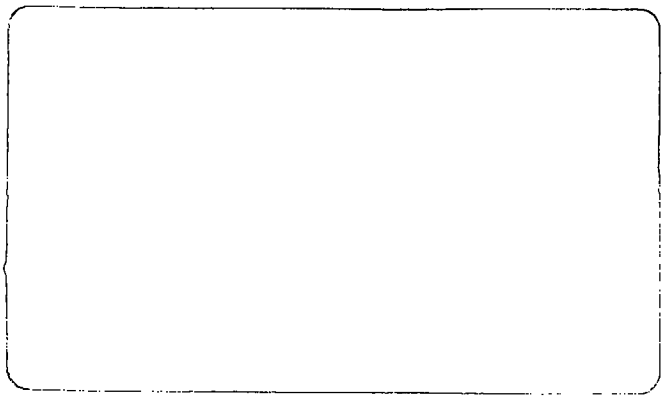
THE DESIGN AND DEVELOPMENT OF A SCPC DIGITAL RADIO PROGRAM RECEIVER

PHASE I

TASK I - MARKET SURVEY

MCS MILLER COMMUNICATIONS SYSTEMS LTD.



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PHASE I

TASK I - MARKET SURVEY

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MARKET ASSESSMENT FOR DIGITAL SCPC AUDIO PROGRAM TRANSMISSION EQUIPMENT

CONTENTS

MAJOR NORTH AMERICAN RADIO NETWORKS[1]

Canada	# of Affiliates
CBC English	501
CBC French	220
Access Alberta	16
CKO Inc.	12

U.S.A.

National Networks:

ABC Radio Networks	1,700
AP Network	900
CBS Radio Network	520
Mutual Broadcasting System	875
National Black Network	98
NBC Radio Network	600
UPI Radio Network	750
RKO Radio Networks	505
Sheridan Broadcasting Network	105
National Public Radio	350
American Public Radio	244

Regional Networks:

Missouri Network	365
Georgia Network	120
Texas State Network	130
Florida Network	130
Arkansas Radio Network	80
Virginia News Network	110
Progressive Farmer Network	75

[1]Examples only, not a complete list

1. EXECUTIVE SUMMARY

1.1 Background and Introduction

Under contract to the Communications Research Centre, Miller Communication Systems (MCS) is investigating the potential for developing state-of-the-art digital SCPC (single channel per carrier) audio program transmission equipment for satellite distribution of radio network programming. To support this investigation Woods Gordon have assisted MCS in undertaking an assessment of the market potential for such equipment in North America.

1.2 The Market for Satellite Audio Program Distribution

The market for the type of digital SCPC equipment under consideration is comprised largely of the national and regional radio networks operating in North America (see opposite).

With the exception of the CBC, all the major national networks have already switched to satellite distribution of their programming to affiliates. Many of the larger regional networks have also switched from terrestrial to satellite distribution, or are in the process of doing so. As a result, virtually all the U.S. first generation market for satellite audio program distribution equipment is already being served by the existing technologies of:

- o Analogue SCPC
- o Video Subcarrier
- o Digital Audio Transmission Service (DATS)

1.3 Market Size and Prospects for Digital SCPC Equipment

The CRC is the only sizeable prospect in North America for sale of the proposed digital SCPC equipment for a first generation satellite radio program distribution system. The major U.S. networks interviewed have only just installed their current equipment and expect this to last for at least ten years. It does not therefore appear likely that any substantial second generation market will materialize before the mid 1990's. Even then the U.S. networks may simply upgrade their existing technology.

If the CBC were to switch to the proposed digital SCPC system this would generate demand for around 720 satellite receivers and between 10 and 32 uplinks.

Without such a major domestic customer the prospects of selling the system outside Canada are not particularly high, and interest by the CBC in this technology appears to be a pre-requisite for its further development. A major customer such as the CBC will provide credibility for the technology and a large enough production volume to move down the production cost/experience curve.

1.4 Cost-Benefit Analysis

A preliminary cost-benefit assessment for the CBC indicates that a full digital SCPC distribution system could be put in place for around $19.0 million, and possibly less. This would replace annual expenditures for leased terrestrial landline use which are currently $4.3 million, suggesting a payback period of 4.4 years.

2. BACKGROUND AND INTRODUCTION

The Communications Research Centre (CRC) has identified a potential opportunity for development in Canada of a digital SCPC (single channel per carrier) system for satellite distribution of radio network programming. The Satellite Systems Division of Miller Communications Systems Ltd. (MCS) is working with the CRC to develop specifications and a preliminary design for such a system.

Woods Gordon were retained by MCS to assist in determining the potential market in North America for the proposed system.

2.1 Background to Potential Market Opportunity

Canada has a telecommunications network and broadcast system second to none, and makes extensive use of satellites for program distribution. Delivery of CBC TV programming via the Anik satellite system was inaugurated in 1973, with distribution of radio programming from six northern service production stations commencing in 1974. In 1981 Cancom commenced TV service to 'rural and underserved' areas via the Anik satellite.

By the end of 1984, the CBC had 9 transponders and Cancom 8 transponders, all on Anik D, delivering TV and radio programming to Canadian communities. Other Canadian broadcasters using satellite distribution facilities include TV Ontario, Access (Alberta Educational Communications Corp.) and CKO (news and information radio).

Currently, the CBC provide English and French language radio programming to almost 100% of the Canadian population via over

700 broadcasting transmitters, the vast majority of which are served by network programming via the terrestrial network. The CBC's cost for radio network distribution was $14.5 million for the year ended March 31, 1984 and $12.6 million for the prior year. The portion of this spent on leasing landlines is currently $4.3 million per year.

The current terrestrial network extends into almost every Canadian community. However, it is becoming more expensive to extend and maintain this network. The network itself is limited to providing 8kHz and 5kHz analogue feeds to broadcasting transmitters. The upgrading of these facilities to enable provision of, say, a 15kHz channel (necessary for high quality stereo program distribution) is considered to be neither technically or economically feasible when compared to satellite delivery.

The Communications Research Centre and Miller Communications Systems Limited consider there are a number of factors that provide an opportunity to develop a high quality satellite delivery system for radio network programming. These factors include:

- A large number of TV channels are carried by the domestic satellite system and FM or digital SCPC carriers can be placed in the same transponders as TV at no further space segment cost if a full transponder is already being leased.
- If deregulation proceeds in Canada, terrestrial costs for leased circuits may rise.
- The CBC serves one of the largest radio program networks in the world and incurs a substantial annual cost for its leased circuits.
- The current FM SCPC equipment used by the CBC for satellite radio program distribution to outlying broadcast transmitters is nearing the end of its useful life.
- Consumers are demanding more choice and improved quality.

The advantages of satellite program delivery for radio networks would include:

- o Total domestic coverage.
- o Ability to readily improve technical standards.
- o Flexibility of networking. For example, the CBC currently requires 5 feeds from Toronto, and also has many other program production centres from which programming originates.
- o Ability to add other services to a digital service, e.g. delivery of text.

2.2 Study Objectives and Methodology

The objective of this assignment was to undertake an assessment of the North American market potential for the digital SCPC audio program transmission equipment that MCS would develop under contract to the CRC.

Specific components of this market study were:

- o Identification of potential users for the digital SCPC equipment, and other potential applications for this technology. This was undertaken through a program of secondary research using our own library facilities and those of the CBC, computer data bases, communications industry periodicals, etc.
- o Development of interview guidelines for a survey of major potential users.
- o A survey of potential Canadian and U.S. users to identify interest in digital SCPC equipment and determine specific requirements of major radio networks. This survey concentrated on major existing radio networks, with most of the emphasis on the U.S. market since the potential users in Canada are relatively few. A list of organizations and individuals interviewed is contained in Appendix A. In-depth personal interviews were undertaken with the CBC in Ottawa, National Public Radio in Washington, and the ABC, CBS and RKO radio networks in New York. The U.S. interviews were undertaken jointly by Woods Gordon and MCS.

Utilizing the results of the market research program we assessed the potential market for digital SCPC equipment and working jointly with MCS developed the cost-benefit and cash flow analysis components of this report. MCS conducted the competitive analysis contained in Section 5.

The market research was concentrated largely on the U.S. market due to the fact that the only sizeable radio networks in Canada are the CBC's. None of the others appears sizeable enough to offer attractive potential for the proposed digital SCPC equipment.

EXHIBIT 1

CANADIAN RADIO NETWORKS

CBC Radio Networks	# of Broadcasters/ Rebroadcasters
English Radio Network	481
Radio Française	212
English Radio - stereo	20
Radio Française - stereo	8
	721
Other Networks	
Access Alberta (Alberta Education Communications Corp.)	16
CKO Inc.	12
Reseau Radiomutuel	12
	40
Network Radio Total	761

3. THE MARKET

3.1.1 Potential Users-Canada

Potential Canadian radio network users for the proposed digital SCPC equipment are summarized in Exhibit 1. With over 700 broadcasting and rebroadcasting stations, the CBC radio networks dominate the Canadian market, accounting for around 95% of network radio stations in Canada.

Analysis of the program distribution networks used by the CBC (as detailed in their 'Distribution Maps') indicates that they have 65 broadcast or rebroadcast stations with satellite ground stations, of which four are dual English/French stations.

Of the other radio networks operating in Canada, both CKO and Access already use satellites for program distribution. In addition there are a variety of other audio subcarrier services operating on Anik D, as indicated below:

Satellite Radio Program Distribution on ANIK D

Audio Subcarrier Services

Transponder	Radio Service
TR-4B	CKO-FM (Toronto, all news and information radio)
TR-6A	CBC Network Radio (English)
TR-7B	CKAC-AM (Montreal, French MOR/contemporary music)
	CITE-FM (Montreal, French traditional MOR music)
TR-8B	CBOF-FM (Ottawa, CRC Stereo Radio - French)
	CBBK-FM (Kingston, CBC Stereo Radio - English)
TR-9B	CIRK-FM (Edmonton, progressive rock - stereo)
TR-10A	CBC Network Radio (English)
TR-10B	CBM-AM (Montreal, CBC Radio English Network station)
TR-11B	CFMI-FM (New Westminister, soft rock)
	CBU-FM (Vancouver, CBC stereo radio, English)
TR-12A	VOCM (St. John's adult contemporary music)
TR-12B	CBOF-FM (Kingston, CBC stereo radio, English)

EXHIBIT 2

NEWS

FEDERAL COMMUNICATIONS COMMISSION
1919 M STREET, N.W.
WASHINGTON, D.C. 20554

News media information 202 / 254-7674
Recorded listing of releases and texts
202 / 632-0002

6260

August 28, 1984

BROADCAST STATION TOTALS FOR JULY 1984

The Commission has announced the following totals for broadcast stations licensed as of July 31, 1984.

AM Radio	4750
FM Radio	3618
FM Educational Radio	1153
UHF Commercial TV	358
VHF Commercial TV	536
UHF Educational TV	173
VHF Educational TV	114
UHF Low Power	93
VHF Low Power	197
Total Radio	9521
Total TV	1471

-FCC-

3.2 Potential Users - U.S.A.

Data provided by the FCC (Federal Communications Commission) indicate a total of 9,500 radio stations in the U.S. in mid 1984 (see Exhibit 2). Over the last 30 years there has been a substantial increase in the number of U.S. radio stations, particularly FM stations, as illustrated in the following table:

U.S. Radio Station Growth

	AM		FM	
	Authorized	On Air	Authorized	On Air
1954	2,636	2,521	580	560
1964	4,039	3,937	1,249	1,146
1974	4,448	4,395	3,360	3,135
1984	4,897	4,733	5,240	4,649

Source: Broadcasting/Cablecasting Yearbook

The majority of these radio stations are affiliated with one or more networks on either a national or a regional basis.

3.2.1 National Networks

The U.S. market has a number of sizeable national radio networks. These are listed in Exhibit 3, along with the number of affiliates in each network. Associated Press (AP), United Press International (UPI) and the Mutual Radio Network are essentially news networks supplying, for example, short 3 or 5 minute news bulletins every hour, while the others such as ABC, NBC and NPR provide a more varied format. The U.S. national radio networks have, between them, around 6,600 affiliates.

In addition to these radio networks there are also two national audio distribution networks, Muzak and Seeburg Music Library

EXHIBIT 3

U.S. NATIONAL RADIO NETWORKS

Network	Number Of Affiliates
ABC Radio Network	1,700
AP Network	900*
CBS Radio Network	520
Mutual Broadcasting System	875
National Black Network	98
NBC Radio Network	600
UPI Radio Network	750*
RKO Radio Network	505
Sheridan Broadcasting Network	105
National Public Radio	350
American Public Radio	244
	6,647

*Includes only affiliates with satellite receiver

Source: Interviews with networks and published information

which provide 'background music' for industrial plants, elevators in commercial buildings, etc. These two systems had 370 earthstations in operation in 1984.

3.2.2 Regional Networks

In additional to the national radio networks the U.S. market also has a substantial number of regional radio networks. The largest of these are state radio networks and farm networks, many of which have 50 or more affiliates. The largest regional network is the Missouri Network which operates in Missouri, Illinois, Arkansas, Indiana, Kansas, Kentucky, etc. and has 365 affiliated radio stations.

We have identified 98 regional networks in the U.S., with a total of 3,888 affiliated radio stations. A list of these regional radio networks is presented in Appendix C. Our research indicates, however, that not all of these networks involve program distribution. Some of these networks such as the Intermountain Network and the Ohio Radio Network just sell commercial time for their affiliated stations and do not require program transmission facilities.

3.2.3 Other Services

The digital SCPC equipment proposed by MCS will have the capability to distribute both audio and data signals. There are a number of potential applications other than radio program distribution for which the equipment could be utilized including:

- Facsimile Transmission
  - i) By radio networks for internal communications to affiliates (e.g., network messages, program schedules)
  - ii) Courier services and other facsimile transmission applications external to the radio networks

- o Data Services
  - i) Wire services similar to AP/UPI
  - ii) Telex-type services
  - iii) Document delivery e.g., word processor to word processor
  - iv) Multi-point data distribution services for stock market and commodity market data (using FM subcarriers)
  - v) Paging services
  - vi) Weather Services
- o Satellite Printing Services
  - i) Multi-plant printing of newspapers and magazines e.g., Wall Street Journal, Financial Times, Time, Newsweek

As an example, in the U.S. market there is growing interest in the use of FM radio subcarriers for data distribution. Background music broadcasters such as Muzak and Seeburg Music Library have been using this portion of FM radio signals to deliver their programming to elevators, department stores, etc. Now subcarriers are increasingly being used by publishers and others to deliver financial information, stock quotes, computer data and even computer software. The chief advantage of subcarrier technology is considered to be its substantially lower cost compared with conventional telephone lines.

A number of companies are combining satellite distribution with FM subcarriers. Mutual Broadcasting System Inc. is introducing a subcarrier service using its national radio network and says it can provide broadcast coverage in the top 100 national markets. The Data Systems Division of Bonneville Telecommunications is another major entrant in the market. They have agreements with 50

FM stations reaching close to 80% of the U.S. population. Bonneville recently concluded a joint marketing agreement with General Electric Co.'s Information Services Co., a large supplier of data communication services. The agreement allows customers to phone in requests for information which is then set over the inexpensive broadcast network.

Several of the major networks we interviewed are looking at various data and information services for both internal network use and external services. NPR in particular has excess capacity and has talked to a wide variety of potential customers about providing FM subcarrier and paging services including a potential national paging service with Mobile Communications Corp. of America.

Newswire services such a UPI and AP are using satellite distribution to newspapers and other clients for services such as 'teletypesetter reports'. UPI's plans, for example, envisage 3,700 dishes for newspaper and broadcast subscribers in the U.S.

Competition for the data distribution market via existing earth stations is also emerging from 'micro earth stations' of the type produced by Equatorial Communications. Dow Jones Information Services is purchasing 2,400 of these micro earth stations as part of a satellite network that will provide real-time distribution of their information services, replacing a dedicated landline system.

3.3 Existing Satellite Distribution

At the present time the CBC's Radio Networks appear to be only major national networks in North America that have not

EXHIBIT 4

DATS SATELLITE GUIDE

DATS	ABC (X23)	CBS (X19)	NBC (X19)	RKD (X19)	IDB(X3)
00	Special Events	Radio/Radio			Westwood 1 Left
01	Service/Sports	Radio/Radio			Westwood 1 Right
02	ICR East	News-East -0 News-C/M -1			Occasional Customers
03	ICR C/M	News-West -0 News Specials -1			Occasional Customers
04	ICR WEST		Source-East		CNN (Braves)-0 CNN (News) -1
05	ICR SE Region		Source-C/M		Motor Racing Net
06	DEF Region		Source-West		
07	DEF East		Source Speciala Concerts-Left		
08	DEF C/M		Source Specials Concerts-Right		
09	DEF West		News-East -0 News-West -1		
10	Stereo 1-Left		News-West -0 News Specials -1		
11	Stereo 1-Right		Talknet -0 -1		
12	Stereo 2-Left			RKO 1	
13	Stereo 2-Right			RKO 2	
14	Stereo 3-Left			Stereo Left	
15	Stereo 3-RIght			Stereo Right	
16	Stereo 4-Left			Spare	
17	Stereo 4-Right (Talk Radio MIX-Minus)			Spare	
18	Talk Radio				
19-					
	00 News Voice Cue	News Voice Cue			
	01 Talk Radio Cue				
	02		News Voice Cue		
	03		Electronic Mail		
	04			Voice Cue	
	05			Voice Cue	
	06				
	07				
	08				
	09				
	10				
	11				

X3	5985/3760	3V	Satcoms 1R,2R,3R,4,5 139,72,131,83,143
X15	6225/4000	15V	
X19	6305/4080	19V	
X23	6385/4160	23V	

IDB Los Angeles CA relays CNN Radio (Galaxy T-7) on DATS T-3 channel 4, sub-divided into two (2) 7.5kHz channels--one for News, one for ATL Braves and other special programs TBD.

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switched substantially all their distribution requirements to satellite. In the U.S., all the major radio networks have switched to satellite distribution over the past three years. Information from the major networks interviewed indicates that they all achieved substantial cost savings over the terrestrial toll line distribution networks they had previously used. Whereas, the CBC uses satellite distribution for some isolated locations, the majority of its network is still terrestrial. In the U.S. the switch-over has been essentially 100% network conversion from terrestrial to satellite.

The extensive nature of the satellite usage by some of the major U.S. radio networks is illustrated by the satellite usage guide provided by ABC Radio Network (see Exhibit 4). Substantial use is also made of satellite audio subcarrier services for distribution of radio programming, as illustrated by Exhibit 5. These two Exhibits do not illustrate the full extent of existing satellite distribution of radio programming. Our research and interview program also identified the following example of regional networks that utilize satellite transmission:

Examples of Regional Networks Using Satellite Transmission

Networks	# of Affiliates
Brownfield Network	110
Florida Network	53
Georgia Radio News Service	102
Georgia Network Inc.	113
Missouri Network Inc,	365
Progressive Farmer Network	75
Texas State Network	159
Louisiana Network	50
Oklahoma News Network	55
Tennessee Radio Network[1]	-
Mid-America Network	-
Alabama Information Network	50
Arkansas Network	80

[1] Not yet operational on satellite

EXHIBIT 5

SATELLITE RADIO PROGRAM DISTRIBUTION

AUDIO SUBCARRIER SERVICES

RCA SATCOM 3R	
TR-2	Satellite Radio Network (contemporary/religious format)
TR-3	Moody Broadcasting Network (religious - stereo) Satellite Music Network/Starstation (adult contemporary format - stereo) Satellite Music Network/Country Coast-to-Coast (country format - stereo Satellite Music Network/Stardust - traditional MOR music format - stereo) WFMT-FM Chicago (fine arts/classical - stereo)
TR-6	SCAN/Starship (country/western - stereo) SCAN/Starship (adult contemporary - stereo) SCAN/Starship (50's/60's format) SCAN/Starship (comedy/specials) SCAN/Starship (big band)
TR-7	ESPN Affiliate Informational Network (ESPN programs schedule)
TR-8	Nice & Easy (easy listening music - stereo) Cable Jazz Network (jazz music - stereo) Love Radio Network (contemporary Christian music - stereo)
RCA SATCOM 1R	
TR-20	AFRTS Radio Network (Armed Forces Radio Television Service)
HUGHES GALAXY 1	
TR-7	CNN Radio Network (all news radio feed)
ANIK D	
TR-4B (8)	CKO-FM (Toronto, all news and information radio)
TR-6A (11)	CBC Network Radio (English)
TR-7B (14)	CKAC-AM (Montreal, French MOR/contemporary music) CITE-FM (Montreal, French traditional MOR music)
TR-8B (16)	CBOF-FM (Ottawa, CBC Stereo Radio - French) CBBK-FM (Kingston, CBC Stereo Radio - English)
ANIK D (Cont'd)	
TR-9B (18)	CIRK-FM (Edmonton, progressive rock - stereo)
TR-10A (19)	CBC Network Radio (English)
TR-10B (20)	CBM-AM (Montreal, CBC Radio English Network station)
TR-11B (22)	CFMI-FM (New Westminister, soft rock) CBU-FM (Vancouver, CBC stereo radio, English)
TR-12A (23)	VOCM (St. John's, adult contemporary music)
TR-12B (24)	CBOF-FM (Ottawa, CBC stereo radio, French) CBBK-FM (Kingston, CBC stereo radio, English)
WESTERN UNION WESTAR 4	
TR-6(D) (11)	CTNA Radio Network (religious)
RCA SATCOM 4	
TR-3	Rhythm & Blues (contemporary jazz/soul music - stereo) Starship/Classical (classical music - stereo) The Rock Channel (top 40 rock - stereo) Georgia State Radio Network In Touch (reading service for blind)
TR-7	Astro Radio Network (religious/instructional format) SBN (Sheridan Broadcasting Network - stereo) Gold Mine Radio Network (country & western)
TR-17	Satellite Jazz Network (jazz music - stereo)
RCA SATCOM 2R	
TR-20	AFRTS Radio Network (Armed Forces Radio & Television Service)

Source: Westsat Communications (see Appendix D)

Other satellite audio networks that were operational at the start of 1984 are listed by type of technology used, in Exhibit 6.

Our discussions with the sample of regional networks and the National Association of State Radio Networks indicate that at present 40-50% of the major regional networks are on satellites and a further 40% are in the process of transferring to satellite. This sector of the radio industry expects that in the next year or two it will have moved about 100% from land lines to satellite transmission.

The smaller networks tend to lease time from the larger networks. The majority of these are not using satellites and it was pointed out that most small networks are not really networks, but representatives who sell time for small radio stations. In reality, there are few small networks with less than 20-30 affiliates. The radio network personnel interviewed considered it probable that most U.S. networks operating on a satellite would have 50 or more affiliates.

3.4 Technology Used

The technology presently used for satellite distribution of radio programming is discussed in more detail in Section 5 (Competitive Analysis). Our interviews with U.S. and Canadian radio networks indicate that the technology used is largely as follows:

- o Multiplexed digital audio systems

  Used by most of the major U.S. national radio networks such as ABC, NBC, CBS and RKO, as well as National Black Network

- o SCPC Analogue Systems

  Used by most of the regional networks

EXHIBIT 6

SATELLITE AUDIO-TRANSMISSION TECHNOLOGY

RCA Americom -- Digital Audio Transmission Service (DATS)

		# of Downlinks	Technical Facilities	# of Channels
ABC Contemporary Network	Satcom 1-R	270	15kHz stereo)	
ABC Direction Network	Satcom 1-R	180	15kHz stereo)	
ABC Entertainment Network	Satcom 1-R	400	15kHz stereo)	
ABC FM Network	Satcom 1-R	120	15kHz stereo)	19
ABC Information Network	Satcom 1-R	530	15kHz stereo)	
ABC Rock Network	Satcom 1-R	60	15kHz stereo)	
ABC Talkradio	Satcom 1-R	60	15kHz stereo)	
CBS Radio Network	Satcom 1-R	340	15kHz stereo)	2(15kHz); 4(7.5 kHz)
CBS Radio Radio	Satcom 1-R	120	15kHz stereo)	
Health Radio Network	Satcom 1-R	n/a	7.5 kHz mono	2
NBC Radio Network	Satcom 1-R	330	7.5 kHz mono)	6
NBC Talknet	Satcom 1-R	70	7.5 kHz mono)	
RKO I	Satcom 1-R	170	15kHz stereo)	6
RKO II	Satcom 1-R	190	15kHz stereo)	
The Source	Satcom 1-R	160	15kHz stereo	5
Single-Channel-Per-Carrier (SCPC)				
Alabama Information Network	Westar 4	50	7.5 kHz mono	2
AP Radio	Westar 3	900	7.5 kHz mono	5 (15kHz)
Arkansas Radio Network	Westar 3	80	7.5 kHz mono	1
Bible Broadcasting Network	Westar 3	10	15 kHz stereo	2
Florida Network	Westar 3	60	7.5 kHz mono	2
Georgia Radio News Service	Westar 4	100	7.5 kHz mono	1
Health Radio Network	Westar 3	n/a	7.5 kHz mono	2
Kansas Information Network	Westar 3	40	7.5 kHz mono	1
Louisiana Network	Westar 3	50	7.5 kHz mono	1
Minnesota News Network	Westar 4	50	7.5 kHz mono	2
Mississippi Network	Westar 3	60	7.5 kHz mono	1
Missourinet	Westar 3	380	7.5 kHz mono	3(7.5kHz); 1(15kHz)
Mutual Radio Network	Westar 4	600	15 kHz stereo	11
National Public Radio	Westar 4	250	15 kHz stereo	12
North Carolina News Network	Westar 3	110	7.5 kHz mono	3
Portland Trailblazers Network	Westar 3	20	7.5 kHz mono	2
RockAmerica	Satcom 3-R	10	15 kHz stereo	2
Southern States Network	Westar 3	40	7.5 kHz mono	2
Texas State Network	Westar 3	130	7.5 kHz mono	1 (15 kHz)
The Wall Street Journal Report	Westar 3	90	7.5 kHz mono	1 (15 kHz)
Total Radio Network	Westar 3	30	7.5 kHz mono	2
Transtar I	Westar 3	110	15 kHz stereo	2
UPI Radio Network	Westar 3	750	7.5 kHz mono	1 (15 kHz)
Virginia News Network	Westar 3	110	7.5 kHz mono	3
VOICE Network	Westar 3	10	7.5 kHz mono	1
Video Subcarrier				
Bonneville Easy Listening	Satcom 3-R	20	15 kHz stereo	2
Cable Jazz Network	Satcom 3-R	10	15 kHz stereo	6
CNN Radio	Galaxy I)	150	15 kHz mono	1
CNN Radio	Satcom 3-R)		15 kHz mono	1
Country Coast-to-Coast	Satcom 3-R	140	15 kHz stereo	2
Family Radio	Satcom 4	10	15 kHz stereo	2
Format 41	Westar 5	n/a	15 kHz stereo	2
Georgia Network	Satcom 4	120	15 kHz mono	1
Lifestyle	Satcom 3-R	150	15 kHz mono	1
Love Sounds	Satcom 3-R	10	15 kHz stereo	6
Moody Broadcasting Network	Satcom 3-R	90	15 kHz stereo	2
Muzak	Westar 5	220	15 kHz mono	2
Nice & Easy	Satcom 3-R	10	15 kHz stereo	6
Satellite Jazz Network	Satcom 4	30	15 kHz stereo	2
Satellite Radio Network	Satcom 3-R	180	15 kHz mono	1
SCAN/50's & 60's	Satcom 3-R	30	7.5 kHz stereo)	
SCAN/Big Bands	Satcom 3-R	30	7.5 kHz mono)	
SCAN/Broadway-Hollywood	Satcom 3-R	30	15 kHz stereo)	
SCAN/Comedy	Satcom 3-R	30	7.5 kHz mono)	4(15kHz); 4(7.5kHz)
SCAN/Country-Western	Satcom 3-R	30	15 kHz stereo)	
SCAN/Nationality Broadcast Network	Satcom 4	10	7.5 kHz mono)	4(15kHz); 2(7.5kHz)
SCAN/Rhythm & Blues	Satcom 4	10	15 kHz stereo)	
SCAN/The Rock Channel	Satcom 4	10	15 kHz stereo)	
Sheridan Broadcasting Network	Satcom 4	80	15 kHz mono	2
Stardust	Satcom 3-R	60	7.5 kHz stereo	2
StarStation	Satcom 3-R	130	15 kHz stereo	2
Transtar 2	Westar 5	10	15 kHz stereo	2
WFMT-FM Chicago	Satcom 3-R	170	15 kHz stereo	2

Source: Developed from 'Satellite Audio - Network Profiles (1984)'

o Audio Subcarriers in TV baseband

Used by the audio networks listed in Exhibit 5. This technology is currently used by the CBC for satellite program transmission. Many of the services are in stereo.

A listing of networks using satellites for audio program distribution and the type of technology used is presented in Exhibit 6.

Equipment suppliers for satellite radio program distribution identified during the research program were:

Company	Type of Equipment
Scientific Atlanta	Digital, multiplexed
Microdyne	Analogue, SCPC
Harris (Advanced Communications)	Analogue, SCPC
Comtech	Analogue, SCPC
Wegener Communications	Analogue, SCPC
Modulation Associates	Analogue, SCPC

3.5 System Costs

The best comparison for system costs is the Scientific Atlanta digital audio transmission service (DATS). According to ABC Radio Network the costs of the receiver package (electronics plus antenna) were U.S. $10,500 per unit and these are now down to only U.S. $9,000 fully installed. CBS Radio Network indicated a cost of U.S. $12-15,000 installed for antenna/electronics (U.S. $10,000/unit + installation). There are now over 2,000 dishes installed for DATS reception.

3.6 Market Size and Future Prospects for Digital SCPC Equipment

3.6.1 U.S.A.

This analysis of the North American market for the type of digital SCPC audio program transmission equipment proposed for

development in Canada over the next couple of years indicates that as far as the U.S. market is concerned, by the time this equipment is available virtually all U.S. radio networks will already have made the switch to satellite transmission using alternative technology and suppliers. There is little prospect of any 'first generation' market in the U.S. for this equipment.

The major U.S. radio networks we visited indicated that they expected the equipment they have installed over the past couple of years to last at least ten years. As a result it will probably be well into the 1990's before they start looking seriously at replacing, upgrading or changing these systems. The U.S. regional networks are still in the process of changing from terrestrial networks to satellite distribution and are unlikely to be looking at further changes or upgraded equipment prior to the mid 1990's.

Any further growth in the size of the U.S. radio networks will simply result in demand for more of the type of satellite receiving equipment that the networks have already chosen.

There is growing demand in the U.S. for non-audio satellite transmission for data related services. The economics of satellite distribution,and the fact that a lot of these services will likely be of the audio subcarrier type, suggests that they will be piggybacked onto existing distribution systems, rather than being established from scratch. It is thus unlikely that the dual-purpose audio/data equipment proposed for development in Canada will successfully penetrate this sector of the market, without first being accepted by major radio networks for audio program distribution.

In the U.S. there are around 17,000 satellite earth stations looking at the satellites which are currently used to provide audio transmission. The satellites used and the number of earth stations looking at each are summarized below.

Satellite Earth Stations

Satellite	# of Earth Stations
Satcom 1-R	2,100
Satcom 3-R	8,000
Satcom 4	1,400
Westar 3	2,600
Westar 4	1,050
Westar 5	1,500
Galaxy 1	300
	16,950

Source: Developed from 'Satellite Audio-Network Profile's, 1984 Edition.

With such a large base of earth stations in place it is likely that any company wishing to offer a data service could do so for the cost of retrofitting appropriate earthstations with the electronics for data reception. The dual stereo radio/data system planned for development in Canada is unlikely to find a ready market in this area.

3.6.2 Canada

In Canada the situation is rather different. The CBC operates the only sizeable national radio networks and, apparently, as yet has no firm plans to switch to satellite distribution. However, in view of both the technical improvements that could be achieved and the cost savings achieved by the U.S. networks, it seems likely that

the CBC will ultimately switch-over to satellite distribution. It is already using satellite distribution for feeds to around 65 outlying broadcast/rebroadcast stations.

Since the CBC is already purchasing substantial transponder capacity for TV program distribution, it would be possible to use a subcarrier digital SCPC approach to radio network program distribution, with no increase in satellite transponder costs. In addition, the proposed MCS system would enable the CBC to provide additional services, either for internal messaging to its affiliates or for resale to other operators such as FM subcarrier distribution of stock market data to portable 'Quotron' type receivers.

3.6.3 International Markets

This market study has not been looked at whether or not there is a potential market for the proposed digital SCPC audio transmission equipment outside North America. However, it appears likely that other countries with satellite systems for broadcasting applications are not as advanced as the U.S. in the switch to satellite radio program distribution. Countries such as Australia, Indonesia, Brazil and India which have their own domestic satellite systems may be potential markets. In the case of these countries it is likely that the costs of the digital SCPC system would have to be competitive with the other available satellite technologies for this system to be chosen.

Australia is certainly showing interest in this area as evidenced by Telecom Australia's purchase of over 200 B-MAC (multiplexed analog components) decoders from Scientific Atlanta for

use in implementing its Homestead and Community Broadcasting Satellite Service. The B-MAC system was preferred "because of its ability to deliver a high quality TV signal even under adverse conditions, as well as delivering six digital audio channels and a data channel." In addition, AAP Reuters Communications of Sidney has placed a U.S. $10 million contract with M/A-Com for three satellite sub-networks, consisting of TDMA, digital and analogue SCPC, and one-way digital data distribution to a large number of receive-only locations.

Also, countries such as France, Germany and the U.K. could be interested for such applications as FM subcarrier distribution for stock market quotation services and similar services in which the U.S. typically leads the market.

EXHIBIT 7

CBC Coverage

Radio and Television, English, French and Composite Networks
Population estimates as of March 31, 1984

	Canada	AM radio coverage %	Television coverage %	FM-stereo coverage %
English Networks				
Population:				
Total	25,100,000	97.1	96.5	67.6
English most often spoken	17,000,000	99.0	98.9	71.8
French Networks				
Population:				
Total	25,100,000	91.7	85.3	25.6
French most often spoken	6,030,000	99.5	99.5	75.5
Composite Networks				
Total population	25,100,000	99.3	99.2	74.4

Note: Statistics are based on the service areas (AM radio—0.5 mv/m daytime service; television—A and B service; FM stereo—0.5 mv/m service) of all CBC-owned and CBC-affiliated stations in operation or approved by the CRTC prior to October 1, 1983.

CBC Research

CBC Stations and Transmitters

TELEVISION March 31, 1984	English Network	French Network	Total
CBC stations	18	13	31
CBC rebroadcast transmitters	420	160	580
Private affiliated stations	26	5	31
Private or community-owned rebroadcast transmitters	205	41	246
Total	**669**	**219**	**888**

RADIO March 31, 1984	English Networks		French Networks		Total
	Mono (AM/FM)	Stereo (FM)	Mono (AM/FM)	Stereo (FM)	
CBC stations	31	15	15	6	67
CBC rebroadcast transmitters	401	4	167	1	573
Private affiliated stations	15	—	7	—	22
Private or community-owned rebroadcast transmitters	34	1	23	1	59
Total	**481**	**20**	**212**	**8**	**721**

CBC SHORTWAVE TRANSMITTERS

March 31, 1984

Sackville, N.B.	7	(RCI and Northern Service)
St. John's, Nfld.	1	(Duplicating local domestic service for outlying areas and shipping.)
Vancouver, B.C.	1	

Television and Radio Households in Canada*

as of January 1, 1984

		% of total
Total households	8,759,000	100
With AM radios	8,634,000	99
With FM radios	8,057,000	92
With TV sets	8,564,000	98
With color TV sets	7,681,000	88
With more than one TV set	3,760,000	43
With cable TV	5,328,000	61
With cable and converter	2,682,000	31
With pay TV	495,000	6

** Less the Yukon and Northwest Territories.*

CBC Research

4. COST-BENEFIT ANALYSIS

4.1 U.S.A. - Examples of Cost Savings

All of the U.S. radio networks that have switched to satellite distribution have done so largely to reduce their program distribution costs and eliminate expensive land lines. All the systems interviewed had experienced, or expected to achieve, cost savings with satellite distribution. Examples include:

- RKO Radio Network - spent U.S.$15 million on their digital system and are saving over U.S.$1 million per year over their previous analogue SCPC system. Over their 8 year deal with RCA for DATS service they expect savings of U.S. $13 million over previous leased analogue system.
- CBS Radio Network - was paying U.S.$4 million/year for landlines; now paying less thatn U.S.$1 million for satellite capacity.
- Florida Network - saving U.S. $10-15,000 per month on landlines. Will recoup capital investment in 3-4 years.
- Arkansas Radio Network - total satellite distribution costs U.S. $12-14,000 per month versus an estimated $20-25,000 per month if they were still using landlines.

4.2 Canada - CBC

This cost-benefit analysis assesses, on a preliminary basis, the potential impact on the CBC of switching from its current terrestrial distribution system to a digital SCPC satellite distribution system. For the purposes of this analysis we have assumed a complete switch-over to satellite distribution by both the English and French radio networks, implying a total of 721 satellite receivers (see Exhibit 7, opposite), unless some of the French and English network receivers can be co-located. At present CBC radio has

EXHIBIT 8

CBC RADIO NETWORK DISTRIBUTION

COST-BENEFIT ANALYSIS[1]
(all figures in 1985 $)

A. Terrestrial Distribution	Cost ($000's)
Land Line Costs - English Network	3,200
- French Network	1,100
Annual Cost	4,300

B. Digital SCPC Network	Cost ($000's)
10 Uplinks @ 100,000	1,000
721 Receivers 25,000	18,025
Capital Cost	19,025
Satellite Transponder Costs	0

$$\text{Payback Period} = \frac{19,025}{4,300} = 4.4 \text{ years}$$

[1] Note: This is a very preliminary analysis, based on limited available data and does not include a number of factors such as differences in annual maintenance costs, financing costs on capital employed, or any other equipment changes necessary for a switch digital SCPC.

It also assumes the use of existing CBC transponders with digital SCPC replacing current FM radio carriers at band edge.

32 program production centres and we have assumed a digital SCPC uplink at 10 of these.

The cost comparison between existing network costs (line charges only) and the costs of a digital SCPC satellite delivery system are summarized in Exhibit 8. No allowance is made in this preliminary analysis for ongoing maintenance costs in either the existing terrestrial system or the proposed satellite system, or for any capital costs that the CBC might have to incur to replace satellite FM SCPC equipment currently used in conjunction with the terrestrial network. The 721 digital SCPC receivers includes replacements for all FM SCPC receivers currently in use. For this analysis satellite transponder costs for the CBC are assumed to be zero since the CBC already has adequate transponders used for TV distribution, in which the digital SCPC signals could be placed.

This prelimary cost comparison indicates a payback period of around 4.4 years. This analysis is based on preliminary cost estimates developed by MCS. These are considerably higher than the levels experienced in the U.S. (see section 3.5). It is possible that a system for the CBC could be developed for a lower capital cost.

Other benefits of digital SCPC distribution system that have not been quantified in cost terms include:

- o The potential for revenue offsets by selling FM subcarrier distribution services or similar, using the data channel in the digital SCPC system.
- o The digital SCPC system allows for stereo broadcast of all signals at no additional cost.

5. COMPETITIVE ANALYSIS

5.1 Alternative Satellite Audio Technologies

There are three radio program distribution techniques which pose a competitive threat to the proposed delivery system. They are:

a) Audio subcarriers in the TV baseband
b) SCPC analogue systems
c) Multiple digital audio transmission systems

All of these techniques are well established and have achieved significant market penetration as radio program stereo delivery systems via satellite.

Audio Subcarrier in TV Baseband

This technique has been significantly exploited by satellite operators throughout the world. It is interesting to note that Telesat Canada has been fielding this system since early in 1973 to deliver the TV related audio for the CBC.

Recent developments have shown that multiple audio subcarriers can be placed in the TV baseband with a small incremental cost per station.

Product suppliers of this equipment include Modulation Associates, Wegener Communications and a new entry, Leaming.

These systems are used extensively in the U.S.A. and Canada, and are now penetrating into Europe.

SCPC Analogue Systems

This technique has also achieve significant penetration since 1975 when the first satellite system became operational (Telesat radio program for CBC).

These systems are used extensively by radio broadcasters in North America. They are also extensively used for telephone message service worldwide.

Suppliers include Microtel, Spar, Skyswitch, California Microwave, Scientific Atlanta, Microdyne and Wegener.

Multiple Digital Audio Transmission Systems

These systems are extensively used by major U.S. radio networks including RKO Radio, CBS Radio and ABC Radio who share transmission facilities via the RCA satellite in the U.S.A. The RCA system is a digital, multiple channel system which occupies a complete transponder. Scientific Atlanta is the equipment supplier for this system.

5.2 Weaknesses of Alternative Technologies

All of these transmission techniques are well established and have been growing at a remarkable rate over the last three years. However, each of them have system weaknesses viz.

- Audio Subcarrier

  Associated with T.V. uplinks whereas most T.V. and radio broadcasters usually have separate program production centres and separate transmitter sites.

- SCPC Analogue

  While analogue is currently more cost effective than digital, there is much activity in digital communications techniques and ultimately the costs could be comparable.

- Multiple Digital Audio

  There are three disadvantages of this technique:

  - backhauling from the program production centre to the uplink earth station - which creates quality and cost problems,

- o use of complete transponder, and the associated high costs,
- o relatively high cost of the demultiplexing receive equipment over SCPC digital.

Nevertheless, despite these weaknesses these system are well established and the "bottom line" will continue to be a tradeoff between cost and performance.

6. MARKET FORECASTS

In January 1985 there were 26 commercial satellites in an equatorial orbit above North America owned by seven operating agencies - RCA, Galaxy, ATT Comstar, Telesat, SBS, Western Union and GTE Spacenet.

Additionally, several countries are operating/have committed to domestic satellite systems including: - Indonesia, India, Brazil, Australia, and Mexico. Still others are in the planning phase. Regional satellite systems include Eutelsat and Arabsat.

Intelsat is an international consortium serving transoceanic fixed service both at C-Band and Ku-Band. They are also providing domestic service to 27 nations.

Thus, in the last 25 years there has been an enormous penetration by satellite communications serving both telecommunications and broadcasting needs.

While wide area telecommunications services are being threatened by new and existing wideband transmission technologies, the use of satellites as a means of broadcasting is growing significantly.

However, as indicated in Sections 3 and 5, there are already a number of competitive techniques serving radio broadcasters. Some of these systems have only just been established, are extremely cost effective, and will likely remain in service for the next ten to fifteen years.

Additionally these well established techniques are proliferating rapidly in the near term in the U.S. and are quite capable of meeting stereo broadcasting needs.

Nevertheless, most broadcasters we visited in the U.S.A. saw the virtue of the single channel per carrier technique in certain instances, and concurred on the attractiveness of stereo for distributing programmed music.

Based on the discussions and visits we had to the major North American radio program broadcasters, we see SCPC digital audio stereo as evolving gradually with not a very high initial market penetration.

Additional discussions with Telecom Canada and CBC staff have indicated a domestic concern for ensuring compatibility between terrestrial and satellite systems. No such issue surfaced in discussions with U.S. Broadcasters.

Thus we see the following market projections which are based on a Canadian commitment to field the technology.

Field prototype unit	Spring 1986
Field Trial to Broadcasters	During 1986
Commit to develop 6 units for extensive field trials via satellite	Late 1986
Commit to Production	Spring 1987
Delivery (Qty 120) Production Units	Early 1988
Delivery (Qty 600) Production Units	During 1988/9
Customer conversion from terrestrial to satellite delivery	Early 1989

This schedule would be an adequate time to negotiate the conversion from terrestrial to satellite delivery between the CBC and Telecom Canada.

With this system successfully in operation, future North American and overseas markets could be pursued with credibility. Without such a domestic system in operation it would be very difficult to penetrate the international market place.

EXHIBIT 9

DIGITAL SCPC EQUIPMENT COST ESTIMATES

PHASE 2

Development and Build of Qty. 1 Enc/Mux/Mod Unit

	$[1]
Development	100,000
Drafting	20,000
Production	5,000
Testing	5,000
Materials	5,000
	135,000

PHASE 3

Production of 10 Encoder/Mux/Mod Units

	$[1]
Engineering Support Costs	60,000
Drafting	10,000
Production	10,000
Testing	15,000
Materials	25,000
	120,000

PHASE 2

Development and Build of Qty. 6 Demod/Demux/Decoder Units

Development	150,000
Drafting	30,000
Production	15,000
Testing	15,000
Materials	18,000
	228,000

Production of 500 Demod/Demux/Decoder Units

Automated Test Systems and Production Set Up	400,000
Engineering Support Cost	200,000
Drafting	30,000
Production	500,000
Testing	400,000
Materials	1,000,000
	2,530,000

[1] All costs in 1985 dollars. Estimates developed by Miller Communications Systems. Excludes federal sales tax, profit and licence fees.

7. CASH FLOW ANALYSIS

The cash flow required to proceed from the stage we are in now to the delivery of five hundred production Demod/Demux/Decoder units and ten encoder/mux/mod units is:

		1985 $
1985	Develop one prototype	400,000
1986	Field Trial Prototype	250,000
1987	Develop Pre-Production Units	363,000
Mid 1987-mid 89	Production Units	2,530,000
	Total Cost	$3,543,000

It is recommended that some 30% is added to this cost to allow for profit, FST and marketing costs.

Future units of Demod/Demux/Decoder would sell in the range of $5,000.

8. SUMMARY

It is concluded that only the CBC is a prospect for the proposed system. Clearly the U.S. networks are not interested.

If the payback period is 4.4 years as indicated in Exhibit 8 and the system can be maintained for a further ten years without additional space sector costs, then the CBC could save about $40M during the 1990's.

Additionally, new stations could be added at a low incremental cost.

APPENDIX A

LIST OF INTERVIEWS

Canadian Networks

Canadian Broadcasting Company	- Ray Anderson
	- Norman Nault
Associated Broadcasting (Muzak/Seeburg)	- Larry Sands

U.S. National Radio Networks

National Public Radio (Washington, D.C.)	- Wayne Hetrich, Senior Engineer Research & Development
	- Blan Shattuck, New Station Interconnect Engineer
RKO Radio Networks (New York)	- Joseph Maguire, Vice President, Director of Engineering
	- Dave Pollard, Chief Engineer
ABC Radio Network (New York)	- Robert Donnelly, Director, Satellite Systems
CBS Radio Network	- Mortimer Goldberg, Manager, Technical Services
	- David Knorr, Director, Radio Audio Systems Engineering
NBC Radio Network (New York)	- Lorna Grant, Manager Program Operations

U.S. Regional Networks

Progressive Farmer Network (Starkville, Miss.)	- Glenn James, Vice President
Florida Network	- Bob Poe, General Manager
Learfield Communications - Missouri Network - Brownfield Network - Delta Network	- Clyde Lear (President)
Illinois Radio Network	- Robert Walton, Manager
Arkansas Radio Network	- Larry Wilson, General Manager

Industry Associations & Government Agencies/Departments

National Association of State Radio Networks	- Bob Poe, President
National Association of Broadcasters	- Marcia DeSomme, Technology Section
Federal Communications Commission	- Joe Harcarufka, Satellite Radio Branch - Bill Johnson, Deputy Chief - Mass Media Bureau - Ron Lepkowsky, Chief, Satellite Radio Branch

Others

Satellite Systems Corporation (Virginia Beach, CA)	- Fred Poteed, President
IDB Communications	- Jeff Sadikoff

APPENDIX B

INFORMATION PACKAGE

This Appendix contains the product information provided to major Canadian and U.S. radio networks prior to our interviews with them. This information was developed by Miller Communications Systems Limited.

DIGITAL SCPC AUDIO PROGRAM TRANSMISSION EQUIPMENT

ADVANCE PRODUCT INFORMATION

INTRODUCTION

The Miller Communications digital single channel per carrier (SCPC) audio program transmission equipment will facilitate the relay and distribution of high fidelity audio programs and data over satellite links.

ADVANTAGES

Satellite links have several advantages over terrestrial links for audio program distribution. Wide and remote area coverage, centralized direct control over network distribution, network flexibility, high reliability, ease of maintenance, and minimum delay to quote a few. Digital transmission techniques can provide superior noise performance, higher dynamic range, lower harmonic distortion and higher immunity to interference as compared to analog systems. The SCPC technique provides both economical and operational advantages (over multiple-channel multiplexed systems) to small and medium size radio networks as well large size radio networks having widely distributed production centres and network feeds. In addition, the high-speed data channel provided along with the digital audio will enable the network production centres to dispatch a large variety of messages viz., coordination, internal mail, program schedules, facsimile, control and command information, etc.

FEATURES

- One stereo (15 kHz) channel and one data channel
- Two mono (15 kHz) channels and one data channel
- Four audio (7.5 kHz) channels and one data channel
- One mono (15 kHz) and two audio (7.5 kHz) and one data channel
- Cost effective equipment
- Minimized transponder leasing cost
- Optimum power-bandwidth utilization
- Built-in circuit reliability
- Audio performance exceeds network requirements
- Frequency agile (programmable for channel selection)
- Built-in monitoring, control and test facilities
- Attractive to small, medium, and large size radio networks with distributed or concentrated affiliates

SYSTEM DESCRIPTION

The SCPC equipment incorporates state-of-the-art technology and offers the user the advantage of lower equipment cost, lower transponder cost, channel agility and networking flexibility. The techniques selected and technology used in the development of the audio digitizer, error correction codec and modem are based on optimizing the power-bandwidth utilization of the transponder and maximizing the audio performance.

MCS MILLER COMMUNICATIONS SYSTEMS LTD.

300 Legget Drive, Kanata North Business Park
Kanata, Ontario, Canada K2K 1Y5
Telephone: 613-592-3020 Telex: 053-4164

Power-Bandwidth Efficiency

The audio digitization and modulation techniques have been chosen to maximize bandwidth efficiency. Power efficiency is improved by introducing forward error correction with a modest bandwidth expansion. The system design is evolved as a result of extensive trade-off considerations between power-bandwidth efficiency and recurring transponder cost.

Audio Program Channels

The audio channel unit processes two independent 15 kHz or four 7.5 kHz audio programs. Appropriate companding, filtering and emphasis techniques are used to achieve an audio performance which exceeds CCIR specifications.

Data Channel

The data channel unit processes a multi-purpose data stream. This data stream is multiplexed with the audio digital stream for combined transmission

FEC Codec

The forward error correction circuit provides error protection to the multiplexed bit stream and decreases the bit error rate. Error concealment techniques are additionally used in the receive equipment to render uncorrectable errors subjectively unperceptible.

Modem

The modem unit modulates the encoded data stream onto a radio carrier obtained from a programmable synthesizer. This unit also includes a spectrum shaping filter to reduce adjacent channel interference. On the receive side, the demodulation is performed with the help of a regenerated reference carrier and data detection is achieved by a regenerated timing reference. End-to-end frequency uncertainties are corrected by an internal AFC circuit.

Frequency Agility

The programmable frequency synthesizers will provide access to any carrier spaced inside the transponder bandwidth.

SPECIFICATIONS

Audio signal bandwidth	:	15 kHz (7.5 kHz)
Signal to quantizing noise ratio	:	>52 dB at 22 dBm
Idle channel noise	:	>80 dB below +24 dBm
Total Harmonic Distortion	:	$<0.3\%$ at +24 dBm
Peak Signal Level (unaffected)	:	+24 dBm into 600 ohms
Impedance	:	600 ohms
Input/output level variation	:	$<.1$ dB at 0 dBm
Cross talk (40 Hz - 15 kHz)	:	>75 dB
Phase Difference (stereo pair)	:	$<3^\circ$
Envelope Delay	:	25 ms at 40 Hz
	:	12 ms at 75 Hz
	:	4 ms at 14 kHz
	:	6 ms at 15 kHz

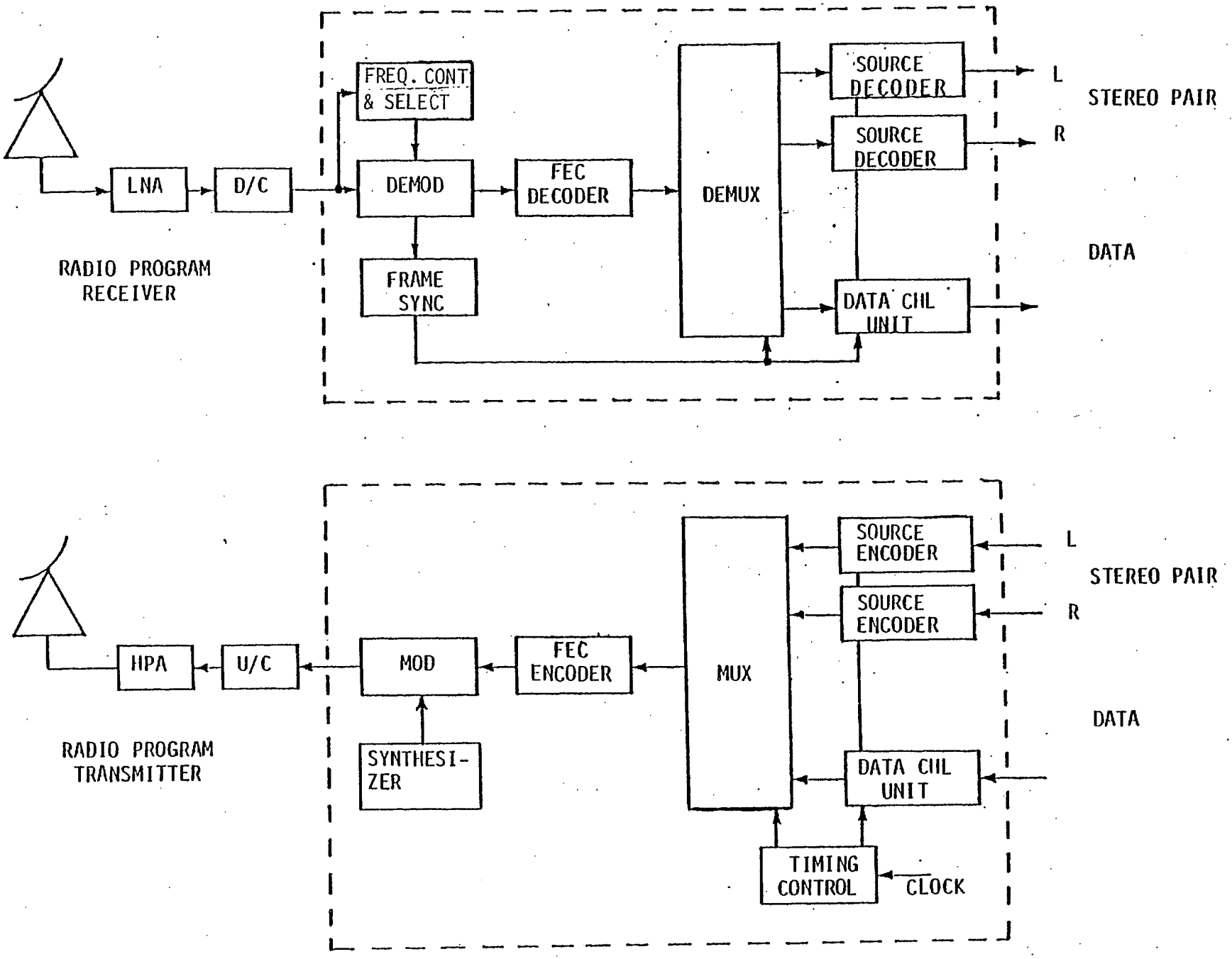

Figure 1: Overall Block Diagram of Radio Program Receiver and Transmitter

SCPC SATELLITE DISTRIBUTION OF DIGITAL AUDIO: A TECHNOLOGY WHOSE TIME HAS COME?

Introduction

Radio broadcasting is a highly competitive business. Retention (and hopefully expansion) of market share depends critically on the production of quality programming with mass appeal, and the ability to cost effectively deliver this programming to the listening public. It also relies on the broadcaster's ability to recognize and provide timely new services, or improve traditional services, and to react quickly and flexibly to such initiatives which may have been instigated by competitors.

Unfortunately, in both cases, broadcasters are hampered, and are suffering, from the inadequacies of the radio distribution systems currently available. In some cases, this situation will persist despite recent network upgrades because of short sighted decisions to purchase compromised technologies at what initially appears to be a lower cost. The most prevalent sources of difficulty are: reliance on terrestrial communications facilities, inflexibility caused by multiplexed transmissions, and obsolesence of analog transmission techniques.

Inadequacy of Terrestrial Communications Facilities

Most broadcast networks currently rely either wholly or partially on terrestrial communication facilities (cable, microwave, etc.) leased from one or more of the telephone common carriers. This approach has served to avoid large capital expenditures, but is now recognized to be plagued with numerous technical and economic problems. For instance,

- land line costs are increasing, and are often prohibitively expensive for remote or underdeveloped areas that might otherwise represent opportunities for new or expanded markets

- line quality is generally quite poor; 5 kHz bandwidth lines are the most prevalent, but depending on location, 3.5 kHz lines may only be available; moreover, these lines offer limited dynamic range and suffer from relatively high harmonic distortion caused by circuit non-linearities

- reliability of reception is generally suspect because of the vast complication of routings before programs reach their final destination, particularly when multiple common carriers are involved; this situation enormously complicates the problem of network monitoring and maintenance, which ultimately manifests itself as consumer disaffection

- simultaneous multiple program transmission is cost prohibitive and impractical with terrestrial lines; thus for a network offering several different program options, or having to cope with time zone switching, the different feeds must be staggered, and the local station is either forced to schedule its broadcasts around the network, or to rebroadcast from taped material.

The elegant solution to all these problems lies with satellite transmission, which can provide:

- fixed costs independent of destination location and the number of destinations

- high quality, transparent, transmission of signals with considerable user control of operational parameters

- vastly simplified channel monitoring, fault isolation, and repair with a minimum of interaction with outside agencies

- considerable flexibility for multiple program transmission, network growth and changes, and versatility in the type of signal it can carry (depending only on the end equipments and the cost of satellite bandwidth/power)

Satellite transmission, however, is not entirely without its drawbacks. In particular, it requires a commitment from the broadcasters to invest in high cost satellite capital programs, with correspondingly high start-up costs. It also introduces the problem of "sun outages", which may result in signal degradation over a couple of minutes per day duration twice a year.

On balance, however, there is no finer technological solution to broadcast networking than the application of satellites. The number of networks either using or converting to satellites speaks louder than words in this respect (e.g. CBC, Broadcast News, ABC, CBS, NBC, RKO, NPR, etc.).

Inflexibility Caused by Multiplexed Transmissions

Even where the value of satellite transmission is recognized, another problem generally intrudes to limit the effectiveness of the investment, namely, a potentially short-sighted decision to multiplex many radio channels together, or to multiplex radio channels with a TV channel for combined distribution. In each case, the intention is to share equipment and space segment in order to reduce capital costs. However, the shortcommings in both cases

are similarly the same, namely, a sacrifice of network flexibility, continued reliance on terrestrial lines, and back-haul/forward-haul ("hidden") operating costs.

In the first instance, many radio channels (typically 20 channels of 15 kHz bandwidth) are combined together at one uplink site in order to fully load a satellite transponder. This allows very efficient use of the transponder, and a large amount of equipment sharing, but necessitates that all radio channels either originate at, or be transmitted to, the uplink site. This poses a problem for medium and small networks that generate fewer than twenty mono (or ten stereo) channels. Generally, the uplink service is offered by a common carrier, and the broadcaster is required to use terrestrial lines to connect its production facility to the uplink site. Thus, the broadcaster is again faced with interactions with multiple agencies, terrestrial facility (forward-haul) costs, and other problems covered previously. Even large networks with the capability of fully loading an entire transponder by themselves are inconvenienced, since multiple production centres (in different states or provinces) are often preferred to a single huge facility. Indeed, in some cases the production facilities already exist and must be accommodated. In this case, the broadcaster is either faced with forward-hauling all its production centres to the uplink site, or imposing strict centralization on its operations (which limits its ability to serve local needs).

In the second instance cited above, a broadcaster might choose to piggyback his radio program channel onto a TV distribution facility, either one operated by a different part of his organization, or one operated by someone else who offers radio multiplexing as a service. In this case, the radio channel is modulated to a convenient subcarrier

frequency and combined with the TV baseband signal prior to transmission. The technique is called the subcarrier mode of transmission. The advantages of this technique are similar to the previous case, namely, equipment sharing to reduce cost, and distributed cost of the satellite transponder (indeed, the transponder might be seen as "free" if the same organization operates the TV distribution facility and has already paid for the transponder). However, the broadcaster is again faced with externally imposed constraints regarding where production centres may be located and/or the prospect of long forward-haul links. Moreover, if the TV receive sites are used as well, then substantial costs to back-haul the program to the radio transmitter sites are also incurred.

Both of these scenarios further preclude the introduction of many new services which might prove vital in a competitive environment, an excellent example being temporary "remote" feeds to cover special events or fast-breaking news.

The solution to these problems lies in the area of single channel per carrier (SCPC) technology. In other words, small, independent uplink stations providing low capacity (e.g. a single stereo channel) and occupying only part of a satellite transponder. Such stations could be located flexibly within the network (e.g. at each production or network control centre), and could be sized to match the network channel requirement. The challenge is to design this equipment in such a way that it can be priced competitively against multiplexed equipment (bearing in mind all the hidden costs associated with the latter approach).

Obsolescence of Analog Transmission Techniques

Recognizing the advantages of satellite transmission and the SCPC technique, some networks currently use such equipment for their radio distribution needs. The prime example in Canada is the CBC, which has supported its Northern Service with such equipment for over 10 years. Examples in the United States include NPR, Mutual Broadcasting, AP, UPI and various State and Regional governments. In all cases, however, the radio program is transmitted in analog form, and this in itself is often a limiting factor. A potentially better approach, which only recently has become technically feasible is digital transmission. Thus far, only one of the large radio multiplex services discussed previously exploits digital technology.

Simply stated, digital transmission techniques can provide a host of advantages for radio program distribution compared with analog transmission techniques, including:

- superior noise performance
- higher dynamic range
- lower harmonic distortion
- higher immunity to interference
- tolerance to component aging
- higher overall reliability

In addition, one needs to recognize additional facets of the larger picture, such as:

- recording studios and production centres are rapidly converting to all-digital storage, processing and packaging of audio

- consumer equipment is now routinely capable of producing much higher quality sound reproduction than was even dreamed of a few years ago; new technologies such as PCM home recording and compact discs are raising the quality expectations of consumers and creating demand (market) for higher quality radio broadcasting

- communications systems generally are converting to digital techniques in a drive towards greater cost effectiveness and worldwide adoption of ISDN (integrated services digital networking); a prime example is the telephone industry

- the robustness of the digital design, the advances in device integration and automated test techniques are reducing digital equipment cost very significantly compared with analog

- digital techniques permit flexible mixing of dissimilar services such as data with audio; in the present context, auxiliary data channels can meet the internal communication needs of the broadcast network (e.g. program schedule and control, internal mail, etc.) as well as provide the medium for externally marketable services (e.g. data distribution, nationwide paging services, etc.).

However, digital audio transmission over satellite, being a comparatively new idea, has yet to be fully analyzed, optimized, and proven. Numerous groups around the world are actively working on questions raised by this technology, and definitive answers are soon to be forthcoming. The challenge to substantiate the claims is clear, but the potential is immense.

Conclusion

The arguments put forth above are neither very new nor particularly original. Many others have recognized these issues and have acted upon them. The trends for radio distribution are now clear:

- increasing use of satellites
- continuing interest in SCPC (although multiplexed systems have often been chosen instead because of the cost)
- developing interest, and use, of digital techniques.

Serious consideration of SCPC satellite distribution for digital audio is certainly warrented.

APPENDIX C

U.S. REGIONAL RADIO NETWORKS

REGIONAL RADIO NETWORKS

Network	Location	# Of Stations
AG - America Radio Network	S. Dakota	28
Agribusiness Today Radio Network	California	7
Agrinet Farm Radio Network	Virginia	55
Alamo Farm Network	Texas	147
Allegheny Mountain Network	Pennsylvania	7
Arizona Lotus Network	Arizona	2
Arizona Recreation Network	Arizona	11
Arkansas Radio Network	Arkansas	69
Badger Farm & Dairy Network	Wisconsin	37
Beasley Broadcasting Group	North Carolina/Alabama/Georgia	12
Beck-Ross Group	Connecticut/Florida/Michigan/New York	5
Beef Empire Radio Group	Nebraska/Colorado	4
Berkshire Group	Mass./Conn.	3
Big-K Media	Texas	3
Brownfield Network	Illinois/Iowa/Nebraska/Missouri/Arkansas/Tennessee/ Kansas/Colorado	110
Buckeye Farm Network	Ohio	30
Caballero Spanish Radio	National	87
California Farm Network	California	27
California Agri-Radio Network	California	19
Capitol Information Bureau	Illinois/Missouri	50
Connecticut Radio Network	National	168
Dakota Farm Network - North Dakota	North Dakota	10
Dakota Farm Network - South Dakota	South Dakota	11
Delmarva Agrinet	Virginia/D. of Columbia/Maryland/Delaware	62
Delta Farm Radio Network	Arkansas/Louisiana/Miss.	3
Delta Net	Arkansas/Tennessee	5
Eastern Public Radio Network	Maine/Conn./Vermount/Maryland/N.Y./Penn/ N.H./N.J./Mass	20
Florida Growers Network	Florida	19
Florida Network Inc.	Florida	53
French Program Group of New England	New England	6
Georgia Network Inc.	Georgia	113
Georgia Radio News Service	Georgia	102
Golden Crescent Network	North Carolina	8
Goldman Group	New York/Vermont	7

Network	Location	# Of Stations
Gulf Central Radio Network	Miss.	4
Houston-Beaumont Network	Texas	3
Illinois Radio Network	Illinois	60[2] (excluding dual AM/FM stations)
Indiana Broadcasters Group	Indiana	72
Indiana Radio Network	Indiana	40
Intermountain Farm/Ranch Network	Nebraska/Idaho/South Dakota/Utah/Wyoming	70
Intermountain Network Inc.	Utah/Wyoming/Idaho/Montona/Nebraska/Colorado/ South Dakota/New Mexico	131
Iowa Hawkeye/Town & Country Radio Network	Iowa	31
Iowa Radio Network	Iowa	22
Ivy Network of College Stations	North East	16
Jalapeno Network	Texas	2
Kansas Agricultural Network	Kansas	33
Kansas Information Network	Kansas	39
Kansas Radio Network	Kansas	20
Kentucky Network Inc.	Kentucky	60
Kentucky Radio Network	Kentucky	85
Knight Quality Stations	New England	7
Laird Group	Wisconsin	3
Laurel Radio Group	Pennsylvania	6
Linder Farm Network	Minnesota	4
Lotus Albertini Spanish Non-Wired Radio Network	Arizona/California/Connecticut/Florida/ Illinois/N.M./N.Y./Texas	54
Louisiana Agri-News Network	Louisiana	37
Louisiana Network	Louisiana	50
Magic Circle Network	Oklahoma	87
Maine Information Radio Networks Inc.	Maine	18
McClatchy Broadcasting Co.	California	4
Michigan Farm Radio Network	Michigan	41
Michigan News Network	Michigan	36
Michigan Rural Radio Network	Michigan	33
Mid Atlantic Network	Virginia/Pennsylvania	5
Minnesota News Network	Minnesota	38

Network	Location	# Of Stations
Missouri Network Inc.	Missouri/Illinois/Arkansas/Indiana/Kansas/ Kentucky/etc.	365
Missouri Radio Network	Missouri	23
Montana Radio Network	Montana	6
Moon Radio Network	10 states	27
Nebraska Radio Network	Nebraska	19
New South Radio Network	Mississippi	5
New York Farm Network	New York	25
North Carolina News Network	North Carolina	74
Ohio Educational Broadcasting Network Commission	Ohio	12
Ohio Radio Network	Ohio	89
Oklahoma Farm Network	Oklahoma	13
Oklahoma News Network	Oklahoma	55
Paul Bunyan Network	Michigan	2
Pennsylvania Farm Network	Pennsylvania	28
Progressive Farmer Network	Tennessee/Arkansas/Louisiana/Mississippi/etc.	75
Radio Smiles Group	North Carolina	2
Pay Sports Radio Network	Virginia	40
Southern Educational Communications Association	Ark/N.C./S.C./Tenn./Va./etc.	23
South West Agri-Radio Network	Arizona/California	9
Sportline	Wisconsin	23
Suburban Radio Group	North Carolina/Va.	8
Tennessee Radio Network	Tennessee	91
TSN Agribusiness Network	Texas	55
TSN Spanish Information Service	Texas	24
Texas State Network	Texas	159
Tichenor Media System	Texas	6
Tobacco Radio Network	Southern States	-
Viking Radio Network	Minn.	23
Virgina Farm Reports	Virginia	42
Virginia News Network	Virginia	54

Network	Location	# Of Stations
VSA Radio Network	Texas	13
West Virginia Radio Network	W. Virginia	57
Wisconsin Educational Radio Network	Wisconsin	9
Wisconsin Farm Broadcasting Network	Wisconsin	10
Wisconsin Network Inc.	Wisconsin	11
		3,888

APPENDIX D

SATELLITE CHANNEL CHART

THE OFFICIAL WESTSAT COMMUNICATIONS

SATELLITE CHANNEL CHART

THE MOST ACCURATE AND UP-TO-THE-MINUTE LISTING OF ALL VIDEO AND ANALOG SUBCARRIER AUDIO PROGRAMMING SERVICES ON THE NORTH AMERICAN C & KU BAND SATELLITES

Vol. 5, No. 1 | JANUARY/FEBRUARY 1985 | Issued 1-1-85

RCA SATCOM 3R (131°W)

Polarization: DDD—Vertical, EVEN—Horizontal

TR—1	**NICKELODEON** (East)—premium children's programming (6.8)
	ARTS & ENTERTAINMENT (Alpha Repertory Television Service)—performing and cultural arts programming (5.58 & 5.76 discrete stereo/6.8 mono)
TR—2	**PTL-THE INSPIRATIONAL NETWORK** (People That Love)—religious (5.58 & 5.76 discrete stereo/6.8 mono)
TR—3	**WGN-TV,** Chicago—Midwest's leading independent station (6.8)
TR—4	**FNN** (Financial News Network)—financial/business reporting with stock market readings (6.8)
	SPORTSTIME—midwest regional pay sports network (6.8)
TR—5	**THE MOVIE CHANNEL**(East)—24 hr/day first-run movies (5.8 & 6.8 matrix stereo)
TR—6	**SPN** (Satellite Program Network)—variety entertainment (5.58 & 5.76 discrete stereo/6.8 mono)
TR—7	**ESPN** (Entertainment & Sports Network)—24 hr/day sports programming (5.58 & 5.76 discrete stereo/6.8 mono)
	BUSINESS TIMES (East)—business/financial news & reporting (6.8)
TR—8	**CBN CABLE NETWORK**—religious/general family entertainment (6.8)
TR—9	**USA NETWORK**— professional sporting events, Calliope, and Ovation (5.58 & 5.76 discrete stereo/6.8 mono)
TR—10	**SHOWTIME** (West)—first run movies, entertainment specials (6.8)
TR—11	**MTV** (Music Television)—Pop/Rock Video (5.8 & 6.62 matrix stereo)
TR—12	**SHOWTIME** (East)—first-run movies, entertainment specials (6.8)
TR—13	**HBO** (Home Box Office)(West)—first-run movies, sports & entertainment specials (6.8)
TR—14	**CNN HEADLINE NEWS**—CNN newsbrief headline service (6.8)
TR—15	**VH-1** (Video Hits One)—adult contemporary music video (6.8 mono/7.4 digital stereo)
TR—16	**ACSN—THE LEARNING CHANNEL** (Appalachian Community Service Network)—educational (6.8)
	PEN (Professional Education Network)—continuing educational programming for lawyers, accountants and CPA's (6.8)
	HTN PLUS (Home Theatre Network)—first-run G and PG movies (6.8 multiplex stereo)
TR—17	**LIFETIME**—health and personal improvement programming (6.8)
TR—18	**REUTER'S MONITOR SERVICE**—commodity/stock market information (digital video)
	EWTN (Eternal Word TV Network)—religious (6.8)
	NJT (National Jewish Television)—religious (6.8)
TR—19	**C-SPAN**—live coverage from the House of Representatives (6.8)
TR—20	**HOME BOX OFFICE CINEMAX** (East)—time structured HBO (6.8)
TR—21	**THE WEATHER CHANNEL**—24 hr/day national & regional weather/environmental reporting (6.8)
TR—22	**MSN - THE INFORMATION CHANNEL** (Modern Satellite Network)—general informational entertainment (6.8)
	USA BLACKOUT NETWORK—substitute sports programming for regional blackout applications (6.8)
	HBO PROMO CHANNEL (6.8)
	OCCASIONAL TRANSMISSIONS—sporting events, news and network feeds (6.2/6.8)
TR—23	**HBO CINEMAX** (West)—time-structured HBO (6.8)
TR—24	**ARTS & ENTERTAINMENT** (Alpha Repertory Television Service)—performing and cultural arts programming (5.58 & 5.76 discrete stereo/6.8 mono)

continued on next page

Audio Subcarrier Services on SATCOM 3R

TR—2 **SATELLITE RADIO NETWORK**—contemporary/religious format (6.2)
TR—3 **MOODY BROADCASTING NETWORK**—religious (5.4/7.92 discrete stereo)
SATELLITE MUSIC NETWORK/STARSTATION—adult contemporary format (5.58/5.76 discrete stereo)
SATELLITE MUSIC NETWORK/COUNTRY COAST-TO-COAST—modern country format (5.94/6.12 discrete stereo)
WFMT (FM) Chicago—fine arts/classical radio (6.3/6.48 discrete stereo)
SATELLITE MUSIC NETWORK/STARDUST—traditional MOR music format (7.38/7.56 discrete stereo)
TR—6 **SCAN/STARSHIP**—Country/Western (5.4/5.94 discrete stereo)
SCAN/STARSHIP—Adult Contemporary (5.58/5.76 discrete stereo)
SCAN/STARSHIP—50's/60's (6.435 mono)
SCAN/STARSHIP—Comedy/Specials (7.695 mono)
SCAN/STARSHIP—Big Band (7.785 mono)
TR—7 **ESPN AFFILIATE INFORMATIONAL NETWORK**—ESPN program schedule information (6.2)
TR—8 **NICE & EASY**—easy listening music (5.58/5.76 discrete stereo)
CABLE JAZZ NETWORK—jazz music format (5.94/6.12 discrete stereo)
LOVE RADIO NETWORK—contemporary Christian music (6.30/6.48 discrete stereo)

ALASCOM AURORA (143°W)

Polarization: DDD—Vertical EVEN—Horizontal

TR—13 **NASA CONTRACT CHANNEL**—live NASA mission and mission related events coverage (operated only during ongoing missions)
TR—19 **OCCASIONAL TRANSMISSIONS**—sporting events, news & network feeds (6.8)
TR—20 **LEARN/ALASKA TELEVISION NETWORK**—educational (5.8)
TR—21 **OCCASIONAL TRANSMISSIONS**—sporting events, news & network feeds (6.8)
TR—24 **ALASKA SATELLITE TELEVISION PROJECT**—various network & independent programming (5.8)

RCA SATCOM 1R (139°W)

Polarization: DDD—Vertical EVEN—Horizontal

TR—1 **OAK ON SATELLITE TELEVISION** (East)—first run movies, sports & entertainment specials (fully encrypted/VIDEONET ORION)
TR—5 **OAK ON SATELLITE TELEVISION** (West)—first run movies, sports & entertainment specials (fully encrypted/VIDEONET ORION)
TR—8 **NBC TELEVISION NETWORK**—NBC regularly scheduled network programming (Central time zone feed)(6.8)
TR—9 **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.8)
TR—11 **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.8)
TR—12 **NETCOM INTERNATIONAL**—occasional transmissions: videoconferencing sports events, news & network feeds (6.2/6.8)
TR—15 **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.8)
TR—20 **ARMED FORCES SATELLITE NETWORK**—various network & independent programming (6.8)
TR—22 **NETCOM INTERNATIONAL**—occasional transmissions: videoconferencing, sports events & network feeds (6.2/6.8)
HI-NET COMMUNICATIONS NETWORK—end-to-end videoconferencing (6.8)
TR—24 **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.8)
RADIOTELEVISIONE ITALIANA—daily Italian network (national service) news feeds (6.8)

Audio Subcarrier Services on SATCOM 1R

TR—20 **AFRTS RADIO NETWORK** (Armed Forces Radio & Television Service)(5.94 mono)

continued on next page

HUGHES GALAXY 1 (134°W)

Polarization: ODD—Horizontal EVEN—Vertical

TR—1 **HBO** (Home Box Office)—not in use

TR—2 **THE NASHVILLE NETWORK**—premium country music/entertainment (5.58 & 5.76 discrete stereo/6.8 mono)

TR—3 **HBO ENCRYPTION TEST CHANNEL**—full-time VIDEOCYPHER II encryption testing

TR—4 **THE DISNEY CHANNEL** (East)—premium family entertainment from the Disney studios (5.8 & 6.8 matrix stereo)

TR—5 **SHOWTIME** (East)—first-run movies & entertainment specials (6.8)

TR—6 **SIN** (Spanish International Network) (6.8)

TR—7 **CNN** (Cable News Network)—24hr/day news (6.8)

TR—8 **CNN HEADLINE NEWS**—CNN newsbrief headline service (6.8)

TR—9 **ESPN** (Entertainment & Sports Network)—24 hr/day sports programming (5.58 & 5.76 discrete stereo/6.8 mono)
BUSINESS TIMES (East)—business/financial news & reporting (6.8)

TR—10 **THE MOVIE CHANNEL** (East)—24-hr/day first-run movies (5.8 & 6.8 matrix stereo)

TR—11 **CBN CABLE NETWORK** —religious/general family entertainment (6.8)

TR—12 **HOME TEAM SPORTS**—Washington, DC/Maryland regional sports network (6.8)

TR—13 **C-SPAN**—live coverage from the House of Representative (6.8)

TR—14 **THE MOVIE CHANNEL** (West)—24hr/day first run movies (5.8/6.8 matrix stereo)

TR—15 **WOR-TV,** Secaucus, New Jersey—the Northeast's top-rated independent station (6.8)

TR—16 **SHOWTIME/THE MOVIE CHANNEL** —not in use
OCCASIONAL TRANSMISSIONS —sports events, news & network feeds (6.2/6.8)

TR—17 **BET** (Black Entertainment Network)—(5.58 & 5.76 discrete stereo/6.8 mono)

TR—18 **WTBS**, Atlanta—Ted Turner's Superstation (6.8)

TR—19 **HOME BOX OFFICE CINEMAX** (East)—time-structured HBO (6.8)

TR—20 **GALAVISION**—premium Spanish oriented entertainment programming (6.8)

TR—21 **HBO** (Home Box Office)—not in use
BUSINESS TIMES (West)—business/financial news & reporting (6.8)
ESPN BLACKOUT NETWORK —part-time alternate sports programming for regional blackout applications (6.8)
ESPN PROMO CHANNEL—(6.8)

TR—22 **GROUP W SATELLITE COMMUNICATIONS**—not in use
OCCASIONAL TRANSMISSIONS—sports events, news & network feeds (6.2/6.8)

TR—23 **HBO** (Home Box Office)(East)—first run movies, sports events and entertainment specials (6.8)

TR—24 **THE DISNEY CHANNEL** (West)—premium family entertainment from the Disney studios (5.8 & 6.8 matrix stereo)

Audio Subcarrier Services on GALAXY 1

TR—7 **CNN RADIO NETWORK**—all news radio feed (6.3)

ATT COMSTAR 4 (127°W)

Polarization: ODD—Vertical EVEN—Horizontal

TR—7V(13) **SELEC-TV**—STV/SMATV FEED—first run movies, concert & entertainment specials (6.8)

TR—9H(18) **CMTV** (Country Music Television)—video country music (5.58 & 5.76 discrete stereo/6.8 mono)

TR—10H(20) **THE PLAYBOY CHANNEL**—adult-oriented entertainment and sexually oriented "R"-rated movies from Playboy (6.8) (Telstar feed-partially encrypted/CLARIDN)

TR—11H(22) **KTVT**, Ft. Worth/Dallas—Texas independent superstation (6.8)

ANIK C2 (Ku) (105°W)

Polarization: Vertical
Active Coverage: Eastern

TR—1 **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds
TR—2 **MOVIETIME**—USCI DBS pay-TV service for Midwest & East
TR—4 **SHOWCASE**—USCI DBS pay-TV service for Midwest & East
TR—5 **OCCASIONAL TRANSMISSIONS**—sports events, encryption testing news & network feeds
TR—6 **ESPN** (Entertainment & Sports Network)—USCI DBS pay-TV service for Midwest & East
TR—7 **MUSIC TV**—USCI DBS pay-TV service for Midwest & East
TR—8 **TV TIME**—USCI DBS pay-TV service for Midwest & East

ANIK D (104.5°W)

Polarization: ODD—Horizontal
EVEN—Vertical

TR—1B(2) **TSN** (The Sports Network)—24-hr/day sports programming (6.8)
TR—2B(4) **GLOBAL TV OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.8)
TR—3A(5) **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.8)
TR—3B(6) **MUCH MUSIC**—Pop/rock video (5.41 & 6.17 discrete stereo/6.7 mono)
TR—4A(7) **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.8)
TR—4B(8) **CHCH-TV,** Hamilton, Ontario—Ontario's leading independent station (fully encrypted/OAK ORION)
TR—5A(9) **WDIV-TV**, Detroit—NBC Network affiliate (fully encrypted/OAK ORION)
TR—5B(10) **WXYZ-TV**, Detroit—ABC Network affiliate (6.8) (fully encrypted/OAK ORION)
TR—6A(11) **CBC NORTH**—CBC network programming (Pacific time zone feed) (6.8)
TR—7A(13) **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.8)
TR—7B(14) **TCTV** (Telemedia Communications Television)—TVA network programming (French) from CHLT, Sherbrooke/CFTM, Montreal (fully encrypted/OAK ORION)
TR—8A(15) **CBC** (French Channel)—French language CBC programming (Eastern time zone feed) (6.8)
TR—8B(16) **CBC PARLIAMENTARY NETWORK** (French)—daily live coverage of the Canadian House of Commons from Ottawa (6.8)
TR—9A(17) **CBC OCCASIONAL TRANSMISSIONS**—occasional CBC affiliate feeds from CBHT, Halifax, NS (6.8)
TR—9B(18) **CITV-TV,** Edmonton, Alberta—Alberta's leading independent station (fully encrypted/OAK ORION)
TR—10A(19) **CBC NORTH**—CBC network programming (Atlantic time zone feed) (6.8)
TR—10B(20) **CBMT,** Montreal—CBC English Network station (6.8)
TR—11A(21) **WTVS-TV**, Detroit—PBS Network affiliate (fully encrypted/OAK ORION)
TR—11B(22) **BCTV** (British Columbia Television), Vancouver, B.C.—British Columbia's leading CTV network station (fully encrypted/OAK ORION)
TR—12A(23) **WJBK**, Detroit—CBS Network affiliate (fully encrypted/OAK ORION)
TR—12B(24) **CBC PARLIAMENTARY NETWORK** (English)—daily live coverage of the Canadian House of Commons from Ottawa (6.8)

Audio Subcarrier Services on ANIK D

TR—4B(8) **CKO-FM,** Toronto, Ontario—All-news and information radio (6.8 mono)
TR—6A(11) **CBC NETWORK RADIO** (English)—(6.12 mono)
TR—7B(14) **CKAC-AM,** Montreal, Quebec—French language MOR/contemporary music (5.41 mono)
CITE-FM, Montreal, Quebec—French language traditional MOR music (6.17)
TR—8B(16) **CBOF-FM** Ottawa, Ontario—CBC Stereo Radio (French)(5.41/5.58 discrete stereo)
CBBK-FM Kingston, Ontario—CBC Stereo Radio (English)(5.76/5.94 discrete stereo)
TR—9B(18) **CIRK-FM** (K-97), Edmonton, Alberta—progressive rock (6.17 mpx stereo)
TR—10A(19) **CBC NETWORK RADIO** (English)—(6.12 mono)
TR—10B(20) **CBM-AM,** Montreal, Quebec—CBC Radio English Network station (6.12 mono)
TR—11B(22) **CFMI-FM,** New Westminster, B.C.—Soft album rock (6.8 mono)
CBU-FM, Vancouver, B.C.—CBC stereo radio (English) (5.76/5.94 discrete stereo)
TR—12A(23) **VOCM,** St. John's Newfoundland—Adult contemporary music (6.17 mono)
TR—12B(24) **CBOF-FM,** Ottawa, Ontario—CBC Stereo Radio (French)(5.41/5.58 discrete stereo)
CBBK-FM, Kingston, Ontario—CBC Stereo Radio (English)(5.76/5.94 discrete stereo)

SBS 4 (Ku) (101°W)

Polarization: ODD—Vertical
EVEN—Vertical or Horizontal

NO VIDEO

SBS 1 (Ku) (99°W)

Polarization: All vertical

TR—7 **OCCASIONAL TRANSMISSIONS**—teleconference & private video network feeds (6.2/6.8)

WU WESTAR 4 (99°W)

Polarization: ODD—Horizontal
EVEN—Vertical

TR—3X(6) **WOLD COMMUNICATIONS**—occasional transmissions: sporting events, news & network feeds (6.2/6.8)
WORD OF FAITH SATELLITE NETWORK—religious (6.8)
ATLANTIC CITY HORSE RACING—live closed-circut horse racing from Atlantic City, NJ (fully encrypted/PROSTAR ORION)
TR—5X(10) **OCCASIONAL TRANSMISSIONS**—sporting events, news & network feeds (6.2/6.8)
TR—6D(11) **WOLO COMMUNICATIONS**—occasional transmissions: sporting events, news & network feeds (6.2/6.8)
CTNA (Catholic Telecommunications Network of America)—religious (fully encrypted/OAK ORION)
CAMPUS SATELLITE NETWORK—general entertainment for college campus distribution (6.8)
TR—8D(15) **PBS** (Public Broadcasting)—schedule A programming (6.8)
TR—8X(16) **CNN** (Cable News Network) Contract Channel—incoming regional bureau news feeds (6.2/6.8)
TURNER BROADCASTING—occasional transmissions: remote sports events feeds (6.2/6.8)
TR—9D(17) **PBS** (Public Broadcasting)—schedule B programming/occasional videoconferencing (6.8)
TR—10D(19) **BONNEVILLE TELECOMMUNICATIONS**—occasional transmissions: sports events, news & network feeds (6.2/6.8)
MUSIC MAGAZINE—rock'n roll video (5.8/6.8)
TR—10X(20) **ABC NETWORK CONTRACT CHANNEL**—live/taped network feeds (6.2/6.8)
OCCASIONAL TRANSMISSIONS—sports events, news & network feeds (6.2/6.8)
TR—11D(21) **PBS** (Public Broadcasting)—schedule C programming (6.8)
OCCASIONAL TRANSMISSIONS—news feeds (6.2/6.8)
TR—12D(23) **PBS** (Public Broadcasting)—schedule D programming (6.8)
PBS OCCASIONAL FEEDS (6.8)
BONNEVILLE TELECOMMUNICATIONS—occasional transmissions: sporting events, news & network feeds (6.2/6.8)

Audio Subcarrier Services on WESTAR 4

TR—6D(11) **CTNA RADIO NETWORK**—religious (6.2/6.8)

SBS 2 (Ku) (97°W)

Polarization: All horizontal

NO VIDEO

SBS 3 (Ku) (95°W)

Polarization: All horizontal

TR—1 **OCCASIONAL TRANSMISSIONS**—teleconference & private video network feeds (5.8/6.2/6.8)
TR—2 **VIDEOSTAR CONNECTIONS**—ad-hoc teleconference, independent news & network feeds (6.8)
TR—3 **NBC TELEVISION NETWORK**—part time occasional network feeds (6.2)
TR—4 **OCCASIONAL TRANSMISSIONS**—teleconference & private video network feeds (5.8/6.2/6.8)
TR—5 **NBC TELEVISION NETWORK**—Burbank to New York & miscellaneous operations video circuit (6.2)
TR—6 **NBC TELEVISION NETWORK**—regularly scheduled NBC network programming (Central time zone feed) (6.2)
TR—7 **CONUS/HUBCOM**—remote satellite newsfeed access channel (6.2/6.8)
TR—8 **PSN** (Private Satellite Network)—teleconference & private video network feeds (fully encrypted/OAK ORION)
TR—9 **NBC TELEVISION NETWORK**—NBC news feeds & partial regularly scheduled network programming (6.2)
TR—10 **OCCASIONAL TRANSMISSIONS**—teleconference & private video network feeds (5.8/6.2/6.8)

ATT TELSTAR 301 (96°W)

Polarization: ODD—Vertical
EVEN—Horizontal

TR—1H(2) **CBS TELEVISION NETWORK**—CBS regularly scheduled network programming (Central time zone feed) (6.2)
TR—2H(4) **ABC TELEVISION NETWORK**—occasional live/taped network feeds (6.2/6.8)
TR—3H(6) **ABC TELEVISION NETWORK**—occasional live/taped network feeds (6.2/6.8)
TR—4V(7) **CBS TELEVISION NETWORK**—CBS regularly scheduled network programming (Central time zone feed) (6.2/6.8)
TR—5V(9) **WOLD COMMUNICATIONS**—occasional transmissions: sports events, news & network feeds (6.2/6.8)
WOLD SATELLITE NETWORK—syndicated programming feeds (6.2/6.8)
TR—5H(10) **ABC TELEVISION NETWORK**—ABC regularly scheduled network programming (Central time zone feed) (5.8/6.8)
TR—6V(11) **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.2/6.8)
TR—6H(12) **ABC TELEVISION NETWORK**—Los Angeles-New York programming & news feeds/Contract Channel (5.8/6.8)
TR—7V(13) **HUGHES TELEVISION NETWORK**—sports events feeds (6.2/6.8)
TR—8V(15) **CBS TELEVISION NETWORK**—not in use
TR—8H(16) **CBS TELEVISION NETWORK**—not in use
TR—9V(17) **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.2/6.8)
TR—9H(18) **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (5.8/6.2/6.8)
TR—10H(20) **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.2/6.8)
TR—12V(23) **WOLD COMMUNICATIONS**—occasional transmissions: sports events, news & network feeds (6.2/6.8)
WOLD SATELLITE NETWORK—syndicated programming feeds (6.2/6.8)
TR—12H(24) **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.2/6.8)

HUGHES GALAXY 3 (93.5°W)

Polarization: ODD—Horizontal
EVEN—Vertical

NO VIDEO

WU WESTAR 3 (91°W)

Polarization: All horizontal

TR—3(5) **CNN** (Cable News Network) Contract Channel—incoming regional bureau news feeds (6.2/6.8)
TR—10(19) **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.2/6.8)
TR—11(21) **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.2/6.8)
INDEPENDENT NETWORK NEWS (6.2)
BRIGHTSTAR INTERNATIONAL—international news feeds (6.2/6.8)
TR—12(23) **OCCASIONAL TRANSMISSIONS**—sporting events, news & network feeds (6.2/6.8)

ATT TELSTAR 302 (86°W)

Polarization: ODD—Vertical EVEN—Horizontal

TR—5H(10) **CBS TELEVISION NETWORK**—CBS regularly scheduled network programming (Central time zone feed (6.2)
TR—8H(16) **CBS TELEVISION NETWORK**—not in use
TR—9V(17) **CBS TELEVISION NETWORK**—Los Angeles-New York programming & news feeds Contract Channel (6.2/6.8)
TR—10V(19) **CBS TELEVISION NETWORK**—occasional network news feeds (6.2/6.8)
TR—11V(21) **NETCOM INTERNATIONAL**—occasional transmissions: videoconferencing, sports events, news & network feeds (6.2/6.8)

RCA SATCOM 4 (83°W)

Polarization: ODD—Vertical EVEN—Horizontal

TR—1 **HBO** (Home Box Office)—remote networking feed channel (6.8)
OCCASIONAL TRANSMISSIONS—sports events, news & network feeds(6.2/6.8)
TR—2 **BRAVO**—performing and cultural arts programming (5.8 mpx stereo/6.8 mono)
TR—3 **SPN** (Satellite Program Network)—variety entertainment (5.58 & 5.76 discrete stereo/6.8 mono) (ends 1-15-85)
TR—4 **NICKELODEON** (West)—premium children's programming (6.8)
TR—5 **ABC TELEVISION NETWORK REMOTE FEEDS** (6.2/6.8)
OCCASIONAL TRANSMISSIONS—sporting events, news & network feeds (6.2/6.8)
TR—6 **HUGHES TELEVISION NETWORK**—sports events feeds (6.2/6.8)
BIZNET (American Business Network)—business and politics news/special features from Washington, DC (6.8)(transfers from S4/TR-15, January 7, 1985)
MADISON SQUARE GARDEN CABLE NETWORK—live sports events from Madison Square Garden (6.2/6.8)
TR—7 **NCN** (National Christian Network)—24 hr/day religious programming (6.8)
PRIME OF LIFE NETWORK—entertainment & informational programming for middle-age viewers (6.8)
TR—8 **NETCOM INTERNATIONAL**—occasional transmissions: sports events, news & network feeds (6.2/6.8)
HSE (Home Sports Entertainment)—live sports events spot feed channel (6.2/6.8)
TR—9 **SPORTSVISION**—regional Chicago area sports network (6.8)
TR—10 **AMC** (American Movie Classics)—vintage/classic movies with daily theme presentation (6.8)
TR—11 **HSE** (Home Sports Entertainment Network)—regional cable sports network (6.8)
OCCASIONAL TRANSMISSIONS—sporting events, news and network feeds (6.8)
TR—12 **THE PLAYBOY CHANNEL**—adult oriented entertainment and sexually oriented "R"-rated movies from Playboy (6.8)
OCCASIONAL TRANSMISSIONS—sports events, news & network feeds (6.2/6.8)
TR—13 **NESN** (New England Sports Network)—regional sports network featuring Red Sox Baseball and Bruins Hockey (6.8)
OCCASIONAL TRANSMISSIONS—sports events, news & network feeds (6.2/6.8)
TR—14 **NETCOM INTERNATIONAL**—occasional transmissions: videoconferencing, sports events & network feeds (6.2/6.8)
HSE (Home Sports Entertainment)—live sports events spot feed channel (6.2/6.8)
TR—15 **BIZNET** (American Business Network)—business and politics news/special features from Washington, DC (6.8)(transfers to S4/TR-6, January 7, 1985)
TVSC (Television Videotape Satellite Communications)—VIDSAT/SYNSAT distribution (6.2/6.8)

continued on next page

TR—16 **NETCOM INTERNATIONAL**—occasional transmissions: videoconferencing, sports events & network feeds (6.2/6.8)
THE SILENT NETWORK—specialized programming for the deaf and hearing impaired (6.8)
TR—17 **TBN** (Trinity Broadcasting Network)—religious (6.8)
TR—18 **SFC** (Santa Fe Communications Network)—regional Catholic religious network for Southern California (6.8)
TR—19 **WPIX**, New York—highly rated independent superstation from the Big Apple (6.8)
TR—20 **CSN** (College Sports Network)—college & professional sports programming (6.8)
TR—22 **ABC TELEVISION NETWORK REMOTE FEEDS**—(6.2/6.8)
OCCASIONAL TRANSMISSIONS—sporting events, news and network feeds (6.2/6.8)
TR—24 **OCCASIONAL TRANSMISSIONS**—sporting events, news and network feeds (6.2/6.8)

Audio Subcarrier Services on SATCOM 4

TR—3 **RHYTHM & BLUES**—contemporary jazz/soul music (5.4 & 6.3 discrete stereo)
STARSHIP/CLASSICAL—classical music (5.94/6.12 discrete stereo)
THE ROCK CHANNEL—upbeat top-40 rock for dancing & exercising (7.38 & 7.56 discrete stereo)
GEORGIA STATE RADIO NETWORK (7.695)
IN TOUCH—reading service for blind and physically handicapped (7.875 mono)
TR—7 **ASTRO RADIO NETWORK**—religious multidenominational talk/instructional format (6.3)
SBN (Sheridan Broadcasting network)—(7.38 & 7.56 discrete stereo)
GOLD MINE RADIO NETWORK—country & western classics music (7.92)
TR—17 **SATELLITE JAZZ NETWORK**—contemporary/traditional jazz music from KKGD-FM, Los Angeles (5.58/5.76 discrete stereo)

WU WESTAR 2 (79°W)

Polarization: All horizontal

TR—3(5) **OCCASIONAL TRANSMISSIONS**—sporting events, news & network feeds (6.2/6.8)
TR—6(11) **OCCASIONAL TRANSMISSIONS**—sporting events, news & network feeds (6.2/6.8)
TR—9(17) **OCCASIONAL TRANSMISSIONS**—sporting events, news & network feeds (6.2/6.8)

ATT COMSTAR 3 (76°W)

Polarization: ODD—Vertical EVEN—Horizontal

NO VIDEO

HUGHES GALAXY 2 (74°W)

Polarization: ODD—Horizontal EVEN—Vertical

TR—15 **ISN** (Independent Satellite Network)—variety entertainment programming (6.8)
TR—16 **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.2/6.8)
TR—17 **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.2/6.8)
TR—18 **OCCASIONAL TRANSMISSIONS**—sports events, news & network feeds (6.2/6.8)

RCA SATCOM 2R (72°W)

Polarization: ODD—Vertical EVEN—Horizontal

TR—20 **ARMED FORCES SATELLITE NETWORK**—various network & independent programming (6.8)

Audio Subcarrier Services on SATCOM 2R

TR—20 **AFRTS RADIO NETWORK** (Armed Forces Radio & Television Service)(5.94 mono)

GTE SPACENET 2 (69°W)

Polarization:
C-Band (36 Mhz): Horizontal
C-Band (72 Mhz): Vertical
Ku-Band (72 Mhz): Horizontal

NO VIDEO

APPENDIX E

CBC RADIO'S SATELLITE USE

A Paper presented by the CBC at the Canadian Satellite User Conference, November 1984.

CBC RADIO'S SATELLITE USE

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ABSTRACT

CBC Radio is presently preparing for the future. It has re-assessed its present program services and determined what must be done to them as well as what new services it must develop for the next decade. Part of this re-assessment has included a look at its distribution system for its present and proposed new services. Satellite use has been scrutinized for economic attractiveness and operational suitability for both distribution and DBS. The conclusions drawn are that for CBC Radio distribution needs the Anik "D" satellite would be more economical than terrestrial systems providing (i) rental tariffs do not start an upward spiral or (ii) user owned and operated uplinks become possible. Their operational suitability for Radio use with or without transponder sharing with TV has yet to be satisfactorily proven. Standards for operational and testing procedures will be needed. Introduction of Radio as a satellite user with TV will demand well-disciplined operational procedures to safeguard the radio signal during fading conditions.

CBC Radio is an experienced pioneer and so is stepping into this new venture with the intention of making it an exciting and successful one.

INTRODUCTION

During 1982/83 CBC English Radio carried out a major study on the future of Radio in Canada. This study looked a decade or so into the future and interpreted what it foresaw into a strategy to guide the future development of the CBC English Radio Service.

As a result of this strategy CBC English Radio is entering into a new era of development, in not only the types of program services to be provided, but also how those program services will be produced and distributed.

It is the latter activity, how they will be distributed, that is the topic of this paper.

Like any other program producer we are looking for a distribution system that allows easy growth and changes, is versatile in the type of signal it can carry, allows user control of its operational parameters, is transparent as far as the program signal is concerned and so delivers an unaltered signal of high technical quality to the audience. All of this of course should be associated with a reasonable and stable rental cost structure, one that will not inhibit growth or change needed to meet the varying circumstances of a broadcaster's life.

Our distribution system has two parts. The first, is the outgoing distribution to the 457 (mono and stereo) transmitters across the country. This has a network distribution component from Toronto to the eight regional centres across the country, and regional distribution components out to the transmitters themselves.

The second part is the program collection and exchange system that links our 32 production centres to each other and to the network production centre in Toronto.

This total system has on occasion been described as a patchwork of microwave, land lines and satellite that has been changed and added to over the last decade as more transmitters and production centres have been added. In total there are some 83,000 km of terrestrial systems across the ten provinces, the N.W.T., Yukon and Artic.

The different links in this system vary in bandwidth, noise and distortion. For additions or changes the lead time can be very long, and they are increasingly more expensive and difficult to obtain in the remoter areas.

When CBC English Radio looked at what it needed to do in the next decade, it found this system one of the main constraints to future development in both operational and economic terms. It felt it was in a strait-jacket and therefore looked for alternate means of delivery for its programs to the audience.

Naturally one of these was satellite, both as a means of distribution to existing terrestrial transmitters and as a means of direct broadcasting to listeners.

The questions that needed to be answered were: (i) Would satellites that had been designed with the particular needs of TV primarily in mind, be suitable carriers for the multi-channel, narrower bandwidth, lower powered signals and more complex distribution needs of CBC English Radio? (ii) Would satellites be more economically attractive than terrestrial systems?

This paper therefore is on the conclusions we have arrived at so far, and how we intend to pursue the rest of the answers. We are entering this new venture with high hopes and expectations. But CBC Radio is an experienced pioneer and we are well aware that not only is satellite use comparatively new to Radio, but also that the carriage of radio signals is comparatively new to the Canadian satellite providers and equipment designers. Although we may not yet know all the answers we certainly recognize most of the questions.

CBC ENGLISH RADIO DISTRIBUTION NEEDS

For this paper English Radio's distribution needs are packaged in two categories, present and proposed. The present needs include:

Network (or backbone system) - both mono and stereo program distribution from the Toronto network centre to the regional distribution and delay centres.

Collector System for program exchange and collection between the regional production locations and the network centre in Toronto.

Regional distribution of mono and stereo programs.

Northern Service distribution of network mono programs and regional program exchange.

International program exchange.

The proposed additions include:

Special program services to cable companies.

SCMO services to a network of FM transmitters.

Direct broadcast to audiences not within a terrestrial transmitter coverage area or not having cable services available.

Syndication feeds, news hot-line and information feeds.

Remotes for emergencies, sports, news events, special program events.

Control data exchange between operational computers in radio master controls.

CAN SATELLITES MEET THESE NEEDS?

Of the two questions to be answered; (i) will the present satellites be operationally suitable for radio use, and (ii) will satellites be more economical, we first tackled the economic question.

Economics Of Satellites

In order to do a comparative cost analysis we developed equivalent satellite networks for Radio's existing terrestrial networks.

This basic exercise showed that satellite use would be attractive provided the satellite uplink rental rate did not spiral up from the level quoted at that time, and that CBC Radio could use the available transponder space segment on the CBC rented transponders without any additional rental cost. Two conditions that since have become less certain.

At the time of the initial economic study in 1983, the rental rate quoted for uplinking on SCPC, of a 15 kHz audio signal was $40,000 per year. In 1984, some six months later, the rental rate was quoted at $58,000 per year. A 45% increase at a time when the capital cost of the ground station equipment was going down. More recently, rental rates have been quoted again at the $40,000 level. Our enthusiasm for satellite has gone up and down inversely to the rental rate quoted.

The question as to who has the right to control the use of the spectrum contained in a satellite, broadcasting or cable channel is presently the subject of study by the DOC. This could effect the control a user has over a rented transponder.

Operational Suitability of Satellites

The more complex question of the suitability of the present satellite systems for radio traffic, we hope to resolve by a co-operative effort with Telesat, equipment designers and manufacturers, and other users.

We start by accepting the fact that Radio has to fit into a system designed primarily for the needs of TV. The wide band amplifiers used in the transponders may not be suitable carriers for the more power efficient signals and complex multi-channeled distribution needs of Radio. Faced with the lack of sufficient suitable test data a figure of twenty to twenty-five SCPC's is currently being accepted as available from one transponder.

Since Telesat are currently quoting space segment rental rates for a 15 kHz audio baseband SCPC based on 2% of the transponder cost, it will certainly be in their interest to test for maximum SCPC occupancy.

Also for a multi-channel user it certainly would seem to be more advantageous under these circumstances to rent individual channels rather than a full transponder.

To be more efficient of spectrum use it may prove preferable in future satellites to use single discrete channel amplifiers instead of a common wide-band amplifier for multi-channel audio use. Well established operational practices and control systems for uplinks will need to be set up, which may prove restrictive to the operational flexibility of a large distribution system.

During our consideration of the modes of transmission available we concentrated on the three most common; sub-carrier (S.C.) of a TV signal; SCPC with TV signal; and SCPC in an audio only transponder. We will, of course, be keeping a watch on the development of digital techniques, especially those providing bandwidth reduction without loss of quality.

CONSIDERATIONS FOR RADIO

To satisfy our general concerns of "economic attractiveness" and "operational suitability" we looked at: uplinks, downlinks, cue and control, satellite characteristics, rental rates; standards for audio processing; ground receive station (GRS) design; testing and operational practices.

Uplinks

Only if S.C. is to be used need the radio uplink be co-located with TV. This S.C. mode of transmission would be, for CBC Radio, the least expensive of the alternatives. Uplinking on a S.C. of one of our own TV signals through one of our rented transponders, would cost nothing. The only cost would be for the back-haul and foreward-haul rental if it was a leased facility, or capital cost to expand the audio channel capacity, if it was an owned facility.

But the fact that the Radio signal has to piggy-back with the TV signal at all times, in a traffic situation like CBC's, makes most of the TV uplink channels unusable for CBC Radio.

SCPC's therefore, from an operational point of view, are to be preferred. Whether they are to be used in a transponder shared with a TV signal or not, they can each be uplinked independently from any location in the country. Telesat will install an SCPC uplink anywhere across the country, where it is required. The only restriction being possible RFI from terrestrial systems. We therefore are looking forward to having radio uplinks directly from our own production buildings.

The attractiveness of operational flexibility with the SCPC's is off-set to some degree, by the high rental rates for the uplinks. These have ranged from $40,000 to $60,000 per year for Anik "B" on 4/6 GHz. Since we intend to use the SCPC channels available on CBC transponders as well as install our own downlink G.R.S. instead of renting, we will not have any other operating cost. Therefore, it will be economically attractive to replace any terrestrial system costing more than the uplink rental with such a satellite system. But it is obviously not economically attractive to use satellites for all services.

This cost picture is improved somewhat if user owned and operated uplinks are considered. The capital cost of an uplink station, capable of transmitting one SCPC audio channel of 15 kHz is about $150,000 (Telesat figures). At an annual rental rate of $40,000 per year this gives an amortization period of just under four years. A very attractive capital investment consideration for an asset that can have a life of at least seven years.

Downlinks

To rent or to own is the option presently open. A single SCPC channel ground receiving station (G.R.S.) can have a capital cost ranging from $30,000 to $50,000 dependent on location. At an annual rental rate of $9,000 the amortization period would be 3 1/2 to 5 1/2 years. Again, an attractive capital investment consideration.

A sub-carrier of a TV signal will usually be used if the radio program is meant for distribution to locations that are already equipped with suitable TVRO's. The simple and relatively inexpensive additions needed are the major attractions of this mode of transmission.

For a whole country distribution system that CBC Radio has been looking at, the number of downlinks could amount to some 500, to include both our production centres and broadcast transmitters. We considered several options on design approach that can be taken for such a system.

1. The whole system can be based on the expected conditions at the worst reception location. This means all stations (G.R.S.) would have the same hardware as that required to give acceptable service at the location expected to have the worst reception.

2. Divide the country into zones to suit the coverage pattern of the satellite transmit antenna.

   (a) Larger receive dishes for fringe locations, and smaller ones for the more centrally placed receive locations.

   or

   (b) Smaller receive dishes at all locations but change uplink transmitter power and channel transponder power share to suit the reception zone.

Cue And Control

We will make every attempt to keep the necessary cue and control system as simple as possible. It is unlikely that we will use a similar system as TV. This has proved troublesome in the control of 10 CBC TV channels. We would therefore want a more reliable and less troublesome system for the more than two score channels needed by CBC Radio.

This could have either a SCPC or terrestrial line as the carrier. The control of receiver and hopefully transmitter operation would be through existing operational computers in the Radio master control rooms (MCR) across the country. The present terrestrial traffic is controlled in this way. The satellite ground stations' control data would either replace some of this, or be a simple addition to it. We have already started discussing the linking of the regional MCR computers with that in Toronto to allow direct and faster traffic data exchange.

Satellite Characteristics

Since Radio needs a program distribution and collection system that covers all points of the country, economically and easily, the satellite's footprint is of major interest. Also since Radio needs to broadcast to a mobile as well as an out-of-doors audience, the simplicity and size of the receiver and antenna are of concern.

Therefore, satellites with whole country coverage and using a channel frequency and power that allows the signal to be picked up on a simple receiver and antenna is needed.

The 4/6 GHz satellites in the Anik "B" and "D" series have the necessary footprint, but require expensive receivers and dishes.

The 12/14 GHz satellites in the Anik "C" series can work with smaller receive dishes but the receivers are costly. As well, the maximum footprint for one channel is only half-country. Full country coverage requires two channel uplinking with a corresponding increase in the system costs.

The 800 MHz satellite "M-SAT" still under discussion and expected to be launched in 1988 will use channel frequencies that can be picked up on a portable receiver with a simple antenna. Although its other characteristics are not totally suitable to Radio's needs, it does open up another level of expectations. True Radio DBS could be just around the corner, say in the 1990's.

Rental Rates

The cost of satellite uplinks, downlinks and space segment rentals will be the main governor to the development of Radio services. It can dampen or stimulate our efforts to develop such services. The need as we see it is for the establishment of realistic and stable rental tariffs for all of these services. Since they are all based mainly on hardware costs they could be held comparatively stable during the period it takes to amortize the original hardware costs. Five years would be a reasonable period.

For uplink rentals, if one user needs more than a single SCPC channel, from the same location, the additional channel rental should be at a lower rate than the first.

The more user owned and operated uplinks and downlinks that are installed, the simpler Telesat's operations should become. Since these operational costs are built into the rental rates, they should help to stabilize them further.

Standards

Since we intend to develop Radio satellite services, and want to set up a national system, as well as increase our international program exchange, the establishment of a number of standards becomes fairly mandatory. We need to concern ourselves about such questions as: pre-emphasis or not, and if so how much; companding or not, and if so how much; should 15 kHz bandwidth be standard; uplinking operating practices and transmitter power levels to ensure agreed on power sharing in a transponder, particularly where TV and Radio are sharing the same transponder; testing specifications and procedures.

CONCLUSIONS DRAWN

Up to this point in time our main concern has been with the economics of CBC Radio's use of satellites. With the set of conditions we find ourselves in, that is; a number of audio channels available on existing corporation rented transponders on Anik "B" and "D"; possibility of increased terrestrial system costs; indications that Telesat uplink rental rates will not increase; possibility that owned and operated uplinks as well as downlinks will be available to further reduce operating costs, we found the use of satellite very attractive for present distribution and collection systems, and also for all of the proposed new services to cable companies, syndication, SCMO feeds, remotes and as a control data carrier.

For direct broadcast to audiences we found Anik "C" far too expensive to consider, for both ourselves as program distributors and for the audience, who would be expected to buy or modify their receiving equipment.

All the operating and testing concerns which will decide the suitability of the Anik satellites for Radio use can only be resolved by trials, tests, discussions and agreements, between ourselves with Telesat, other Canadian users, U.S.A. users and equipment manufacturers. CBC Radio is stepping into this new venture with the intent of doing our utmost to make it a successful and exciting one. To show our faith we have already started to install some Radio G.R.S. with the double purpose of program distribution and testing.

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