years in the FCC Advisory Committee on Advanced Television, its sub-committees, working parties and associated testing laboratories in the development, testing and eventual selection of an advanced television (ATV) system standard.

There were numerous proponents that began this activity, but only five now that remain, namely: Zenith/AT&T; ATRC; GI; MIT/GI; and MUSE. The proponent testing activities that have been undertaken in the United States at the ATTC and in Canada at ATEL are scheduled to be completed in November, 1992. It is planned to have a special multi-party industry panel to decide on a final recommended system early in 1993, which will be subsequently field-tested. Assuming a satisfactory completion to this phase of the testing, a final decision on an ATV system standard is expected in mid-1993.

Canadian broadcasting industry representatives have been active in the American advisory committee activities since their inception and are expected to continue with these efforts. Final ATV system planning work, including allotment planning, is expected to coincide with the U.S. schedule of activities.

5.2. Regulatory Activities

The Federal Communications Commission (i.e. FCC) in the United States announced this year what is considered an ambitious transition plan from NTSC to ATV services for broadcasters in the United States. The basic tenets of the U.S. regulatory approach are:

- A block allotment of frequencies for ATV broadcasting will be made by the FCC. The initial eligibility for those ATV frequencies will be limited to existing broadcasters for a period of two years;
- A three-year deadline will be imposed by the FCC for the construction of an ATV facility by the ATV licensee.
- The FCC will allow others to apply for ATV licenses where opportunities for additional allotments can be found;

- The FCC has put the American broadcaster on notice that when ATV becomes the prevalent television broadcasting medium, the broadcaster will have to convert fully to ATV. This will involve the surrendering of one of two licenses (i.e. for NTSC service) and the cessation of NTSC broadcasting.
- As a preliminary schedule, the FCC has proposed an ATV conversion date of 15 years after either an ATV standard or a final Table of ATV Allotments is effective, whichever is later.

The various transition scenarios to ATV service in Canada are less defined. It can be estimated however, that the Department of Communications will consult with industry via the various government/industry advisory committees and Canada Gazette Notices to develop the most appropriate transition strategy for Canada. Given the current timetable of international events, the start of ATV broadcast experimentation could commence as early as 1995 in Canada.

6. Section 6: Conclusions

WARC-92 represents a watershed for the broadcasting industry internationally. With cooperation and shared objectives, the possibility now exists to move the industry forward, away from conventional analogue technologies and their well-known shortcomings. The need to implement a technology quickly has never been more urgent, than is the case with DAB.

In essence, WARC-92 puts into place the final piece of the puzzle in order for the broadcaster to move forward totally into the digital domain.

Acknowledgements

The author wishes to acknowledge the assistance provided by Mr. John C. Lee, Manager, Networks & Technology

and Mr. François Conway, Supervising Engineer both of Transmission and Distribution Department CBC for their assistance in preparing this paper.

References

- [1] "Digital Sound Broadcasting, Systems Concepts", CCIR Joint Interim Working Party 10-11/1, Canadian Contribution Document 042, Sydney, Australia, November, 1990
- [2] Conway, F., 1992, "Frequency Allocations Options for Digital Radio Broadcasting", IBC 1992 Conference Proceedings, Amsterdam, Netherlands.

SESSION 2

**TRANSITION, INTERNATIONAL PERSPECTIVES
AND A WIRELESS SOCIETY**

SÉANCE 2

**TRANSITION: LA FUTURE "SOCIÉTÉ SANS FIL"
VUE DE DIFFERENTS PAYS**

ABSTRACT

Restructuring of ITU Including VGE Recommendations

By

GARY C. BROOKS
International Telecommunications Union

This paper covers the present organization functions of the ITU. It then goes on to describe the decisions of the Nice Plenipotentiary Conference to establish a High Level Committee to review the structure and functioning if the ITU and the changes being proposed with a general view of the overall structure and particular emphasis on the radio communications functions including the present CCIR and IFRB activities. The paper also discusses the present approach to World Administrative Radio Conferences and what the High Level Committee is recommending for their future. In addition, it describes the current activities in the ITU relating to the simplification of the ITU's Radio Regulations resulting from a decision of the Nice Plenipotentiary Conference to establish a Voluntary Group of Experts (VGE). The VGE will have just finished its 4th meeting the day before the start of the Spectrum 20/20 Symposium, and an update of its decisions will be given. The decisions of the ITU Administrative Council relating to the conversion of the report of the VGE to a set of new proposed regulations are also explained. Lastly, a few comments are provided on some of the problems facing the ITU in the future.

RÉSUMÉ

«Restructuration de l'UIT, y compris les recommandations du GEV»

Par

GARY C. BROOKS
Union internationales des télécommunications

Cette communication porte sur les fonctions d'organisation actuelles de l'UIT. L'auteur y décrit les décisions de la Conférence plénipotentiare de Nice d'établir un comité de haut niveau et de charger celui-ci d'examiner la structure de l'UIT et son fonctionnement ainsi que les changements proposés; ainsi, il étudiera la structure générale de l'UIT, notamment ses fonctions qui touchent les communications radio, en particulier celles du CCIR et de l'IFRB. L'auteur se penche aussi sur l'organisation actuelle des Conférences administratives mondiales des radiocommunications et sur les recommandations avancées à ce sujet par le Comité de haut niveau. En outre, il décrit les démarches entreprises par l'UIT en vue de simplifier son règlement sur les radiocommunications, à la suite de la décision la Conférence plénipotentiare de Nice de créer un groupe d'experts volontaires (GEV). L'auteur fait le point sur les travaux de ce groupe, qui aura tenu sa quatrième réunion la veille du début de Spectre 20/20 1992. Il explique aussi les décisions du conseil d'administration de l'UIT concernant la façon de transformer les recommandations du GEV en un nouveau règlement. Enfin, l'auteur présente quelques observations sur certaines des difficultés qui guettent l'UIT.

RESTRUCTURING OF ITU AND INCLUDING VGE RECOMMENDATIONS

Gary C. Brooks

1. BACKGROUND

The ITU is an intergovernmental organization and is the UN agency responsible for telecommunication matters. Up until recent years there has been no major problems with this conceptual approach as the major users of spectrum and providers of telecommunication services were the governmental PTTs (there were some exceptions - primarily in North America). Today, however, that is changing very quickly. Many of the European PTTs have now separated the regulatory from the operational aspects, and in many cases there has been privatization of the operating agency. The second major change in the environment, which is related to the first, is that with the quickly changing technology, there is a need for more timely response to the need of new standards. This has resulted in the establishment by the Europeans of their regional standards organization ETSI, which, with its working methods, is able to respond very quickly to the need for new standards. This type of organization is to some degree a competitor of the ITU, but working in a commercial/industry field rather than the more bureaucratic intergovernmental field.

At the Nice Plenipotentiary Conference in 1989, there were a number of proposals (mainly from developing countries) to change the structure of the ITU. These proposals were very diverse in scope, but seemed to be based on the premise that this type of restructuring could lead to some economies in the work of the ITU. In addition, the period preceding the Nice Plenipotentiary Conference had seen a very large programme of WARC conference in which considerable changes had been made to the Radio Regulations, resulting in a more general acceptance of the need for drastic simplification in the Radio Regulations. The Nice Plenipotentiary Conference took, among its many decisions, two decisions which will have a significant impact on the long term approach to radio communications by the ITU. These two decisions are the following:

- to establish a High Level Committee (HLC) within the ITU to review the structure and functioning of the ITU;
- to establish a Voluntary Group of Experts (VGE) to review the Radio Regulations with the view of making recommendations on their simplification.

Both of these decisions were acted upon by the ITU Administrative Council and the two groups were set up.

2. PRESENT ITU STRUCTURE

The present ITU structure is as follows:

- a) the International Telegraph and Telephone Consultative Committee (CCITT) which prepares recommendations on telecommunication service matters;
- b) the International Radio Consultative Committee (CCIR) which prepares reports and recommendations on radio matters;
- c) the Telecommunications Development Bureau (BDT) which is responsible for coordinating all ITU telecommunication development activities;
- d) the International Frequency Registration Board (IFRB) which is responsible for overseeing the implementation of various international and regional treaties on the use of the radio frequency spectrum;
- e) the General Secretariat which is responsible for administrative support (personnel, finance, computer, etc.) to the main functions of the ITU.

3. STRUCTURE AND FUNCTIONING OF THE ITU

3.1 High Level Committee (HLC)

The HLC was set up at a special meeting of the Administrative Council in 1989 and consisted of 21 named experts from administrations. It was chaired by Mr. Gaby Warren of Canada and it held 5 meetings between January 1990 and April 1991. Its Final Report "Tomorrows ITU: The Challenges of Change" was issued in April 1991 and was considered by the 1991 session of the ITU Administrative Council. Council decided to recommend to the Member administrations of the ITU that a special Additional Plenipotentiary Conference (APP) be held in December 1992 to consider the report of the HLC. The 1991 session of Council also established a drafting group to convert the HLC recommendations into the necessary regulatory text of the revised Constitution and Convention of the ITU for consideration at the APP.

3.2. HLC Recommendations

There were a number of recommendations of a general nature relating to the role and functions of the ITU, however the major essence of these recommendations is that the role and mandate of

the ITU does not need changing, but what is necessary is many changes to the ITU structure and its functioning.

3.3 ITU Restructuring

The report of the HLC has now been issued and it will be considered at a special Additional Plenipotentiary Conference this December. From the structural point of view, the HLC has recommended that the activities of the ITU be grouped into three sectors: Standardization, Radiocommunications and Development. The Standardization Sector will be effectively the existing CCITT plus some network related activities of the CCIR. The Development Sector will be the present Telecommunications Development Bureau, and the Radiocommunications Sector will be the merging of the bulk of the CCIR activities with the activities of the IFRB. The Study Group activities of the CCIR will be grouped with the regulatory activities of the IFRB with the new Radiocommunication Conference being the merging of the WARC and the CCIR Plenary Assembly.

3.4 New Radiocommunication Sector of the ITU

As you are mainly interested in the Radiocommunication Sector, I will elaborate a little in that area. With the Recommendations of HLC, the new Radiocommunications Sector will consist of the following:

- a Radiocommunication Conference - comprising the present CCIR Plenary Assembly activities and the WARC activities meeting normally every two years with 2 major committees, the Regulatory Committee and the Technical Committee which will deal with the former CCIR Plenary Assembly issues;
- a 9 member part-time Radio Regulatory Board to replace the present full-time 5 member Board of the IFRB. This part-time Board will continue to perform the interpretative functions for which a collegiate body is necessary and will meet, at least initially, about 3-4 times a year;
- the study group structure will continue its work much as the present CCIR study groups, except it will have added to its tasks the study of regulatory issues in its preparation for conferences;
- and lastly, the secretariats of the CCIR and IFRB will be merged under one elected director. This director, with the secretariat, will be charged with carrying out the normal tasks of the present IFRB which do not require any new interpretations and he will issue the findings on behalf of the new Board. This secretariat will also continue with the functions of the present CCIR secretariat.

3.5 Need for Changes

One might ask why is there a need to change the present functioning of the ITU? With respect to the Radiocommunication Conferences, there has been a series of large and important WARCs since 1979, each one having a limited and specific agenda. The present ITU approach to holding conferences/meetings on radiocommunication matters consists of two parallel streams of meetings.

The first stream is the CCIR meetings which, as you are aware, consists of the various study groups and their task groups meeting over a four year period. Every four years the CCIR Plenary Assembly is held, which reviews the work programme and structure of the CCIR and used to approve all Recommendations. The last Plenary Assembly also adopted the accelerated process for approving Recommendations.

The second stream of conferences are those of a treaty-making nature called World Administrative Radio Conferences - WARC for short. The ITU approach that has been followed since 1959 has been to hold a general WARC about every 20 years which would consider any matter in the Radio Regulations. The previous two general WARCs were in 1959 and 1979. In between these general WARCs a number of specialized WARCs have been held. These specialized WARCs also had the authority to modify the Radio Regulations, but in a restricted sphere. There were space conferences in 1963, 1971, 1977, 1985 and 1988. There were mobile conferences in 1974, 1978, 1983, and 1987. There were also other specialized conferences with the last WARC in Spain having some mobile issues as well as some broadcasting issues, plus a few other limited issues.

What has been the problem with the present approach to holding WARCs? With the specialized WARC, the agenda has to be approved by the Administrative Council and the Member administrations about 2-3 years before the conference. For the preparation of conferences a period of this length is necessary, however, an issue that is on the agenda of one conference could not be expected to be covered by another conference for at least 4-6 years, and many would say that in the fast developing field of telecommunications, this is not able to adequately respond to the changing needs. During the period since 1979, we have had an average of one conference per year with two conferences in some years such as 1987. Therefore, it has been impossible to quickly schedule a conference to deal with an urgent matter. Perhaps it is due to the knowledge that, if a conference does not take a decision on any item, the next opportunity to have this on a conference agenda may not be for 4-6 years, which leads to our decisions being taken in the middle of

the night, under far from optimum conditions. If it was known that a particular decision could be deferred for two years, to allow more study, more opportunity to reach a consensus, maybe, we would not have had such hurried decisions.

Another aspect of the present conference, and the recent WARC is a good example, is that a number of issues had been waiting for some time for a conference and these were all put on the agenda of the WARC-92. This resulted in many very controversial topics all being discussed at the same time and all being considered for inclusion in a package deal - a multi-dimensional package.

With respect to the IFRB, more and more of its work, particularly its findings on notices submitted by administrations, is being automated with there being less and less a need for interpretive decisions that require a collegial body for such decisions. It was decided by the HLC that the objective of having the interpretive decisions being made by a collegial body could be maintained, if the Board was converted into a part-time Board meeting about 4 times a year.

An example of the perception of need for change is in a recent paper by Ivor N. Knight of Comsat in "Telecommunications Policy" (May/June 1992 issue) in which he stated "The bottom line here is that 12 years will have elapsed since the first warning signs of structural instability in the ITU process were detected by the CCITT until the implementation of corrective reorganization." and "Maybe the ideal solution to the development of standards for the telecommunications business is through an international organization. But the fact of the matter is that the present process results in too little too late."

4. SIMPLIFICATION OF THE RADIO REGULATIONS

4.1 Present Radio Regulations

The present Radio Regulations consist of 3 volumes (about 10cm) of text of a treaty nature. The major elements of the Radio Regulations are as follows:

- a) The Table of Frequency Allocations in which individual bands of frequencies are allocated to one or more of the 40-plus different radio services. There are so many different services now with the distinction between some services being very hazy with today's technology.
- b) Many different sets of administrative procedures dealing with the notification to the IFRB and recording by the IFRB

of frequency usage. As an example there are 6 distinctly separate procedures for space networks - each of the procedures being very similar in concept but different in detail and very detailed:

- Art11/13 -most space networks
- App.30 -broadcasting satellite service 12 GHz
- App.30A -feeder links for 12 GHz broadcasting satellite service
- App.30B -some fixed satellite bands
- Res.33 -all broadcasting satellite services not covered by App.30
- Res.46 -some mobile satellite bands and other services sharing these bands.

- c) Technical limits and technical calculation methods. These are normally developed first in the CCIR and subsequently adopted by a WARC (often with changes) and incorporated in the Radio Regulations. These technical decisions then have treaty status and can only be changed by another WARC (perhaps 5-10 years). This leads to a very inflexible and slow process in keeping with technology. An example of this is the 1977 Plan for broadcasting satellite service which was based on technology of the 1976/77 period and these technical criteria are still the only valid criteria for use in the administration of that Plan, in spite of the significant changes in technology since 1977.
- d) There are over 500 footnotes to the Table of Frequency Allocations which provide additional or alternative allocation for individual countries or groups of countries, or specifies conditions on the use of the frequencies.
- e) Many operational issues such as operator certificates.

4.2 Voluntary Group of Experts (VGE)

As mentioned previously the ITU Administrative Council established a Voluntary Group of Experts (VGE) to consider various possibilities for the simplification of the Radio Regulations. The VGE has had 3 meetings with the 4th meeting scheduled for September 1992, and a fifth meeting scheduled for February 1993.

The VGE decided early on to prepare a questionnaire to administrations on various aspects of the Radio Regulations. The VGE also decided to structure its work into 3 tasks:

Task 1 matters relating to the allocation of frequency bands

Task 2 procedural matters relating to the use of the frequency assignments

Task 3 operational and administrative provisions.

The VGE questionnaire contained 21 questions on Task 1, 69 questions on Task 2 and 17 questions on Task 3. Many administrations plus staff and elected officials of the ITU responded either specifically or more generally to the questionnaire. The VGE has analysed the replies and as a result of their discussions, has arrived at the following 4 basic guidelines:

a) Everything done in relation to simplification of the Radio Regulations must be in conformity with the Convention (or the new Constitution and Convention).

b) The Radio Regulations, after they have been simplified, should contain only that material appropriate for inclusion in an international treaty, i.e., material relating to the rights and obligations of administrations bound by the treaty. By inference all other material should either be transferred elsewhere or cancelled.

c) For the material to be transferred, the Technical Standards and Rules of Procedures of the IFRB or the Recommendations of the CCIR might be appropriate. Additionally, transfer to either ICAO or IMO or other inter-governmental organizations might (with caution) be considered.

d) For the purposes of simplification of the Radio Regulations, it would be useful to consider them as the primary document, with support being provided in secondary documentation. For the latter, there must be a procedural mechanism to ensure that administrations have the opportunity to consider and express their approval before such documents are adopted, extended or modified in substance affecting the administrations' rights and obligations.

In addition, the VGE has adopted guidelines for each of the 3 tasks. As an example with respect to the allocation of frequency bands, the VGE has proposed the following 3 guidelines:

a) The work of the VGE should facilitate the utilization of the radio frequency spectrum in order that administrations may

better meet the needs of users. This should include:

- improving the flexibility of the Table of Frequency Allocations;
- maintaining, in general, the ability of administrations to utilize the present allocations in the Table, and;
- enhancing the options available to administrations in their national spectrum management in so far as usage of the allocations is concerned;
- balancing the increased allocation freedom given to administrations with their increased responsibility to recognize the rights of other administrations.

b) Several mergers of existing radiocommunication services in the Table of Frequency Allocations are preferred over alternative allocation methods, but there seems to be scope for the application of the "Technical Rules" approach in conjunction with the "merged services" approach in some areas of the spectrum.

c) An ultimate objective of a number of families of services, possibly five to seven, was foreseen, but this could only be achieved progressively. The initial reduction to something just under twenty is seen as broadly acceptable as a first step. The families chosen should provide for further changes to be considered for adoption in the future.

4.3 Future Activities of the VGE

The 5th and 6th meetings of the VGE will finalize its recommendations and adopt its Final Report which will be submitted to the 1993 session of the ITU Administrative Council (June 1993). In addition, the 1992 session of Administrative Council agreed with the establishment of a drafting group to convert the VGE recommendations/guidelines into specific and detailed text of the revised Radio Regulations which would be submitted to an appropriate Radio Conference for adoption. The plan of the VGE is that this drafting group, which will consist of a small number of volunteers from administrations, will start work after the September 1992 meeting of the VGE and would require up to 1 year full-time to draft the necessary text. This text of a revised Radio Regulations would be completed by September 1993 and would be submitted to a Radio Conference in 1995 for adoption.

5. GENERAL OBSERVATIONS ON THE FUTURE OF THE ITU

One of the major challenges facing the ITU is its ability to interact on an effective basis with the private sector and react quickly to the rapidly changing environment. The HLC recommendations are intended to allow the ITU to move positively in that direction, however the ITU will continue to be an intergovernmental organization of 170-plus countries working in 6 languages. Therefore, it will be difficult for the ITU to respond as quickly as the regional organizations, such as ETSI. In addition, once ETSI has agreed to a standard (30-plus countries) the broader ITU forum will have great difficulty in having ETSI agree to change.

The second major challenge is to administrations in the simplification of the Radio Regulations. The VGE is coming up with many very good guidelines, but each of these guidelines will be faced with many practical reasons why it cannot be implemented. Traditionally administrations are very conservative at Radio Conferences. An example of this was the idea of using a generic service allocation (mobile satellite) instead of the more specific land, maritime and aeronautical sub-services. A number of proposals of this type were made to the WARC-92 at Torremolinos, and they generated much opposition.

ABSTRACT

Future Directions and Deregulation of Spectrum Management in Japan

By

**YOSHIHIRO ISHIDA
Ministry of Posts and Telecommunications**

WARC '92 made it possible to introduce new technologies and services even though some restrictions are imposed on their introduction. Most of these technologies and services require an orderly and harmonized introduction all over the world. On the other hand, the result of WARC '92 shows that the spectrum utilization in each country is expanding at a different pace and for different services. Newly introduced service must be well coordinated in different regions and countries.

The ITU is trying to change its organization structure to cope with technology development, and the VGE is tackling with the simplification of the RR. Those activities might help to facilitate the introduction of new technology and services while allowing diversified use of spectrum in response to different demands in each country. It is most important to exchange views among countries as often as possible and coordinate each country's spectrum policies.

We should start talking about the issues such as the introduction of FPLMTS, frequency allocation for the post FPLMTS mobile system, operational aspect of mobile satellites, frequency allocation and regulatory matters for multi-function satellites, and a plan for digital broadcasting satellite, etc.

As to deregulation, some international organizations have considered the issue. We should review and identify what should be regulated in international radio society through the activities in those organizations.

RÉSUMÉ

Déréglementation de la Gestion du Spectre et Orientations Futures au Japon

Par

YOSHIHIRO ISHIDA
Ministère des postes et des télécommunications

CAMR-92 a autorisé le lancement de certains services et technologies, même si quelques restrictions ont été imposées. Le lancement de la plupart de ces services exige des mesures de coordination et d'harmonisation à l'échelle planétaire.

Par contre, CAMR-92 a révélé que le rythme de croissance de l'utilisation du spectre et les services où cette croissance se manifeste varient d'un pays à l'autre. Il y a donc lieu de coordonner de près le lancement de nouveaux services par rapport à ceux qui existent déjà dans différents pays et régions.

L'UIT tente actuellement de modifier sa structure pour pouvoir composer avec l'évolution de la technologie, tandis que le Groupe d'experts volontaires s'attaque à la simplification du Règlement des radiocommunications. Ces activités faciliteront peut-être le lancement de nouvelles technologies et de nouveaux services tout en permettant des diverses utilisations du spectre à la demande de différents pays. Il est de la plus haute importance que les pays s'informent les uns les autres de leurs positions le plus souvent possible et coordonnent entre eux leurs politiques relatives au spectre.

Nous devrions commencer à discuter de certains dossiers : le futur système mobile terrestre public de télécommunications, l'allocation de fréquences pour la période subséquente, les dimensions opérationnelles des satellites des services mobiles, l'allocation de fréquences et les questions de réglementation touchant les satellites multifonction, la planification préliminaire d'un satellite de radiodiffusion numérique, etc.

Certaines organisations internationales ont déjà étudié le dossier de la déréglementation. Il faudrait examiner et cerner les domaines qui devraient être réglementés par l'intermédiaire de ces organisations.

FUTURE DIRECTIONS AND DEREGULATION OF
SPECTRUM MANAGEMENT IN JAPAN

Yoshihiro Ishida

INTRODUCTION

It is my great pleasure to have the opportunity to make a presentation on future direction and deregulation of spectrum management when we are about take a new step to the 21st century in response to the result of WARC-92. In this rapidly changing environment, however, it is very difficult to predict the future of radio telecommunication, it is even more difficult for the government to make official predictions. Here, I would like to tackle the topic not as a representative of Japanese government but as a private individual deals with spectrum management policy.

Thus, in my remarks here, I would like to discuss firstly, two contradicted trends of spectrum use which are observed in WARC-92 and necessity of mid- and long-term planning and establishment consensus among countries to harmonize these two trends in one allocation table. Secondly, I would like to introduce my thoughts on mid-and long-term plan based on recent development in radio telecommunication in my country. Third, and finally I will briefly touch on the current movement of deregulation and illustrate items to be discussed in the international community.

TRENDS IN WARC-92

Introduction of New Technology and Service

WARC-92 made it possible to introduce new technologies and services even though some restrictions were imposed on their introduction. Most of those technologies and services require orderly and harmonized introduction all over the world.

In order to achieve orderly and harmonized introduction of those services it is necessary to make a standard, formulate an international frequency allocation plan, and coordinate frequency assignment internationally, as we used to do. For example, an international standard for FPLMTS will be made in CCIR and we must further coordinate international spectrum policy to make specific allocation in the bands designated for FPLMTS in WARC-92 in order to facilitate standardization activities. An International plan

will be necessary for broadcasting satellite services and it is a challenge to formulate a flexible plan to accommodate technology development. In WARC-92 studies to permit the establishment of a standard for the operation of low-orbit satellite system were resolved. ITU is also expected to act positively in this field.

Diversity of Spectrum Use

On the other hand of the necessity of international standard the result of WARC-92 also shows that the spectrum utilization in each country is expanding at a different pace and in different services. And there are various requests to newly introduced services. Therefore they must be well coordinated with present services in different regions and countries.

For example demand for FPLMTS is not uniform around the world. We must pay attention to the fact that there are some countries which continuously need the fixed services and there are various types of suitable mobile systems depending on natural and economical environment of the countries. We also have to study the roles of the mobile service and the mobile satellite services considering density of population. There is also varied demand in the sound broadcasting satellite. Some countries see it as substitute for the compact disc player in automobiles and some see it as a means to ease congestion in HFBC or to expand the coverage of MFBC. In order to respond to the various uses of spectrum it is necessary to allow co-existence of the different systems and to promote sharing frequency among them. It is very important to establish sharing criteria in the CCIR and to adopt spectrum efficient technology suitable for actual demand in the region.

New ITU structure and necessity of International Coordination

The ITU is trying to change its organization at structure to cope with technological development and the VGE is trying the simplification of the RR. Those activities might help to facilitate the introduction of new technology and services while allowing diversified use of spectrum in response to the different demands of each country. It is most important to exchange views among countries as often as possible and to coordinate their spectrum policies.

WRC in every two years will help the Radio Regulation catch up with the rapid development of technology, and will also help countries exchange their views more often. Close contact and discussion among policy makers and system developers in the new

Radio sector will facilitate internationally harmonized introduction of new technology, frequency allocation to new services, establishment of frequency coordination procedure and sharing criteria, and standardization of system. The simplified Radio Regulation by the VGE will accommodate diversified spectrum use. When we promote WARC activities and ITU re-structure, we have to bear in mind, however, that such a new system can only work under the spirit of cooperation which allow the existence of various revels of demand in different parts of the world.

FUTURE DIRECTIONS OF SPECTRUM USE

Mobile Service

230MHz was designated for FPLMTS by the WARC-92 but we do not know which part of the spectrum will be transferred from fixed service to FPLMTS and when it will be done. The situation will be varied among nations. We must take this into account in making a standard for FPLMTS.

In Japan, up until the year 2010 the fixed service will remain in the frequency band 1885 to 2025MHz except in a small portion of the band. In many other countries, on the other hand, the frequency band 2110 to 2200MHz seems to be difficult to clear for FPLMTS.

The bands 1980-2010MHz and 2170-2200MHz are designated for the satellite FPLMTS. Therefore, a two way TDMA using 1920-2010MHz and 2110-2200MHz might be the most suitable system for FPLMTS. This is one of the many possibilities.

The most important thing is to start discussion as soon as possible on a long term frequency plan for FPLMTS among countries which have plans to introduce it at an early stage.

ISDN networks are expanding in many countries while targets of FPLMTS are mainly telephone and low speed data. As mobile systems must support ISDN in the future, post-FPLMTS can be foreseen above 3GHz. In Japan, we will start propagation experiments next year. We are considering 4 and 6GHz bands for the experiment but 3300-3400MHz is also a good candidate because this band is allocated to the mobile service by footnote 779 in Asian countries and there is not much difficulty in transferring the existing stations in the band.

Mobile Satellite Service

At WARC-92 many frequency allocations to the mobile satellite services were achieved. However, some countries still express that allocations are not enough. As the mobile satellite services affect many services using same frequency band, we should start exchanging ideas well in advance if further allocation to the mobile satellite service is to be discussed in the future WARC. In that case, considering that it is extremely difficult to allocate new bands under 3GHz, I propose that we change some of the allocations to the fixed satellite services above 3GHz to allocations to the mobile satellite service in a long transition period. In this case we should discuss whether we go further to Ka or O band for mobile satellite or change a part of allocations to the fixed satellite service in C band to mobile satellite.

Multi-function Satellite System

The demand for the mobility of small VSAT will emerge strongly in the near future. The handling of this kind of new system in the Radio Regulation should be discussed. Adding a new definition is one way but removing unnecessary regulation in the mobile satellite service is also a possible solution.

Ka band is a good candidate for this kind of new satellite communication. However, as C band and Ka band have been already packed with the fixed satellite service, we should evaluate demand for the conventional fixed satellite service carefully before introducing a new system in this band. In Japan we use Ka band intensively for the fixed satellite service. Therefore, we are developing technology for new satellite services in O band. Various experiments are scheduled using ETS-VI satellite to be launched in 1994 and COMETS to be launched in 1997.

Broadcasting Satellite Service

First of all, I would like to express my admiration of the Canadian effort to lead development of sound broadcasting satellite and to say that I expect fruitful results from it. We wish that efforts, to reduce power flux density of satellite by improving side-lobe of satellite antenna and the performance of receivers, will be made in order to reduce harmful interference to neighboring countries, bearing in mind the difficult discussion in WARC-92.

In Japan we are planning to launch an experimental satellite for sound broadcasting in 2.5GHz band at the end of this century and we hope that a practical satellite will be launched at the beginning of the next century.

As for TV satellite broadcasting, we will launch BS-4 satellite in 1997 and use up 8 channels in 12GHz band which are allotted to Japan in WARC-ORB-77. At present transmission characteristics and broadcasters are under consideration. MUSE system is the strongest candidate for HDTV. There are many broadcasters who wish to enter the satellite broadcasting business and additional allotment will be required after BS-4 when a future conference revises the plan in 12GHz band.

Digital transmission experiments of W-HDTV are now conducted using 60MHz transponder in BS-3 satellite. In 21GHz band we are planning to conduct an experiment using 200W TWT of COMETS satellite in 1997.

In Japan, many people are now interested in UDTV which has higher resolution than HDTV and 3-dimensional TV. When we revise or make a plan in future, we should make it flexible enough to accommodate these new technologies.

Deregulation of International Spectrum Management

Deregulation in the telecommunications field has been taking place around the world since the 1980's, and is also being considered by many countries and international organizations.

There are two main points about deregulation in connection with radio wave utilization. One is about the service supply in the mobile and satellite telecommunications, and the other is the method of frequency spectrum use.

The former point of deregulation will proceed gradually as follows.

(1) Introduction of competition policy

It has been already adopted in many countries, and it is causing a rapid increase in demand of frequency spectrum and satellite orbit.

(2) Open door policy of capitals for foreigner

This policy has been adopted in many countries, and it is useful in popularizing telecommunication systems rapidly.

(3) Supply of separate systems in satellite telecommunications

The approval procedure to separate systems in INTELSAT and INMARSAT has been released. These systems will be operated gradually under the laws and regulations of each individual country.

(4) Beyond the boundary use of land mobile telecommunications terminals or land earth stations

This use is required by INMARSAT and broadcasting companies and is the assumption of FPLMTS system.

In order to realize this, it will be necessary to release the exclusive limitation to the foreigner about getting the radio station licenses and operating radio stations by international cross approval of the license.

However, as it makes possible international tele-communication without using national telecommunication networks using the method of deregulation indicated in (3) and (4). Therefore administrations may have to examine advisability in view of telecommunications sovereignty.

Concerning about the latter, it requires the deregulation which will enable to determine the use of frequency spectrum according to demands already noted in this paper, in order to expand discretion of the each administration. VGE makes an effort to integrate several services used in the frequency allocation table in the Radio Regulations. This effort will achieve above deregulation under the condition with development of frequency sharing technologies and frequency coordination procedure.

CONCLUSION

According to diversity and improvement in quality using digital technologies, demand for telecommunications will increase accelerately. However we have to recognize that its expansion is different in each country or society. It is necessary to construct an efficient order by standardization and planning in telecommunication field. And on the other hand, it is also necessary to permit a flexible coexistence between different systems. It is important for countries to exchange each opinions at an early stage.

I think this is a really timely seminar, and I express my thanks to the Department of Communications of Canada and Radio Advisory Board of Canada for allowing me the opportunity to speak at this symposium.

AUTHORS ADDRESS (OFFICE)

Ministry of Posts and Telecommunications
1-3-2, Kasumigaseki
Chiyoda-ku, Tokyo
100-90 JAPAN
TEL +81-3-3504-4842
FAX +81-3-3580-5754

RÉSUMÉ

La Diffusion Numérique de Terre des Signaux Audiovisuels

Par

**BERTRAND SUEUR, DAMIEN CASTELAIN, GABRIEL DEGOULET,
MARC RIVIÈRE, BERNARD LE FLOCH
CCETT (Centre Commun d'Études de Télédiffusion et
Télécommunications)**

La diffusion hertzienne terrestre se heurte à la présence d'échos naturels, dus au phénomène de propagation par trajets multiples, et à la saturation de la ressource spectrale.

Ces deux difficultés majeures - la qualité intrinsèque du signal et la planification des fréquences, sont souvent considérées comme indépendantes. Pourtant, les interférences provoquées par les émetteurs distants diffusant le même programme que l'émetteur local doivent être considérées comme des échos artificiels, si bien qu'en réalité les deux problèmes évoqués ci-dessus se confondent.

Les potentialités d'un nouveau système ne dépendront donc que de la stratégie adoptée vis-à-vis des échos, qu'ils soient naturels ou artificiels: si la solution est traditionnelle - les éliminer au maximum, un système même numérique n'apportera que peu d'avantages; si par contre la gestion des échos est innovante, et tire parti du caractère numérique du signal pour les exploiter systématiquement au lieu d'en souffrir, alors seulement les perspectives ouvertes par l'introduction d'un système numérique deviennent révolutionnaires.

L'article qui suit rappelle les principes de la modulation multiporteuses COFDM développée en ce sens au CCETT, expose ses avantages, et insiste sur ses conséquences bénéfiques sur l'économie et l'ingénierie des réseaux de diffusion terrestre.

ABSTRACT

Terrestrial Digital Transmission of Audio-Visual Signals

By

**BERTRAND SUEUR, DAMIEN CASTELAIN, GABRIEL DEGOULET,
MARC RIVIÈRE, BERNARD LE FLOCH
CCETT (Centre Commun d'Études de Télédiffusion et
Télécommunications)**

Terrestrial broadcasting is hampered by the presence of natural echos produced by multipath propagation and spectrum saturation.

These two major problems related to the intrinsic quality of the signal and frequency planning are often considered independent. However, interference caused by distant transmitters broadcasting the same program as a local transmitter must be considered a problem of artifical echos. In fact, in reality, these two problems merge.

The potential of a new system will therefore depend only on the strategy adopted with respect to echos, be they natural or artifical. If the solution is traditional (eliminating them as much as possible), even a digital system will have few advantages. Only if echo management is innovative and takes advantage of the digital nature of the signal to use the echos systematically, rather than be adversely affected by them, will the introduction of a digital system have the potential to make a real difference.

The following article recalls the COFDM multicarrier modulation principles developed in this respect at CCETT, describes the advantages of such modulation and emphasizes its beneficial effects on the economy and the engineering of terrestrial broadcasting networks.

La diffusion numérique de terre des signaux audiovisuels :

B. SUEUR, D. CASTELAIN, G. DEGOULET, M. RIVIERE, B. LE FLOCH

1. QUEL SERAIT UN SYSTÈME IDÉAL ?

1.1. Les limitations des systèmes analogiques d'aujourd'hui

1.1.1. La qualité intrinsèque

La transmission analogique des signaux audiovisuels est principalement affectée par les bruits thermique et industriel ("neige" sur les images, et "souffle" sur le son) et par les accidents de propagation des ondes électromagnétiques -réflexions, diffraction- matérialisés par des images "fantômes" superposées à l'image principale, ou par une qualité sonore fluctuante selon l'environnement du récepteur.

1.1.2. Des services insuffisants

La non-flexibilité de la qualité des signaux analogiques gêne le développement de services plus exigeants (par exemple la TV haute définition) ou au contraire plus frustes (un son monophonique de qualité sommaire suffirait pour la diffusion d'informations routières par exemple).

Parallèlement, l'encombrement du spectre hertzien est un obstacle considérable à l'introduction de nouveaux services, tandis que leur viabilité économique est freinée par la difficulté de définir une méthode d'embrouillage complètement transparente vis-à-vis de la qualité du signal analogique désembrouillé.

D'autre part, les services de radiodiffusion sonore n'ont résolu qu'approximativement le problème de l'accord du récepteur mobile au fur et à mesure de son déplacement dans des zones couvertes par des émetteurs fonctionnant à des fréquences différentes. Quant à la télévision, elle n'a pas su se libérer de la nécessité d'être raccordée à une antenne fixe, ignorant d'un même coup la spécificité de la diffusion hertzienne et le confort domestique qu'apporterait un récepteur autonome.

1.1.3. Une ingénierie coûteuse

L'impossibilité de contourner le problème des interférences co-canal autrement qu'en interdisant le réemploi d'un même canal jusqu'à des distances considérables -quelques centaines de km- de la zone de service, conduit à une planification de fréquences extrêmement peu efficace, (voir figure 13a) puisque dans les schémas classiques dits à 9 fréquences, chacune d'elles est interdite sur environ 89 % du territoire !

De plus, la faible immunité aux bruits des signaux analogiques exigeant des puissances émises considérables, ajoutée aux omniprésents problèmes de masquages nécessitant autant de réémetteurs, induisent une infrastructure de diffusion extrêmement coûteuse.

1.2. Le cahier des charges d'un système idéal

Bien sûr, un nouveau système devrait effacer toutes les limitations des systèmes conventionnels listées au paragraphe précédent ! En d'autres termes, son efficacité spectrale, et son efficacité en puissance devront être excellentes, comme sa capacité à s'accommoder des échos et donc de toutes les formes de distorsions linéaires, même variables dans le temps.

Surtout, ce nouveau système devra pouvoir être introduit dans le contexte analogique actuel.

Enfin, n'oublions pas que les critères économiques, et notamment le coût du récepteur, restent déterminants dans l'acceptabilité de tout nouveau système grand-public.

2. COMMENT TROUVER CE SYSTÈME IDÉAL ?

2.1. L'attitude de principe vis-à-vis des échos

Les deux difficultés majeures de la diffusion terrestre -la qualité intrinsèque de signal, et la planification des fréquences-, sont souvent considérées comme indépendants. Pourtant, les interférences provoquées par les émetteurs distants diffusant le même programme que l'émetteur local, peuvent être considérées comme des échos artificiels, si bien qu'en réalité les deux problèmes essentiels évoqués ci-dessus se confondent. *Dans ces conditions, on comprend que les potentialités d'un système dépendent essentiellement de sa stratégie vis-à-vis des échos !* Les systèmes analogiques traditionnels se contentent d'ignorer le problème ; les systèmes numériques conventionnels -du type monoporteuse avec égaliseur- essaient d'éliminer les échos, ce qui garantit une bonne qualité intrinsèque de la réception dans un grand nombre de cas -à condition cependant que la réception soit fixe- mais n'apporte pas de solution satisfaisante à long terme au problème de la planification des fréquences et du coût des réseaux.

Il apparaît qu'une attitude radicalement innovante vis-à-vis des échos serait seule capable de résoudre l'ensemble des problèmes de la diffusion hertzienne terrestre, et d'ouvrir des perspectives réellement révolutionnaires.

2.2. Le canal radioélectrique équivalent

Le canal de transmission peut être simplement décrit par sa réponse à une impulsion qui caractérise les différents échos en termes de retard et d'atténuation.

Analysons l'exemple très simple d'un écho unique (modèle de propagation à 2 chemins)...

Soient e^{2imft} le signal émis
 α le niveau relatif de l'écho
 φ le déphasage du signal retardé ($\varphi = 2\pi f \delta t$)
 δt le retard de l'écho

alors le signal reçu est $e^{2imft} (1 + \alpha e^{i\varphi})$, encore de fréquence f ,

d'amplitude $A = \sqrt{1 + \alpha^2 + 2\alpha \cos \phi}$ et de phase $\phi = 2\pi f t + \arctg \frac{\alpha \sin \phi}{1 + \alpha \cos \phi}$.

Si le déphasage ϕ du signal retardé est aléatoire et équiréparti dans $[0, 2\pi[$, alors l'amplitude statistique moyenne est $\bar{A} = \sqrt{1 + \alpha^2}$ qui est supérieure à la valeur normalisée 1, ce qui laisse entrevoir la bonne efficacité en puissance d'un système qui ne filtrerait pas les échos, mais saurait au contraire exploiter leur puissance. D'autre part, la courbe amplitude/fréquence (voir figure 1) met clairement en évidence la sélectivité du canal en fréquences, périodique de période $(\delta t)^{-1}$ dans ce cas simple d'un écho unique.

Plus le produit de l'étalement des retards par la largeur de bande utilisée est élevé, et plus le canal sera sélectif en fréquence. Cela signifie que certaines composantes fréquentielles du signal seront bien transmises (c'est le phénomène d'interférences constructives bien connu en optique), alors que d'autres composantes seront mal transmises, ce qu'on appelle en radio les "fadings" (interférences destructives).

amplitude de la
fonction de transfert du canal

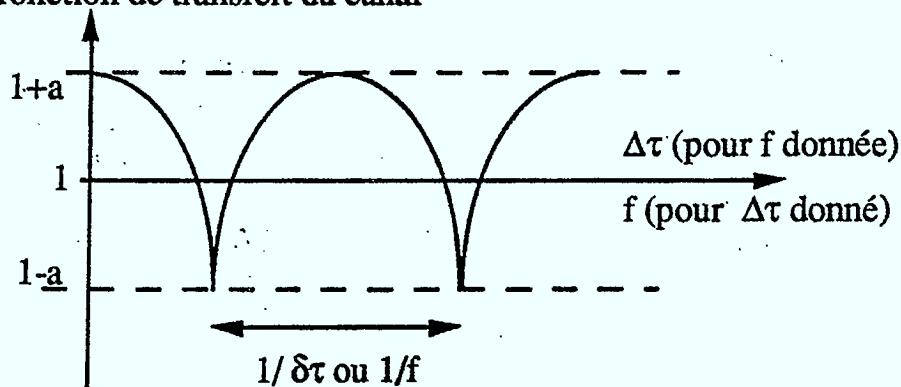


Figure 1
Exemple d'un canal à 2 chemins

Enfin, il importe de remarquer que le terme de distorsion de phase par rapport à la phase linéaire ($\arctg \frac{\alpha \sin \phi}{1 + \alpha \cos \phi}$) est minimal -et s'annule à la limite- précisément pour les fréquences pour lesquelles l'amplitude est maximale, ce qui indique qu'un signal à bande étroite serait transmissible sans grande distorsion dès l'instant où sa fréquence centrale serait suffisamment éloignée des zones fréquentielles de fading.

Par signal "à bande étroite", il faut entendre un signal dont la largeur de bande reste petite devant la périodicité fréquentielle des fadings : en réception urbaine pour laquelle la réponse impulsionale du canal s'étend sur plusieurs microsecondes, "bande étroite" signifie quelques dizaines de KHz.

Pour exploiter le fait que les échos sont statistiquement constructifs, il suffit donc de garantir un caractère aléatoire au produit $f \cdot \delta t$, en associant suffisamment de signaux à bande étroite (diversité en fréquences), et en captant le plus d'échos possible (diversité des chemins et des retards, assimilable à une diversité d'espace).

3. LES PRINCIPES DU COFDM⁽¹⁾

3.1. Les principes de l'OFDM

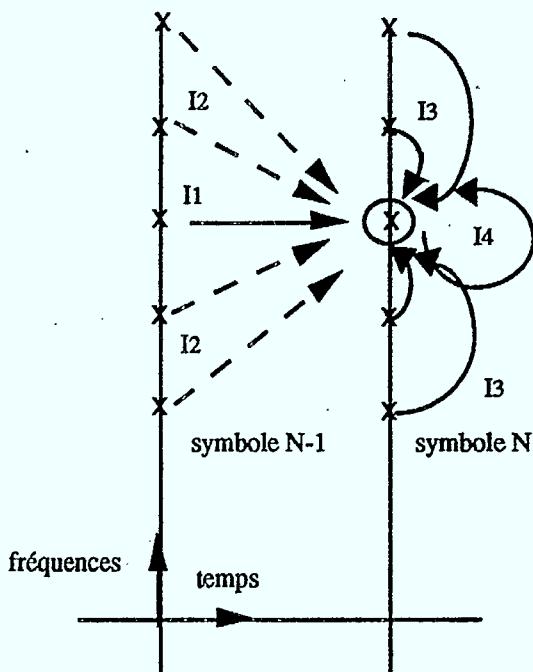
La première idée consiste à répartir l'information à transmettre sur un grand nombre de porteuses (≈ 1000) en parallèle, individuellement modulées à bas débit. Ceci équivaut à préférer une transmission « parallèle » à une transmission « série », et rend le canal non sélectif en fréquence vis-à-vis de chacune de ces porteuses [ref. 4].

Un espace-temps fréquentiel inter-porteuses égal à l'inverse de la durée d'un symbole a alors deux avantages :

- Les spectres de toutes les sous-porteuses se recouvrent mutuellement, garantissant ainsi une excellente efficacité spectrale : près de 2 bits/s/Hz avec une modulation 4PSK de chaque sous porteuse , par exemple.
- Le signal vérifie toujours la condition cruciale d'orthogonalité qui permet d'extraire l'information portée par chaque porteuse sans pârir d'interférences dues à la présence des porteuses voisines. De plus, les fonctions de modulation et démodulation peuvent être réalisées simplement par les algorithmes de Transformée de Fourier Rapide appliqués successivement à chaque symbole [ref. 3 et 5].

Le maintien de cette condition vitale d'orthogonalité à l'entrée du récepteur suppose une maîtrise parfaite des interférences inter- et intra-symboles d'une part, et inter- et intra-porteuses d'autre part.

Comme indiqué sur la figure 2, 4 types d'interférences sont à prendre en compte.



- I₁ = Interférence intersymbole intraporteuse
- I₂ = Interférence intersymboles interporteuses
- I₃ = Interférence intrasymboles interporteuses
- I₄ = Interférence intrasymbole intraporteuse

Figure 2 : Analyse des interférences dans le système OFDM

(1) Coded Orthogonal Frequency Division Multiplex

- Les interférences intersymboles I_1 et I_2 s'annulent dès que l'on sait éviter la pollution de chaque symbole par les échos retardés du symbole précédent : la solution retenue consiste à insérer un intervalle de garde temporel entre les symboles $N - 1$ et N , qui joue le rôle d'un tampon absorbant les échos intersymboles. Le dimensionnement de ce tampon ne dépend que de l'étalement des retards du canal considéré.
- Les interférences intrasymboles interporteuses I_3 s'annulent sous la condition raisonnable et vérifiée en pratique que les caractéristiques amplitude et phase/fréquences du canal puissent être considérées comme invariantes sur un temps symbole : dans le cas d'une réception mobile, cette limite impose des contraintes sur le choix des paramètres longueur des symboles, vitesse maximale de déplacement (effet Doppler) et fréquence porteuse maximale.
- Enfin les interférences intrasymbole intraporteuse I_4 concernent les effets des échos du signal modulant une sous-porteuse sur lui-même. Sous réserve que l'on profite de l'intervalle de garde séparant les symboles $N-1$ et N pour émettre la recopie de la fin du symbole N (figure 2), on a montré au paragraphe 2.2 que cette interférence I_4 est statistiquement plus souvent constructive que destructive, et que l'augmentation de la puissance reçue grâce aux échos améliore directement le taux d'erreurs (grâce à l'utilisation d'un codage de canal approprié - voir paragraphe 3.2) : en ce sens, il est juste de dire que le COFDM profite d'autant mieux des échos qu'ils sont plus intenses.

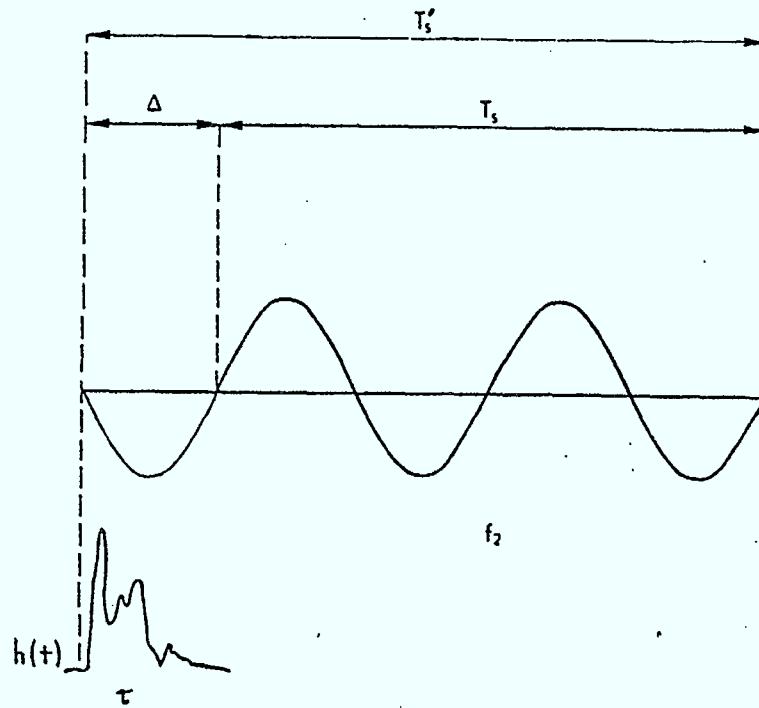
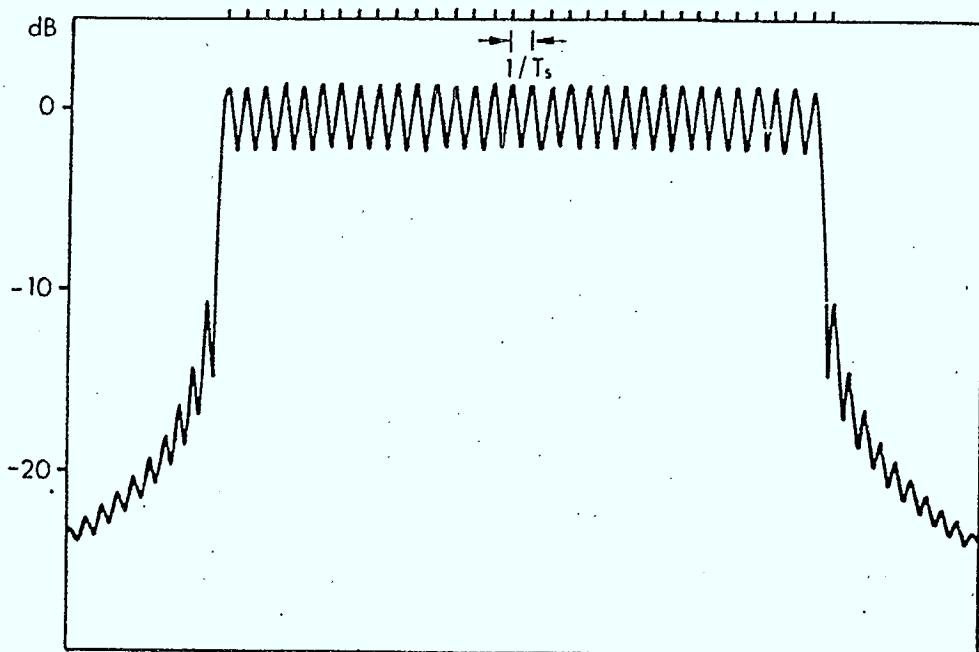


Figure 3 : Structure temporelle d'une porteuse durant un symbole



*Figure 4
Exemple de la densité spectrale de puissance d'un signal OFDM à 32 sous-porteuses avec un intervalle de garde $\Delta = \frac{T_s}{4}$*

L'annulation des interférences intersymboles par adjonction d'un intervalle de garde est une méthode moins conventionnelle que le recours à un égaliseur, plus simple, et plus efficace puisque le nombre et le niveau des échos sont ici quelconques, alors qu'il n'existe pas à notre connaissance d'égaliseur capable d'effacer des échos aussi importants en niveau que le signal utile. Enfin, rappelons qu'un égaliseur priverait le système de l'utilisation positive des échos intrasyrnboles.

La représentation du signal en temps et en fréquence est alors celle illustrée par la figure 5.

Il est intéressant de noter à ce niveau que la mise en forme temps/fréquence du signal est remarquablement bien adaptée aux caractéristiques du canal de transmission :

- séparation des symboles dans le domaine temporel pour lequel la dispersion du canal est considérable ;
- chevauchement des sous-porteuses dans le domaine fréquentiel pour lequel la dispersion du canal est moindre (effet Doppler dans le cas des récepteurs mobiles).

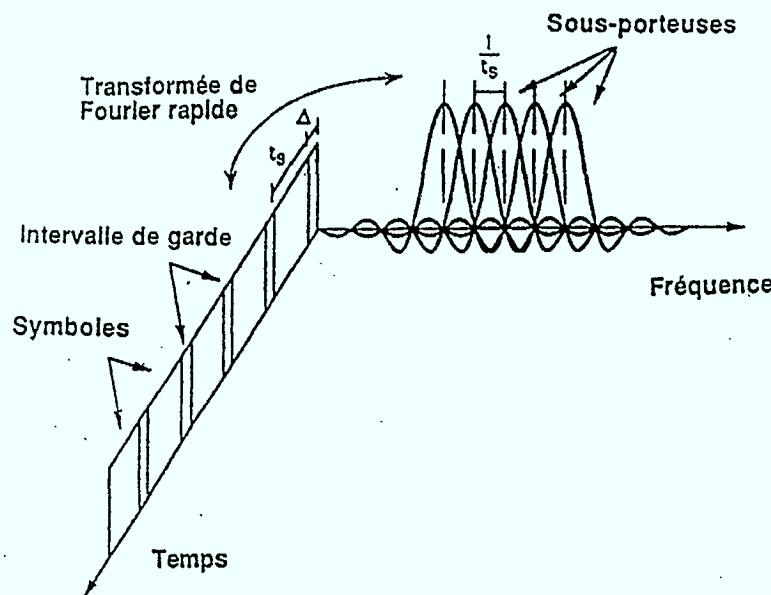


Figure 5 : Représentation en temps et en fréquence du signal COFDM

3.2. La nécessité du codage de canal

La répartition de l'information en N porteuses parallèles ne suffit pas : s'intéressant à l'une quelconque d'entre elles, on peut considérer que, selon sa position dans le domaine fréquentiel, elle sera reçue avec une atténuation plus ou moins importante, conséquence d'interférences (intrasympbole intraporteuse) destructives ou constructives. Mais si seul ce principe était appliqué, certaines informations seraient bien transmises, alors que d'autres seraient absorbées par les « fadings » du canal. Dans le cas extrême où un écho d'amplitude identique à celle du signal principal crée un évanouissement local absolu, il est intéressant de noter que le taux d'erreur ne diminue pas, et ce, quelle que soit la puissance émise ! Si on suppose par exemple que 10 porteuses parmi les 1000 sont éteintes à l'entrée du récepteur, le taux d'erreurs plafonne alors à $5 \cdot 10^{-3}$!

La seconde idée exploite encore de façon systématique les trajets multiples entre l'émetteur et le récepteur en utilisant le fait que des signaux suffisamment séparés en fréquence et en temps ne peuvent être affectés de façon identique. Les informations transmises à des instants différents sur des porteuses éloignées de l'espace des fréquences sont liées entre elles par un codage produisant une redondance qui assure au récepteur la possibilité de reconstituer les informations perdues lors de la transmission, grâce à la corrélation qui les lie aux informations correctement reçues. Ceci peut être réalisé par un codage convolutif associé à un entrelacement en temps et en fréquence.

La diversité apportée par cet entrelacement joue un rôle vital dans le système. Le décodeur ne peut fonctionner correctement que si les échantillons successifs présentés à son entrée sont affectés par des distorsions indépendantes. En pratique, ces distorsions sont fortement corrélées en temps et en fréquence. L'entrelacement a pour effet de briser cette corrélation, et permet au décodeur d'intégrer les phénomènes de fading locaux

sur toute la bande et sur toute la profondeur de l'entrelacement temporel : les performances du système ne dépendent plus alors que de la puissance moyenne reçue. Lorsque le récepteur est à l'arrêt, la diversité en fréquence est suffisante pour assurer un bon fonctionnement du système : de ce point de vue, l'existence de trajets multiples est une forme de diversité et doit être considérée comme un avantage.

En conclusion, l'association du Codage et de l'OFDM - baptisée COFDM - permet de tirer pleinement profit de la propagation par trajets multiples, notamment en exploitant les échos constructifs -statistiquement majoritaires-, à la fois pour augmenter la puissance utile du signal reçu, et aider au recouvrement de l'information perdue dans les échos destructifs.

3.3. Synoptique d'un récepteur COFDM

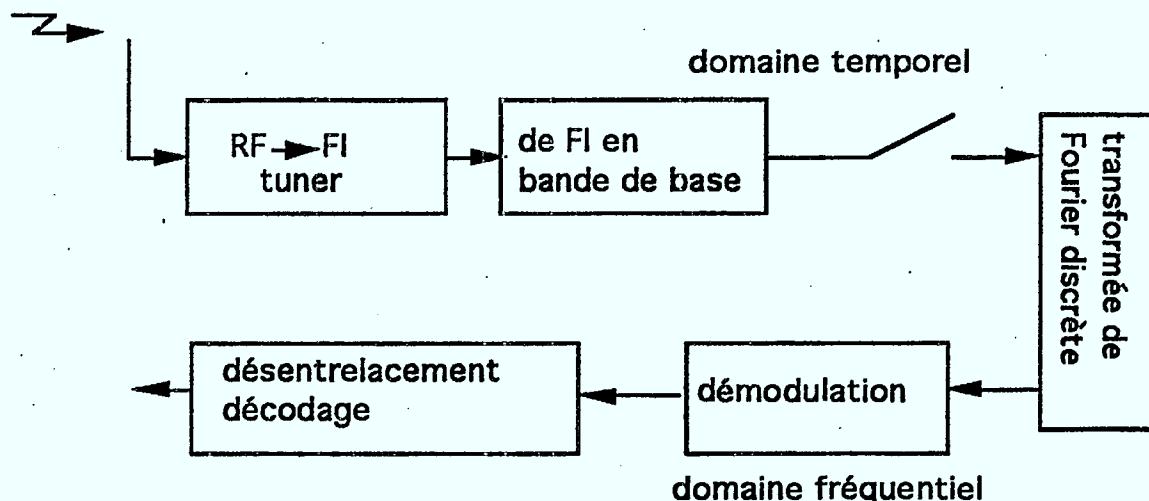


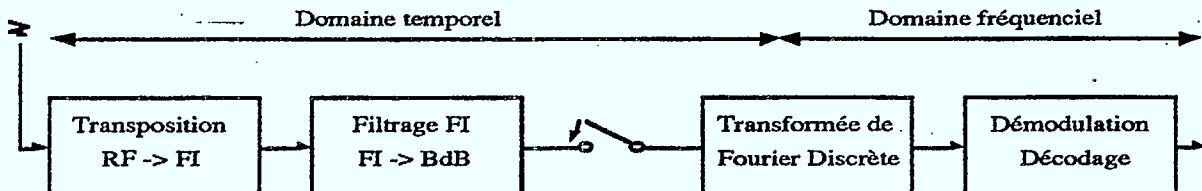
Figure 6 : Synoptique d'un récepteur COFDM

4. LES PERFORMANCES INTRINSÈQUES DU COFDM

On se reportera aux articles [1], [2] et [3] de la bibliographie pour approfondir la représentation mathématique des signaux, ainsi que les règles de décodage.

4.1. Discussion sur le choix des paramètres

Rappel sur le synoptique d'un récepteur COFDM :



Soient δt le retard maximal induit par le canal
 Δ la durée de l'intervalle de garde
 T la durée utile du symbole
 $T' = \Delta + T$ la durée totale du symbole

On choisira $\Delta > \delta t$, et d'autre part, on maximisera le débit utile en réduisant la fraction du temps symbole consommée par l'intervalle de garde : ceci conduit à allonger T .

Inversement, augmenter T augmente dans les mêmes proportions le nombre de sous-porteuses (puisque elles sont espacées de $\Delta f = 1/T$), c'est-à-dire le nombre de points complexes à traiter dans les circuits de FFT dont la complexité croît alors logarithmiquement (voir paragraphe 4.3). Un compromis souvent adopté est de prendre $T = 4\Delta$.

Une autre limitation, théorique et plus seulement pratique, à l'allongement du temps symbole vient de la "cohérence temporelle" du canal, lorsque le récepteur est mobile et se déplace à la vitesse maximale V_{max} . Si c désigne la vitesse de la lumière, et f_0 la fréquence porteuse du signal, alors l'effet Doppler est responsable d'un décalage en fréquence de valeur $f_0(V_{max}/c)$ qu'on doit maintenir petit devant l'espacement inter-porteuses.

$$\text{On a donc: } f_0 \frac{V_{max}}{c} \ll \frac{1}{T}$$

Le même résultat peut s'obtenir en considérant que la distance parcourue par le mobile pendant un temps-symbole doit rester faible devant la demi-longueur d'onde porteuse, de façon à ce que le canal puisse être considéré comme invariant pendant la durée d'un symbole, ce qui s'écrit :

$$V_{max} \cdot T' \ll \frac{1}{2} \frac{c}{f_0}$$

$$\text{et l'on retrouve: } \left(f_0 \frac{V_{max}}{c} \right) T' \ll 1.$$

Le respect des inégalités $\delta t \approx \Delta \ll T$ (ou T') $\ll \frac{1}{f_0} \frac{c}{V_{max}}$ permet de définir les limites de fonctionnement du système selon les 3 paramètres externes δt , f_0 et V_{max} .

On peut raisonnablement fixer à 4 dB la dégradation équivalente maximale acceptable pour définir les limites de fonctionnement du système. Celles-ci sont indiquées ci-dessous, pour différentes valeurs de l'étalement des retards du canal.

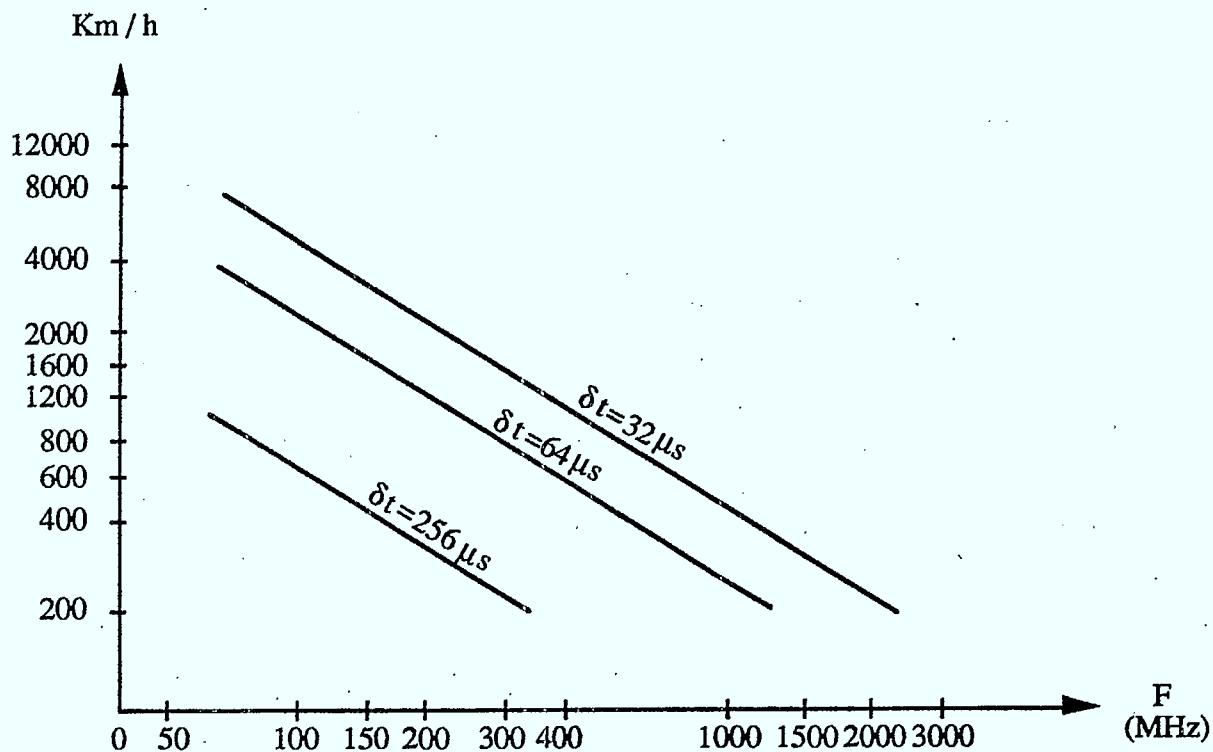


Figure 7 : Limites de fonctionnement du COFDM

Par exemple, si $V_{max} = 200 \text{ km h}^{-1}$
et $f_0 = 1,5 \text{ Ghz}$
alors $T' \approx 5\delta t \ll \frac{c}{V_{max}} \frac{1}{f_0} = 3,6 \text{ ms}$

Dans ces conditions, T' -c'est à dire la durée maximale pendant laquelle le canal peut être considéré comme invariant- doit rester inférieure à $250 \mu s$. Avec une modulation de type COFDM, et en choisissant $\Delta \approx 60 \mu s$, on peut encore s'affranchir d'échos aussi longs que 18 kms.

Par contre, un égaliseur classique serait confronté à de graves problèmes de temps de convergence.

4.2. Le compromis niveau/retard maximal des échos

Tant que la longueur des échos est inférieure à la durée de l'intervalle de garde, ceux-ci sont constructifs, et d'autant plus que leur niveau est plus fort ! Ainsi, et contrairement aux systèmes conventionnels avec égaliseur, le niveau maximal tolérable des échos ne dépend pas de leur longueur.

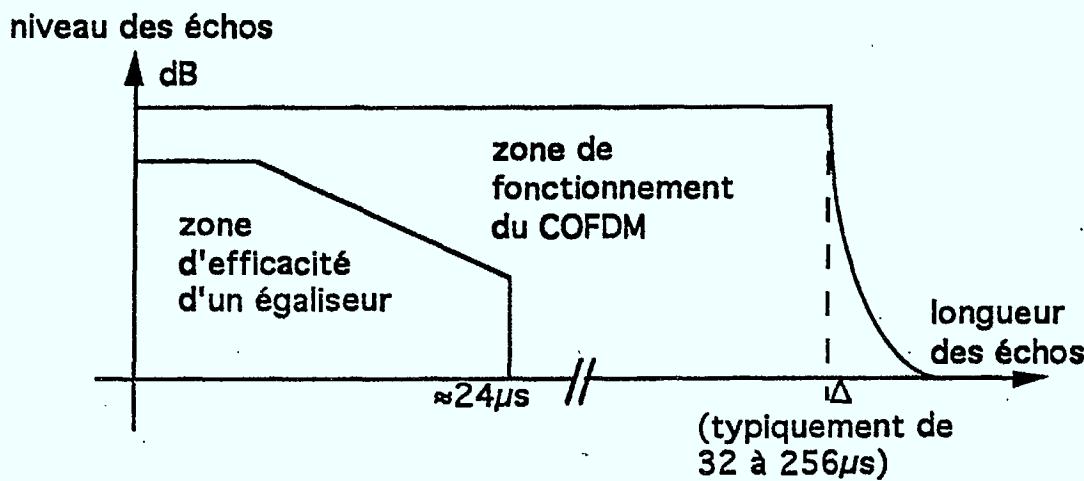


Figure 8
*Comparaison des zones (niveau/longueur des échos)
 de fonctionnement du COFDM et d'un égaliseur traditionnel*

4.3. Le compromis complexité/longueur maximale des échos

Augmenter la longueur maximale des échos constructifs exige d'augmenter la taille de l'intervalle de garde, et donc de l'intervalle utile dans les mêmes proportions pour garantir la transmission du même débit. Ceci est possible au prix d'un accroissement du nombre de points traités par le circuit qui réalise la Transformée de Fourier Discrète. Imaginons que l'on veuille augmenter "l'horizon utile des échos" dans un rapport p . Le circuit qui calculait 1 FFT à N points en T' secondes -soit p FFT à N points en pT' secondes- doit maintenant calculer 1 FFT à pN points dans le même temps pT' , et il s'agit de comparer $p.N/2 \log_2 N$ à $pN/2 \log_2 pN$:

La complexité s'est donc accrue dans le rapport $1 + \frac{\log_2 p}{\log_2 N}$

Par exemple, si $N = 1024$, la complexité ne croît que de 10 % quand on double le retard maximal acceptable des échos, ce qui est beaucoup plus favorable que l'accroissement de complexité des égaliseurs traditionnels (voir figure 9).

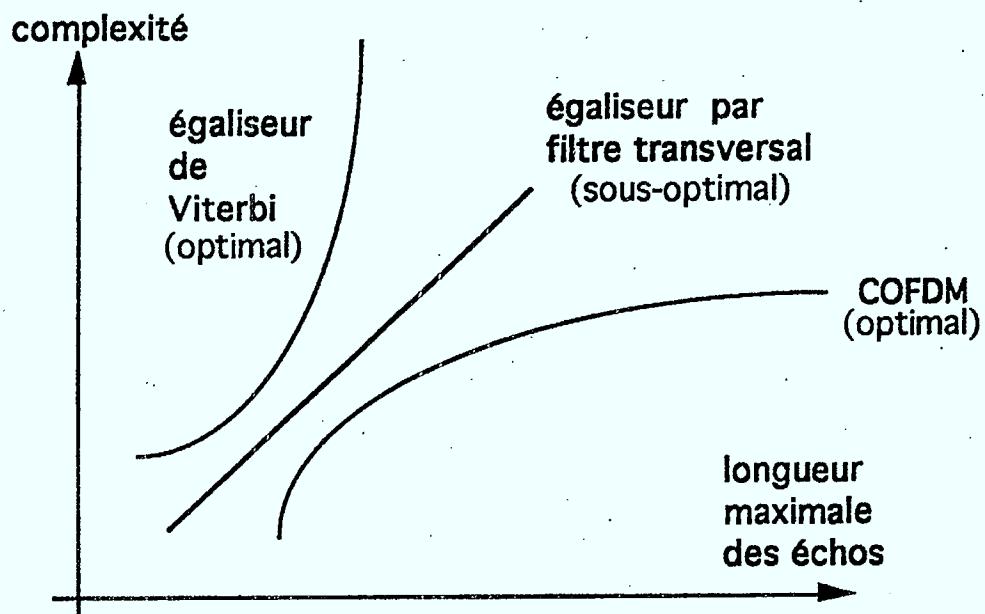


Figure 9 :
Complexité en fonction de la longueur maximale des échos

4.4. Efficacité spectrale et efficacité en puissance

Le COFDM autorise bien sûr l'utilisation des techniques les plus récentes de modulations codées en blocs ou en treillis. Le choix du type de modulation appliquée à chaque sous-porteuse ne dépend que du compromis entre le débit transmis et la robustesse souhaitée.

Type de modulation sur chaque sous-porteuse	Redondance du code	Débit net utile dans un canal de 7 MHz	Efficacité spectrale	Eb/No par bit utile mesuré pour un TEB = 10^{-4}	$\frac{C}{N} = \frac{E_b}{N_0} \times \frac{\text{Débit}}{\text{Bande}}$
4-PSK	$1 \rightarrow 2$	6 Mbits	0,85	7 dB	6,3 dB
16-QAM	$2 \rightarrow 4$	12 Mbits	1,7 bit/Hz	12 dB	14,3 dB
64-QAM	$4 \rightarrow 6$	24 Mbits	3,4 bit/Hz	18 dB	23,3 dB
64-QAM	$5 \rightarrow 6$	30 Mbits	4,3 bit/Hz	23 dB	29,3 dB

ATTENTION : la bonne lecture de ce tableau suppose que l'on se souvienne des conditions dans lesquelles ces chiffres ont été établis :

1. La valeur de l'intervalle de garde a été fixée au quart de la durée de l'intervalle utile : la pénalité qui en résulte, en débit (-20 %) et en E_b/N_0 (+ 1 dB) a bien sur été prise en compte dans ce tableau.
2. Le canal est supposé sélectif en fréquences (et pas seulement gaussien), de largeur 7 MHz.
3. Le Taux d'Erreur Binaire pris comme référence est 10^{-4} . Pour obtenir les valeurs correspondantes à 10^{-9} , on devra prendre en compte la pénalité supplémentaire de l'ordre de 10 % induite sur le débit utile par le code de Reed Solomon.

Pour fixer les idées, on peut considérer en première approximation qu'un débit de 24 Mbits/s permet d'acheminer un programme de qualité "haute définition", ou 2 programmes distincts de qualité "TV améliorée" du type D2MAC au format 16/9, ou encore 4 programmes de qualité conventionnelle de type PAL ou SECAM.

Il est utile ici de remarquer que le facteur 4 ou 5 obtenu en gain d'efficacité spectrale par rapport aux systèmes analogiques existants est essentiellement dû aux bonnes performances de la compression des images réalisées par le codage de source.

5. LA SOUPLESSE DE MULTIPLEXAGE DES SERVICES

Parce qu'il est entièrement numérique, le système COFDM offre tous les avantages habituels de ce type de transmission, en particulier la flexibilité -les bits diffusés peuvent coder n'importe quel type de service-, et la facilité de l'embrouillage.

Vis-à-vis du multiplexage de différents services, le COFDM apporte de plus quelques caractéristiques originales :

- parce qu'une même bande de fréquence est partageable entre plusieurs services, et que le COFDM exploite de façon systématique la diversité en fréquences, les services multiplexés sont plus robustes que si on les transmettait séparément : par exemple, dans le cas de l'application du système à un service de radiodiffusion sonore (DAB), le fait de multiplexer 6 programmes stéréo de haute qualité dans une bande de 1,5 MHz, les rend à peu près invulnérables aux fadings plats.
- aux potentialités classiques des multiplexages en temps et en fréquence, le COFDM ajoute la possibilité de choisir des types de modulation différents pour des sous-porteuses différentes ; des modulations de type "multirésolution", c'est-à-dire interprétées différemment selon la qualité du canal ou du récepteur, sont également envisageables sur toutes ou seulement certaines sous-porteuses : la souplesse résultante de toutes ces combinaisons rend crédible la faisabilité d'un service de télévision hiérarchique par exemple, capable de s'adapter aux différents niveaux de mobilité du récepteur ou de qualité de canal.

6. LES ATOUTS DU COFDM VIS-À-VIS DE L'INTRODUCTION DES NOUVEAUX SERVICES DE DIFFUSION NUMÉRIQUE

En ce qui concerne la diffusion numérique de télévision, une stratégie d'introduction envisagée repose sur l'hypothèse de l'allocation aux nouveaux services des bandes de fréquence dites "tabou" (voir figure 13b).

Il existe principalement deux familles de canaux "tabou" : les 2 canaux adjacents supérieur et inférieur d'un canal exploité, par suite de l'insuffisance de sélectivité des tuners des télésiteurs ; et les canaux -dits "cocanaux"- pollués par un signal transmis depuis un émetteur géographiquement trop lointain pour donner une image non bruitée, mais trop proche pour ne pas brouiller un éventuel autre programme. Quoique alléchante, l'utilisation de ces canaux habituellement interdits dicte deux contraintes a priori inconciliables : le signal numérique devra être extrêmement résistant aux brouilleurs cocanaux PAL ou SECAM et, inversement, être très peu gênant pour les programmes conventionnels déjà existants.

6.1. La résistance des signaux COFDM vis-à-vis des brouilleurs analogiques co-canal

Les porteuses des signaux analogiques conventionnels, ainsi que les sous-porteuses de chrominance et de son, peuvent être considérés comme des brouilleurs à bande étroite, et de ce fait n'affectent qu'une portion limitée du spectre du signal COFDM qui se comporte alors spontanément comme si les quelques sous-porteuses concernées étaient victimes d'un fading local : la remarquable résistance de COFDM aux évanouissements étroits lui garantit par la même occasion une exceptionnelle immunité vis-à-vis des brouilleurs à bande étroite.

6.2. La résistance des signaux analogiques conventionnels au brouillage induit par le COFDM

Parce qu'il est constitué d'une somme de porteuses indépendantes avec des phases aléatoires, le signal COFDM a une distribution gaussienne en amplitude ; en conséquence, il est vu par un récepteur PAL, SECAM ou NTSC comme du bruit blanc, ce qui est idéal du point de vue de la gêne subjective subie par le téléspectateur des programmes conventionnels.

Cette remarquable caractéristique est encore accentuée par la bonne efficacité en puissance du système.

Enfin, le COFDM offre la possibilité inédite de synthétiser un spectre "par morceaux" :

il est possible, au prix d'une légère perte de débit, d'éteindre les sous-porteuses COFDM qui correspondent aux fréquences particulièrement fragiles d'un signal PAL ou SECAM cocanal : on peut, par exemple, créer un spectre "sur mesure" -à la limite en peigne- pour éviter tout risque de parasite (souffle) sur la sous-porteuse son du SECAM (voir figure 10) [réf. 6].

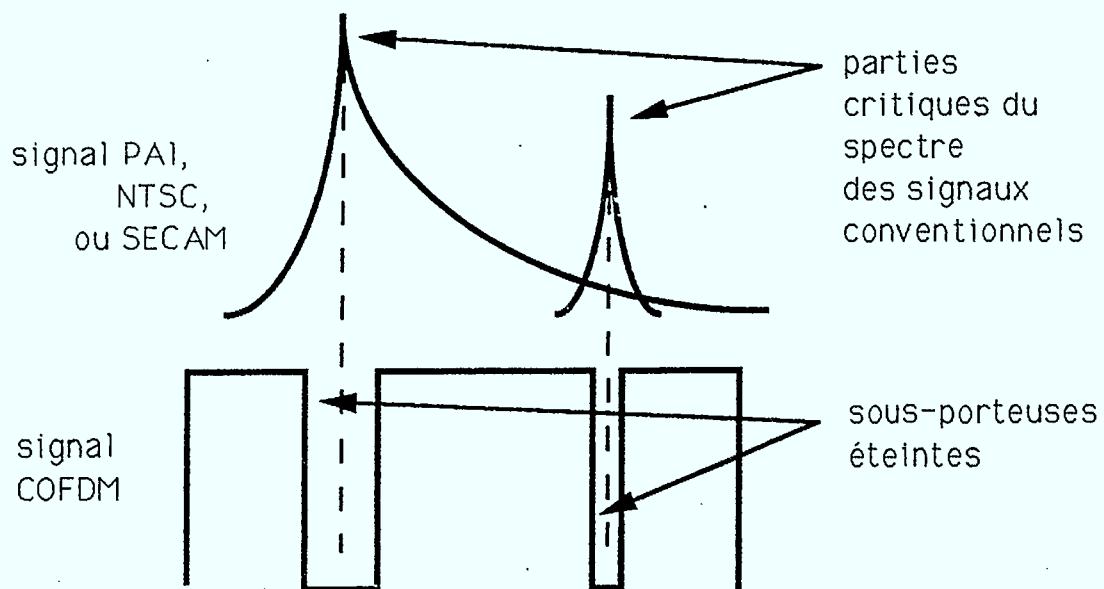


Figure 10
Mise en forme du spectre COFDM pour optimiser le non-brouillage des signaux existants

7. LA RÉVOLUTION DES RÈGLES D'INGÉNIERIE PERMISE PAR LE COFDM

Nous avons montré ci-dessus les excellentes efficacités spectrale et en puissance du COFDM, vu sous l'aspect "modulation". Les paragraphes qui suivent examinent le COFDM sous l'aspect "système de diffusion" et montrent que les perspectives ouvertes par cette technique sont encore plus attractives quand on s'intéresse à la mise en oeuvre du système de diffusion dans son ensemble.

7.1. Les "gap-filters"

Puisque le système a été conçu pour tirer parti des échos, il est possible d'en créer volontairement.

La première application de cette idée permet d'éliminer les zones d'ombre résiduelles par l'emploi de réflecteurs passifs ou de petits réémetteurs actifs SANS AVOIR BESSON DE CHANGER DE FREQUENCE PORTEUSE pour le signal réfléchi ou réémis. Le signal est capté à un endroit où les conditions de réception sont satisfaisantes, réamplifié, puis rediffusé à la même fréquence vers la zone d'ombre qu'on souhaite supprimer, par exemple un tunnel routier. Ces "gap-filters" ne consomment aucune bande de fréquences supplémentaire et leur simplicité de principe garantit un coût de revient très faible. Si l'on se souvient que le parc de réémetteurs nécessaire pour obtenir une couverture nationale dans un pays comme la France se chiffre à plusieurs milliers d'unités, on comprend l'intérêt d'une telle approche.

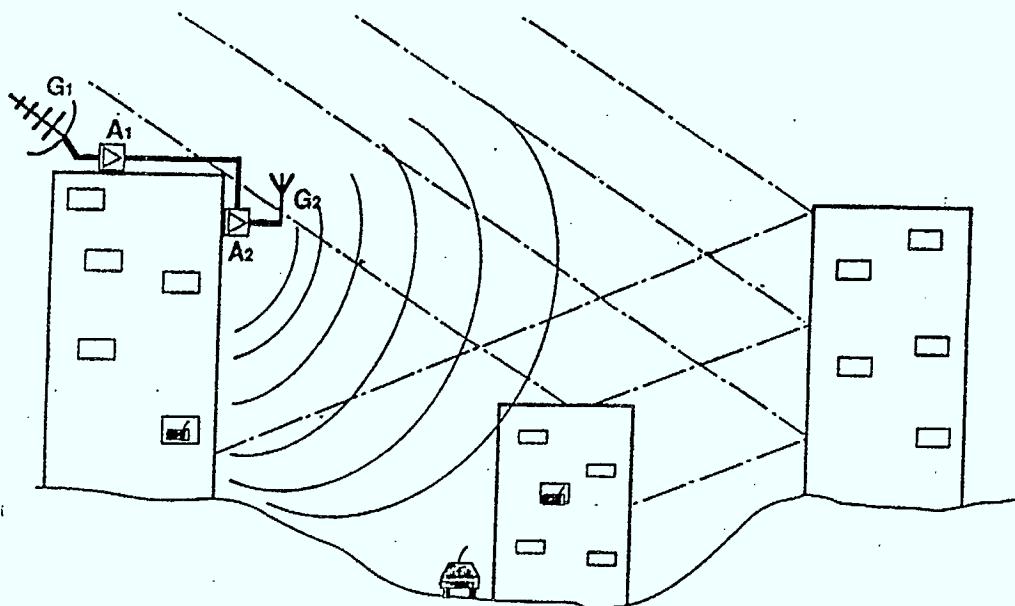


Figure 11 : Principe d'un gap-filler

La faisabilité de ces "gap-filters" a été testée avec succès et en vraie grandeur dès 1988 à Rennes (France) autour de 900 MHz.

7.2. Les réseaux hybrides satellites gap-filters

L'alliance d'un satellite dont la puissance suffirait à garantir de bonnes conditions de réception en zone parfaitement dégagée, et d'un réseau terrestre de petites stations réémettrices fonctionnant bien sûr à la même fréquence que la liaison satellite, et destinées à renforcer le niveau du signal dans les zones d'ombre, est attractive dans la mesure où elle permet de réduire significativement la puissance émise depuis le satellite, tout en garantissant une zone de couverture aussi bonne que nécessaire. Une analyse approfondie de ce schéma a montré que la marge de propagation du satellite pourrait dans ces conditions être aussi faible que 5 dB [réf. 7].

7.3. Les réseaux denses et l'efficacité en puissance du système

Si l'on imagine un réseau d'émetteurs terrestres répartis sur un territoire donné, tous synchronisés en temps et diffusant le même signal sur la même fréquence, on a vu que la puissance utile reçue à l'entrée du récepteur est la somme des puissances reçues depuis chaque émetteur : les différents signaux reçus sont vus comme des échos d'un même signal et se combinent positivement dès l'instant où leur étalement dans le temps est compatible avec la durée choisie pour l'intervalle de garde. En d'autres termes, le COFDM permet de faire se chevaucher de façon constructive les zones de couverture des différents émetteurs. L'association par cette technique d'un nombre aussi grand que nécessaire d'émetteurs fonctionnant de façon solidaire offre beaucoup d'avantages :

- L'infrastructure de diffusion est moins chère puisqu'elle évite le recours à des émetteurs trop puissants, dont le coût croît de façon exponentielle avec la zone de couverture.
- Elle permet de lancer un nouveau service avec un investissement initial minimal, puis d'élargir progressivement la zone de service.
- Elle permet un meilleur rendement de la puissance émise comme le fait comprendre qualitativement le schéma ci-dessous (figure 12).
- Contrairement aux systèmes analogiques qui s'accomodent de rapports signal/bruit très variables, les systèmes numériques sont très sensibles à un effet de seuil en-deça duquel la qualité s'effondre et au-delà duquel la qualité ne s'améliore plus : en autorisant un dessin plus précis de la zone de service, et une grande homogénéité de la puissance reçue, les réseaux denses limitent considérablement cet inconvénient des systèmes numériques. Un bon résumé du concept COFDM pourrait être : "la bonne puissance, au bon endroit".
- Elle garantit une meilleure maîtrise des pollutions co-canal.
- Aux diversités en temps et en fréquence du COFDM, elle ajoute la diversité d'espace à l'émission.

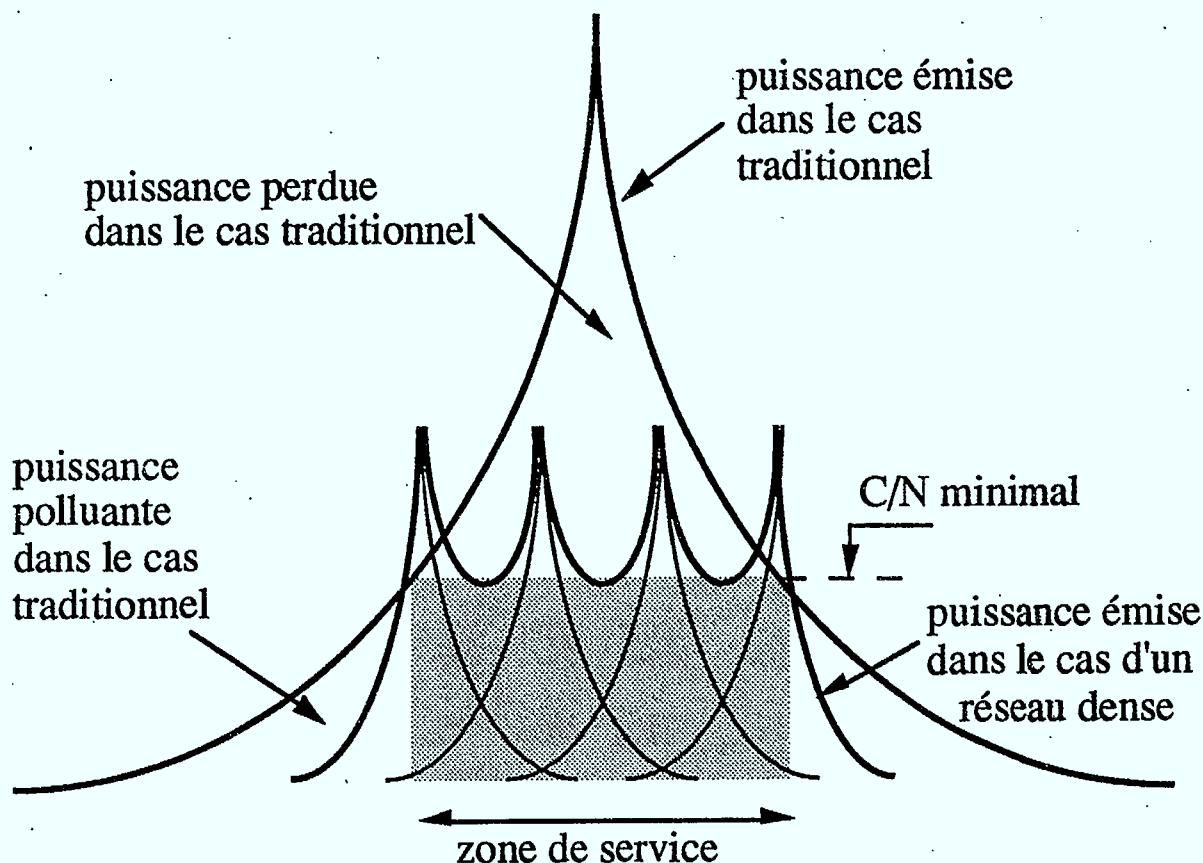


Figure 12 : Efficacité en puissance des réseaux denses

La mise en service autour de la ville de Rennes d'un réseau expérimental constitué de deux émetteurs fonctionnant à 60 MHz a confirmé le fait que la zone de couverture globale assurée par les deux émetteurs fonctionnant simultanément est sensiblement supérieure à la somme des zones de couverture de chacun des émetteurs fonctionnant seul.

7.4. Les réseaux monofréquence et l'efficacité spectrale du système

Le concept d'un réseau d'émetteurs fonctionnant de manière synchrone sur la même fréquence s'oppose aux techniques d'ingénierie classiques astreintes à diffuser le même programme à partir d'émetteurs géographiquement voisins sur deux fréquences distinctes.

Si l'on considère que les 45 canaux de 8 MHz en bande UHF, alloués en France à la télévision, sont totalement saturés par 5 chaînes nationales, c'est un facteur 9 que l'on gagne avec le COFDM ; que l'on prenne de plus en compte une hypothèse de débit de 24 Mbits/s dans chaque canal, suffisant pour acheminer 4 programmes de qualité conventionnelle, c'est alors un rapport $9 \times 4 = 36$ que l'association COFDM/codage de source permet de gagner en termes d'occupation spectrale !

Le schéma ci-dessous illustre la spectaculaire efficacité spectrale globale atteinte par un système basé sur le COFDM (voir figure 13c, comparée à 13a).

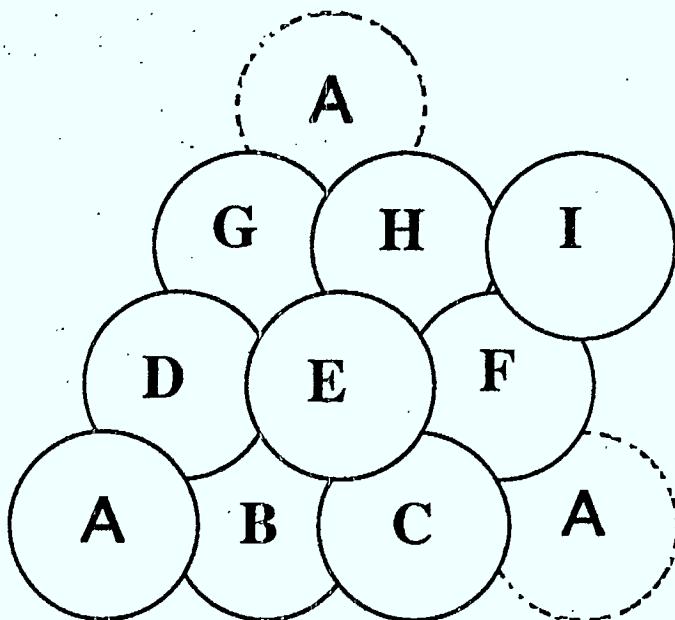


Fig. 13a : Planification de fréquences pour les systèmes analogiques ou numériques conventionnels

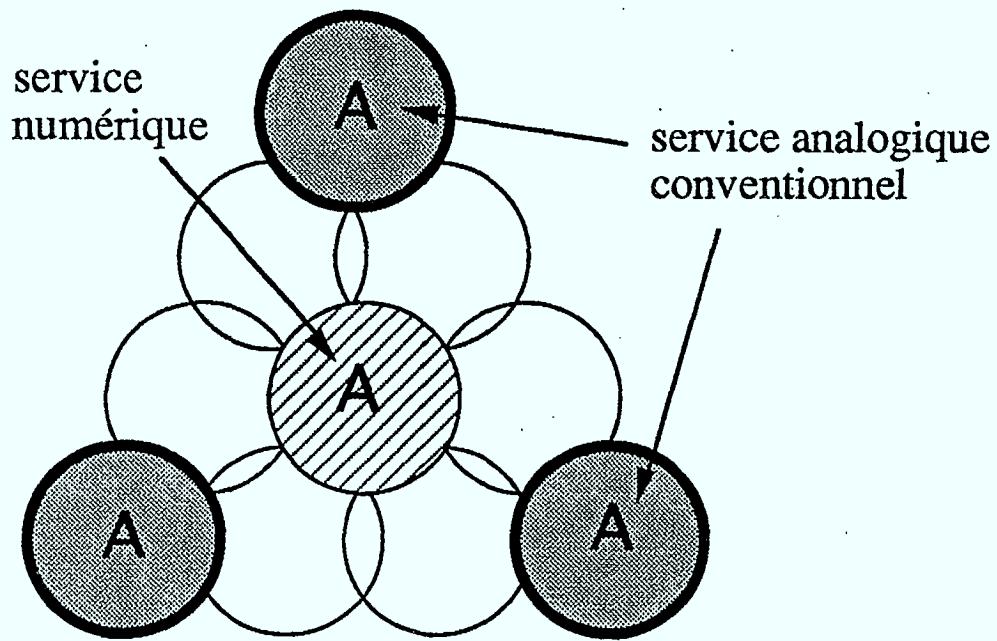


Fig. 13b : Introduction d'un service numérique dans un contexte analogique

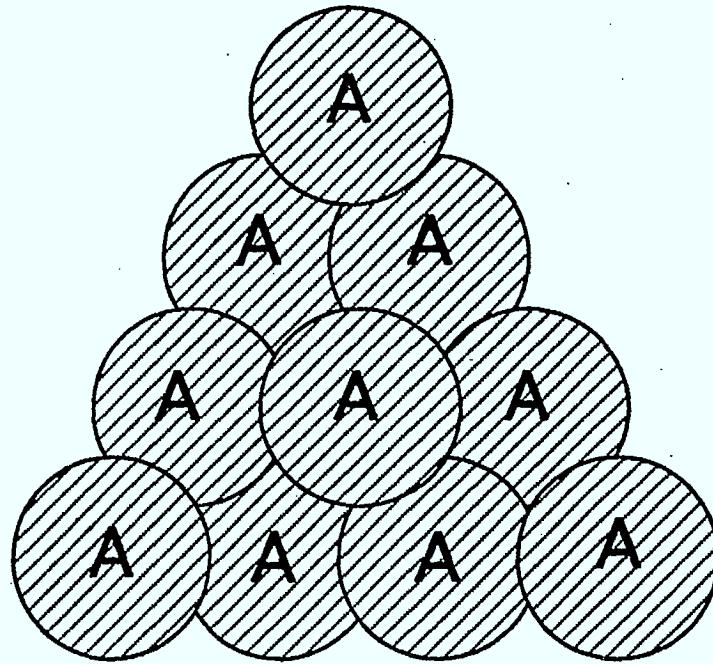


Fig. 13c : Efficacité en fréquence d'un réseau monofréquence

En outre, dans le cas d'émissions destinées aux récepteurs mobiles (typiquement, l'application DAB de radiodiffusion sonore numérique), le concept monofréquence permet d'éviter de devoir modifier manuellement ou automatiquement la fréquence d'accord au fur et à mesure des déplacements dans la zone de couverture du service.

8 . Conclusion

Le COFDM n'est pas seulement une nouvelle modulation très performante : en unifiant les problèmes de trajets multiples et de planification de fréquence, et en les résolvant élégamment, cette technique permet d'utiliser toutes les ressources de la numérisation du signal pour concevoir des récepteurs et des réseaux de diffusion moins chers, tout en facilitant l'émergence de nouveaux services grâce à l'extraordinaire efficacité spectrale équivalente du système, très largement supérieure à celle des systèmes numériques conventionnels avec égaliseur.

Depuis septembre 1988, date à laquelle le CCETT réussissait à Genève (Suisse) la première démonstration mondiale de diffusion numérique, les qualités du COFDM ont été largement démontrées dans toute l'Europe, aux Etats-Unis (Las Vegas et San Francisco en 1991), et dans les principales villes canadiennes. A ce sujet, nous voudrions remercier nos collègues canadiens pour avoir été parmi les premiers à faire confiance en notre savoir-faire, et pour avoir, grâce au succès de leurs campagnes de mesure, largement contribué à l'obtention de la bande de fréquences 1452-1492 MHz lors de la dernière WARC-92.

Bibliographie

- [1] LE FLOCH, HELARD, CASTELAIN, RIVIERE : Démodulation cohérente du système COFDM dans un canal de radio mobile - 13ème colloque GRETSI, septembre 1991.
- [2] LE FLOCH, HALBERT, CASTELAIN : Digital sound broadcasting to mobile receivers - IEEE Transactions on Consumer Electronics, Vol 35, n° 3, août 89.
- [3] ALARD, HALBERT : Principes de modulation et de codage canal en radiodiffusion numérique vers les mobiles - Revues de l'UER n° 224, août 1987.
- [4] WEINSTEIN, EBERT : Data transmission by frequency division multiplexing using the discrete Fourier Transform - IEEE Transactions on Communication Technology, Vol COM, 19, n° 15.
- [5] POMMIER, WU : Interleaving or spectrum spreading in digital radio intended for vehicles. EBU review n° 217, June 1986.
- [6] MASON, DRURY, LODGE : Digital TV to the home, when will it come ? Proceeding IBC 90.
- [7] POMMIER, RATLIFF, MEIER-ENGELEN : a hybrid satellite/terrestrial approach for digital audio broadcasting. NAB, Atlanta, 30 March, - 4 April 1990

Coordonnées de l'auteur

Bertrand Sueur
Téléphone (33) 99 12 44 95
Télécopie (33) 99 12 40 98

ABSTRACT

Market-Driven Initiatives - New Zealand Experience

By

IAN HUTCHINGS & KEN MCGUIRE
Ministry of Commerce

Prior to 1987, spectrum management in New Zealand was "traditional", with a State-owned monopoly providing telecommunications services and heavy State ownership in the generic broadcasting industry. Private broadcasting was controlled by a tribunal system.

Since then, as part of the overall process for economic reform in New Zealand, barriers to entry into telecommunications and broadcasting markets have been removed. There are no restrictions on the activities of operators, the number of entrants into the markets, or special licensing requirements (other than a radio license, where applicable). There are no barriers to foreign ownership, operation or investment.

Competition within the industry is not controlled by industry-specific regulations but relies on general competition law (the Commerce Act 1986) and a multi-sectoral body, the Commerce Commission, to cope with competition issues.

Legislation, the Radiocommunications Act 1989, established a new method by which spectrum users are licensed. It provides a market-based system for allocating spectrum, with up to 20 year, tradeable "property rights". The 20-year rights regime sits parallel to a traditional licensing regime for certain classes of user, such as maritime, aeronautical, amateur and citizen services.

There are two categories of rights; management rights, and licenses. A management right is a legal right to issue licenses to use frequencies within the management right, while a license gives authority to transmit radio waves on a specific frequency, under specified conditions, such as power, class of emission, radiation pattern and so on. There is flexibility of use, within the defined technical parameters and the ITU framework, but no content or service restrictions.

Tendering is a simple allocation mechanism, which minimizes the need for subjective decisions being made as in a beauty contest!

In the past 2 years, there has been the creation of property rights for: UHF TV (in spectrum which was largely unused); AM and FM sound broadcasting (using the ITU GE 75 plan); 4 cellular telephony bands at 800/900 MHz, which recognized one incumbent; and, spectrum at 2.3-2.4 GHz for 12 nationwide 8MHz channels.

The regime is working. There is trading of management and license rights. Given the experience gained in the past two years, a review of the legislation is being carried out, in order to create more flexibility, within the constraints of the laws of science.

RÉSUMÉ

Les initiatives tributaires du marché – L'expérience en Nouvelle Zélande

Par

KEN MCGUIRE and IAN HUTCHINGS
Ministère du commerce

Jusqu'en 1987, la gestion du spectre en Nouvelle-Zélande suivait le modèle conventionnel : services de télécommunication fournis par un monopole d'État et présence gouvernementale prononcée dans l'industrie de la radiodiffusion. Les questions touchant les radiodiffuseurs privés étaient réglées par un tribunal spécial.

Depuis, dans le cadre d'un processus général de réforme économique, on a éliminé les obstacles à l'entrée de nouveaux venus sur les marchés des télécommunications et de la radiodiffusion. Il n'existe plus aucune restriction en ce qui a trait au nombre de joueurs ni à leurs activités, et on n'impose plus de conditions spéciales, sauf celle de posséder une licence radio quand il y a lieu. Aucune restriction ne frappe les étrangers en matière de propriété, d'exploitation ni d'investissement.

Ce ne sont pas des règlements particuliers qui régissent la concurrence dans l'industrie, mais une loi générale (la Commerce Act de 1986) et un organisme multisectoriel, la Commerce Commission.

La Radiocommunications Act de 1989 a servi à établir un nouveau régime de licences pour les utilisateurs du spectre : reposant sur le concept du marché, il prévoit un régime de répartition des bandes du spectre comportant certains «droits de propriété» dont la durée peut atteindre 20 ans et qui peuvent être vendus. Ce régime novateur coexiste avec d'autres régimes beaucoup plus conventionnels pour les services maritime, aéronautique, amateur et le service radio général.

Il existe deux catégories de droits: les droits de gestion et les licences. Un droit de gestion est un droit légal de délivrer des licences permettant d'utiliser certaines fréquences tandis qu'une licence confère l'autorisation d'émettre des ondes radio sur une fréquence donnée, dans certaines conditions précises (puissance, classe, diagramme de rayonnement, etc.). Il existe de la souplesse au niveau de l'utilisation, sous réserve de certains paramètres techniques et des exigences de l'UIT, mais aucune restriction en ce qui a trait au contenu ni aux services offerts.

La délivrance de licences devient alors un simple mécanisme d'allocation où, contrairement à ce qui se passe lors d'un concours de beauté, les éléments subjectifs sont minimisés.

Au cours des deux dernières années, on a créé des droits de propriété pour la télévision UHF, dont les bandes étaient autrefois largement inutilisées, pour la radiodiffusion audio AM et FM (à l'aide du plan GE75 de l'UIT), pour 4 bandes de téléphonie cellulaire à 800/900 MHz (on reconnaît un titulaire existant) et pour les bandes de 2,3 à 2,4 GHz, afin d'y disposer 12 canaux nationaux de 8Mhz.

Le régime donne de bons résultats. Les droits de gestion et de licences sont vendus et achetés. À la lumière de l'expérience acquise au cours des deux dernières années, le gouvernement est en voie de réexaminer la Loi afin de l'assouplir d'avantage, sous réserve des possibilités scientifiques.

MARKET DRIVEN INITIATIVES
THE NEW ZEALAND EXPERIENCE

By

Ian R Hutchings and Kenneth J McGuire

1 INTRODUCTION

1.1 There is a substantial amount of literature available on the rationale behind both "administered" and "market-based" approaches to spectrum management and allocative mechanisms. I do not believe there is much to be gained from attempting to advance the general arguments any further. However, I think my most useful contribution to Spectrum 20/20 will be to touch on the New Zealand experience, so far, with a system of defined and tradeable spectrum rights and market-based allocation of those rights.

1.2 New Zealand is a geographically isolated country, with a land mass close to that of the United Kingdom. Our population is about 3.3 million people. Our nearest neighbours are over 2000 kms away in Australia.

1.3 Except for frequencies below 30 MHz, and recognised bands allocated to satellite services, there is little practical need to coordinate frequency usage with other administrations. There is comparatively low spectrum occupancy, with international usage and manufacturing, largely dictating utilisation. Not surprisingly, internal spectrum allocations are quite conventional and reflect most developed countries' environments. Why then, given the glorious isolation, consider alternative methods of allocation?

2 THE ENVIRONMENT FOR REFORM

2.1 Up until the mid 1980s the New Zealand Government held a near monopoly on the provision of all telecommunication services. Broadcasting was controlled through a judicial tribunal system, which assessed the value, or otherwise, of broadcasters to fill potential markets, using criteria such as, the impact on the economic viability of existing broadcasters, and the suitability, in the eyes of the Tribunal, of programme content. State-owned television operated two nation-wide networks, with a privately-owned third network having just gained a warrant. All television operated at VHF. The recognised UHF television bands lay empty, but a pay-TV company was keen to enter the market to provide 3 channel eventual- nationwide coverage. There were 67 FM and 101 AM sound broadcasting stations, of which, 80 were state-owned.

2.2 The Government, keen for economic reform, brought about extensive deregulation to both the provision of tele-communication services and broadcasting. Deregulation brought about a dramatic increase in demand for radio frequency spectrum and New Zealand's centrally administered allocation system, working on a "first come, first served" basis, was considered inappropriate in the new environment. In line with these reforms, a consultancy study recommended that tradeable spectrum rights were necessary for market-based allocative mechanisms to operate effectively and efficiently. This process of reform has since been extended to removing all barriers to foreign ownership, operation and investment.

3 LEGISLATIVE PROVISIONS

3.1 Late in 1989, the Radiocommunications Act was passed into law and contained several important provisions. These included:

- an ability for the Government to be able to create nation-wide property rights (known as management rights) for any contiguous portion of the radio spectrum;
- the ability of the Government, as manager of the rights, to either continue to administer that spectrum, by issuing licences, or transfer it to private ownership;
- the ability for any manager to issue tradeable licences for technically specific, but not purpose specific, uses of that spectrum;
- a public register, recording the ownership, and transfer, of management rights and licence rights;
- "grandfathering", under commercial terms, of most existing spectrum users when management rights created;
- private administrative "apparatus" licensing to continue in spectrum where management rights have not been created;
- civil action to replace criminal proceedings in the resolution of interference disputes; and
- the application of anti-trust legislation (The Commerce Act), using market-dominance tests, to the acquisition of spectrum rights.

3.2 The registry system is analogous to land ownership and tenure. Spectrum rights can be mortgaged and traded. Management rights may initially be created for any period up to 20 years and, so far, this timeframe has been applied. Licences

may also be created for any period up to the expiry date of the parent management right. Leasing of rights is not specifically provided for, but is implicit by contractual arrangements between parties. Once created, rights cannot be arbitrarily cancelled or revoked by the manager, who is defined as "a person named on a record of management rights as the manager of the range of frequencies to which the record of management rights relates". Licences continue in force, even when the management right is transferred or sold. This is similar to the sale of a building, with current leases.

There are no restrictions on the use to which a licence can be put; the licence only contains technical limits.

4 PROVISIONS FOR ALLOCATION OF SPECTRUM LICENCES

4.1 At the same time as the new regime was established, the Government adopted a "sealed-bid, second-price" public tender process, as the initial means of distribution of rights. This involves the highest bid winning the right, but only paying the amount bid by the second highest bidder. The intention was to promote rational bidding, in a marketplace where the real value of spectrum was unknown. This was also tempered by the Government's intention not to be exploitative in the process. Some theories indicate that the second-price process realises a price which is closer to true market value, but a body of opinion perceived it as the Government underselling a public asset. However, the process attracted considerable criticism, especially where vastly differing amounts were paid for basically identical rights, such as for VHF sound broadcasting rights in the same geographical area. In fact, the problem lay in a very thin market, rather than the second-price process.

4.2 The point needs to be made, that it was not the intention of the Government to use spectrum auctions as a source of revenue. In a recent paper on the New Zealand regime, Dr Milton Mueller stated that if raising revenue had been the prime purpose of the process, we had done an extraordinarily bad job. However, after careful consideration of all views, a decision was made to adopt the highest price for the last tender. It is very difficult to determine the relative impact of this change, but it has a wider measure of support from the marketplace and is perceived to be more rational.

5 TELEVISION BROADCASTING

5.1 The Radiocommunications Act passed into law on 19 December 1989, and two days later the first tender suitable for UHF television rights was released. The package comprised 70 lots, each allocated separately. The first seven lots each contained 29

licences for transmitting sites up and down the country, essentially a near-nationwide network, but without provision for "gap fillers". The remainder, 63 licences, generally low-powered, rights were put up for tender as individual lots.

The public tender was preceded by a call for "expressions of interest", which, to an extent, dimensioned the preferred coverage areas and the transmission sites.

5.2 Four of the 7 "networks" were won by the pay-TV company, which immediately set about establishing its news, movie and sports channels. It has about 60,000 subscribers currently, representing some 6% of the viewing market. Another channel was won by the Totalisator Agency Board, the national horse racing body, while another was awarded to a Christian broadcasting group, already active in AM broadcasting. Broadcast Communications Ltd, a state-owned enterprise, won a nation-wide network, with the intention to facilitate would-be broadcasters with complete transmission systems. There has been some activity in this area, but not to any large extent.

5.3 Not all the UHF spectrum was allocated by the tender process. The equivalent of two nation-wide networks have been reserved for non-commercial television, for Maori language and cultural purposes, and for possible educational television.

5.4 Interestingly, a low-powered station was won in Dunedin, one of our South Island cities, by a university student for \$1 - it was sold some 18 months later for \$12 500. The market does work!

6 SOUND BROADCASTING

6.1 There have been two tenders of MF-AM and VHF-FM broadcasting licence rights. The first tender being the most significant, with all remaining frequencies, allocated to New Zealand in the 1975 Geneva Plan (for Regions 1 and 3), in main centres, being put up for tender. The procedure used in the UHF TV process was used - there was a call for expressions of interest, followed by the publication of a draft proposal, which elicited further comment. The tender was opened on 26 July 1990. This was followed by the second tender on 3 October 1991. As for television broadcasting, not all assignments were put to tender. There has been spectrum reserved for non-commercial and Maori language broadcasters.

6.2 One of the most significant issues to arise out of the tender process, especially in FM broadcasting, was how the Government, in its role as band manager, could deal with requests from licence right holders to improve, or amend, the coverage associated with the right. The variation process is particularly important where significant value would result from improved coverage brought about by a change of transmitter site or, an increase in power.

6.3 Where a change is technically possible, and there is no impact on other rights, a policy has been developed which assesses the percentage of population increase against the prices paid for comparable rights. If the increase is above a certain threshold, the right holder can enter a contractual arrangement with the Ministry to relinquish that right for the amount paid, in order that a new improved right can be engineered and included in the next tender. In return, the improved right can be rented on a temporary basis until the tender, with the important condition that the "incumbent" has the option of pre-empting the successful bidder by matching the amount bid. The contract also covers such eventualities as the price being too great. In this circumstance, the opportunity is there for the "incumbent" to take a pre-determined percentage share of the difference between that which was originally paid and the second bid. Should the new right attract a lesser bid than that originally paid, the difference will be made up by the party from whom the licence was repurchased. In this way, there is no financial loss to either contracting party. However, there have been a number of variations and in all instances the pre-emption option was exercised.

7 CELLULAR TELEPHONY

7.1 The Telecom Corporation of New Zealand emerged as a state-owned enterprise following the break-up of the Post Office. Telecom was already operating a nation-wide cellular service on AMPS B channels when the corporation was sold by the Government to the American Bell-Atlantic and Ameritech consortium. As such, the private company had incumbency rights to continue operating in that band.

7.2 In addition, the AMPS A, the TACS A and TACS B bands, which are also suitable for GSM, were available and largely unused. The decision was made to put the three additional cellular bands to tender. On 18 May 1990 the tender was completed and Telecom provisionally won both the AMPS A and TACS B bands, with Bell-South winning TACS A.

7.3 Prior to the tender result becoming final, Telecom was required to obtain a "market dominance clearance", under normal provisions applicable for any merger or company takeover. The Commerce Commission declined Telecom's acquisition of AMPS A and, following legal action, Telecom lost both AMPS A and TACS B. That decision has recently been overturned by the Court of Appeal, leaving Telecom with both AMPS A and AMPS B. Telecom is now withdrawing the TACS B band appeal. The delay in settling ownership of the bands is, from a competition standpoint, unfortunate, but short of Government intervention to the actions before the courts, little could be done to speed up the process.

8 SUMMARY

8.1 After 4 tender rounds, much of the UHF television and sound broadcasting spectrum is covered by 20-year licence rights. The right holders, in exercising, or trading these rights are required only to comply with:

- 1 the technical description of the rights as registered under the Radiocommunications Act (transmitter location, power, frequency and the like);
- 2 the provisions of the Broadcasting Act in terms of programming standards; and
- 3 the market monopoly and dominance provisions of the Commerce Act.

8.2 There are no "use or lose" provisions with respect to rights, but serious cases of anti-competitive spectrum hoarding could be dealt with under the present anti-trust legislation. No cases of such action have been identified.

8.3 The Government has retained the management rights to the broadcast bands to ensure it can meet its policy objectives on non-commercial broadcasting. However, there are about 375 AM and FM licence rights, with most of them in use. Mortgages, trading and private leasing arrangements have all featured in transactions on licences, mostly without Government involvement.

8.4 The experience with broadcasting licence rights, with the removal of subjective judgement in favour of letting the market-place decide, is the most successful element of the New Zealand regime. However, a significant number of AM and FM broadcasting frequencies, together with UHF television channels, approximating two nation-wide networks, were not put out to tender and have been reserved by the Government to meet various public policy objectives, including non-commercial usage.

8.5 A criticism levelled at a totally market-based approach to spectrum management is the apparent incompatibility with, say, the International Radio Regulations. In this regard, the New Zealand legislation specifically identifies the requirement that a licence right be in accordance with the ITU regime, together with ICAO, IMO and SOLAS. In the UHF bands, often referred to as UHF TV spectrum, the band 470-890 MHz is allocated, in Region 3, to the fixed, mobile and broadcasting services, all with equal co-primary status. There is total flexibility within those international allocations.

8.6 Clearly there are spectrum allocations which could not easily fit within an international market-based allocation philosophy, such as aeronautical, maritime, radionavigation, and amateur, to mention but a few. It would be absurd to even contemplate a tender process for the band 108-136 MHz, even though there may be people in the market place with claims that the spectrum could be put to higher value use than the aviation industry. The same situation applies to those services with a high "safety service" orientation.

8.7 A similar constraint lies with those bands with an international interface, such as those allocated to the fixed satellite service. Take the band 3 700-4 200 MHz, where the fixed service, the fixed-satellite service and the mobile service enjoy joint co-primary status. In New Zealand, both the fixed service and mobile service could cohabit under a market-based management regime, but the fixed-satellite downlink element, with the potential for transponder changes, being made externally, over a wide band of frequencies, represents an area totally out of the influence of the band manager.

9 CONCLUSION

New Zealand has introduced a market based spectrum allocation regime for some frequency bands. In the sound broadcasting area, the supply of frequencies has been overtaken by demand. A market has emerged and is functioning. High costs associated with network television have, to an extent, suppressed active market-place trading, but the original pay TV requirement has become reality. There is some interest in local and regional television, where access to spectrum is possible, either by a further tender round or negotiation with holders of licences. Competition is emerging in the provision of cellular telephone services.

We are currently reviewing the Radiocommunications Act, not to materially change these market-based initiatives, but to overcome what has emerged as a rigidly engineered environment, with little room to manoeuvre, and to create more flexibility.

Thank you for your attention.

ABSTRACT

Towards a Wireless Society

By

LLOYD V. KUBIS
Motorola Canada Ltd.

The explosive growth of cellular radio demonstrates the growing trend towards increased mobility by telecommunications users. Cellular users to-day exceed 8 millions in North America - a number reached in less than a decade of service. By the end of the decade, the number of cellular users alone is expected to exceed 100 millions of users.

Yet, there still appears to be an insatiable demand for additional services, which in turn has resulted in the proposals for such services as public telepoint, PCN, Mobile Satellite, etc. Besides bringing additional wireless capacity, these new services will make these offerings more personal and more global in availability.

In parallel with public services, private use of radio continues to grow in a similar manner. The drive to become more productive is driving the use of radio by more and more commercial institutions, as well as public services such as public safety, medical, etc.

"Towards A Wireless Society" will review this growing use of wireless technology, as well as give the audience a glimpse into the future of these new services and wireless capabilities. The resulting pressure on spectrum resources will also be discussed and solutions proposed.

RÉSUMÉ

Vers la société sans fil

Par

LLOYD V. KUBIS
Motorola Canada Ltée.

La croissance fulgurante de la radio cellulaire est signe de l'attrait de plus en plus marqué qu'exercent les services mobiles sur les utilisateurs des télécommunications. Il y a aujourd'hui plus de 8 millions d'utilisateurs des services cellulaires en Amérique du Nord et ces services ne sont offerts que depuis moins de dix ans. D'ici la fin de la décennie, on prévoit qu'il y aura plus de 100 millions d'utilisateurs des services cellulaires.

Néanmoins, il semble y avoir une demande insatiable de nouveaux services publics et, pour la satisfaire, de nombreux projets ont vu le jour, dont les services de télépoints publics, les réseaux de communications personnelles et les services mobiles par satellite. Ces nouveaux services augmenteront les possibilités de transmission sans fil, offriront des produits plus personnalisés et seront plus largement répandus.

L'utilisation des services privés de radiocommunications croît au même rythme que celle des services publics. Pour accroître leur productivité, de plus en plus d'entreprises et de services publics, dont les services de police et les services médicaux, font appel aux radiocommunications.

L'exposé intitulé « Vers une société des communications sans fil » donnera un aperçu de l'utilisation croissante de la technologie des systèmes sans fil ainsi que de l'avenir des nouveaux services et des transmissions sans fil. L'exposé abordera également le problème de l'augmentation de la demande de fréquences aux fins de ces services ainsi que les solutions possibles.

ABSTRACT

"Whistle While You Work"

By

**ALVIN LAW
AJL Communications**

The world we live in, especially the media's portrayal, seems so negative and being optimistic is difficult at best. From his birth without arms, Alvin's life was projected by medical experts to have little or no potential for success. This became a challenge for his family who instilled in Alvin a belief that anything is possible, if you believe in yourself.

Many companies face a similar prognosis and need beliefs to make it in the 90's. Alvin is not a corporate consultant who can troubleshoot and plot a "five year plan". However, his good, and bad, life experience with humanity gives him an extraordinary perspective that you will never forget.

"Whistle While You Work", is all about self-perception. Alvin believes it's no coincidence that every work day begins in the bathroom. How you see yourself when you look in that mirror reflects on everything you do. Alvin shares his life story with a focus on how a positive self-image not only allowed him to overcome his disability, but prepared him to face any obstacle that to-day's world presents. Most important, his quest for excellence was not based on greed or selfishness, but on self fulfilment.

Says Alvin, "Life is funny, but so many people never laugh because they take everything too seriously". This attitude is everywhere, but in the race to the best in life, negativity can be magnified. Alvin will show you that slowing down and appreciating what really counts can bring about true success. Alvin law is a perfect example that nice guys don't always finish last, and he wants to help you get out of the starting blocks with the "Positive Attitude Edge".

RÉSUMÉ

«WHISTLE WHILE YOU WORK»

Par

ALVIN LAW
AJL Communications

Dans l'apparente grisaille du monde actuel, en particulier celui que nous présentent les médias, garder son optimisme ne va pas de soi. Né sans bras, Alvin n'avait guère de chance de réussir selon les experts de la médecine. Mais sa famille ne partageait pas cet avis. Tout est possible, disait-on chez lui, à qui croit en soi.

De nombreuses sociétés, face aux pronostics des experts, ont elles aussi besoin de cette assurance pour réussir dans les années 90. Certes, Alvin n'est pas le spécialiste omnipotent qui vous tracera votre «plan quinquennal». Mais son expérience des bons et des mauvais côtés de la vie lui donne une vision que vous n'oublierez pas.

«Whistle While You Work» tourne autour de l'image qu'on a de soi. Pour Alvin, il est logique que chaque jour de travail commence dans la salle de bain. Le face à face matinal avec soi devant le miroir donne le ton à la journée. Alvin raconte sa vie en montrant comment une image positive de soi lui a non seulement permis de surmonter son handicap, mais l'a préparé à tous les obstacles du monde actuel. Loin de la cupidité et de l'égoïsme, sa quête d'excellence a toujours visé l'épanouissement de soi.

«La vie est drôle, dit Alvin, mais tant de gens ne rient pas parce qu'ils prennent tout terriblement au sérieux.» Cette attitude est omniprésente, mais aussi bien dans la course des entreprises que dans les salons de BMW, le pessimisme peut faire boule de neige. Alvin Law vous montrera comment, en s'arrêtant pour apprécier l'essentiel, on peut parvenir au véritable succès. Par son exemple, il nous prouve que la bonne humeur peut être gagnante. Il veut aider votre société à partir du bon pied, avec une longueur d'avance!

SESSION 3

EMERGING TECHNOLOGICAL DEVELOPMENTS

SÉANCE 3

L'ACTUALITÉ: NOUVELLES TECHNOLOGIES

ABSTRACT

Communications is Becoming Personal

By

PETER J. MACLAREN
Northern Telecom Wireless Systems Inc.

The decade we are in will doubtless be remembered by historians as the one which communications came of age. While such a statement may appear strange given the 100 year history of the telecommunications business, it is only with the evolution to the personalization of communications that we will achieve the full value from the technology that has been evolving over this time. There have been three technical forces which have come together in the last two or three years which are creating this change. These are;

- a) the almost complete transition of our communications information structure to being computer controlled. This is allowing significantly more intelligence in the way communications transactions are handled by both Public and Private Networks - i.e. "Network Intelligence".
- b) stimulated by the dramatic success worldwide of Mobile Cellular Radio Systems, we are now seeing the rapid development of more compact, more user friendly and potentially significantly less expensive personal wireless telephones which will have the result of taking the phones out of the car and out of the backyards and into everyone's pockets wherever they go.
- c) the recognition, firstly at regional level and now at the global level, of the need to reassign radio spectrum to provide the bandwidth appropriate for accommodating the wireless revolution associated with the move to personal communications.

As we plan for this new age, it is extremely important that all participants - industry, government and end-users - recognize that true personal communications requires true standardization.

A good example of the problems that can come from short sighted approach in this arena comes from existing consumer electronics equipment. While the audio cassette and compact disk have become truly universal as a method of exchanging and circulating information on a global basis, videotape remains much more complex due to the three or four different television standards in use globally, the three or four different television standards in use globally, and the two or three different tape formats also in use. As we consider standardization we need to recognize that it must address all aspects of personal communications - from the way the phone is used i.e. human interface, right through the

wireless protocols and the standards for network databases and inter network communications. At the same time these standards must be developed in a way that allows for innovation and evolution to ensure that as we design the technology of the third millennium we don't constrain it to meet only the user requirements of the second.

Personal communications are a paradigm shift for our business. It represents an exciting new opportunity to make Communications Systems an ever more valuable part of the overall economic structure both for our own country and for the world at large.

RÉSUMÉ

Les télécommunications prennent un caractère personnel

Par

PETER J. MACLAREN
Northern Telecom Systèmes sans fil

Les historiens se souviendront sans doute de la présente décennie comme de celle où les télécommunications ont vraiment pris leur essor. Bien que cette affirmation puisse paraître étonnante, puisque les télécommunications datent déjà d'une centaine d'années, ce n'est qu'avec l'évolution de la personnalisation des télécommunications que nous exploiterons intégralement le potentiel d'une technologie qui a évolué pendant toute cette période. Trois forces ont convergé ces deux ou trois dernières années pour créer ce changement:

- a) L'informatisation presque complète des structures d'information sur les télécommunications permet aux réseaux publics et aux réseaux privés de traiter les télécommunications de façon beaucoup plus intelligente - nous disposons aujourd'hui de réseaux intelligents.
- b) Suite au succès spectaculaire remporté dans le monde entier par les systèmes de radiotéléphones mobiles cellulaires, nous assistons maintenant à la mise au point rapide de téléphones personnels sans fil plus compacts, plus faciles à utiliser, et susceptibles de devenir beaucoup moins coûteux, qui permettront à chacun de ne plus avoir le téléphone seulement dans sa voiture ou dans sa cour, mais également dans sa poche, partout où il ira.
- c) La reconnaissance, d'abord à l'échelle régionale et maintenant à l'échelle mondiale, de la nécessité de réattribuer le spectre de manière à fournir les fréquences permettant de répondre à la révolution des télécommunications sans fil liée au passage aux communications personnelles.

Au moment où nous planifions pour cette nouvelle ère, il est de la plus haute importance que tous les intervenants (industrie, gouvernement et utilisateurs) reconnaissent qu'une normalisation véritable est essentielle à l'implantation de véritables communications personnelles.

L'équipement électronique grand public fournit un bon exemple des problèmes qui peuvent découler d'une approche à courte vue dans ce domaine. Alors que les cassettes audio et les disques compacts sont devenus des moyens vraiment universels de transmettre et d'échanger de l'information à l'échelle mondiale, le cas des bandes vidéo demeure beaucoup plus complexe en raison de l'existence de trois ou quatre normes de télévision utilisées dans

le monde et des deux ou trois formats de bandes également utilisés. Quand nous pensons à la normalisation, nous devons reconnaître qu'elle doit englober tous les aspects des communications personnelles, depuis la façon dont on utilise le téléphone (interface humaine) jusqu'aux protocoles de télécommunications sans fil, aux normes sur les bases de données réseau et aux télécommunications entre les réseaux. En même temps, ces normes doivent être élaborées de manière à laisser place aux innovations et à l'évolution pour que, dans la conception de la technologie du troisième millénaire, nous ne limitions pas cette technologie aux besoins du deuxième millénaire.

Les communications personnelles représentent un changement d'une importance exemplaire pour nos activités. Elles offrent une possibilité nouvelle et emballante de faire des systèmes de télécommunications un élément de plus en plus précieux de la structure économique globale de notre propre pays et de l'ensemble du monde.

Communications is Becoming Personal

Author: **Peter J. MacLaren**

INTRODUCTION:

The decade we are in will doubtless be remembered by historians as the one in which communications came of age. While such a statement may appear strange given the 100 year history of the telecommunications business, it is only with the evolution to the personalisation of communications that we will achieve the full value from the technology that has been evolving over this time.

There have been three technical forces which have come together in the last few years which are creating this change.

These are:

- a) the almost complete transition of our communications infrastructure to being computer controlled. This is allowing significantly more intelligence in the way communications transactions are handled by both Public and Private Networks - i.e. "Network Intelligence".
- b) stimulated by the dramatic success worldwide of Mobile Cellular Radio Systems, we are now seeing the rapid development of more compact, more user friendly and potentially significantly less expensive personal wireless telephones which will have the result of taking the phones out of the cars and out of the backyards and into everyone's pockets where ever they go.

- c) the recognition, firstly at regional level and now at global level, of the need to reassign radio spectrum to provide the bandwidth appropriate for accommodating the wireless revolution associated with the move to personal communications.

Perhaps the most dramatic step in this direction was taken earlier this year at the ITU World Administrative Radio Conference 1992 (WARC '92) which was held February 3rd to March 3rd at Torremolinos, Spain. More than 1,400 delegates represented 127 countries, and observers from 31 international and regional organizations also participated. Among the final decisions were the initial steps for the future public land mobile telecommunication systems (FPLMTS). The conference decided to create a worldwide primary allocation to the mobile service in the band 1700 - 2690 MHz.

PROGRESS IN CANADA:

This year has been also been particularly busy in Canada for Wireless Communications.

In May of this year, the Department of Communications continued a process started with an October 1989 Gazette Notice, when the Minister announced the selection of CT2Plus Class 2 as the Canadian PCS standard and initiated the formal request for licence applications for public PCS service in Canada. With this announcement, Canada is forging a leadership position in North America in the area of Personal Communications, heralding benefits for both Canadian communications users and for the communications industry as a whole.

In June, Canada became the North American leader in deploying digital cellular technology. On June 25th AGT Cellular announced the availability of the world's first commercial TDMA digital mobile cellular telephone service, using unique, dual-mode cellular base station radio equipment supplied by MOTOROLA NORTEL Communications and manufactured in Calgary. Digital cellular service coverage became available immediately to 80 per cent of AGT Cellular's subscribers and this was extended to virtually all AGT subscribers by the end of August.

Bell Mobility and Rogers Cantel have also announced their intention to upgrade their cellular networks to digital over the coming year or so, and thus it is likely that, as a parallel to our leadership in digital technology in the wired network, Canada will become among the first countries, if not THE first country, to have a fully digital wireless cellular network.

The following month, on July 2nd, Northern Telecom and Matra announced that a joint venture would be formed between the two companies which will be responsible for developing and supplying cellular infrastructure switching and radio equipment for public networks using GSM-900 and DCS-1800 specifications. The joint venture will combine the complementary strengths of Matra Communication's radio base station technology and Northern Telecom's digital cellular central office switching, providing a complete range of GSM and PCN cellular infrastructure products. GSM and PCN are the digital cellular systems being deployed throughout Europe and in other countries worldwide including, for example, Australia where Northern Telecom recently won a major contract for GSM equipment.

Over a few short months Canada has put itself on the map as one of the leading players in the wireless communications business. Northern Telecom is proud to be playing a major role in this success.

We have also been very excited about the ongoing development of our wireless business system based on the CT2 CAI and CT2Plus Class 2 standards. First to be demonstrated at Telecom '91 in Geneva, it is a wireless business communication system which will enable people to carry their telephone handsets with them as they move throughout their place of work.

Northern Telecom's wireless business communication system can be used as a stand-alone device supporting both wired and wireless terminals, or as a wireless controller to be used in conjunction with our Meridian 1 private branch exchange (PBX), Meridian Centrex and Meridian Norstar key systems. It will also serve as a wireless controller for PBX systems from other major manufacturers. The system provides complete freedom of movement within the work environment through leadership in implementing automatic roaming and hand-off capability transparent to the end user.

THE FUTURE OF STANDARDS:

But we must not rest on our laurels - we must plan for the future.

While we in Canada have established a premier role in wireless through our leadership with digital cellular and through adopting an enhanced approach to PCS service deployment, it is extremely important that all participants - industry, government and end-users - recognize that personal communications requires true standardization on a global basis as we move forward to the next century.

A good example of the problems that can come from a short sighted approach in this area comes from existing consumer electronics equipment. While the audio cassette and compact disk have become truly universal as a method of exchanging and circulating information on a global basis, videotape remains much more complex due to the three or four different television standards in use globally and the two or three different tape formats also in use. As we consider standardization we need to recognize that it must address all aspects of personal communications - from the way the phone is used i.e. human interface, right through the wireless protocols and into the standard for network databases and inter network communications. At the same time these standards must be developed in a way that allows for innovation and evolution to ensure that, as we design the technology of the third millennium, we don't constrain it to meet only the user requirements of the second.

While clearly various PCS applications will have some different requirements from the others, cost penalties show strong justification for a single low power common air interface standard, where practical. An optimal common air interface (CAI) will have the attributes of low complexity for basic applications, but be expandable to support more sophisticated applications. Perhaps the most important issue for the success of PCS is the concern about market fragmentation. The public currently views the public telephone network as a single ubiquitous network and the cellular network as a second ubiquitous network, which is connected to the telephone network. A key facet of launching a Personal Communications service is to maintain this ubiquity, which implies that a single terminal operates in all major applications - business, residence and public service. Market research has indicated that users will perceive a high value from this ubiquity.

With current generation technology it makes practical sense to support two levels of wireless technology:

1. High power wide area systems with the need for heavier batteries and additional complexity to deal with fast moving terminals eg in automobiles.
2. Low power local area systems optimised for pedestrian use in-building or in high density public areas.

It is, however, desirable that, as we define the next generation of technology to implement the vision of FPLMTS, we strive globally to converge both the current different regional differences of high power system standards and that we address the technology requirements to merge the high power and low power applications into a single seamless approach. A realistic timeframe for achieving such objectives is in the last few years of this decade.

CONCLUSION:

In conclusion, Personal Communications is a paradigm shift for our business. It represents an exciting new opportunity to make communications systems an ever more valuable part of the overall economic structure both for our own country and for the world at large.

Northern Telecom is committed to the development and deployment of personal communication services (PCS) that provide mobility, reachability, and accessibility to mobile business and residential telephone users. Such services will evolve to deliver any or all communications functions to people on the move who need to keep in touch, using network intelligence to "follow" the user to the home, office, car, customer location, hotel, airport, shopping mall, or wherever is most convenient at any given moment.

Communications IS becoming Personal.

ABSTRACT

Radio Propagation, Coding, and Modulation Considerations For Indoor Wireless Communications

By

R.J.C. BULTITUDE, J.H. LODGE and R.W. BREITHAUPT
Communications Research Centre

A new family of wireless communications services is in the process of being developed and introduced for the workplace. These will include LAN's for PC's, microcellular voice and a growing set of data applications that will require wireless transmission in indoor environments. While some of the desired services can be provided with transmission speeds in the 100s of kb/s range, it is expected that future demands will require transmission speeds up to the full B-ISDN rate of 155.52 Mb/s.

This paper provides an overview of some of the radio propagation, coding and modulation issues that are being raised by the demand for these new services, and reports current work at the Communications Research Centre in these areas. A method is given for performance prediction on low data rate systems using indoor radio channels with bursty fading characteristics. Then, it is shown that multipath propagation in indoor environments imposes additional severe degradation when transmission speeds are increased. Finally, means for mitigation of the multipath-related degradation through the use of modulation, coding and diversity are discussed.

RÉSUMÉ

Facteurs liés à la propagation radio, au codage et à la modulation, dont il faut tenir compte aux fins de la transmission sans fil à l'intérieur des immeubles.

Par

R.J.C. BULTITUDE, J.H. LODGE et R.W. BREITHAUPT
Centre de recherches sur les communications

Une nouvelle famille de services de transmission sans fil est en cours d'élaboration et de mise en oeuvre en milieu de travail. Ces services comprendront notamment des réseaux locaux de micro-ordinateurs, des services de radiotéléphonie microcellulaire et un nombre croissant d'applications de transmission de données qui feront appel à la transmission sans fil à l'intérieur des immeubles. Certains des services envisagés peuvent être assurés à des vitesses de transmission de quelque centaines de kbit/s, mais on prévoit que la demande future exigera des vitesses de transmission pouvant atteindre le plein débit des RNIS à large bande, c.-à-d. 155,52 Mbit/s.

Le présent exposé donne un aperçu de certaines des questions liées à la propagation radio, au codage et à la modulation, qui sont soulevées par la demande pour ces nouveaux services, ainsi que des travaux actuellement effectués par le Centre de recherches sur les communications dans ces domaines. On y présente une méthode de prédiction du rendement des systèmes de transmission de données à faible débit qui exploitent des voies radio intérieures caractérisées par un évanouissement sporadique. On démontre ensuite que la propagation multivoie à l'intérieur des immeubles entraîne une très importante dégradation supplémentaire des signaux quand les vitesses de transmission augmentent. En dernier lieu, on expose des méthodes permettant d'atténuer la dégradation produite par la transmission multivoie grâce à l'utilisation de techniques de modulation, de codage et de diversité.

**Radio Propagation, Coding and Modulation Considerations
For Indoor Wireless Communications**

By

R. J. C. Bultitude, J. H. Lodge and R. W. Breithaupt

A new family of wireless communications services is in the process of being developed and introduced for the workplace. These will include LANs for PCs, microcellular voice and a growing set of data applications that will require wireless transmission in indoor environments. While some of the desired services can be provided with transmission speeds in the 100s of kb/s range, it is expected that future demands will require transmission speeds up to the full B-ISDN rate of 155.52 Mb/s.

This paper provides an overview of some of the radio propagation, coding, and modulation issues that are being raised by the demand for these new services, and reports current work at the Communications Research Centre in these areas. A method is given for performance prediction on low data rate systems using indoor radio channels with bursty fading characteristics. Then, it is shown that multipath propagation in indoor environments imposes additional severe degradation when transmission speeds are increased. Finally, means for mitigation of the multipath-related degradation through the use of modulation, coding and diversity are discussed.

1.0 Introduction

A new family of wireless communications services is in the process of being developed and introduced for the workplace. These include such things as LANs for PCs, microcellular voice services, and a growing set of data applications. Many of these are being implemented using systems which operate in the VHF and UHF frequency bands. While some of the currently desired services can be provided with transmission speeds, which are less than the basic ISDN access rate of 144 kb/s, it is expected that future applications will exploit speeds up to the full B-ISDN rate of 155.52 Mb/s.

This paper is intended to provide a brief overview of some of the radio propagation, coding, and modulation issues that are being raised by the demand for these services over wireless indoor radio channels, and to report highlights of current Canadian work at the Communications Research Centre (CRC) in these areas. It appears clear that the indoor propagation environment,

in particular, is not well understood, resulting in a tendency for some systems to be overdesigned in terms of transmit power, thus contributing to a growing problem of interference and pollution in our electromagnetic environment. Coding modulation and diversity are therefore important techniques to consider in system design to assure spectrum efficiency in an increasingly congested radio environment. Some issues associated with an anticipated move to the EHF bands, and the necessity for the achievement of lower transmission bit-error rates also require consideration.

It will be shown that multipath propagation in indoor environments imposes severe degradation on radio link error performance. Means by which this degradation can be overcome in both the UHF and the EHF frequency bands through careful selection of appropriate signalling, coding, and diversity techniques are also suggested and discussed.

2.0 Indoor Radio Propagation

In order to provide the knowledge required for the design of systems and equipment for the efficient transmission of digital information over indoor radio channels between stationary terminals (eg. desk-top and portable notebook computers) at the desired transmission rates, a good knowledge of radio channel characteristics in different operating environments is required. Since 1987, part of the work conducted by the Land Mobile and Indoor Radio Propagation Group at CRC has therefore been focused in this area. While others [1,2,3] have been concerned with propagation loss characteristics, the CRC work has had the objective of studying the distorting and performance degrading properties of various indoor channels and the identification of key parameters by which these channels can be characterized, and from which digital system performance can be predicted.

From early on [4] it was recognized that indoor channels between fixed terminals are considerably different from land mobile channels, which have been extensively studied in the past. On these channels, the assumptions that the received signal envelope has a Rayleigh probability distribution [5], with well-behaved, statistically stationary, channel statistics can no longer be automatically applied to worst-case designs as they can for land mobile systems. One reason is that in most cases, these assumptions can be shown to be invalid. A second is that worst-case designs will probably be proven to be less than adequate for indoor systems. This is because closer cells spacings, sometimes more favourable loss characteristics than those experienced on land mobile channels, and health and safety concerns all require the minimization of transmit powers and efficient use of the available spectrum.

Experimental research at CRC began [4] with the transmission of CW signals at 910 MHz between fixed terminals with monopole antennas. Specially-designed receive equipment was constructed to enable recordings of received signal amplitude and phase in a time series for data

analysis. These measurements showed that indoor radio channels are very nonstationary in a statistical sense, and would require the development of special mathematical procedures if propagation data is to be used for the prediction of performance in design calculations for future digital systems. As shown in Fig. 1, it was found that fading periods are interspersed at irregular intervals by periods during which the received signal remains constant at either a power level that will ultimately be calculable through link budget analysis, referred to [6] as the quiescent received power, or a "faded" power level which is either enhanced, or diminished with respect to the quiescent power as a result of multipath propagation, or shadowing. On these channels, the intermittent fading is caused by people moving within a zone of influence close to the communication link of interest, and terminates when the motion in the environment terminates. It is distinctly different from the fading on a mobile channel because of its bursty nature, and because the channel always returns to the same (quiescent) state after the "intruder" has left the zone of influence. Dozens of measurements in many different locations and different indoor environments over the past 5 years have shown that this type of fading is relatively independent of environment and can result in received powers that can vary at rates between 2 and 10 Hz over a range from +15 dB to -45 dB with respect to the quiescent power. The length of fading bursts typically varies between 1 and 75 seconds, while inter-burst intervals can be as short as tens of seconds and last for as long as several minutes. Statistics of the envelope during fading periods are not usually very well characterized by a Rayleigh distribution, but compare better with more Rician [4,5,6] characteristics, with random-to-specular (K) power ratios between -2 dB and -20 dB. Normally, Rayleigh characteristics are associated with non-line-of sight link configurations, whereas Rician characteristics are associated with configurations which allow line of sight between transmit and receive terminals. On fixed indoor channels, the Rician characteristics persist, however, whether or not there is line of sight. This occurs because of the severe multipath nature of the environment and the frequent localization of motion, which almost invariably allows one or a combination of several nonvariant multipath signals to provide an invariant and dominant contribution to the total received signal, while the other contributing signals fade.

CRC has developed a method [6] by which the special demands of the nonstationary channel characteristics can be accounted for in performance analyses. This method has been tested against actual performance (BER) measurements on narrowband (nonselective) indoor channels, and has been found to produce much better results than previously available worst-case design procedures. Reformulation and testing has still not been completed, however, for the broadband (frequency selective) case. Briefly, a received signal is classified as being in either a (1) quiescent, (2) fading, or (3) faded state, and a three-term equation is written for the probability of bit error as:

$$P_e = p_0 P_{e0} + p_1 P_{e1} + p_2 P_{e2}, \quad (1)$$

where, P_{e0} is the nonfading probability of error at the quiescent received signal power level, P_{e1} is the probability of error during fading, P_{e2} is the probability of error during faded intervals, and p_0 , p_1 and p_2 are the probabilities of the associated types of channel behaviour.

In eqn(1), P_{e0} is easily calculable using simple equations found in many text books [5] and a knowledge of the occurrence probability for quiescent behaviour resulting from propagation reports [6]. P_{e1} and P_{e2} , however are randomly time variant and must be calculated through a knowledge of the probability distribution for the power level and, in the case of P_{e1} , some parameter (the K ratio in Rayleigh and Rician cases) which describes the received power distribution during fading intervals. The result is a slight modification of eqn(1) to give the maximum probability of error that must be tolerated during "x" percent of the time as:

$$P_e^x(\gamma_0) = p_0 P_{e0}(\gamma_0) + p_1 P_{e1}(\gamma_1^x, k^x) + p_2 P_{e2}(\gamma_2^x), \quad (2)$$

where, γ_i ($i = 0, 1, \text{ or } 2$) represents the received signal-to-noise power ratio during quiescent, faded, and fading intervals, respectively,

$$\gamma_i^x = \gamma, \text{ s.t. } \text{Prob}[\gamma_i > \gamma_1^x] = x/100,$$

s.t. is an abbreviation for "such that", and

$$K^x = K, \text{ s.t. } \text{Prob}[K \leq K^x] = x/100.$$

Fig. 2 shows the difference in performance prediction that can result when all the various probabilities involved in characterizing the nonstationary channel behaviour are accounted for rather than simply assuming Rayleigh fading characteristics and designing for a worst-case scenario. In this case, the worst-case (Rayleigh) assumptions would have lead to the transmission of much less power than that required to meet any specified performance objectives at the 99 percent reliability level without channel protection. Viewed from a different perspective, however, results such as those shown by the lower curve in the figure, computed using eqn(2), would allow the design of individual indoor links at a lower (50 % shown in the figure) reliability level if, for example, path diversity were employed to simultaneously to ensure reliability. As a first approximation, "n" branch diversity would have the effect of multiplying the cumulative distribution for error performance by a power of "n", thereby decreasing the upper bound of error performance at each performance percentile. This would result in lower transmit powers on any individual link, thereby reducing the possibility of interference and allowing the specification of lower frequency reuse distances to give increased spectrum efficiency. Experimental work at CRC will continue with the objective of reporting the statistical parameters required in the above prediction method,

and hence enable the design of future indoor systems without the need for additional propagation measurements.

The above reported methods and analyses are suitable for the prediction of performance on indoor radio channels when transmission rates are below about 500 or 600 k symbols/sec. With some added diversity, required transmit powers could be reduced another 3 or 4 dB to make such systems predictable and perform with acceptable reliability for services such as E mail, voice messaging, and low resolution graphics [7]. When higher transmission rates are required, however, in addition to the bursty fading, distortion of transmitted signals as a result of multipath propagation becomes a problem. Again, it is important to consider fading and nonfading intervals separately. In fact, performance on a wideband channel can actually be worse when the channel is not fading than it is under fading conditions. Because the amount of performance-degrading signal distortion depends on the uniformity of the equivalent transfer function for the radio channel, degradation can be worse when the transfer function is severely nonuniform and invariant than it is when the channel is changing continuously, and therefore has severe nonuniformities for only some of the time.

Distortion of the channel transfer function due to multipath propagation causes inter-symbol interference that results in error performance bounds beyond which performance can no longer be increased by simple increases in received signal-to-noise ratio (SNR). This is because in any given system, one must increase transmit power in order to increase SNR. However, when transmit power is increased, the multipath signal powers increase proportionally with that of the direct (or desired) signal and the amount of inter-symbol interference remains unchanged. Fig. 3 is the result of a lengthy and complicated analysis procedure based in the theoretical work of Bello [8] that has been implemented at CRC to compute the effects of inter-symbol interference during portions of the fading intervals when the statistics of the fading are well behaved. This result was computed based on the statistical analyses of a time series of estimates for the impulse response of fixed indoor 910 MHz radio channels recorded at CRC. The figure clearly shows the effects of inter-symbol interference on DPSK transmission using equipment with practical receive and transmit filter pairs (Nyquist, $\alpha = 0.3$). The lowest curve in the figure, representing a transmission rate of 50 kB/s, is similar to those of Fig. 2 in that, as SNR is increased, the probability of error can always be seen to decrease. The change in slope of the curves at SNR values between 20 dB and 30 dB takes place because at this point, the quiescent received power is so high that the received signal no longer ever fades to power levels below the noise. As the transmission rate is increased, it can be seen that at higher values of SNR, the error performance begins to level off at "floors" representing higher and higher values for probability of error.

Propagation research at CRC is continuing with the objective of developing techniques such as that outlined earlier for the narrowband case to enable performance predictions for the broadband case based on a few statistics of the channel behaviour. Investigations are also being made to determine differences in channel characteristics within different frequency bands. For example, some theoretical models have been developed to predict differences between channel characteristics in the UHF band and those in the EHF band at 60 GHz. Such extremely high frequencies are being considered for indoor communications because of expected wider available transmission bandwidths. In addition, there is currently low demand for allocations at these frequencies because they are not suitable for communications over the longer transmission distances required for the provision of other services because of severe attenuation caused by atmospheric absorption due to oxygen atomic resonances. Based on theoretical results it is anticipated that fading will be very much more rapid at these frequencies, and that channel transfer function characteristics in a given location could be significantly different due to rough surface scattering effects. To verify these predictions CRC is now readying for extensive wideband channel characterization measurements at 40 GHz and 60 GHz.

Regardless of the band of operation, it is anticipated that the same type of error floors as those shown in Fig. 3 will exist at the higher of the transmission rates required for provision of broadband ISDN services. It is therefore clear that channel protection in the form of diversity, equalization, or coding, or the selection of more multipath and fading-resistant modulation schemes will be required if all services normally provided through wired ISDN connections are to be made available to wireless system users. The following section of this paper discusses techniques that are available to achieve better performance results on channels with characteristics such as those described in this section.

3.0 Modulation, coding and diversity considerations

For wireless indoor applications, radio equipment must offer high performance at low cost. Most of the data services that will be provided require the maintenance of very low bit-error rates, ranging between 1 in 10^5 and 1 in 10^{10} , especially if wireless services are to compete, or interface with fibre services, which currently offer performance with error rates lower than 1 in 10^{10} . Such low error rates can only be achieved with the aid of robust modulation schemes, diversity and error control coding. In the specification of such schemes, however, serious attention must be paid to cost/performance tradeoffs. The requirement for low cost means that constant envelope signalling schemes will probably be chosen so that amplifier linearity constraints can be reduced. Signalling schemes that are tolerant of phase noise and frequency errors will also be strong contenders, as they will allow the use of low cost oscillators and frequency synthesizers.

Since it is clear that there will be difficulty in the provision of B-ISDN (155.52 Mb/s) on indoor radio channels, a first step is to consider the provision of various multiples of the basic ISDN rate of 144 kb/s or the DS-1 rate of 1.544 Mb/s over short radio links to backbone system interface units. There, rate conversion to B-ISDN would take place before transmission over less impaired channels, such as fibre, or backbone radio systems aligned so as to have line of sight and low probability of fading (eg. systems between antennas at ceiling height [9]). Such sub-rate services could be provided at UHF, or EHF. One would expect, however, that signalling might have to be different in the two bands because of differences in propagation characteristics, component costs and spectrum availability.

At UHF, spectrum is quickly becoming an extremely scarce resource. Consequently, signalling schemes must be spectrally efficient and tolerant of interference. Direct sequence code division multiple access (CDMA) with some form of phase shift keying is a logical modulation choice as it satisfies these requirements, and additionally, can be implemented with built-in diversity due to the capability of properly designed receivers to discriminate among different multipath components. This could result in high order diversity with only a small number (eg. 2) of antennas [10]. A complication, however, is that such systems must employ power control to prevent capture by the strongest received signal. AT&T, Mitsubishi, Philips and Litton currently offer this sort of equipment for indoor communications. Until now, these kinds of system have typically used convolution, or Bose-Chaudhuri-Hocquenghem (BCH) codes for error correction coding. These types of code are suitable for correcting random errors. In order to meet future demands for extremely low error rates, while maintaining high capacity under bursty fading conditions, however, more powerful codes that are capable of correcting burst errors will be required. A likely approach might be to use a concatenated coding scheme with a convolutional inner code and a Reed-Solomon outer code [11]. With such a scheme, the convolutional inner code would correct random errors, while the Reed-Solomon code would correct burst errors. Concatenated codes can enable the achievement of very low error rates under conditions of low signal-to-noise ratios, thereby reducing transmit power requirements, interference potential, and equipment costs. In addition, when these codes are not capable of correcting errors satisfactorily, they are capable of detecting the decoding failure with very high probability so that path diversity, or some other form of rerouting to provide a better channel can be evoked. Concatenated coding schemes are particularly suited for use on indoor channels, as they have been shown to yield robust performance under Rician fading conditions [12].

At EHF, system design constraints are somewhat different from those which apply at UHF. Signalling schemes that are more tolerant of phase noise and frequency offsets are imperative here because of the high cost of obtaining stable oscillators. Faster rates of fading must also be dealt

with. Fortunately, however, because of less crowding than at UHF, spectral efficiency is not so stringent a requirement. This allows the use of more robust modulation schemes that are not very spectrally efficient, but can be detected using simple processing and are therefore very tolerant of frequency offsets and phase noise. Examples include M-ary frequency-shift keying and chirp-based techniques [13]. Diversity, available through the use of spread spectrum, may also be desirable. Frequency hopping, however, may be preferable to direct sequence spread spectrum modulation, as it has no requirement for power control and its lower spectral efficiency is not as significant here as it is at UHF. It is considered that Reed-Solomon codes would be appropriate in determining appropriate hopping sequences, as well as being employed for error detection and correction coding [14,15].

The greatest challenge to be faced in the development of indoor wireless systems is to eliminate the requirement for rate conversion at backbone interfaces and effect their direct operation at B-ISDN rates, with performance comparable to that available over fibre. The 155.52 Mb/s data rate requires large transmission bandwidths, which in turn means that such systems must operate at EHF. In addition, because of the short duration of transmitted symbols, the transmission of such extremely high data rates demands higher transmit powers to maintain high enough bit energies to achieve acceptably low error rates. This implies that power-efficient constant envelope modulation schemes are imperative. As for the narrow band EHF systems discussed above, modulation schemes must be robust to frequency and phase errors since any requirement for very stable oscillators is cost prohibitive. An example of an appropriate modulation scheme therefore would be quaternary continuous phase modulation, with pulse shaping that satisfies Nyquist's third criterion [16]. Its transmit waveform is a constant envelope approximation to that of $\pi/4$ quaternary PSK, which has been chosen for the North American digital cellular system. Because of the anticipated higher fading rate and bursty characteristics, pilot symbol assisted techniques [1,18] may also be attractive for this application. Such techniques require that a known "pilot" symbol be inserted at regular intervals in the transmit data sequence. These symbols are extracted by the system receivers and used to provide carrier phase tracking and symbol synchronization with simple, but robust signal processing [19]. Pilot symbol assisted techniques are capable of yielding performance close to that achievable with coherent detection. For 155.52 Mb/s services, frequency division multiple access (FDMA) is preferable to CDMA or time division multiple access (TDMA), because the spread spectrum spreading required for CDMA and the higher transmission rates required for TDMA would make an already very large transmission bandwidth even larger, with concomitant increases in noise and component costs.

One benefit of the required large transmission bandwidths is inherent frequency diversity. However, since multipath conditions at EHF are expected to be as poor, or worse than those

at UHF, reference to Fig. 3 shows that ISI-related degradation will probably be so bad that good performance at extremely high data rates will necessitate the use of an adaptive equalizer in addition to coding and diversity. In view of the fact that the number of taps required for equalization at such high symbol rates could be very large it, is envisaged that a modal approach to channel modelling could provide a useful basis for equalizer design. The composite multipath channel would be modelled by several dominant multipath groups represented as single rays with time variant characteristics, thus reducing the number of "paths" to be considered. This is similar in concept to the approach being taken by Bell Northern Research for equalizing digital land mobile radio channels [20]. For equalizers designed using such a simplified channel model it may be necessary to augment performance by using narrow beam, or adaptive beam shaping antennas for multipath mitigation. Concatenated coding could be employed to offer the advantages discussed earlier concerning narrowband systems at EHF. Finally, it is speculated that diversity of reasonably high order (eg. 3 or 4) may be necessary to achieve even higher performance gains than those needed to eliminate error floors at lower data rates.

4.0 Discussion and Conclusions

This paper has reported bursty fading characteristics, peculiar to indoor radio propagation channels, that must be fully understood and modelled in order to design systems for the most efficient use of the available spectrum. Methods for performance prediction that have been developed at CRC to take account of these peculiarities for the improved design of low data rate (eg. below 500 or 600 kb/s) systems have been reported, and problems envisaged in adapting these methods for high rate transmission have been discussed. Finally, modulation, coding and diversity techniques have been suggested to enable the improvement of bit-error performance beyond that which can be achieved on unprotected channels in order to meet future indoor system demands.

Based on this overview, it can be concluded that there is still much in-depth research required to properly understand indoor radio channel characteristics and to develop models and techniques for use in system design procedures. Simultaneously, much effort needs to be expended in the choice, testing and development of methods for system performance improvement. It is only through such a combination of research and development that the ultimate goal of making full B-ISDN services available over spectrum efficient indoor wireless networks can be achieved.

As a final observation, it should be noted that the growing proliferation of radio and other EMI/RFI signals in our environment is an increasing cause for concern. There is a need to consider this carefully, both from person-to-machine, and machine-to-machine points of view, as this is an important, albeit invisible, dimension of our physical environment!

REFERENCES

- 1 Alexander, S. E. , and Pugliese, G. , "Cordless communications within buildings: Results of measurements at 900 MHz and 60 GHz," Br. Telecom Journal, Vol. 1, No. 11, pp 99-105, July 1983.
- 2 Murray, R. R. Arnold, H. W. and Cox, D. C. , "815 MHz radio attenuation measured within a commercial building," Proc. IEEE International Symposium on Ant. & Prop. pp 209-212, Vol. 1, June 1986.
- 3 Patsiokas, S. J. , Johnson, B. K. , and Dialing, J. L. , "Propagation of radio signals inside buildings at 150, 450, and 850 MHz," 1987 IEEE Veh. Tech. Society Conference Proceedings, pp 66-71, March 1987.
- 4 Bultitude, R. J. C. , "Measurement, characterization and modelling of indoor 800/900 MHz radio channels for digital communications," IEEE Communications Magazine, Vol. 25, No. 6, June 1987.
- 5 Proakis, J. G. "DIGITAL COMMUNICATIONS", McGraw Hill Co. , New York, 1983.
- 6 Melançon, P. , and Bultitude, R. J. C. , "A method for the prediction of probability of error on indoor radio channels with bursty fading characteristics," Submitted for publication in The IEEE Journal on Selected Areas in Communications, Special Issue on Wireless Personal Communications, to be published in August, 1993.
- 7 Falconer, D. D. , "Broadband services accessed through microcellular indoor wireless systems," Internal memo, Canadian Institute for Telecommunications Research, July 31, 1992.
- 8 Siu, Frederick Wing Cheung, "A FEASIBILITY STUDY OF INTRABUILDING WIRELESS COMMUNICATIONS USING LOW LEVEL NOMINAL 60 GHZ RADIATION," MSc Thesis, Department of Electrical Engineering, University of British Columbia, January 1988.
- 9 Bello, P. A. , "Binary error probabilities over selectively fading channels containing specular components", IEEE Trans. Commun. Vol. COM-14, No. 4, August 1966.
- 10 Kavehrad, M. , and McLane, P. J. , "Spread spectrum for indoor digital radio," IEEE Communications Magazine, pp 32-40, June 1987.
- 11 Berlekamp, E. R. , Peile, R. E. , and Pope, S. P. , "The application of error control to communications", IEEE Communications Magazine, pp 44-57, April 1987.
- 12 Moher, M. L. and Lodge, J. H. , "Performance of concatenated Reed-Solomon trellis-coded modulation over Rician fading channels," Proc. 2nd International Mobile Satellite Conf. , pp 600-604, Ottawa, June 1990.
- 13 Alles, M. , and Pasupathy, S. , "Binary communications on the indoor wireless channel," Proc. 16th Biennial Symposium on Communications, Kingston, May 1992.
- 14 Peterson, D. J. , Wang, Q. , and Bhargava, V. K. , "On the hit distribution of Reed-Solomon

- frequency hop sequences," Proc. Fourth International Conference on Wireless Communications, Calgary, July 1992.
- 15 Wang, Q. , and Bhargava, V. K. , "Spread spectrum coding for multiple access communications," to be published in The Canadian Journal of Electrical and Computer Engineering, Vol. 17, No. 4, October 1992.
- 16 Sayer, B. and Pasupathy, S. , "Nyquist 3 pulse shaping in continuous phase modulation," IEEE Trans. Commun. , Vol. COM-35, pp 57-67, January 1987.
- 17 Moher, M. L. , and Lodge, J. H. , "TCMP-A modulation and coding strategy for Rician fading channels," IEEE Journal on Selected Areas in Communications, Vol. 7, No. 9, pp 1347-1355, December 1989.
- 18 Cavers, J. K. , and Liao, M. , "A comparison of pilot tone and pilot symbol techniques for digital mobile communications," Proc. Fourth International Conference on Wireless Communications, Calgary, July 1992.
- 19 Young, R. J. , Lodge, J. H. , and Pacola, L. C. , "An implementation of a reference symbol approach to generic modulation in fading channels," Proc. Second International Mobile Satellite Conference, pp 182-187, June 1990.
- 20 Javed, A. , "Digital cellular technology and performance," Proc. Fourth International Conference on Wireless Communications, Calgary, July 1992.

ABSTRACT

Future Developments in Satellite Technologies

By

JOHN T. FENELEY
Teleglobe Canada Inc.

Successful satellite system operators have continuously undertaken research and development programs that have been oriented towards the development of those satellites related technologies where the results have led to improved satellite communications to the customer. These new technologies have been included in the design of satellites and the technical requirements of earth stations, both fixed and mobile. They have equally been instrumental to the development of the technical basis for an expanding range of satellite related services.

This paper addresses the future development of satellite technology from the international perspective undertaken by the INMARSAT and INTELSAT organizations, where Teleglobe Canada is Canada's Signatory. Both of these organizations undertake extensive satellite technology development by means of their research and development programs, and special programs oriented to specific services.

In general, these programs focus on the future space and ground segment requirements; efficient use of the orbital and spectrum resources; improving the efficiencies and broadening the capabilities of the various satellite communications services; and development of user equipment.

RÉSUMÉ

Progrès futurs de la technologie des télécommunications par satellite

Par

JOHN T. FENELEY
Téléglobe Canada Inc.

Les exploitants prospères de systèmes de télécommunications par satellite ont mis en place des programmes permanents de recherche et de développement axés sur l'élaboration de technologies qui permettent d'offrir de meilleurs services à leurs clients. Ces nouvelles technologies sont prises en considération lors de la conception des satellites et de l'établissement des exigences techniques applicables aux stations terriennes du service fixe et du service mobile. Elles servent également de fondement technique à la conception d'une gamme de plus en plus importante de services exploitant les télécommunications par satellite.

Le présent exposé traite des futurs travaux internationaux de développement de la technologie des télécommunications par satellite, qui seront entrepris par INMARSAT et INTELSAT. Téléglobe Canada est le membre-signataire canadien de ces deux organismes qui effectuent des travaux intensifs de développement de technologies de télécommunications par satellite dans le cadre de leurs programmes de recherche et de développement et de programmes spéciaux conçus en fonction de services précis.

De façon générale, ces programmes sont axés sur les questions suivantes: exigences futures du secteur spatial et du secteur terrien, exploitation efficiente des ressources du spectre et de l'orbite, amélioration de l'efficience et des possibilités des divers services de télécommunications par satellite et développement du matériel d'abonné.

FUTURE DEVELOPMENTS IN SATELLITE TECHNOLOGIES

John T. Feneley

1. INTRODUCTION

Satellite related technologies developed over the last decade continue to be incorporated not only in the satellites providing service today and planned for the future, but also in the ground stations and the types of satellite services being implemented. Development of satellite related technologies is a continuing process, and much of the results of the research and development effort being undertaken today will be placed into commercial use in the future.

Both the INMARSAT and INTELSAT Organizations, where Teleglobe Canada is the Canadian Signatory, undertake extensive Research and Development activities, the results of which continue to benefit the public in improved and a broad range of satellite based communications.

2. INMARSAT

The International Maritime Satellite Organization, INMARSAT, which is really a misnomer as it now provides aeronautical, land and maritime mobile satellite services on a global basis, has from its beginnings as a maritime service provider, undertaken extensive Research and Development activities that have provided the technical basis for the new aeronautical and land mobile services, and also for the broadening of the portfolio of the maritime services. These activities have mainly focused on the technical developments for the mobile terminals and the complex requirements for the fixed earth stations, so as to ensure that the service is truly global and without discrimination as to its accessibility. Additionally, some of the results of INMARSAT's Research and Development effort will be incorporated in the communications payload and the navigation payload of the Inmarsat 3 series of satellites due to be launched in 1994.

3. INMARSAT R&D PROGRAM

This program focuses on the following major areas for future satellite technology development:

- Future space segment to provide the desired capabilities, capacity and coverage in the most cost effective manner, including use of geostationary and non-geostationary solutions;
- More efficient use of the limited mobile satellite service orbit/spectrum resource and reduction in space segment utilization costs through advanced techniques and technology;
- Efficient and timely Inmarsat introduction of new mobile satellite service frequency bands resulting from WARC-92;
- Improving the efficiency of aeronautical, land and maritime mobile satellite communications in general and the cost benefit advantages of Inmarsat mobile satellite services in particular;

- Encouraging development of smaller and lower cost user equipment, including those for land mobile applications which would be interoperable with terrestrial networks as part of the ITU Future Public Land Mobile Telecommunications System;
- Applications of new services that have global applicability and need global uniformity in service provision;
- Placing appropriate Inmarsat services as an integral part of Universal Public Telecommunications and Aeronautical Telecommunication Network services;
- Introduction of integrated Communications, Navigation and Surveillance services for mobile users;
- Taking advantage of technology developments, development of new concepts to meet user requirements that are not addressed by existing and planned service systems, e.g. wideband services, audio/data broadcasting to mobiles with medium and small gain antennas; and
- Cost effective land earth stations and network interfaces associated with new services and possible future space segments.

4. CURRENT INMARSAT R&D PROGRAMS

Non-GSO Spacecraft Designs

Study of the implications of LEO, MEO and HEO orbits on spacecraft design, for example, radiation environment, thermal and electrical design considerations, launch options, station keeping and attitude control.

System Impacts of WARC-92

WARC'92 resulted in new mobile bandwidth at L-band and S-band. It also imposed power flux density limits in some bands and requirements to share with non-geostationary orbits. System studies are being undertaken as to how future Inmarsat systems, including the space and ground segments, will be affected by new allocations or regulations.

Voice Coding

The study of bit rates in the range 600 to 2400 bit/s operating in difficult satellite propagation environments. Of particular interest is subjective voice quality as function of bit rate, adaptive rates, embedded error correction, low delay codecs, interpolation over lost frames and estimation of required rates for future systems.

Inmarsat Personal Communications Service

System studies related to modulation and coding issues, and the access control and signalling system.

Ground segment studies related to gateway implementation, networking, and handheld terminals.

Propagation Studies.

Study of Inter-Satellite Links for a LEO satellite constellation.

Low cost Land Earth Station design

Study of software, channel units, terrestrial network interfaces, suitability of existing and planned protocols and network configurations operating over a satellite system.

Long Term Satellite Availability and Integrity

Increasingly, Inmarsat is offering services where continuity of service is essential for support of communications related to safety. This applies particularly to aeronautical services, but will in the future also apply to the Global Maritime Distress and Safety System and to navigation. Where satellites are the sole means of communication, interruptions in communications, from whatever cause, must be minimized.

The study will establish the criteria that the system must satisfy to meet the needs for availability and integrity for future applications (e.g. aeronautical, GMDSS, navigation), investigate changes to the Inmarsat network architecture that would result in these criteria being satisfied, identify the technical and operational requirements and estimate the potential financial impact.

Advanced Vehicle mounted antennas for Inmarsat-M

Development of models for flat antenna mounting on the roof or on the trunk lid, and vertical rod antenna for permanent installation on a wing, on the roof using a magnetic foot, or clamped to a window.

Mixed Data Rates in Quadrature for Navigation Overlay

The Inmarsat 3 satellites due to be launched commencing in 1994 will each include a navigation payload. The geostationary overlay to the GPS and GLONASS systems will provide the integrity data. The quadrature technique permits more than one tier of service, for example a basic global integrity service on one channel, and a separate differential connections channel on the other. The study will address the alternatives for such quadrature operation.

Inmarsat Satellite Paging Service

Development of the equipment for use at the land earth stations and with industry for the satellite paging receivers.

Data Compression and ARQ for Inmarsat-M links

On-line data applications, including file transfer are being planned for the Inmarsat-M service. The Inmarsat-M channel itself includes only forward error control. The latest voice band data modems employ both compressed data and ARQ techniques, usually in an integrated manner. Similar integrated techniques will be essential for the many Inmarsat-M data applications. The study will analyze and develop these techniques for inclusion in the mobile terminals and the land earth station.

Video Transmission from Mobile Satellite Terminals

The field of digitized video compression, at data rates in the range of 56 Kbit/s to 2 Mbit/s, is in a very active state of development worldwide. Inmarsat has encountered widespread and strong interest in using the method of store-and-forward video, for journalism and video program distribution applications. In this method, a video codec is employed to convert the analogue video information to an intermediate rate such as 384 kbit/s. The data stream is captured and stored in a computer file. This file is then transmitted using the Inmarsat satellite at 56 or 64 kbit/s. This is captured at the user's central facility, and then played back at the original 384 kbit/s through a matching video codec, thus recovering the full motion analogue video. The same technique could make 64 kbit/s transmissions useful for "downloading" of video material, e.g. news bulletins, to mobile receivers. The R&D activity will examine currently available video compression algorithms such as CCITT H.261, and develop modifications to the codec and to the associated computer and software used for the temporary storage, so as to ensure the technical characteristics of the transmission are suitable for satellite transmission.

5. INTELSAT

INTELSAT has consistently been at the leading edge of satellite technology development which has resulted in many of the results of its Research and Development effort being included in the current system. Notable examples are as follows:

Space Segment

- development of dual-polarized antennas at C-band
- development of technologies for lightweight multiplexers and filters
- development of a Ku-band TWT technology
- invention and development of the nickel-hydrogen battery technology
- development of solar array technology for large body-stabilized spacecraft

- SS-TDMA sub-system technology and specification development
- power FET development for C-band SSPAs
- development of near-field test range techniques for antenna sub-systems
- development of radiation hardness test techniques for on-board microprocessor devices

Ground Segment

- dual-polarized earth station antennas and components
- broadband earth station antennas
- development of the TDMA ground terminal equipment, including modem, high-speed FEC codec, and acquisition synchronization unit
- site diversity switching implementations
- development tests and standardization of voiceband coding and DSI at 32 kbit/s and 16 kbit/s
- development of FEC for data rates at up to 45 Mbit/s

6. INTELSAT R&D PROGRAM

This program focuses on the following major areas for future satellite technology development:

- Provision of the most efficient, reliable and cost effective facilities through the most advanced technologies available to meet the needs of the users, consistent with the best and equitable use of the radio spectrum and orbital space.
- Provision of the best service at the lowest possible cost and to achieve the highest standards of service quality and reliability on an economical basis.
- Provision of the necessary technology base for a comprehensive family of services and, in so doing, to provide a meaningful response to competitive pressures, both present and future.

- Planning for the future for a flexible space segment, with global interconnectivity, to stimulate new and expanded services and higher fill factors and to ensure that the construction and operation of the space segment is undertaken on the basis of an optimum combination of costs, risk and benefits.

7. CURRENT INTELSAT R&D PROGRAMS

Variable Rate Voice Transmission

This project will be concerned with establishing the feasibility of voice compression at various low bit rates, so enabling a dynamic utilization of space segment capacity within the INTELSAT system, with the retention of fully acceptable service quality.

Advanced Modem/Codec Development for better spectral efficiency

The aim is to develop a modem which can be switched manually between the conventional QPSK mode and a more efficient trellis-coded modulation format, permitting significant increases in capacity especially with the continued use of original Standard A and Standard B earth stations.

Concurrent Ku-band beacon measurements along adjacent low-elevation angle satellite paths

The aim is to quantify the interference potential between collocated satellites due to severe tropospheric scintillation effects to assist in the definition of collocated satellite concepts or reductions in satellite spacing.

Compact Transmit/Receive C-band feed for a shaped reflector antenna

This project will be concerned with the development of a physically compact, broadband feed for use with a shaped (non-parabolic) reflector, so providing a greatly simplified, lightweight alternative to the present technology adopted for producing INTELSAT Hemi/Zone beam coverages at C-band.

Hybrid Solid-State/Vacuum Electronic Technology for satellite high power amplifiers

The development of a high power amplifier based upon the best and specifically complementary features of both solid-state and travelling wave tube hardware, to produce a fully integrated, internally linearized high power amplifier which can be made available by a single sub-contractor on a reduced lead-time delivery schedule.

- Encouraging development of smaller and lower cost user equipment, including those for land mobile applications which would be interoperable with terrestrial networks as part of the ITU Future Public Land Mobile Telecommunications System;
- Applications of new services that have global applicability and need global uniformity in service provision;
- Placing appropriate Inmarsat services as an integral part of Universal Public Telecommunications and Aeronautical Telecommunication Network services;
- Introduction of integrated Communications, Navigation and Surveillance services for mobile users;
- Taking advantage of technology developments, development of new concepts to meet user requirements that are not addressed by existing and planned service systems, e.g. wideband services, audio/data broadcasting to mobiles with medium and small gain antennas; and
- Cost effective land earth stations and network interfaces associated with new services and possible future space segments.

4. CURRENT INMARSAT R&D PROGRAMS

Non-GSO Spacecraft Designs

Study of the implications of LEO, MEO and HEO orbits on spacecraft design, for example, radiation environment, thermal and electrical design considerations, launch options, station keeping and attitude control.

System Impacts of WARC-92

WARC'92 resulted in new mobile bandwidth at L-band and S-band. It also imposed power flux density limits in some bands and requirements to share with non-geostationary orbits. System studies are being undertaken as to how future Inmarsat systems, including the space and ground segments, will be affected by new allocations or regulations.

Voice Coding

The study of bit rates in the range 600 to 2400 bit/s operating in difficult satellite propagation environments. Of particular interest is subjective voice quality as function of bit rate, adaptive rates, embedded error correction, low delay codecs, interpolation over lost frames and estimation of required rates for future systems.

Inmarsat Personal Communications Service

System studies related to modulation and coding issues, and the access control and signalling system.

Ground segment studies related to gateway implementation, networking, and handheld terminals.

Propagation Studies.

Study of Inter-Satellite Links for a LEO satellite constellation.

Low cost Land Earth Station design

Study of software, channel units, terrestrial network interfaces, suitability of existing and planned protocols and network configurations operating over a satellite system.

Long Term Satellite Availability and Integrity

Increasingly, Inmarsat is offering services where continuity of service is essential for support of communications related to safety. This applies particularly to aeronautical services, but will in the future also apply to the Global Maritime Distress and Safety System and to navigation. Where satellites are the sole means of communication, interruptions in communications, from whatever cause, must be minimized.

The study will establish the criteria that the system must satisfy to meet the needs for availability and integrity for future applications (e.g. aeronautical, GMDSS, navigation), investigate changes to the Inmarsat network architecture that would result in these criteria being satisfied, identify the technical and operational requirements and estimate the potential financial impact.

Advanced Vehicle mounted antennas for Inmarsat-M

Development of models for flat antenna mounting on the roof or on the trunk lid, and vertical rod antenna for permanent installation on a wing, on the roof using a magnetic foot, or clamped to a window.

Mixed Data Rates in Quadrature for Navigation Overlay

The Inmarsat 3 satellites due to be launched commencing in 1994 will each include a navigation payload. The geostationary overlay to the GPS and GLONASS systems will provide the integrity data. The quadrature technique permits more than one tier of service, for example a basic global integrity service on one channel, and a separate differential connections channel on the other. The study will address the alternatives for such quadrature operation.

Inmarsat Satellite Paging Service

Development of the equipment for use at the land earth stations and with industry for the satellite paging receivers.

Data Compression and ARQ for Inmarsat-M links

On-line data applications, including file transfer are being planned for the Inmarsat-M service. The Inmarsat-M channel itself includes only forward error control. The latest voice band data modems employ both compressed data and ARQ techniques, usually in an integrated manner. Similar integrated techniques will be essential for the many Inmarsat-M data applications. The study will analyze and develop these techniques for inclusion in the mobile terminals and the land earth station.

Video Transmission from Mobile Satellite Terminals

The field of digitized video compression, at data rates in the range of 56 Kbit/s to 2 Mbit/s, is in a very active state of development worldwide. Inmarsat has encountered widespread and strong interest in using the method of store-and-forward video, for journalism and video program distribution applications. In this method, a video codec is employed to convert the analogue video information to an intermediate rate such as 384 kbit/s. The data stream is captured and stored in a computer file. This file is then transmitted using the Inmarsat satellite at 56 or 64 kbit/s. This is captured at the user's central facility, and then played back at the original 384 kbit/s through a matching video codec, thus recovering the full motion analogue video. The same technique could make 64 kbit/s transmissions useful for "downloading" of video material, e.g. news bulletins, to mobile receivers. The R&D activity will examine currently available video compression algorithms such as CCITT H.261, and develop modifications to the codec and to the associated computer and software used for the temporary storage, so as to ensure the technical characteristics of the transmission are suitable for satellite transmission.

5. INTELSAT

INTELSAT has consistently been at the leading edge of satellite technology development which has resulted in many of the results of its Research and Development effort being included in the current system. Notable examples are as follows:

Space Segment

- development of dual-polarized antennas at C-band
- development of technologies for lightweight multiplexers and filters
- development of a Ku-band TWT technology
- invention and development of the nickel-hydrogen battery technology
- development of solar array technology for large body-stabilized spacecraft

- SS-TDMA sub-system technology and specification development
- power FET development for C-band SSPAs
- development of near-field test range techniques for antenna sub-systems
- development of radiation hardness test techniques for on-board microprocessor devices

Ground Segment

- dual-polarized earth station antennas and components
- broadband earth station antennas
- development of the TDMA ground terminal equipment, including modem, high-speed FEC codec, and acquisition synchronization unit
- site diversity switching implementations
- development tests and standardization of voiceband coding and DSI at 32 kbit/s and 16 kbit/s
- development of FEC for data rates at up to 45 Mbit/s

6. INTELSAT R&D PROGRAM

This program focuses on the following major areas for future satellite technology development:

- Provision of the most efficient, reliable and cost effective facilities through the most advanced technologies available to meet the needs of the users, consistent with the best and equitable use of the radio spectrum and orbital space.
- Provision of the best service at the lowest possible cost and to achieve the highest standards of service quality and reliability on an economical basis.
- Provision of the necessary technology base for a comprehensive family of services and, in so doing, to provide a meaningful response to competitive pressures, both present and future.

Planning for the future for a flexible space segment, with global interconnectivity, to stimulate new and expanded services and higher fill factors and to ensure that the construction and operation of the space segment is undertaken on the basis of an optimum combination of costs, risk and benefits.

7. CURRENT INTELSAT R&D PROGRAMS

Variable Rate Voice Transmission

This project will be concerned with establishing the feasibility of voice compression at various low bit rates, so enabling a dynamic utilization of space segment capacity within the INTELSAT system, with the retention of fully acceptable service quality.

Advanced Modem/Codec Development for better spectral efficiency

The aim is to develop a modem which can be switched manually between the conventional QPSK mode and a more efficient trellis-coded modulation format, permitting significant increases in capacity especially with the continued use of original Standard A and Standard B earth stations.

Concurrent Ku-band beacon measurements along adjacent low-elevation angle satellite paths

The aim is to quantify the interference potential between collocated satellites due to severe tropospheric scintillation effects to assist in the definition of collocated satellite concepts or reductions in satellite spacing.

Compact Transmit/Receive C-band feed for a shaped reflector antenna

This project will be concerned with the development of a physically compact, broadband feed for use with a shaped (non-parabolic) reflector, so providing a greatly simplified, lightweight alternative to the present technology adopted for producing INTELSAT Hemi/Zone beam coverages at C-band.

Hybrid Solid-State/Vacuum Electronic Technology for satellite high power amplifiers

The development of a high power amplifier based upon the best and specifically complementary features of both solid-state and travelling wave tube hardware, to produce a fully integrated, internally linearized high power amplifier which can be made available by a single sub-contractor on a reduced lead-time delivery schedule.

Collocation Strategies and Techniques

This project will be concerned with the control and manoeuvre strategies needed for "dual illumination" collocations (whereby two satellites have the same nominal location and can be accessed by a single earth station antenna) and the identification of the associated technology requirements.

Other current R&D Programs include the following:

Robust Digital TV Transmission Techniques, Operational Satellite Reliability Study, On-board Processing Benefits/Technologies, Transmission Capabilities for Video Services, Advanced Modulation Techniques, Ion Propulsion/Advanced Positioning and Attitude Control and Non-Geosynchronous Satellite System Capabilities.

8. CONCLUSIONS

Both INMARSAT and INTELSAT have clearly understood the need for a broad range of Research and Development Programs orientated towards the future development of those types of satellite technologies which are directly related to their respective businesses. Significant amounts of financial and human resources are allocated to these programs, all of which are funded by their members. The satellite industry is encouraged to participate in these programs, as much of it is contracted out, and thus successful companies can enhance their own commercial positions for the future.

John T. Feneley
Teleglobe Canada Inc.
1000 de la Gauchetière Street West
Montreal, Quebec
Canada
H3B 4X5

Telephone +1 514 868 7978
Facsimile +1 514 868 7234

ABSTRACT

Emerging Technologies for Fixed Services

By

**ROGER T. POOLE
Unitel Communications Inc.**

Historically, telecommunications has been applied on a dedicated, service-specific basis. Voice, data, and messaging networks have been distinct, separate entities in all aspects, from access through to switching and transport. There were many innovations but only a few shared technologies.

To-day, we have a unique opportunity to integrate services. This is created by the concurrent emergence of low-cost, high-capacity processing power and unprecedented transmission bandwidth, fuelled by innovations in VLSI, optics, and radio. High processing power allows us to create an intelligent network. Wide bandwidth provides the capacity to deliver the advantages of this intelligence to the customer.

These are emerging technologies that will influence and create fixed services in this decade and into the twenty-first century. The impact of integrated and wireless-access technology, high bandwidth switch fabrics, SONET-based transmission systems, and intelligent network platforms on entertainment, education, and telecommunication services will be discussed.

By examining the opportunities these technologies present to manufacturers, common carriers and, most importantly, users of telecommunication services, we will be better able to anticipate the benefits of innovation in our industry and appreciate the importance of the integration of technology and services.

RÉSUMÉ

De Nouvelles technologies pour services fixes

Par

**ROGER T. POOLE
Unitel Communications Inc.**

Historiquement, les applications de la technologie des télécommunications ont été spécialisées et spécifiques à tel ou tel service. Les réseaux de transmission de la voix, des données et des messages ont été des entités distinctes et indépendantes à tous égards, depuis l'accès jusqu'à la commutation et au transport. Nombreuses ont été les innovations, mais rares les technologies partagées.

Aujourd'hui, nous avons une occasion unique d'intégrer les services. Cette possibilité est attribuable à l'apparition simultanée d'une puissance de traitement grande capacité et bon marché et d'une largeur de bande de transmission sans précédent, facilitées par les innovations dans les domaines de l'intégration à très grande échelle, de l'optique et de la radio. Grâce à une grande capacité de traitement, nous sommes en mesure de créer un réseau intelligent. Une largeur de bande considérable permet par ailleurs de faire profiter le client des avantages de cette intelligence.

Ce sont là les technologies naissantes qui créeront et influenceront des services fixes au cours de la présente décennie et au début du XXI^e siècle. Les répercussions que la technologie intégrée et à accès sans fil, le matériel de commutation haut de gamme, les systèmes de transmission conformes à la norme SONET et les plates-formes en réseau auront sur les loisirs, l'éducation et les services de télécommunications feront l'objet de discussions.

Grâce à l'examen des possibilités que ces technologies offrent aux fabricants, aux entreprises de télécommunications et, ce qui est plus important, aux usagers des services de télécommunications, nous pourrons mieux prévoir les avantages des innovations pour notre industrie et apprécier l'importance de l'intégration de la technologie et des services.

ABSTRACT

Vision 2000

By

**EDWARD M. STRAIN
Vision 2000 Inc.**

Vision 2000 is a consortium of equipment, software and service providers primarily from the telecommunications industry, along with government departments and agencies, and academic institutions. It was formed as a result of an initiative by the Department of Communications.

The focus of VISION 2000 activities is in the area of Personal Communications, defined as the total communications environment experienced by the individual in their business and private lives. The mission of the organization is:

"... to empower the individual by fostering and accelerating the development and deployment of integrated systems of personal communications in Canada."

By achieving this mission statement, the objectives of creating new products and services for domestic and international markets will be realized.

The strategic plan is based on the work of industry markets and technology working groups, and involves the implementation of a number of specific Focus Projects having time frames from two to ten years. The definition of the projects commenced with a workshop of all members in June, and is now an ongoing process.

These projects have been chosen to represent areas where cross-cooperation can have a beneficial effect on the size and rate of acceptance of new products and services by the market. The industry participants will benefit by sharing in this enhanced market opportunity. In addition, the risks of new product development and deployment are reduced inside of this cooperative framework.

One of the major project areas of VISION 2000 is portable, mobile and remote area communications systems. Our geography and industry structure makes this a natural field in which we can take a leadership position. This of course opens the whole area of spectrum allocation and utilization as a subject of interest to VISION 2000 and its members. The coming explosion of wireless personal communications devices and systems will place new and more stringent demands on us to deliver all of the media functionality available with wired systems in the "tetherless" world. This will include text, data, graphics and in the end, full motion video. There will be pressures to release spectrum not currently being used for necessary or efficient functions, and to develop technologies for media compression, coding and modulation, spatial re-use, in-building systems and portable satellite terminals.

RÉSUMÉ

Vision 2000

Par

EDWARD M. STRAIN
Vision 2000 Inc.

VISION 2000 est un consortium de fournisseurs de matériel, de logiciel et de services -- principalement du secteur des télécommunications -- de ministères et organismes gouvernementaux et d'établissements universitaires. Il résulte d'une initiative du ministère des Communications.

Les activités de VISION 2000 concernent surtout les communications personnelles, c'est-à-dire l'ensemble des moyens de communication dont se sert le particulier, au travail ou à domicile. La mission de VISION 2000 consiste d'ailleurs à

conférer plus de pouvoir «...à l'individu en favorisant et en activant, au Canada, le développement et le déploiement de systèmes intégrés de communications personnelles de pointe.»

Si nous atteignons cet objectif, nous créerons du fait même de nouveaux produits et services pour les marchés canadien et étrangers.

Notre plan stratégique découle des efforts de différents groupes de travail qui ont étudié l'industrie, les marchés et les technologies; il prévoit plusieurs grands projets à réaliser sur deux à dix ans. Nous avons commencé à les définir en juin, à l'occasion d'un atelier auquel ont participé tous les membres et qui a été constitué en processus permanent.

Nous avons choisi des projets susceptibles de bénéficier de la collaboration des différents segments de l'industrie, particulièrement en ce qui a trait à la vitesse à laquelle les nouveaux produits et services seront acceptés sur le marché. Nos membres du secteur privé pourront évidemment tirer parti de cette amélioration du marché. La coopération réduira aussi les risques liés à l'élaboration et à la commercialisation de nouveaux produits.

L'un des principaux domaines d'activité de VISION 2000 est celui des systèmes de communications portatifs, mobiles et pour régions isolées. C'est un domaine où il serait naturel que les Canadiens prennent les devants vu l'énorme superficie de notre pays et la structure de notre industrie. Aussi VISION 2000 et ses membres s'intéressent-ils au dossier de l'allocation et de l'utilisation des bandes du spectre. En effet, bientôt, la multiplication effrénée des systèmes et des appareils de communications personnelles nous mettra tous plus que jamais au défi d'assurer les fonctions actuelles des réseaux câblés dans le monde du sans-fil: textes, données, graphiques et illustrations et, plus tard, vidéo plein mouvement. Certains feront pression en vue de faire libérer des bandes du spectre qui ne remplissent pas de fonction essentielle ou qui sont utilisées inefficacement, et en vue de favoriser

l'élaboration de technologies de compression, de codage et de modulation de signaux, de techniques permettant d'utiliser une même fréquence dans différentes zones proches les unes des autres, de systèmes d'immeuble et de stations portatives pour les communications par satellite.

VISION 2000

E. M. (Ted) STRAIN

VISION 2000 GENESIS

Telecommunications and Radio/Television broadcasting have been traditional strengths of Canadian industries in technology, applications, and services. These strengths have been fostered by our need to integrate business activities and culture among a sparse population scattered over large areas of urban, rural and remote geography. However, the recent explosion of new technological opportunities, coupled with aggressive deregulation of international markets, particularly in the United States, threatens to have us fall behind the rate of development and implementation of new systems in the rest of the world. This not only threatens the continued success of these industries, but in fact the productivity and competitiveness of all Canadian industry by delaying the application of communications technology to the development of new management structures, faster reaction to business situations, sales and marketing analysis and presentation, and a myriad of other business applications.

In 1989, with these challenges on the horizon, the Department of Communications convened a workshop they called "Search 20". It was attended by over sixty senior executives from industry, academia, and government. The participants agreed that while the technology and business challenges were real, the situation also represented opportunity for participation by Canadian industry in global markets. It was also agreed that the small size of the Canadian market and our close relationship to the U.S.A., meant that we should adopt a different approach to the development of our industry. Neither the European model of large, centrally controlled project development, nor the American model of open market "free-for-all" seemed to be the right solution in Canada. The consensus was that we should focus on an area of expertise, and that high level cooperation among the industry members, academia and government be used to integrate and accelerate the development of new products and services in the selected area. The area chosen for concentration was identified as Personal Communications. The participants left this workshop with a conviction and a commitment to continue the process.

Over the next two years the activities, now identified by the Vision 2000 name, centred around markets, technology and environment working groups in order to identify and quantify the selected project areas. In the fall of 1990, Vision 2000 was incorporated as a not for profit corporation with over 40 members supporting ongoing operations. In May 1991, a number of projects which related to the objectives were announced by the members and government research organizations. During this period the members expressed a desire to see a more focused set of mission, strategy and objectives which would translate into a specific set of major system projects which could be undertaken to provide new products and services for Canadian and international markets.

VISION 2000 MISSION AND STRATEGY

Starting in September 1991, a review of the output of the working groups, the capabilities of member companies and research labs, and the status of the competition was carried out. Particular attention was paid to the isolation of most of the current systems of personal communications, and to the forces of convergence which are rapidly drawing these together. At the terminal, HDTV and CD-ROM are pulling together the computing communications and television worlds, while our telephones are sprouting screens and becoming more "intelligent". At the access level, the telephony world is going wireless in search of mobility, while the broadcast world is becoming wired, digitized and compressed in search of more bandwidth for the explosion of channel capacity. In the network, the carriers and others are exploring technologies to switch and connect video frequencies, while the broadcast world is increasing network topology to become interactive. The personal communications environment of the not too distant future will be a much more integrated one.

The Mission of any organization must relate to the satisfaction of a need of its customers for the measurement of success. The Mission statement of Vision 2000 was therefore redeveloped to read:

"The mission of Vision 2000 is to empower the individual by fostering and accelerating the development and deployment of integrated systems of Advanced Personal Communications in Canada."

There are a number of key concepts in this statement. First of all, it is aimed at the individual as the customer. The systems under consideration are those which satisfy a broad range of the population in their work and personal lives. Secondly, the acceleration of the process is the means by which we can get back on the "power curve" of the implementation of these systems around the world. The strategy must address the acceleration problem. Thirdly, Vision 2000 will focus on product and service development and deployment. This is a major difference from those consortia which concentrate on precompetitive research, and is a challenge for industry competitors to accept. Lastly, we will use the Canadian market as an implementation test bed for the system concepts, but the eventual objective is to create opportunities in global markets for the participants.

This Mission statement gives rise to a clear strategy and action plan. Vision 2000 has defined a number of system projects which meet the criteria for market need and the potential of acceleration by industry cooperation. These projects have also been selected to represent a time sequence of deployment, with early stage projects which make use of existing technologies and infrastructures, and longer term projects which require advances in functionality of terminals and networks, lower costs for processing and bandwidth and new access and network connection and switching capability.

These projects are as follows:

1. A National Public System for the interchange of text, data, documents and images.
2. Mobile and remote personal systems and terminals.
3. Multimedia databases and networks.
4. Desktop Video systems.
5. Personalization of the network.
6. Secure integrated communications networks.
7. Bandwidth of the future.

In June of this year, Vision 2000 held a member's workshop which initiated industry discussion of the first four project areas. This process will be continued by means of an electronic conference, publication of the results as they progress and a series of regional meetings to be held across the country this fall. Our objective is to reach a consensus on the definition of the first project early in 1993 and to begin the development and deployment process at that time.

VISION 2000 BENEFITS

In Canada, the telecommunications product industry has revenues of about \$6 Billion, spends about \$1.5 Billion annually on Research and Development, and employs about 50,000 Canadians in high quality jobs. The telecommunications service industries have revenues in excess of \$16 Billion and employ a further 200,000 individuals. When you add to those figures the communications component of the semiconductor, Information Technology and Broadcast industries the full extent of the importance of this high technology sector to our economy is clear. It is also clear from the declining balance of trade figures, and the massive programs launched in Europe, America and the Far East to advance their communications sector industries that we are in danger of losing our traditional position of leadership. We need to take action to ensure that we get our share of these new market opportunities, and give our other industrial areas the opportunity to employ advanced communication systems at an early stage in their quest for efficiency and productivity.

We are all aware of the risks inherent in our businesses, particularly in the large commitment that must be made to bring a new product or service to the market. Because of the many interdependent layers that constitute the communications industry, the problem is magnified if elements of each layer act independently without detailed knowledge of the business strategy of

the other business elements. This market approach may work in very large markets with room for many competing system solutions, but our environment does not fit that description. Vision 2000 proposes that in the defined project areas that the industry adopt a strategy of cooperation and consultation that will achieve agreements on the framework which will be used to define system concepts at an early stage. This process will enable developments to proceed in parallel, permit content and means of delivery to be available simultaneously, and minimize the investment risk for the participants. The process may also lead to the formation of natural consortia for the execution of portions of these projects. This overall process will achieve the acceleration of availability which is the key mission objective. The products and services should be available in a time frame which will permit exploitation in international markets.

There is extensive evidence that markets are slow to develop when they are characterized by multiple competing proprietary solutions. Customers are unwilling to commit until they can be sure that their investment is not going to result in some dead-end which will limit their options. We see evidence around the world that this fact has been recognized as major and minor industry players participate in consortia, standards organizations and informal agreement processes. While these companies compete vigorously for market share, they also cooperate to create market expansion in which all market players can participate. This represents a new management paradigm which we have been slow to adopt in Canada. Vision 2000 intends to act as a catalyst to accelerate the acceptance of this process among the management of the relevant industries in Canada. The communications market in Canada is by no means saturated; customers are ready and willing to adopt useful new products and services when compatibility and standardization can clearly be demonstrated. The benefits to the industry participants will be increased revenues from market expansion.

VISION 2000 AND SPECTRUM

One of the key project areas for Vision 2000 activity is portable, mobile and remote systems and terminals. This is, of course, one of the most rapidly expanding markets for personal communications systems. The basic driving forces of accessibility regardless of location and personalization of network addressing which characterize the portable personal terminal are pushing this market forward rapidly. There is probably nothing that Vision 2000 needs to do, or indeed could do, to accelerate the implementation of the basic network and personal terminal markets in this area. However, the existence of the basic infrastructures for cellular, PCN and satellite mobile opens up many opportunities for advanced systems which go beyond the traditional voice services. Vision 2000 will concentrate its activities in this area to the extension of text, data, document and image media; to systems which relate to information access; and to management, control, navigation and location of individuals and vehicles. In addition, there are also opportunities in the areas of multiple access terminals and network integration, addressing and directory services. These are fertile areas for development in which content, infrastructure and terminal design must be integrated across normal business boundaries.

The demands of these new systems for bandwidth will greatly intensify the competition for spectrum allocation. We must obviously make use of the most advanced techniques for data compression, modulation and coding efficiency, time and spatial re-use of spectrum. As the cost of processing continues its rapid decline, for which there is no end yet in sight, and new algorithms for the optimal utilization of bandwidth become known and cost-effective, the industry will be able to meet the market demand for all of the communications services available in a fixed environment to also be available in a portable or mobile environment.

In order to meet the stated Vision 2000 objectives of acceleration and early deployment of advanced systems, we must be prepared in this country to take a leadership position in the reallocation and redeployment of spectrum resources. We must continue our examination of the uses to which we currently put our spectrum allocations. If they are not necessary, or if they are not being used efficiently, pressures should be brought to bear to free up those resources to meet the demands of new systems. An aggressive program with respect to the availability of spectrum for advanced applications will create in Canada a market and development opportunity which will continue the growth and leadership that we have enjoyed. Our geography, not often seen on a list of Canadian "advantages", and our strong industries in the resource and transportation sectors, make us a natural candidate for the development of these systems.

BIOGRAPHIES

BIOGRAPHY

NISAR AHMED

Director General, Engineering Programs Branch Department of Communications, Ottawa, Ontario

As Director General of the Engineering Programs Branch of DOC, Mr. Ahmed is involved in spectrum planning and in standardization governing the deployment of new and existing radio communication services and equipment in Canada.

Mr. Ahmed began his career in Britain working for a well-known radio communications manufacturer. There he was involved in communications research, development and commercial exploitation. After immigrating to Canada he began working for Bell-Northern Research Ltd. where he was appointed senior manager responsible for the systems design of new telecommunications services and distribution.

Since joining the Department of Communications, Mr. Ahmed has served as a director in the fields of Education Technology, Rural Communications and Data Communications. For the past 14 years he has worked primarily in the field of spectrum management. However, his current responsibilities also include the development and promulgation of mandatory network-protection standards for the attachment of customer provided terminal equipment to the telecommunications network.

BIOGRAPHIE

NISAR AHMED

Directeur général des Programmes techniques Ministère des Communications, Ottawa (Ontario)

En sa qualité de directeur général de la Direction générale des programmes techniques, M. Ahmed participe à la planification du spectre et à l'élaboration des normes régissant la répartition des services et des matériels de radiocommunications nouveaux ou déjà en service au Canada.

La carrière de M. Ahmed a débuté en Grande-Bretagne, où il travaillait pour un fabricant de matériels de radiocommunications bien connu. Ses fonctions l'ont amené à participer à la recherche, puis au développement et à l'exploitation commerciale des produits. A la suite de son immigration au Canada, il entra à l'emploi des Recherches Bell-Northern Ltée, où il fut nommé gestionnaire principal chargé de l'analyse organique de nouveaux services de télécommunications et de la distribution.

Depuis qu'il est au ministère des Communications, M. Ahmed a oeuvré à titre de directeur général dans les domaines de la technologie de l'enseignement, des communications rurales et de la télématique. Depuis 13 ans, il a surtout travaillé dans le domaine de la gestion du spectre. Cependant, ses fonctions actuelles comprennent en outre l'élaboration et la promulgation de normes de protection du réseau pour le raccordement de matériel d'abonné au réseau de télécommunications.

BIOGRAPHY

JAN WITOLD BARAN

**Ambassador, US Delegation WARC '92
Partner, Wiley, Rein & Fielding, Washington, D.C.**

Jan Witold Baran is a partner in the Washington, D.C. law firm of Wiley, Rein & Fielding where he is head of the firm's election and ethics laws practice.

In 1991, President Bush conferred on Mr. Baran the personal rank of Ambassador as Chairman of the U.S. Delegation to the World Administrative Radio Conference (WARC) in Torremolines, Spain which concluded in March 1992. Mr. Baran previously served on President Bush's Commission on Federal Ethics Law Reform and, from 1977-1979, was Executive Assistant to the Chairman of the Federal Election Commission.

Mr. Baran has consulted on election laws worldwide and has served as General Counsel to the 1988 Bush for President campaign, the American Bicentennial Presidential Inaugural and the Republican National Committee.

In addition to writing and lecturing on election law, Mr. Baran is chairman of the National Advisory Board of the Journal of Law & Politics at the University of Virginia and Chairman of the Standing Committee on Election Law of the American Bar Association.

Mr. Baran is a graduate of Ohio Wesleyan University and the Vanderbilt University School of Law where he was a Patrick Wilson Scholar of Law. He is a naturalized American, having immigrated to the United States in 1951. He and his wife, Kathryn Kavanagh, have four children and reside in Alexandria, Virginia.

BIOGRAPHIE

JAN WITOLD BARAN

**Ambassadeur, Délégation américaine à CAMR 92
Partner - Wiley, Rein & Fielding, Washington, (D.C.)**

Jan Witold Baran est membre de l'étude d'avocats Wiley, Rein et Fielding de Washington (D.C.) dont il dirige le bureau du droit des élections et de la déontologie.

En 1991, le président Bush a conféré à M. Baran le rang d'ambassadeur à titre personnel en tant que président de la délégation américaine à la Conférence administrative mondiale des radiocommunications (CAMR) de Torremolinos (Espagne) en mars 1992. M. Baran avait auparavant fait partie de la Commission du président Bush sur la réforme fédérale du droit de la déontologie et, de 1977 à 1979, avait été adjoint administratif du président de la Commission fédérale des élections.

M. Baran a été conseiller pour divers pays en matière de droit des élections et avocat général pour la campagne présidentielle de George Bush en 1988, l'American Bicentennial Presidential Inaugural et le Comité national républicain.

Outre ses écrits et conférences sur le droit des élections, M. Baran est président du conseil consultatif national du Journal of Law & Politics à l'Université de Virginie et président du comité permanent du droit des élections de l'American Bar Association.

M. Baran est diplômé de l'Ohio Wesleyan University et de la Vanderbilt University School of Law où il a été «Patrick Wilson Scholar of Law». Il est naturalisé Américain, ayant immigré aux États-Unis en 1951. Sa femme, Kathryn Kavanagh, et lui ont quatre enfants et vivent à Alexandria, en Virginie.

BIOGRAPHY

THE HONOURABLE PERRIN BEATTY

Minister of Communications

The Honourable Perrin Beatty, M.P. for Wellington-Grey-Dufferin-Simcoe, was born in Toronto in 1950 and educated at Fergus Public School, Upper Canada College and the University of Western Ontario.

Following his graduation in 1971, Mr. Beatty worked as Special Assistant to the Honourable Bert Lawrence, then Ontario's Minister of Health. Mr. Beatty was first elected to the House of Commons in 1972, at the age of 22.

In 1972, he served as a member of the Special Joint Committee studying the Constitution. The following year, he became the youngest Cabinet Minister to that point in Canadian history, serving as Minister of State for the Treasury Board. Following the 1980 election, Mr. Beatty became the Party's spokesperson on Communications and co-chaired the Standing Joint Committee on Regulations and Other Statutory Instruments. He was also a member of the Special Joint Committee on the Constitution of Canada.

In 1983, Mr. Beatty led the Progressive Conservative Caucus Task Force on Revenue Canada which held hearings across Canada and made sweeping recommendations to make tax collection fairer and more effective.

In 1984, he became Minister of National Revenue and Minister Responsible for Canada Post Corporation. During his time, he implemented the Progressive Conservative Task Force report on Revenue Canada and drafted the Declaration of Taxpayers' Rights.

As Solicitor General of Canada (August 1985), Mr. Beatty amended the Young Offenders Act and steered new legislation through Parliament to protect society from dangerous offenders. He also initiated a program to help find missing children.

Mr. Beatty was named Minister of National Defence in June 1986. One year later, he introduced a White Paper on National Defence, the first such policy review in 16 years. In July 1988, he succeeded in repealing the Wars Measures Act and replacing it with modern emergencies legislation to better protect civil rights.

He was appointed Minister of National Health and Welfare in January 1989. Major initiatives during this time included new measures to combat AIDS and programs to improve the status of children in Canada and to address the problem of family violence. Mr. Beatty chaired the Cabinet Committee on Human Resources, Income and Health, and was Vice-Chairperson for the Cabinet Committee on the Environment.

Mr. Beatty was named Minister of Communications on April 21, 1991. He now chairs the Cabinet Committee on the Environment and sits on a number of other important committees, including the committee on Canadian Unity and Constitutional negotiations.

Mr. Beatty and his wife, Julia, have two sons, Christopher and Patrick. The Beattys live in Fergus, Ontario.

BIOGRAPHIE

L'HONORABLE PERRIN BEATTY Ministre des Communications, Ottawa (Ontario)

L'honorable Perrin Beatty, député de Wellington-Grey-Dufferin-Simcoe, est né à Toronto en 1950 et a fait ses études à l'école publique de Fergus, au Collège Upper Canada et à l'Université Western Ontario.

En 1971, à la fin de ses études, il est nommé adjoint spécial de l'honorable Bert Lawrence, alors ministre de la Santé de l'Ontario. M. Beatty est élu pour la première fois à la Chambre des communes en 1972 à l'âge de 22 ans.

En 1978, il est membre du Comité mixte spécial chargé de l'étude de la Constitution. L'année suivante, il est nommé ministre d'État au Conseil du Trésor et devient alors le plus jeune ministre du Cabinet de l'histoire du Canada. Après les élections de 1980, M. Beatty est nommé porte-parole du caucus en matière de communications et il est élu coprésident du Comité mixte permanent des règlements et autres textes réglementaires. Il est également membre du Comité mixte spécial sur la Constitution du Canada.

En 1983, il dirige le groupe de travail du caucus conservateur sur Revenue Canada, qui tient des audiences publiques partout au Canada et fait des recommandations radicales en vue de rendre la perception des impôts plus efficace et quitable.

En 1984, M. Beatty est nommé ministre du Revenue national et ministre chargé de la Société canadienne des postes. Il donne alors suite aux recommandations du rapport du groupe de travail progressiste-conservateur sur Revenu Canada et rédige la Déclaration des droits des contribuables.

Au cours de son mandat à titre de Solliciteur générale du Canada (août 1985), il modifie la **Loi sur les jeunes contrevenants** et pilote, jusqu'au parlement, une nouvelle loi destinée à protéger la société contre les criminels dangereux. Il crée également un programme pour aider à trouver les enfants disparus.

M. Beatty est nommé ministre de la Défense nationale en juin 1986. En juin 1987, il dépose le Livre blanc sur la Défense nationale, la première étude d'orientation de ce genre depuis 16 ans. En juillet 1988, il fait abolir la **Loi sur les mesures de guerre** et la remplace par la **Loi sur les mesures d'urgence** afin de mieux protéger les droits civils.

Il est nommé ministre de la Santé nationale et du Bien-être social en janvier 1989. Durant ce mandat, on compte parmi les principales initiatives de M. Beatty des mesures pour combattre le sida et des programmes destinés à améliorer le statut de l'enfant au Canada et à prévenir la violence familiale. Il préside le Comité du Cabinet chargé des ressources

humaines, revenus et santé, et il est vice-président du Comité du Cabinet sur l'environnement.

M. Beatty est nommé ministre des Communications le 21 avril 1991. En outre, il est président du Comité du Cabinet sur l'environnement et membre de plusieurs autres comités importants, dont celui chargé de l'unité canadienne et des négociations constitutionnelles.

M. Beatty et sa femme Julia ont deux fils, Christopher et Patrick. Ils vivent à Fergus, en Ontario.

BIOGRAPHY

MICHAEL BINDER

**Acting Deputy Minister
Department of Communications, Ottawa, Ontario**

Michael Binder is Acting Deputy Minister of the Department of Communications.

Michael Binder joined the public service in 1971. He has held various professional and managerial positions in a number of departments and agencies, including the Defence Research Board, the Ministry of State for Urban Affairs and the Canada Mortgage and Housing Corporation.

In May 1981, he became Director of Departmental operations in the Program Evaluation Branch of the Office of the Comptroller General of Canada. He joined the Department of Communications (DOC) in 1985 as Assistant Deputy Minister, Corporate Management.

In January 1992, Mr. Binder assumed new responsibilities as DOC's Senior Assistant Deputy Minister, Research and Spectrum. In this capacity, he is responsible for coordinating cross-departmental activities and for the department's extensive regional operations. In addition, he is responsible for a number of industry support programs, R&D policy, management of the departmental informatics branch, and for providing substantive direction to the department's laboratories and the Government Telecommunications Agency. He also carries corporate responsibility for standards which is discharged through his authority by the Standards Program Office.

Mr. Binder holds both Masters and Doctoral degrees in Physics from the University of Alberta.

BIOGRAPHIE

MICHAEL BINDER

**Sous-ministre par/int.
Ministère des Communications, Ottawa (Ontario)**

Michael Binder est le sous-ministre intérimaire du ministère des Communications.

M. Binder s'est joint à la fonction publique en 1971. Il a occupé différents postes fonctionnels et gestionnels au sein de plusieurs ministère et organismes, entre autres le Conseil de recherches sur la défense, le ministère canadienne d'hypothèques et de logement.

En 1981, il a été nommé directeur des Opérations ministérielles de la Direction générale de l'évaluation des programmes, Bureau du contrôleur général. C'est en 1985 qu'il est passé au ministère des Communications en qualité de sous-ministre adjoint, Gestion intégrée.

En janvier 1992, M. Binder a accepté les responsabilités de sous-ministre adjoint principal, Recherche et spectre. A ce titre, il doit coordonner les activités interministérielles et voir aux opérations régionales, très étendues, du ministère. Il est aussi chargé d'un certain nombre de programmes de soutien de l'industrie, de la politique de R-D et de la Direction générale de l'informatique. Il oriente généralement les travaux des laboratoires du MDC et de l'Agence des télécommunications gouvernementales. Enfin, M. Binder est le responsable des normes, responsabilité que le Bureau des normes remplit en son nom.

M. Binder possède une maîtrise et un doctorat en physique de l'Université de l'Alberta.

BIOGRAPHY

DR. ROBERT W. BREITHAUPt

**Interim President
Communications Research Centre, Ottawa, Ontario**

Dr. R.W. Breithaupt received his BSc (Hon) and MSc in Electrical Engineering from Queen's University at Kingston. He then received his PhD. in Electrical Engineering from University College in London, England. During this combined period, Dr. Breithaupt received several scholarships from Queen's University, National Research Council and Commonwealth Scholarship.

Upon graduation, Dr. Breithaupt joined the Department of Communications and was Director of the MSAT program in the Telecommunications and Informatics Section. He was also Director of Space and Telecommunications and worked on ESA programs, SPAR CDP and Telesat procurement.

In 1987 he was appointed Director General Communications Applications at DOC. During this period he was responsible for SCAP, MSAT, and ICS program development. Later the following year, Dr. Breithaupt joined the Communications Technologies Research branch of DOC as Director General and responsible for propagation, radio and satellite communications for MSAT. He was also Chairman for MSAT PIC, alternate member ICS, IAC representative for RES, NSERC Grant Committee member and responsible for the DND recoverable program.

In early 1992, Dr. Breithaupt was head of the CRC Transition management team responsible for establishing CRC as a research institute of DOC.

Presently, Dr. R.W. Breithaupt is Interim President of the Communications Research Centre and accountable for all DOC research activity at the CRC.

BIOGRAPHIE

ROBERT W. BREITHAUPT, Ph.D.

Président intérimaire

Centre de recherches sur les communications, Ottawa (Ontario)

M. R. W. Breithaupt a obtenu un B.Sc. (avec mention) et une M.Sc. en génie électrique de l'université Queen's à Kingston. Il a ensuite obtenu un Ph.D. en génie électrique du University College, à Londres, Angleterre. Au cours de ses études, M. Breithaupt a obtenu plusieurs bourses d'études de l'université Queen's et du Conseil national de recherches ainsi qu'une bourse du Commonwealth (Commonwealth Scholarship).

Après avoir terminé ses études universitaires, M. Breithaupt s'est joint au ministère des Communications et il a été directeur du programme MSAT de la section des télécommunications et de l'informatique. Il a également été directeur du programme des télécommunications et de l'espace et il a pris part à des programmes de l'ASE et à des activités d'approvisionnement auprès de Télésat, de CDP et de SPAR.

En 1987, il a été nommé directeur général des Applications des télécommunications au MDC. Il était alors responsable des programmes SCAP, MSAT et ICS. L'année suivante, M. Breithaupt est devenu directeur général de la Recherche en technologies de télécommunications au MDC, où il était chargé de l'étude de la propagation et des communications radio et par satellite aux fins du programme MSAT. Il était également président du MSAT PIC, membre suppléant de l'ICS, représentant de l'IAC pour le RES, membre du Comité des subventions du CRSNG et responsable du Programme de la Défense nationale à frais recouvrables.

Au début de 1992, M. Breithaupt était à la tête de l'équipe chargée de la gestion de la transition du statut CRC à celui d'institut de recherche du MDC.

M. Breithaupt est actuellement président intérimaire du Centre de recherches sur les communications et, à ce titre, il est responsable de toutes les activités de recherche du MDC menées au CRC.

BIOGRAPHY

GARY C. BROOKS

Chairman, IFRB

International Telecommunications Union (ITU), Geneva, Switzerland

Gary C. Brooks graduated in Electrical Engineering from the University of British Columbia, Canada in 1959.

After many years with the Canadian Department of Communications, he was appointed in 1977 to head the Engineering Department of the IFRB. In 1980 he returned to the Canadian Communications Department in a senior management position in the Radio Regulations area. Mr. Brooks participated in CCIR meetings and in numerous administrative radio conferences before he was elected member of the IFRB by the Nairobi ITU Plenipotentiary Conference in 1982 and re-elected by Nice ITU Plenipotentiary Conference in 1989.

He is also a registered Professional Engineer in the Province of Ontario, Canada.

BIOGRAPHIE

GARY C. BROOKS

Président, Comité international d'enregistrement des fréquences (IFRB), Union internationale des télécommunications (UIT), Genève (Suisse)

Monsieur Gary C. Brooks a reçu son diplôme de génie électrique de l'université de la Colombie-Britannique en 1959. Après de nombreuses années au service du ministère des Communications du Canada, il a été nommé chef du service de Génie de l'IFRB en 1977. En 1980, il a réintégré le ministère des Communications comme cadre supérieur dans le secteur de la réglementation radio. M. Brooks a participé à de nombreuses réunions du CCIR et conférences administratives des radiocommunications avant d'être élu, en 1982, membre de l'IFB par la Conférence plénipotentiare de Nairobi. Son mandat a été reconduit à l'occasion de la Conférence plénipotentiare de l'UIT tenue à Nice en 1989. M. Brooks est ingénieur professionnel accrédité par la province de l'Ontario, au Canada.

BIOGRAPHY

MICHAEL H. CALLENDAR

**Senior Member, Technical Staff
MPR Teltech Ltd., Burnaby B.C.**

Michael H. Callendar graduated with a London University B.Sc. in 1959, is a chartered engineer and a member of the Institute of Electrical Engineers. He worked in the communications field in a number of countries before joining British Columbia Telephone Company in 1974, where he was responsible for automation of their radio telephone network.

He is a Senior Member of the Technical Staff of MPR Teltech, the Research and Development arm of the B.C. Tel Group of Companies, and chairman of the CCIR Task Group 8/1 (formally IWP 8/13), which is studying the requirements for Future Public Land Mobile Telecommunications Systems.

BIOGRAPHIE

MICHAEL H. CALLENDAR

**Membre principal du personnel technique
MPR Teltech Ltée., Burnaby (C.-B.)**

Titulaire d'un B.Sc. de l'Université de Londres (1959), ingénieur breveté et membre de l'Institution de Electrical Engineers, Michael H. Callendar travaille en communications dans un certain nombre de pays avant d'entrer en 1974 à la British Columbia Telephone Company, où il est chargé de l'automatisation du réseau radiotéléphonique.

Membre éminent du personnel technique de MPR Teltech, société responsable de la recherche et du développement pour le B.C. Tel Group of Companies, il est président du groupe de travail 8/1 (auparavant IWP 8/13) du CCIR, qui étudie les besoins liés aux futurs systèmes de télécommunications publics du service mobile terrestre.

BIOGRAPHY

RAYMOND J. CARNOVALE

**Vice President, Engineering
Baton Broadcasting Inc. Scarborough, Ontario**

Raymond Carnovale was born in Timmins, Ontario and graduated with a Bachelor of Applied Science Degree in Electrical Engineering from the University of Toronto in 1968. He obtained his Master of Business Administration degree from York University in 1974.

He has worked exclusively in the broadcast industry, starting with RCA Limited in Montreal in the Broadcast Engineering Group in 1968. From 1970-1973 he was assistant to the Vice-President of Engineering of CFRB Limited in Toronto. In 1973 and 1974 Ray was Manager of Engineering for Ward-Beck Systems. During the period 1974-1979 he was Transmission Engineer and then Chief Engineer of the Ontario Educational Communications Authority, of Toronto.

Ray then went to CFTO-TV Limited in 1979 where he was Chief Engineer and then Vice President of Engineering. He is currently Vice-President of Engineering for Baton Broadcasting Incorporated, the parent company of CFTO-TV.

BIOGRAPHIE

RAYMOND J. CARNOVALE

**Vice-président, Ingénierie
Baton Broadcasting Inc., Scarborough (Ontario)**

Raymond J. Carnovale est né à Timmins, en Ontario. Il a d'abord obtenu un baccalauréat en sciences appliquées, génie électrique, à l'Université de Toronto, en 1969, puis une maîtrise en administration des affaires à l'Université York en 1974.

M. Carnovale a toujours travaillé dans l'industrie de la radiodiffusion. Il a commencé en 1968 dans le groupe des services techniques de radiodiffusion de la RCA Limitée, à Montréal. De 1970 à 1973, il a été vice-président adjoint des services techniques de CFRB Limitée, à Toronto. En 1973 et 1974, il a occupé le poste de gestionnaire des services techniques à Ward-Beck Systems. De 1974 à 1979, il a été ingénieur des transmissions, puis chef ingénieur de l'Office de la télévision éducative de l'Ontario.

M. Carnovale passa ensuite, en 1979, à CFTO-TV Limitée, où il fut ingénieur en chef, puis vice-président des services techniques de la Baton Broadcasting Inc., société mère de CFTO-TV.

BIOGRAPHY

JOCELYN M. CÔTÉ-O'HARA

**President and CEO
Stentor Telecom Policy Inc., Ottawa, Ontario**

Ms. Côté-O'Hara is B.C. Tel vice-president, government relations, a position she has held since joining the company in September 1985. On February 3, 1992, Ms. Côté O'Hara was appointed President and Chief Executive Officer of Stentor Telecom Policy. Stentor Telecom Policy is the government relations and policy arm for Canada's major telephone companies and their cellular affiliates. It also acts as an advocacy group, presenting a united voice on national telecommunications issues and policy.

From early 1984 to September 1985, Ms. Côté O'Hara was a senior member of Prime Minister Brian Mulroney's office. Prior to that, she served as special advisor to the chairman of Petro-Canada International Assistance Corporation. Before that assignment, Ms. Côté O'Hara held increasingly senior positions with various federal and provincial departments, including five years with the Treasury Board of Canada, where, as a financial analyst, she was responsible for various government investments including those of Teleglobe and Telesat.

A native of Northern Ontario, Ms. Côté O'Hara holds a Bachelor of Social Sciences from the University of Ottawa and is a graduate of the Advanced Management of the Harvard Business School. At present, she is a director of the Ontario Share and Deposit Insurance Corporation, a trustee of the Ottawa General Hospital, and a member of the Conference Board of Canada. Ms. Côté O'Hara is also a Director if the Information Technology Association of Canada, member of the International Trade Advisory Group on International Trade on Telecom and Computer Services.

BIOGRAPHIE

JOCELYNE M. CÔTÉ-O'HARA

**Présidente et chef de direction
Stentor politiques publiques Télécom Inc., Ottawa (Ontario)**

Mme Côté-O'Hara est vice-présidente de BC Tel, Relations gouvernementales, depuis son entrée à la société en septembre 1985. Le 3 février 1992, elle est nommée présidente-directrice générale de la Stentor politiques publiques Télécom (SPPT) Inc. La SPPT représente auprès des pouvoirs publics les grandes compagnies de téléphone canadiennes et les sociétés de téléphonie cellulaire affiliées et les conseille en matière de politiques. En outre, elle permet aux membres de Stentor de faire front commun pour défendre des questions et politiques de télécommunications nationales.

Du début de 1984 à septembre 1985, Mme Côté-O'Hara joue un rôle important au sein du cabinet du Premier ministre Mulroney. Auparavant, elle avait été conseillère spéciale auprès du président du conseil d'administration de La corporation Petro-Canada pour l'assistance internationale. Avant cette affectation, Mme Côté-O'Hara avait occupé des postes de plus en plus élevés dans différents ministères fédéraux et provinciaux, notamment au Conseil du Trésor du Canada, où pendant cinq ans, à titre d'analyste financière, elle était chargée de divers investissements publics, entre autres dans Téléglobe et Télésat.

Née dans le nord de l'Ontario, Mme Côté-O'Hara possède un baccalauréat en sciences sociales de l'Université d'Ottawa et est diplômée de la Harvard Business School (Advanced Management Program). Actuellement, elle siège aux conseils d'administration de la Société ontarienne d'assurance des actions et dépôts, de l'Hôpital général d'Ottawa et de l'Association canadienne de la technologie informatique. En outre, elle est membre du Conference Board du Canada, membre du Comité consultatif sur le commerce extérieur et présidente du conseil d'administration du Groupe de consultations sectorielles sur le commerce extérieur des services de télécommunications et d'informatique.

BIOGRAPHY

JOHN T. FENELEY

**Director, INMARSAT & Radio Matters
Teleglobe Canada Inc., Montreal Quebec**

John Feneley commenced his career in telecommunications with Cable & Wireless in 1955, spending the next 15 years at it's overseas stations in Gibraltar, Peru, Argentina, Fiji Islands and Bermuda. He joined Teleglobe Canada (then called Canadian Overseas Telecommunication Corporation) in 1971 at its Head Office in Montreal. For the next 7 years, he provided the interface with INTELSAT on operations related activities. In 1978, he joined the International Affairs Department with responsibility for Teleglobe's participation at the INMARSAT Council and the INTELSAT Board of Governors, the governing bodies of both organizations. He has provided Teleglobe's representation at the INMARSAT Council since 1978, including a period as its Chairman.

In 1990, with the increasing importance of mobile satellite services and issues, he became responsible for Teleglobe's activities related to INMARSAT and the Radiocommunications sector of the ITU. Recently, his responsibilities have been broadened to encompass Mobile Services and Radiocommunications within the Strategic Development Department of Teleglobe Canada.

BIOGRAPHIE

JOHN T. FENELEY

**Drecteur, INMARSAT et radiocommunications
Téléglobe Canada Inc., Montréal (Québec)**

M. Feneley commence sa carrière en télécommunications à la Cable & Wireless en 1955. Il passe les 15 années suivantes aux stations d'outre-mer de la société à Gibraltar, au Pérou, en Argentine, aux îles Fidji et aux Bermudes. En 1971, il entre au siège social de la Téléglobe Canada (alors appelée Société canadienne des télécommunications transmarines) à Montréal. Puis, pendant sept ans, il assure la liaison avec INTELSAT pour les questions touchant les opérations. En 1978, affecté au Service des affaires internationales, il s'occupe de la participation de la Téléglobe au Conseil d'INMARSAT et au conseil d'administration d'INTELSAT. Depuis cette date, il représente la Téléglobe au Conseil d'INMARSAT, dont il a déjà été président.

En 1990, avec l'importance croissante des services mobiles par satellite et des questions connexes, il devient responsable des activités de la Téléglobe relatives à INMARSAT et au secteur des radiocommunications de l'UIT. Depuis quelque temps, ses responsabilités englobent les Services mobiles et les Radiocommunications au sein du Service du développement stratégique de la Téléglobe.

BIOGRAPHY

GEORGE A. FIERHELLER, B.A., LL.D.

Chairman & CEO

Rogers Cantel Mobile Communications Inc., North York, Ontario

Mr. Fierheller graduated from Trinity College at the University of Toronto with an Honours Degree in Political Science and Economics in 1955. He joined IBM in Toronto that year and subsequently progressed through a number of positions in their sales organization. He was Marketing Manager for IBM's federal government business in Ottawa prior to founding Systems Dimensions Limited (SDL) in 1968.

Mr. Fierheller was President of SDL from the inception of the company until it was acquired by Crown Life of Toronto. SDL was one of the pioneering companies in the computer services industry in Canada.

In April, 1979, Mr. Fierheller moved to Vancouver as President and Chief Executive Officer of Premier Cablesystems Limited. In July, 1980, Premier merged with Rogers Cablesystems Inc. to form one of the world's largest cable TV companies. Mr. Fierheller was a Vice Chairman, as well as the President and CEO of Rogers Cable TV - British Columbia Limited.

During 1983, Mr. Fierheller led the team that was successful in winning the mobile cellular radio licences for Cantel, a consortium of First City Capital, Telemedia Inc. and Rogers Telecommunications Inc. He was the founding President and CEO of Cantel Inc. In September, 1989, he was promoted to Chairman and CEO of Rogers Cantel Mobile Inc.

Mr. Fierheller was actively involved in community affairs in Ottawa and Vancouver including: Chairman of the Board of Governors of Carleton University, Chairman of the Finance Committee of the Board of Governors of Simon Fraser University, Chairman of the United Way Campaigns in Ottawa in 1971 and Vancouver in 1981, President of the Canadian Information Processing Society, member of the Executive Committee of the National Arts Centre, a Trustee of the Vancouver General Hospital Foundation, a Director of Vancouver Opera and a member of the Vancouver Centennial Commission.

Mr. Fierheller was Chairman of the 1991 United Way Campaign of greater Toronto, and is currently Vice Chairman of the Information Technology Association of Canada and immediate Past Chairman of Vision 2000.

He serves on a number of Boards including: Crownx Inc., Rogers Communications Inc., GBC North America Fund Inc., Telesat Mobile Inc., NORR and Teleglobe Inc.

Mr. Fierheller was awarded a Doctor of Laws degree from Concordia University in 1976 for his contribution to the computer services industry.

In March 1991, he received Toronto's highest honour, The Award of Merit.

BIOGRAPHIE

GEORGE A. FIERHELLER, B.A., LLD

**Président-directeur général
Rogers Cantel Mobile Communications Inc., North York (Ontario)**

M. Fierheller obtient un baccalauréat spécialisé en science politique et en économique au Trinity College de l'Université de Toronto en 1955. La même année, il entre à IBM à Toronto. Il y occupe successivement divers postes liés à l'organisation de la force de vente. Gestionnaire du marketing, il s'occupe des affaires d'IBM avec le gouvernement fédéral à Ottawa, puis fonde Systems Dimensions Limited (SDL) en 1968.

M. Fierheller demeure président de la SDL jusqu'à son acquisition par la compagnie d'assurance-vie Crown de Toronto. La SDL est l'une des premières sociétés de services informatiques établies au Canada.

En avril 1979, M. Fierheller devient président-directeur général de Premier Cablesystems Limited à Vancouver. En juillet 1980, Premier fusionne avec Rogers Cablesystems Inc. pour former l'une des plus grandes sociétés de câblodistribution du monde. M. Fierheller est alors vice-président de Rogers Cablesystems Inc., président du conseil de la Canadian Cablesystems Limited et président-directeur général de Rogers Cable TV - British Columbia Limited.

En 1983, M. Fierheller dirige l'équipe qui réussit à obtenir les licences de radio mobile cellulaire pour Cantel, consortium regroupant First City Capital, Telemedia Inc. et Rogers Telecommunications Inc. Fondateur et président-directeur général de Cantel Inc., il est promu président-directeur général de Rogers Cantel Mobile Inc. en septembre 1989.

Actif dans la vie communautaire d'Ottawa et de Vancouver, M. Fierheller a été président du conseil des gouverneurs de l'Université Carleton, président du comité des finances du conseil des gouverneurs de l'Université Simon Fraser, président de la campagne Centraide d'Ottawa en 1971 et de celle de Vancouver en 1981, président de l'Association canadienne de l'informatique, membre du comité exécutif du Centre national des Arts, membre du conseil d'administration de la Vancouver General Hospital Foundation, membre du conseil d'administration de l'Opéra de Vancouver et membre de la Vancouver Centennial Commission.

M. Fierheller a présidé la campagne Centraide de la région métropolitaine de Toronto en 1991. Il est actuellement vice-président de l'Association canadienne de la technologie informatique et président sortant de Vision 2000.

Il siège à divers conseils, notamment ceux de Crownx Inc., Rogers Communications Inc., GBC North America Fund Inc., Télésat Mobile Inc., NORR et Téléglobe Inc.

M. Fierheller a reçu un doctorat en droit de l'Université Concordia en 1976 pour sa contribution au développement de l'industrie des services informatiques.

En mars 1991, il a obtenu la plus haute distinction de la Ville de Toronto, l'Award of Merit.

BIOGRAPHY

MICHAEL T. N. FITCH

Executive Director, US Delegation WARC '92 US State Department, Washington, D.C.

Michael Fitch is the Senior Advisor to the United States Coordinator for International Communications and Information Policy in the Department of State. He is also the Executive Director of the United States Delegation to the 1992 World Administrative Radio Conference (WARC) of the International Telecommunications Union.

A native of Glenwood Springs, Colorado, Mr. Fitch received a Bachelor of Science Degree in Electrical Engineering from Purdue University and a Juris Doctor Degree from Columbia University. After graduation, he was an attorney in the Mass Media Bureau of the Federal Communications Commission. In 1976, he was appointed a Deputy Division Chief in the Private Radio Bureau.

In 1979, he was selected as a Presidential Exchange Executive. Under the President's Executive Exchange Program, a select group of managers from government and the private sector serve for one year in the opposite sector. Fitch was an Exchange Executive with the Westinghouse Electric Corporation in Pittsburgh, Pennsylvania, working on energy regulation issues.

Upon his return to the FCC, he was appointed Chief of the Land Mobile and Microwave Division of PRB. In 1984, he was promoted to Deputy Bureau Chief and in 1986 to Bureau Chief. From 1987-89, he served as the Senior Legal Advisor to the Chairman of the FCC. He then assumed his present responsibilities at the State Department.

Mr. Fitch was Vice-Chairman of the United States delegations to the 1987 Mobile WARC and the 1989 Plenipotentiary Conference of the ITU. He was a member of the United States delegations to the 1988 WATTC and the High Level Committee meetings on the future of the ITU.

BIOGRAPHIE

MICHAEL T. N. FITCH

**Directeur exécutif, délégation américaine, CAMR 92
Département d'État du gouvernement des É.-U.
Washington (D.C.)**

M. Michael Fitch est le conseiller principal du coordonnateur de la Politique des communications et de l'information internationales des États-Unis, Département d'État. Il est aussi le directeur exécutif de la délégation américaine à la Conférence administrative mondiale des radiocommunications (CAMR) de l'Union internationale des télécommunications (UIT).

Né à Glenwood Springs au Colorado, M. Fitch a reçu un baccalauréat ès sciences en génie électrique de l'université de Purdue et un doctorat de droit de l'université Columbia. Après ses études, il a travaillé comme avocat pour le Bureau des mass-média de la Federal Communications Commission. En 1976, il a été nommé sous-chef de division au Bureau de la radio privée (PRB).

En 1979, M. Fitch a été choisi comme participant au Programme présidentiel d'échange de cadres, où des cadres des secteurs public et privé ont l'occasion de travailler pendant un an dans l'autre secteur. Ainsi, M. Fitch a travaillé à des questions de réglementation de l'énergie pour le compte de la Westinghouse Electric Corporation, à Pittsburgh en Pennsylvanie.

De retour à la FCC, il a été nommé chef de la Division des services terrestres mobiles et micro-ondes du PRB. En 1984, il devenait sous-chef du Bureau de la radio privée et, en 1986, il en devenait le chef. De 1987 à 1989, il a servi de conseiller juridique principal au président de la FCC. Il a ensuite assumé ses fonctions actuelles au Département d'État.

M. Fitch a rempli les fonctions de vice-président des délégations américaines à la CAMR mondiale sur les communications mobiles et de la Conférence plénipotentiaire de 1989. En outre, il a fait partie des délégations des États-Unis à la Conférence administrative mondiale télégraphique et téléphonique de 1988 ainsi qu'aux réunions du Comité de haut niveau sur l'avenir de l'UIT.

BIOGRAPHY

DAVID L. GARFORTH

Director, Transmission and Distribution Department Canadian Broadcasting Corporation, Montreal, Quebec

David L. Garforth is Director, Transmission and Distribution Department of the Canadian Broadcasting Corporation. He is also Past-President of the Radio Advisory Board of Canada.

Mr. Garforth graduated from the King's College, University of Durham, England, in 1960 with an honours degree in Electrical Engineering. On graduation, he served a two-year apprenticeship with the British Broadcasting Corporation which covered all facets of Broadcasting, before joining Canadian Marconi in Montreal.

He joined the CBC as a Transmission Project Engineer in 1964. Between 1968 and 1974, he was Assistant Regional Engineer in Halifax providing engineering expertise to the regional operating locations in matters relating to transmitters, studios, buildings, etc.

In 1974, he returned to Engineering Headquarters in Montreal as Supervising Engineer (Standards), responsible for Equipment Evaluation, Methods and Standards required by Transmission Systems Department.

In 1975, he was appointed Manager, Systems Engineering in the Transmission Systems Department, in charge of special technical studies, long range planning, frequency coordination, etc.

He was appointed to the position of Director of Engineering, Transmission Systems Department in 1983, responsible for the Planning & Implementation of all new Transmitters Plant as well as the Systems Engineering activity.

He was appointed Director, Strategic Engineering Department on its creation in 1986. Strategic Engineering was charged with acquiring and maintaining the necessary knowledge base required to provide specialized engineering services to all areas of the Corporation, Industry and Government in terms of new technologies, future directions, etc.

In April 1990, Mr. Garforth was appointed Director, Transmission and Distribution Department the position he currently holds.

BIOGRAPHIE

DAVID L. GARFORTH

Directeur du Service des transmissions et de la distribution Société Radio-Canada, Montréal (Québec)

David L. Garforth est directeur du Service des transmissions et de la distribution à la Société Radio-Canada. Il a en outre été président du Conseil consultatif canadien de la radio.

M. Garforth est titulaire d'un baccalauréat spécialisé en génie électrique qu'il a obtenu en 1960 au Kings College, University of Durham, Angleterre. Son diplôme obtenu, il a fait un apprentissage de deux ans chez la British Broadcasting Corporation où il a touché à tous les domaines de la radiodiffusion avant de se joindre à la société Canadian Marconi de Montréal.

En 1964, il s'est joint à la SRC en tant qu'ingénieur de projet de transmission.

De 1968 à 1974, il a occupé le poste d'ingénieur régional adjoint à Halifax, faisant profiter de ses connaissances techniques les bureaux régionaux dans les domaines des émetteurs, des studios, des bâtiments, etc.

En 1974, il est retourné à l'administration centrale des services techniques à Montréal en tant qu'ingénieur surveillant (normes) chargé de l'évaluation de l'équipement, des méthodes et des normes requises par le service des systèmes de transmission.

En 1975, il a été nommé gestionnaire de l'ingénierie des systèmes au sein du service des systèmes de transmission, et chargé des études techniques spéciales, de la planification à long terme, de la coordination des fréquences, etc.

En 1983, il fut nommé au poste de directeur de l'ingénierie, service des systèmes de transmission, chargé de la planification et de la mise en oeuvre de toutes les nouvelles installations d'émetteurs ainsi que de l'ingénierie des systèmes.

Il a été nommé directeur du service de l'ingénierie stratégique lors de la mise sur pied de celui-ci en 1986. Les services de l'ingénierie stratégique avaient pour mandat d'acquérir et de maintenir les connaissances requises pour fournir des services spécialisés d'ingénierie à toute la Société, à l'industrie et au gouvernement en ce qui concerne les nouvelles technologies, les orientations futures, etc.

En avril 1990, M. Garforth a été nommé au poste de directeur, Service des transmissions et de la distribution, poste qu'il occupe encore aujourd'hui.

BIOGRAPHY

YOSHIHIRO ISHIDA

**Director, Office of Telecommunications Standards,
Telecommunications Policy Bureau
Ministry of Posts & Telecommunications, Tokyo, Japan**

Mr. Ishida graduated from the Kyoto University, Japan, with a Bachelor of Engineering degree.

Upon graduation, he joined the Ministry of Posts and Telecommunications in an engineering capacity. In 1990 he became Director of the Telecommunications Division for the Kanto Regional Bureau of Telecommunications.

In 1991, Mr. Ishida was appointed to the position of Director of the International Frequency Affairs Office, Telecommunications Bureau.

Recently, in July of 1992, Mr. Ishida became Director, Office of Telecommunications standards in the Telecommunications Policy Bureau.

BIOGRAPHIE

YOSHIHIRO ISHIDA

**Directeur, Bureau des affaires relatives aux fréquences internationales, Bureau des communications
Ministère des Postes et des Télécommunications, Tokyo, Japon**

M. Ishida est titulaire d'un baccalauréat en génie de l'Université de Kyoto, Japon.

À la fin de ses études, il entre au ministère des Postes et des Télécommunications à titre d'ingénieur. En 1990, il devient directeur de la Division des télécommunications au Bureau régional des télécommunications de Kanto.

En 1991, M. Ishida est nommé directeur du Bureau des affaires relatives aux fréquences internationales au Bureau des télécommunications.

Récemment, en juillet 1992, il est devenu directeur du Bureau des normes de télécommunications au Bureau de la politique des télécommunications.

BIOGRAPHY

ROBERT W. JONES

**Director General, Radio Regulatory Branch
Department of Communications, Ottawa, Ontario**

Robert W. Jones is Director General of the Radio Regulatory Branch in the Canadian Department of Communications. He holds Bachelor of Applied Science and Master of Applied Science degrees in Electrical Engineering from the University of Toronto and a Master of Business Administration degree from York University. In addition to ten years in the Canadian radio communications manufacturing industry and fifteen years in increasing responsibilities at the Department of Communications, he held a senior position with the International Telecommunications Union in Geneva for two years. Mr. Jones headed the Canadian delegation to the recent ITU World Administrative Radio Conference at Torremolinos, Spain.

BIOGRAPHIE

ROBERT W. JONES

Directeur général de la Réglementation des radiocommunications Ministère des Communications, Ottawa (Ontario)

Robert W. Jones est directeur général de la Direction de la réglementation des radiocommunications au ministère des Communications du Canada. Il est titulaire d'un baccalauréat et d'une maîtrise en sciences appliquées dans le domaine du génie électrique obtenus à l'université de Toronto et d'une maîtrise en administration de l'université York. Fort d'une expérience de dix ans dans l'industrie canadienne du matériel de radiocommunications et de quinze ans à des postes de responsabilité croissante au ministère des Communications, M. Jones a en outre occupé pendant deux ans un poste de niveau supérieur au sein de l'Union internationale des télécommunications à Genève. Il a dirigé la délégation canadienne lors de la récente Conférence administrative mondiale des radiocommunications qui a eu lieu à Torremolinos en Espagne.

BIOGRAPHY

LLOYD V. KUBIS, P.Eng.

Vice President & Director of Government Relations, Motorola Canada Ltd., North York, Ontario

Graduated in 1961 from the University of Windsor with a Bachelor of Applied Science degree in Electrical Engineering. Also a 1978 graduate of Motorola Inc.'s Executive Institute.

Lloyd joined Motorola Canada Ltd. in May 1961 as a Design Engineer and has since progressed through many senior managerial positions in the Motorola organization, one of which was being responsible for all of Motorola Canada's Product Development efforts for many years.

During a three year assignment in Australia, Lloyd was responsible for establishment of Motorola in that country, which included the development of a complete operation modeled on Motorola Canada. This was followed by an appointment as General Manager of Motorola in Mexico.

Currently Lloyd is a senior executive with Motorola Canada, responsible for policy and external relations, representing total Motorola operations with associations and government. As such, Lloyd is a member of a number of associations and presently sits on the boards of the RadioComm Association of Canada where he is chairman; the Electrical and Electronic Manufacturers Association of Canada where he is past-chair; the Radio Advisory Board of Canada and Vision 2000. He is also a member of:

- Association of Professional Engineers of Ontario
- Board of Trade
- Canadian Radio Relay League
- Canadian Standards Association
- Electrical and Electronic Manufacturers Association of Canada
- Institute of Electrical and Electronic Engineers
- RadioComm Association of Canada
- Vision 2000

BIOGRAPHIE

LLOYD V. KUBIS, ing.

**Vice-président et
Directeur des affaires extérieures
Motorola Canada Ltée, North York (Ontario)**

Lloyd Kubis a reçu un baccalauréat en sciences appliquées, génie électrique, de l'université de Windsor en 1961. Il est également diplômé (1978) de l'institut des cadres supérieurs de Motorola Inc.

Il s'est joint à la Motorola Canada Ltée en mai 1961 à titre d'ingénieur concepteur. Il a depuis occupé de nombreux postes de haute direction à la société Motorola. Il a notamment été longtemps responsable de toutes les activités de développement de produits chez Motorola Canada.

Au cours d'une affectation de trois ans en Australie, M. Kubis a été chargé de la création de la filiale australienne de Motorola, qui a été montée de toute pièce sur le modèle de Motorola Canada. Il a ensuite été nommé directeur général de Motorola au Mexique.

M. Kubis est actuellement cadre supérieur chez Motorola Canada, où il est chargé de la politique et des relations extérieures. À ce titre, il représente Motorola auprès des associations et des gouvernements. Il est membre de nombreuses associations et il siège actuellement au conseil de l'Association RadioComm du Canada, dont il est le président, de l'Association des manufacturiers d'équipement électrique et électronique du Canada, dont il est le président sortant, du Conseil consultatif canadien de la radio et de VISION 2000. Il est également membre des organismes suivants :

- Ordre des ingénieurs de l'Ontario
- Board of Trade
- Ligue canadienne de la radio amateur
- Association canadienne de normalisation
- Chambre de commerce
- Association des manufacturiers d'équipement électrique et électronique du Canada
- Institute of Electrical and Electronic Engineers
- Association RadioComm du Canada
- VISION 2000

BIOGRAPHY

ALVIN LAW

President
AJL Communications, Regina, Saskatchewan

In 1960 Alvin was born without arms in Yorkton, Saskatchewan. He attended regular schools and graduated with honours. While in high school, he became an award winning trombonist, drummer and vocalist, and received his graduating class "Medal of Excellence". In 1978 Alvin was chosen a Saskatchewan Junior Citizen of the Year and left home for college in Calgary.

Alvin received his Honours diploma in Broadcasting from Mount Royal College in 1980 which led to a job as a radio disk jockey back in Saskatchewan.

However, this career path was shortened by an opportunity to travel to schools lecturing about disabilities and more specifically, his life without arms. He started with an Alberta based company but moved back to Saskatchewan and created his own program of awareness for the rehabilitation agency, the Abilities Council. Alvin visited over 500 schools in three years, and Alvin and the program received national recognition for the impact on young people.

In 1982, Alvin became the second youngest person to ever receive the George Vanier Award for Outstanding Young Canadians, the youngest being Wayne Gretzky. That same year Alvin, along with Queen Elizabeth, dined at a Youth Banquet in Ottawa. In 1983, Alvin became the first-ever recipient of Mount Royal College Board of Governors' Most Distinguished Alumnus Award.

In 1985, Alvin's life took a different course, both professionally and personally. In the spring of that year he decided to pursue a career in Advertising and in August he became a father to son Vance. A year later he ran unsuccessfully for a seat in the Saskatchewan legislature, all the while lecturing on the side to various groups about motivation and self-image.

Alvin has appeared on countless telethons, media features and has been the subject of two award winning television documentaries. The first, "Alvin, His Best Foot Forward" was shown across Canada in 1978. The second, "Broken Promises", focused on the plight of Canada's Thalidomide victims and after it's Canadian showing was seen on American Public Broadcasting's "Frontline". Re-named "Extraordinary People", it was nominated for an Emmy Award. As a result, Alvin appeared on CNN Live, CBS News Nightwatch and the Joan Rivers Show.

In 1988, Alvin's life changed dramatically. He took a dream step and began working for himself as a full-time speaker. He sees his abilities as gifts and to date his message has been heard by over 400,000 students and at least 150,000 others.

Alvin lives in Regina, Saskatchewan and shares his life with his bestest buddy, Vance and his best friend and partner, Darlene.

BIOGRAPHIE

ALVIN LAW

**Président
AJL Communications, Regina (Saskatchewan)**

En 1960, Alvin naît sans bras à Yorkton (Saskatchewan). Il fréquente les écoles ordinaires et est diplômé avec mention. À l'école secondaire, ses talents de tromboniste, de batteur et de vocaliste lui valent des prix; il reçoit la «médaille d'excellence» de sa promotion. Jeune Saskatchewanais de l'année en 1978, Alvin part faire ses études collégiales à Calgary.

Après ses études en radiodiffusion au Mount Royal College, en 1980, Alvin devient disc-jockey à la radio en Saskatchewan.

Toutefois, cette carrière est éphémère, car il commence bientôt à donner dans les écoles des conférences sur les handicapés et, en particulier, sur son expérience personnelle. D'abord associé à une société albertaine, il revient en Saskatchewan et crée son propre programme de sensibilisation pour un organisme de réadaptation, l'Abilities Council. Alvin visite plus de 500 écoles en trois ans. Son programme et son action sont reconnus dans tout le pays pour leur influence sur la jeunesse.

En 1982, Alvin devient le plus jeune lauréat du Prix Vanier pour cinq jeunes Canadiens remarquables, après Wayne Gretzky. La même année, il est reçu à un banquet des jeunes à Ottawa en même temps que la reine Élisabeth. En 1983, Alvin est le premier récipiendaire du prestigieux «Alumnus Award» du conseil des gouverneurs du Mount Royal College.

En 1985, sa vie prend un nouveau tournant, sur le plan professionnel et personnel. Au printemps, il décide de se lancer en publicité et, en août, devient père d'un fils, Vance. Un an plus tard, il présente en vain sa candidature aux élections provinciales de la Saskatchewan tout en continuant ses conférences sur la motivation et l'image de soi.

Alvin a participé à d'innombrables téléthons et reportages. Il a été le sujet de deux documentaires télévisés primés par la critique. Le premier, «Alvin, His Best Foot Forward» a été diffusé dans tout le Canada en 1978. Le deuxième, «Broken Promises», portant sur les victimes de la thalidomide au pays, a d'abord été présenté au Canada, puis diffusé à l'émission américaine «Frontline». Rebaptisé «Extraordinary People», il a été mis en nomination pour un Emmy, ce qui a valu à Alvin d'être invité à CNN Live, à CBS News Nighwatch et au Joan Rivers Show.

En 1988, la vie d'Alvin change du tout au tout. Réalisant un vieux rêve, il commence à travailler à son compte comme conférencier à temps plein. Pour lui, ses capacités sont des

dons. Jusqu'à maintenant, il a communiqué son message à plus de 400 000 étudiants et au moins 150 000 autres personnes.

Alvin vit à Regina, en Saskatchewan, et partage sa vie avec son meilleur copain, Vance, et sa meilleure amie et partenaire, Darlene.

BIOGRAPHY

DAVID LYON

Executive Director, Ontario Region Department of Communications, Toronto, Ontario

Mr. Lyon is a native of New Brunswick. He received his B.Sc. in Electrical Engineering from the University of New Brunswick in 1958 and his M.B.A. from the University of Western Ontario in 1969.

He joined the Department of Transport (DOT) in Moncton, N.B. in 1958 and moved to Toronto with DOT in 1969. He subsequently joined Communications Canada in 1974.

He is currently Executive Director, Ontario Region for Communications Canada. In this capacity, Mr. Lyon is responsible for the delivery of all departmental programs and services in Ontario. Activities include radio frequency spectrum management, communications technology and cultural development programs, and the procurement of telecommunications services for federal departments located in the region.

He is a member of the Association of Professional Engineers of Ontario, and the Association of Professional Executives of the Public Service.

BIOGRAPHIE

DAVID LYON

Directeur exécutif, Région de l'Ontario Ministère des Communications, Toronto (Ontario)

M. Lyon est originaire du Nouveau-Brunswick. Il est titulaire d'un B.Sc, en génie électrique de l'université du Nouveau-Brunswick (1958) et d'un M.B.A. de l'université Western Ontario (1969).

Il s'est joint au ministère des Transports, à Moncton (N.-B.) en 1959. Il a été ensuite muté aux bureaux du MDT à Toronto en 1969. Il s'est joint à Communications Canada en 1974.

Il est actuellement directeur exécutif du bureau régional de l'Ontario de Communications Canada, où il est responsable de la présentation de tous les programmes et services du Ministère en Ontario. Le bureau régional assure notamment les services suivants: gestion du spectre des fréquences radioélectriques; programmes liés à la technologie des télécommunications et au développement culturel; et acquisition de services de télécommunications pour les ministères fédéraux de la région.

M. Lyon est membre de l'Ordre des ingénieurs de l'Ontario et de l'Association professionnelle des cadres de la Fonction publique du Canada.

BIOGRAPHY

PETER J. MACLAREN

**Assistant Vice President, Business Development
Northern Telecom Wireless Systems Inc., Ottawa, Ontario**

Peter MacLaren is Assistant Vice President, Business Development of Northern Telecom Wireless Systems. He has been directly involved in the wireless business since May of 1990.

He earned his B.Sc. in Electrical Engineering with 1st Class Honours from Strathclyde University in Scotland, then worked for 3 years with what is now British Telecom Research Labs before joining Bell Northern Research in Ottawa in 1975. He held a number of positions of increasing responsibility in Transmission and Data Services planning before joining Northern Telecom's Transmission Group in Edmonton in 1983. For the next four years he was responsible for product line strategy for Transmission, latterly as Assistant Vice President, Business Development. Following that assignment he spent 18 months in BNR as AVP Technology Management. He then moved back to Northern Telecom and until May of 1990 was responsible for overall strategy for voice terminal evolution, before taking on his current responsibilities.

Peter's business development activities span the evolution of to-day's cellular product line and new opportunities for low power wireless systems on a global basis.

Peter lives in Ottawa with his wife Susan and five year old son Logan.

BIOGRAPHIE

PETER J. MACLAREN

**Vice-président int., Prospection commerciale
Northern Telecom Wireless Systems Inc., Ottawa (Ontario)**

Peter MacLaren est vice-président adjoint responsable de l'expansion commerciale de Northern Telecom Wireless Systems. Il s'occupe directement de télécommunications sans fil depuis mai 1990.

Il a obtenu, avec la mention très honorable, un baccalauréat en sciences, avec spécialisation en génie électrique, à l'Université Strathclyde, en Écosse. Il a ensuite travaillé trois ans dans ce qui s'appelle maintenant British Telecom Research Labs, puis s'est joint à la société Recherches Bell Northern Ltée en 1975. Il y a occupé un certain nombre de postes comportant des responsabilités croissantes dans la planification des services de transmission et de données avant de se joindre au Groupe des transmissions de Northern Telecom, à Edmonton, en 1983. Pendant les quatre années qui ont suivi, il fut responsable de la stratégie relative à la gamme de produits dans le secteur des transmissions, et il fut finalement vice-président adjoint à l'expansion commerciale. Après cette affectation, il a passé 18 mois à Recherches Bell Northern Ltée, à la gestion de la technologie des produits audiovisuels. Il revint ensuite à Northern Telecom où, jusqu'à mai 1990, il fut responsable de la stratégie globale relative à l'évolution des terminaux vocaux, avant d'assumer ses responsabilités actuelles.

Les activités d'expansion commerciale de Peter englobent l'évolution des produits cellulaires actuels et les nouvelles possibilités qui s'offrent, à l'échelle mondiale, pour les systèmes de télécommunications sans fil de faible puissance.

Peter vit à Ottawa avec sa femme Susan et leur fils Logan, qui est âgé de cinq ans.

BIOGRAPHY

KEN McGUIRE

**Manager, International Radio Policy, Communications Division
Ministry of Commerce, Wellington, New Zealand**

Ken commenced his career in radio as an operator in the maritime mobile service, spending years both at the sea and ashore. He moved into the administrative side of radiocommunications some 20 years ago and has wide experience in matters related to New Zealand's international activities, such as the ITU and INMARSAT.

He is responsible to Ian Hutchings for New Zealand's international spectrum policy objectives and to ensure that the regulatory environment places minimal constraints on the Government's stated policies with respect to the broad field of radiocommunications. Ken is also a member of the Voluntary Group of Experts of the ITU.

In his spare time he can be found near an amateur radio transceiver, or perhaps with a good book, having discovered Tom Clancy in 1987.

BIOGRAPHIE

KEN MCGUIRE

Gestionnaire de la politique internationale de la radioélectrique

Division des Communications

Ministère du commerce, Wellington (Nouveau Zéland)

M. McGuire a commencé sa carrière dans le domaine de la radio comme opérateur du service maritime mobile. Après avoir passé plusieurs années en mer et sur terre ferme, il est passé à la dimension administrative des radiocommunications, il y a environ vingt ans. Il possède beaucoup d'expérience au titre des activités internationales de la Nouvelle-Zélande, celle de l'UIT et d'INMARSAT, par exemple.

Ken McGuire est comptable envers M. Hutchings des objectifs de la politique internationale néo-zélandaise du spectre radio; il doit notamment voir à ce que la réglementation contraine le moins possible l'application des différents volets de la politique gouvernementale dans tout le domaine des radiocommunications. Il est aussi membre du GEV de l'UIT.

À ses moments perdus, on le trouvera penché sur un émetteur-récepteur ou le nez dans un bon livre, ayant découvert Tom Clancey en 1987.

BIOGRAPHY

DAVID MULCASTER

Acting Assistant Deputy Minister, Research & Spectrum Department of Communications, Ottawa, Ontario

David Mulcaster received his Bachelor of Arts (Honours) degree in Industrial Economics from Carleton University. He subsequently enroled in several other courses and seminars at the Nierenburg Institute, Universite de Montreal, Canadian Centre for Management Development and the Public Service Commission.

In the early years after graduation, David Mulcaster worked as a Program and Research Analyst at the Department of Indian and Northern Affairs and the Department of Secretary of State.

In 1976, he joined the Canadian Radio-Television and Telecommunications Commission (CRTC) as Chief, Planning Division of the Broadcasting Planning Branch. In this position, David Mulcaster directed policy formulation, regulatory analysis, research strategy, interdepartmental and industry liaison. He also undertook and directed major activities such as US/Canada bilateral broadcasting issues and a host of other senior responsibilities in cable systems and broadcast commercial operations.

In 1980, David Mulcaster joined the Department of Industry, Trade and Commerce (ISTC) as Senior Commerce Officer, Electrical and Electronics where he developed and implemented programs and strategies to assist consumer electronics industries and negotiated assistance package to companies for various programs.

During the past 10 years since joining the Department of Communications, David Mulcaster has held increasingly responsible senior management positions in strategy, planning, economic development, communications development and planning.

In early summer of 1992, David Mulcaster was appointed Acting Assistant Deputy Minister, Research and Spectrum at the Department of Communications. In this role he is responsible for directing the orderly development and use of communications, information and broadcast systems/services and infrastructure to meet Canadian economic, social and cultural needs. He is also responsible for ensuring the accommodation of as many users of the radio frequency spectrum as possible.

BIOGRAPHIE

DAVID MULCASTER

Sous-ministre adjoint intérimaire, Recherche et spectre Ministère des Communications, Ottawa (Ontario)

David Mulcaster a obtenu un baccalauréat es arts avec spécialisation en économie industrielle de l'université Carleton. Il a par la suite suivi plusieurs autres cours et séminaires offerts par l'institut Nierenburg, l'Université de Montréal, le Centre canadien de gestion et la Commission de la fonction publique.

Après ses études universitaires, M. Mulcaster a travaillé comme analyste des programmes et de la recherche au ministère des Affaires indiennes et du Nord canadien ainsi qu'au Secrétariat d'État du Canada.

En 1976, il s'est joint au Conseil de la radiodiffusion et des télécommunications canadiennes (CRTC) à titre de chef, direction de la planification, direction générale de la planification de la radiodiffusion. À ce poste, M. Mulcaster était chargé de l'élaboration des politiques, de l'analyse de la réglementation, de la stratégie en matière de recherche et des rapports avec les autres ministères et l'industrie. Il était également responsable de dossiers importants, dont celui des questions bilatérales (Canada - États-Unis) relatives à la radiodiffusion et il avait de nombreuses autres responsabilités de niveau supérieur ayant trait à l'exploitation des systèmes de câblodistribution et de radiodiffusion commerciale.

En 1980, David Mulcaster s'est joint au ministère de l'Industrie et du Commerce (ISTC) à titre d'agent de commerce principal, matériel électrique et électronique. Il a alors élaboré et mis en oeuvre des programmes et des stratégies visant à soutenir l'industrie électronique de consommation et il a négocié des ententes d'aide aux entreprises dans le cadre de nombreux programmes.

Depuis 10 ans, M. Mulcaster travaille au ministère des Communications où il a occupé des postes de haute direction de responsabilités croissantes dans les secteurs de la stratégie, de la planification, du développement économique et du développement et de la planification des communications.

Au début de l'été 1992, David Mulcaster a été nommé sous-ministre adjoint intérimaire, Recherche et spectre, au ministère des Communications. À ce titre, il est chargé d'assurer l'exploitation et le développement ordonnés des systèmes, des services et de l'infrastructure de communications, d'information et de radiodiffusion pour répondre aux besoins économiques, sociaux et culturels du Canada. Il doit également garantir l'accès aux fréquences radio au plus grand nombre possible d'utilisateurs.

BIOGRAPHY

NICHOLAS NEGROPONTE

Director
MIT Media Laboratory, Cambridge, Massachusetts

Nicholas Negroponte is a founder and the director of the Massachusetts Institute of Technology's uniquely innovative Media Laboratory. The six-year-old Media Lab, an interdisciplinary, multi-million dollar research centre of unparalleled intellectual and technological resources, is focused exclusively on study and experimentation with future forms of human communication, from entertainment to education. Programs include: Television of Tomorrow, School of the Future, Information and Entertainment Systems, and Holography. Media Lab research is supported by federal contracts as well as by more than seventy-five corporations worldwide.

Negroponte studied at MIT, where as a graduate student he specialized in the then-new field of computer-aided design. He joined the Institute's faculty in 1966, and for several years thereafter divided his teaching time between MIT and visiting professorships at Yale, Michigan and the University of California at Berkeley.

In 1968 he also founded MIT's pioneering Architecture Machine Group, a combination lab and think tank responsible for many radically new approaches to the human-computer interface. Out of this experience came several influential texts by Negroponte, including The Architecture Machine, Soft Architecture Machine and Computer Aids to Design and Architecture.

In 1980, he served a term as founding chairman of the International Federation of Information Processing Societies' Computers in Everyday Life program in Amsterdam, the Netherlands. Two years later, Negroponte accepted the French government's invitation to become the first executive director of the Paris-based World Centre for Personal Computation and Human Development, an experimental project originally designed to explore computer technology's potential for enhancing primary education in underdeveloped countries.

Since then, Negroponte has travelled extensively throughout the world as a lecturer. He has delivered hundreds of presentations, including the prestigious Murata "People Talk" address in Kyoto in 1990.

In addition, he consults to both government and industry, serves as an active member of several corporate boards of directors and is a special general partner in a venture capital fund dedicated to new technologies for information and publishing.

BIOGRAPHIE

NICHOLAS NEGROPONTE

**Directeur
MIT Media Laboratoire, Cambridge (Massachusetts)**

Nicholas Negroponte est fondateur et directeur du Media Laboratory au Massachusetts Institute of Technology. Centre de recherche interdisciplinaire remarquablement innovateur, le Media Lab, laboratoire de plusieurs millions de dollars, existe depuis six ans. Doté de ressources intellectuelles et techniques sans pareilles, il s'occupe exclusivement de la recherche prospective sur les moyens de communication. Ses programmes touchent divers domaines allant du divertissement à l'éducation, par ex. : télévision de demain, école de l'avenir, information et équipements de distraction, holographie. Le Media Lab est financé par des contrats du gouvernement américain et de plus de 75 sociétés du monde entier.

M. Negroponte a étudié au MIT, où il fait des études supérieures spécialisées en conception assistée par ordinateur, domaine alors nouveau. En 1966, il devient professeur à l'Institute. Pendant plusieurs années, il enseigne au MIT et, à titre de professeur invité, à Yale, à l'Université du Michigan et à l'University of California at Berkeley.

En 1968, il fonde au MIT l'Architecture Machine Group, groupe de réflexion et laboratoire d'avant-garde à qui l'on doit nombre d'innovations radicales dans la façon de voir l'interface homme-machine. Il rend compte de cette expérience dans plusieurs textes marquants, dont : The Architecture Machine, Soft Architecture Machine et Computer Aids to Design and Architecture.

En 1980, Negroponte assume à Amsterdam les fonctions de président-fondateur du programme «L'ordinateur dans la vie de tous les jours» de la Fédération internationale pour le traitement de l'information. Deux ans plus tard, sur l'invitation du gouvernement français, il devient le premier directeur général du World Center for Personal Computation and Human Development (Paris), projet expérimental visant initialement à explorer les utilisations possibles de l'informatique au profit de l'enseignement primaire dans les pays sous-développés.

Depuis lors, Negroponte a donné des centaines de conférences de par le monde, notamment à la prestigieuse conférence de la Murata, à Kyoto, en 1990.

En outre, il conseille le gouvernement et l'industrie, siège à plusieurs conseils d'administration et participe à l'administration d'un fonds de capital-risque consacré aux nouvelles technologies d'information et d'édition.

BIOGRAPHY

ROGER T. POOLE

**Vice President of Network Services
Unitel Communications Inc. Toronto, Ontario**

Roger Poole is Vice President of Network Services for Unitel Communications Inc., based in Toronto, Canada. Mr. Poole joined Unitel in September of 1990. He chaired Unitel's technical panel before the Canadian Radio-Television and Telecommunications Commission (CRTC) in the company's successful bid to introduce competition into the Canadian Switched Long Distance market. Prior to joining Unitel, Mr. Poole was Vice President of Engineering and Planning in the Government Network Systems Division of U.S. Sprint.

Mr. Poole has over 26 years of experience in the telecommunications industry and has held senior executive positions in both the regulated and non-regulated areas of the business.

BIOGRAPHIE

ROGER T. POOLE

**Vice-président, des services réseau
Unitel Communications Inc., Toronto (Ontario)**

Roger Poole est vice-président des services de réseau d'Unitel Communications Inc., une entreprise de Toronto, au Canada. M. Poole s'est joint à Unitel en septembre 1990. Il a présidé le comité technique de la firme qui a comparu devant le Conseil de la radiodiffusion et des télécommunications canadiennes (CRTC) lorsque la compagnie a réussi à faire réintroduire la concurrence sur le marché des communications interurbaines établies par commutation au Canada. Avant de se joindre à Unitel, M. Poole a été vice-président de l'ingénierie et de la planification au sein de la Division des systèmes de réseaux gouvernementaux de U.S. Sprint.

M. Poole a plus de 26 ans d'expérience dans le domaine de l'industrie des télécommunications et a occupé des postes de cadre supérieur dans le secteur réglementé et le secteur non réglementé des télécommunications.

BIOGRAPHY

PAUL RACINE

Assistant Deputy Minister, Communications Policy Department of Communications, Ottawa, Ontario

A graduate in law from the University of Montreal, Mr. Racine's first career was in broadcasting, both public and private. He held positions as reporter, Parliamentary Correspondent, Editor-in-Chief and President of the Syndicat general du Cinema et de la Television a Radio-Canada.

His second career began in 1982 when he joined the public service of Canada, serving successfully as Director-General of Information Services, Director-General of federal-Provincial Relations, Director-General of Telecommunications Policy in the Department of Communications.

As of July 3, 1990, he is Assistant Deputy-Minister, Communications policy, consultation and policy development on telecommunications in Canada.

BIOGRAPHIE

PAUL RACINE

Sous-ministre adjoint, Politique des communications Ministère des Communications, Ottawa (Ontario)

M. Racine, qui détient un grade en droit de l'Université de Montréal, a d'abord travaillé en radiodiffusion dans le secteur public et dans le secteur privé. Il a occupé des postes de reporter, de correspondant parlementaire, de rédacteur en chef et de président du Syndicat général du cinéma et de la télévision à Radio-Canada.

Il a entrepris une deuxième carrière en 1982 quand il s'est joint à l'administration fédérale du Canada, où il a successivement occupé les postes de directeur général de l'information, des relations fédérales-provinciales et de la politique des télécommunications au ministère des Communications.

Dupuis le 3 juillet 1990, il est sous-ministre adjoint, Politique des communications.

BIOGRAPHY

OREST S. ROSCOE

**Vice President, Engineering
Telesat Mobile Inc., Ottawa, Ontario**

Mr. Orest S. Roscoe obtained a Bachelor's Degree in Electrical Engineering from the University of Manitoba in 1957, followed by a Master's Degree in 1962. He was employed at the Communications Research Centre in Ottawa from 1958 to 1970, and was involved in the Canadian satellite communications program from 1963. During this period, he was posted to the Norwegian Defence Establishment from 1967 to 1969 as an Exchange Officer.

Mr. Roscoe moved to the Department of Communications headquarters in 1971, where he undertook planning activities for satellite communications systems, including mobile satellite and direct broadcasting satellite systems. In 1978, he was awarded a Japanese Government Research Fellowship and spent six months in Japan studying the Japanese space program. Subsequent to his return to the Department of Communications he became Director, Satellite Communications Planning.

In 1984, he moved to Telesat's direct-to-home satellite television program and in MSAT program. Mr. Roscoe joined Telesat Mobile in 1988. As Vice President, Engineering, he is responsible for all activities related to the implementation of the satellite and ground segment facilities of Telesat Mobile's communications network.

BIOGRAPHIE

OREST S. ROSCOE

**Vice-président, Ingénierie
Telesat Mobile Inc., Ottawa (Ontario)**

Diplômé de l'université du Manitoba, M. Orest S. Roscoe a obtenu un baccalauréat en génie électrique en 1957 et une maîtrise en 1962. Il a travaillé au Centre de recherches sur les communications d'Ottawa de 1958 à 1970, où il a contribué au programme canadien de télécommunications par satellite à compter de 1963. De 1967 à 1969, il a été affecté à l'établissement norvégien de recherche pour la défense à titre d'officier stagiaire. M. Roscoe est passé à l'administration centrale du ministère des Communications en 1971. Il a alors participé à la planification de systèmes de télécommunications par satellite, y compris de systèmes mobiles et de systèmes de radiodiffusion directe. En 1978, il a reçu une bourse de recherche du gouvernement japonais et a passé six mois au Japon pour étudier le programme spatial japonais. Suite à son retour au ministère des Communications, il a été nommé directeur de la planification des télécommunications par satellite. En 1984, il est entré à Télésat Canada dans le cadre d'un programme de permutation des cadres. Il a alors participé au programme de télédiffusion directe par satellite de Télésat et au programme MSAT. M. Roscoe s'est joint à Télésat Mobile en 1988. À titre de vice-président des services techniques, il est responsable de toutes les activités liées à la mise en place des installations satellite et des installations du secteur terrien du réseau de télécommunications de Télésat Mobile.

BIOGRAPHY

JOHN A. ROTH

President

Northern Telecom Wireless Systems Inc., Mississauga, Ontario

John A. Roth is president, Northern Telecom Wireless Systems, Northern Telecom Limited, Mississauga, Ontario. Northern Telecom Wireless Systems develops and produces cellular and personal communications networks products.

Mr. Roth has held a wide range of executive positions within Northern Telecom and its subsidiaries. He started his career with the company in 1969 as a design engineer and moved through various project management and marketing positions to become division general manager of Northern Telecom Canada Limited's station apparatus division in 1977. He then became vice-president, operations manufacturing, Northern Telecom Limited in 1978.

In 1981 he returned to the field of research and development as executive vice-president, Bell-Northern Research Ltd. and was appointed president of BNR in 1982. He held this position until becoming executive vice-president Product Line Management in 1986.

BIOGRAPHIE

JOHN A. ROTH

Président

Northern Telecom Wireless Systems Inc., Mississauga (Ontario)

John A. Roth est président de Northern Telecom Systèmes sans fil, Northern Telecom Ltée, Mississauga, Ontario. Northern Telecom Systèmes sans fil met au point et produit des équipements pour les réseaux de télécommunications cellulaires et personnelles.

M. Roth a occupé des postes de direction très variés à Northern Telecom et dans ses sociétés affiliées. Il a commencé sa carrière à Northern Telecom en 1969 comme ingénieur d'études, puis occupé divers postes en gestion de projet et en marketing. En 1977, il est nommé chef de la Division des équipements de postes à Northern Telecom Canada Ltée. Il devient ensuite vice-président, Exploitation et Fabrication, à Northern Telecom Ltée en 1978.

En 1981, il réintègre le secteur de la R et D à titre de vice-président exécutif de Recherches Bell-Northern (BNR) et est nommé président de BNR en 1982. Il conserve ce poste jusqu'en 1986, puis devient vice-président exécutif à la Gestion des gammes de produits.

BIOGRAPHY

EDWARD M. STRAIN

**President
Vision 2000 Inc., Ottawa, Ontario**

Mr. Edward Strain received his Bachelor's Degree in Electrical Physics at the University of Toronto with honours and also received the St. James Scholarship, Governor General's Award and the RCE Memorial Scholarship.

From 1957-1960 Edward Strain served as Lieutenant and military pilot in the Royal Canadian Corps of Signals. In 1960, he joined Ferranti-Packard Electronics in the radio communications and computer/logic design departments.

In 1965 Edward Strain was Chief Engineer at ESE Limited in the digital systems and modem fields. In 1976 he became president of the company.

From 1978-1990 he was President of Motorola Information Systems Limited where he had the world product mandate for modems, and packet switching equipment. During the period 1984-1990 he was Chairman of Motorola Canada Limited.

Currently, Edward Strain is President of Vision 2000 Inc., a Canadian communications consortium.

BIOGRAPHIE

EDWARD M. STRAIN

**Président
Vision 2000 Inc., Ottawa (Ontario)**

M. Edward Strain a obtenu un baccalauréat en physique (électricité), avec la mention distinction, à l'Université de Toronto. Il a reçu la bourse St. James, le Prix du Gouverneur général et la bourse RCE Memorial.

De 1957 à 1960, Edward Strain a été lieutenant et pilote militaire dans le Corps royal canadien des transmissions. En 1960, il est entré à la société Ferranti-Packard Electronics, où il a travaillé en radiocommunications ainsi que dans les services de conception par ordinateur ou conception logique.

En 1965, Edward Strain est devenu ingénieur en chef à la société ESE Limited pour les systèmes numériques et les modems. En 1976, il accéda à la présidence de cette société.

De 1978 à 1990, il fut président de la Motorola Information Systems Limited, où il avait le mandat de la production en exclusivité mondiale des modems et du matériel de transmission par paquets. De 1984 à 1990, il fut président du conseil d'administration de Motorola Canada Limited.

Edward Strain est actuellement président de Vision 2000 Inc., consortium canadien dans le domaine des télécommunications.

BIOGRAPHY

BERTRAND SUEUR

**Department Head, Digital Terrestrial Broadcasting
Centre Commun d'Etudes de Telediffusion et Telecommunications,
(CCETT), Rennes, France**

A graduate of ENST (Ecole Nationale Supérieur des Télécommunications) in Paris France, Bertrand Sueur joined the CCETT (Centre Commun d'Etudes de Telediffusion et Télécommunications) in Rennes, France, in January 1986. The first subject on which he focused was the broadcasting of high-definition television signals on cable networks. Since 1990, he has been in charge of the laboratory for digital broadcasting of television signals. He is currently chairman of the channel coding and modulation group for the European DTTB (Digital Terrestrial Television Broadcasting) project.

BIOGRAPHIE

BERTRAND SUEUR

**Chef, Radiodiffusion numérique de Terre
Centre commun d'Études de télédiffusion et de télécommunication
(CCETT), Rennes, France**

Diplômé de l'ENST (École Nationale Supérieure des Télécommunications de Paris, France) en 1982, Bertrand Sueur a rejoint le CCETT (Centre Commun d'Études de Télédiffusion et Télécommunications à Rennes, France) en janvier 1986 et s'est d'abord intéressé à la transmission des signaux de télévision haute définition sur les réseaux de câble. Depuis 1990, il est responsable du laboratoire de diffusion numérique des signaux de télévision, et est actuellement Chairman du groupe 'modulation et codage de canal' au sein du projet européen dTTb (digital Terrestrial Television broadcasting).

BIOGRAPHY

ERNIE WELLING

President

Radio Advisory Board of Canada (RABC), Ottawa, Ontario

Ernie Welling is Director of Communications for the Electrical and Electronic Manufacturers Association of Canada (EEMAC). He represents the Association on the Radio Advisory Board of Canada (RABC), where he is currently President; on the Board of the Canadian Committee on Electrotechnologies; and on the Board of the IEEE Canada Foundation.

Trained in sciences and telecommunications at the University of London, he also graduated from Concordia University in Montreal. He is a veteran of the Royal Air Force Signals Branch and a senior Member of the Institute of Electrical and Electronic Engineers. (IEEE).

Before joining EEMAC, he was a technical journalist and editor for seventeen years following engineering and sales positions with leading electronic and aerospace manufacturers.

BIOGRAPHIE

ERNIE WELLING

Président

Conseil consultatif canadien de la radio (CCCR), Ottawa (Ontario)

M. Ernie Welling est directeur des communications de l'Association des manufacturiers d'équipement électrique et électronique du Canada (AMEEEC). Il représente cette association au Conseil consultatif canadien de la radio, dont il est actuellement président, au conseil d'administration du Comité canadien des électotechnologies et au conseil d'administration de l'IEEE Canada Foundation.

Il a étudié en sciences et en télécommunications à l'Université de London. Il est également diplômé de l'Université Concordia, à Montréal. Il a déjà fait partie du service des transmissions de l'Aviation royale du Canada et il est membre supérieur de l'Institute of Electrical and Electrical Engineers (IEEE).

Avant de se joindre à l'AMEEC, M. Welling a été journaliste et rédacteur en chef dans le domaine technique pendant dix-sept ans après avoir occupé des postes d'ingénieur et de vendeur chez de très importants fabricants de matériel électronique et aérospatial.



29944

QUEEN QC 454 .R3 S64 1992
Spectrum 20/20 : Symposium o
Spectrum 20/20 1992 : procee

DATE DUE

OCT 27 2005

OCT 28 2005

