EX PARTE OR LATE FILED

Mintz, Levin, Cohn, Ferris, Glovsky and Popeo, P.C.

701 Pennsylvania Avenue, N.W.
Washington, D.C. 20004

One Financial Center
Boston, Massachusetts 02111
Telephone: 617/542-6000
Fax: 617/542-2241

Telephone: 202/434-7300
Fax: 202/434-7400
Telex: 753689

James A. Kirkland

Direct Dial Number
202/434-7329

DOCKET FILE COPY ORIGINAL

June 2, 1994

VIA HAND DELIVERY

RECEIVED
JUN 2 1994
FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

Mr. William Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N .W.
Room 222
Washington, D.C. 20554

Re: Gen. Docket No. 90-314, Notice of Ex Parte Presentation

Dear Mr. Caton:

On May 31, 1994, representatives of Cablevision Systems Corporation ("Cablevision") met with the PCS Task Force to discuss issues raised in Cablevision's most recent comments in the above referenced docket, filed on April 22, 1994. Cablevision first summarized its findings as to economically feasible PCS network architectures, which are reflected in the chart attached as attachment 1. (A copy of this chart was left with the representatives of the Task Force present).

Cablevision representatives indicated, as argued in its prior comments, that Cablevision was ready to participate in the initial rollout of PCS, but was very concerned that the channelization plan initially adopted for broadband PCS would shut out medium sized companies such as Cablevision, as well as smaller companies. This concern results from the emphasis in the initial channelization plan on larger major trading areas, as well as the higher price at auction of the large 30 MHz spectrum blocks. Cablevision believes that it can effectively compete at auction for basic trading area licenses, and that such geographic areas will better match its own business plans and economic realities. Cablevision representatives also indicated that 20 MHz blocks would be sufficient for economically viable PCS services, and that such smaller blocks would be economically accessible for a far greater range of PCS participants.

No. of Copies rec'd 0+1
List ABCDE

Based on these concerns, Cablevision submitted the chart attached as attachment 2, which laid out a channelization plan with 2 20 MHz MTA licenses, 2 20 MHz BTA licenses, and 3 10 MHz BTA licenses. This proposal was mapped onto the spectrum in the 1.8 to 1.9 GHz band which Motorola proposed for allocation to broadband PCS in its written ex parte presentation in this docket of May 25, 1994. **Cablevision believes, however, that if the Commission were to adopt Motorola's proposed plan, which involves 3 30 MHz licenses and 3 10 MHz licenses, at least one of the 30 MHz and two of the 10 MHz licenses should be granted on a BTA basis.** Such a plan would not foreclose aggregation of BTAs into broader regional systems at auction, while at the same time allowing a much broader range of parties to bid for smaller geographic areas.

In support of this proposal, Cablevision also described the findings of a study performed by Comsearch, commissioned by Cablevision, of the New York metropolitan area, which demonstrates that, due to the manner in which microwave licensees are distributed in this area, larger 30 MHz blocks would not make it appreciably easier to clear a minimum amount of spectrum necessary for initial rollout of PCS, compared with 20 MHz licenses. Cablevision believes this is representative of a number of major urban areas. A copy of the study, as presented at the meeting, is attached. A supplemental report by Comsearch, which addresses certain questions raised by representatives of the Task Force, is also attached. (Copies of these reports are submitted with the docket file copy only).

This letter and one copy thereof are furnished for inclusion in the public record of the above captioned docket in compliance with Section 1.1206(a)(2) of the Commission's Rules. Please direct any questions regarding the foregoing to the undersigned.

Sincerely,

James A. Kirkland/rk

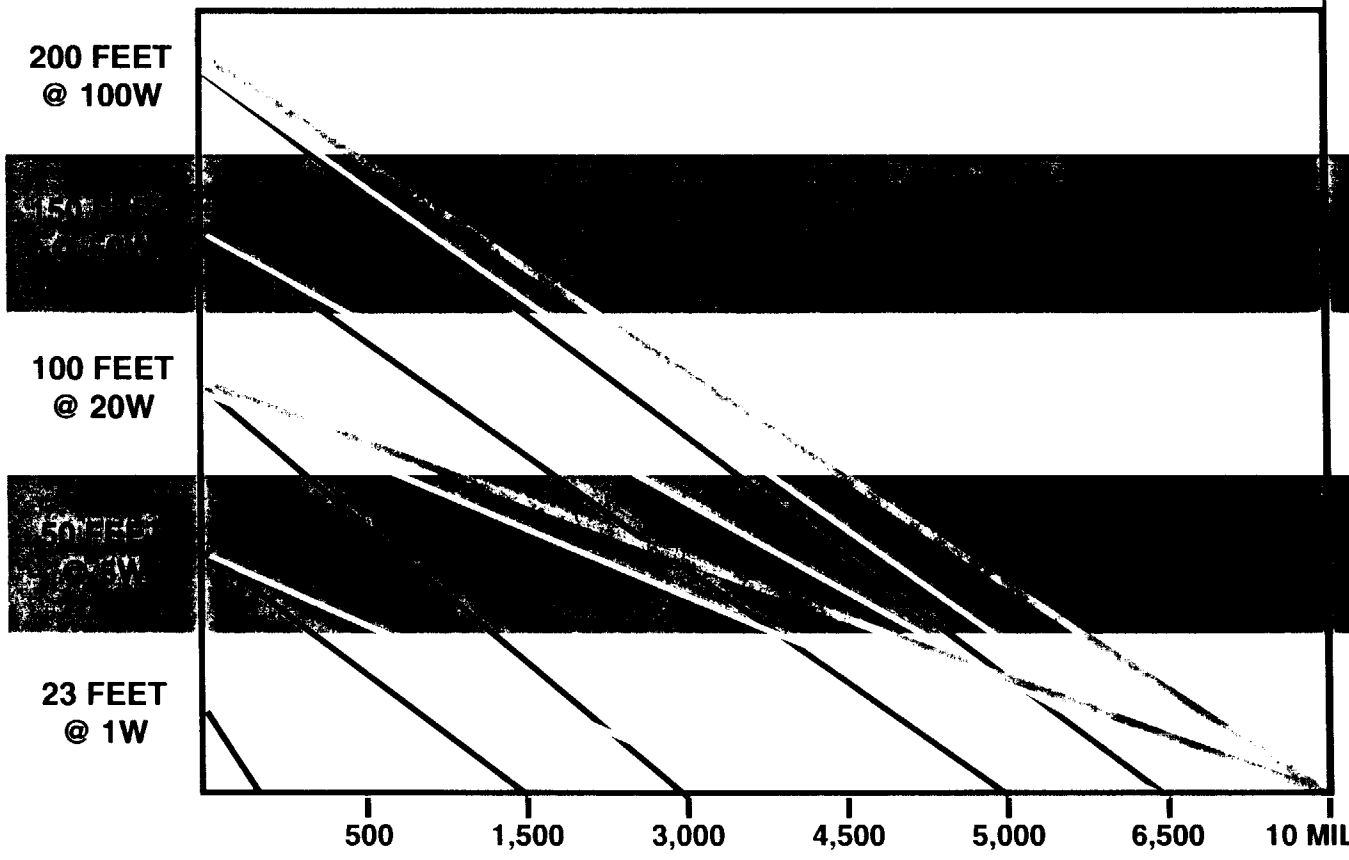
James A. Kirkland

Enclosure

cc: See Attached Service List

D28449.1

HOMES PER SERVICE CLASSIFICATION vs. COVERAGE AREA



	MICROWAVE COORDINATION DISTANCE	TIME TO MARKET	TOWER CONSTRUCTION TIME
200 FEET @ 100W	175 MILES	3 YRS	2.5 YRS
100 FEET @ 20W	134 MILES	1 YR	1 YR
23 FEET @ 1W	62 MILES	TODAY	TODAY

IN-BUILDING 200 mW HS	30	486	1,352	4,379	5,548	16,863	16,863
OUTDOOR 200 mW HS	100	6,071	16,863	16,863	16,863	16,863	16,863
WILLS/ VEHICULAR [illegible]	200	16,863	40,000	80,000	150,000	200,000	300/400,000

CABLEVISION

CABLEVISION			**MOTOROLA**	
		LICENSED PCS		
1850-1860	1930-1940	MTA	1850-1865	1930-1945
1860-1870	1940-1950	MTA	1865-1880	1945-1960
1870-1880	1950-1960	BTA	1880-1895	1960-1975
1880-1890	1960-1970	BTA		
1890-1895	1970-1975	MTA		
1895-1900	1975-1980	MTA	1895-1900	1975-1980
1900-1905	1980-1985	BTA	1900-1905	1980-1985
1905-1910	1985-1990	BTA	1905-1910	1985-1990
		UNLICENSED PCS		
1910-1920	VOICE[1]		1910-1920	VOICE[2]
1920-1930	DATA		1920-1930	DATA

[1] Unlicensed voice spectrum channelized at 1.25 MHz spacing.

[2] Unlicensed voice spectrum channelized at 1.25 MHz spacing.

CERTIFICATE OF SERVICE

I, Kathleen M. Birch, hereby certify that the foregoing letter was served by hand this 2nd day of June, 1994, on the following persons:

Chairman Reed E. Hundt
Federal Communications Commission
1919 M Street, N.W.
Room 814
Washington, D.C. 20554

Commissioner James H. Quello
Federal Communications Commission
1919 M Street, N.W.
Room 802
Washington, D.C. 20554

Commissioner Andrew C. Barrett
Federal Communications Commission
1919 M Street, N.W.
Room 826
Washington, D.C. 20554

Commissioner Rachelle B. Chong
Federal Communications Commission
1919 M Street, N.W.
Room 844
Washington, D.C. 20554

* Commissioner Susan Ness
Federal Communications Commission
1919 M Street, N.W.
Room 832
Washington, D.C. 20554

* Blair Levin
Chief of Staff
Federal Communications Commission
1919 M Street, N.W.
Room 814
Washington, D.C. 20554

Karen Brinkmann
Special Assistant
Office of the Chairman
Federal Communications Commission
1919 M Street, N.W.
Room 814
Washington, D.C. 20554

Rudolfo M. Baca
Legal Advisor
Office of Commissioner Quello
Federal Communications Commission
1919 M Street, N.W.
Room 802
Washington, D.C. 20554

Byron F. Marchant
Senior Legal Advisor
Office of Commissioner Barrett
Federal Communications Commission
1919 M Street, N.W.
Room 826
Washington, D.C. 20554

Richard Welch
Office of Commissioner Chong
Federal Communications Commission
1919 M Street, N.W.
Room 844
Washington, D.C. 20554

Gregory J. Vogt
Office of Commissioner Ness
Federal Communications Commission
1919 M Street, N.W.
Room 832
Washington, D.C. 20554

Robert M. Pepper
Office of Plans and Policy
Federal Communications Commission
1919 M Street, N.W.
Room 822
Washington, D.C. 20554

Donald H. Gips
Office of Plans and Policy
Federal Communications Commission
1919 M Street, N.W.
Room 822
Washington, D.C. 20554

David Reed
Office of Plans and Policy
Federal Communications Commission
1919 M Street, N.W.
Room 822
Washington, D.C. 20554

Jackie Chorney
Federal Communications Commission
1919 M Street, N.W.
Room 822
Washington, D.C. 20554

Thomas P. Stanley
Chief Engineer
Federal Communications Commission
2025 M Street, N.W.
Room 7002
Washington, D.C. 20554

Bruce Franca
Federal Communications Commission
2025 M Street, N.W.
Room 7002-A
Washington, D.C. 20554

David Siddall
Federal Communications Commission
Federal Communications Commission
2025 M Street, N.W.
Room 7102-A
Washington, D.C. 20554

A. Richard Metzger
Acting Chief, Common Carrier Bureau
Federal Communications Commission
1919 M Street, N.W.
Room 500
Washington, D.C. 20554

Gerald P. Vaughan
Deputy Bureau Chief (Operations)
Federal Communications Commission
1919 M Street, N.W.
Room 500
Washington, D.C. 20554

Ralph Haller
Chief, Private Radio Bureau
Federal Communications Commission
2025 M Street, N.W.
Room 5002
Washington, D.C. 20554

William Kennard
General Counsel
Federal Communications Commission
1919 M Street, N.W.
Room 614
Washington, D.C. 20554

F. Ronald Netro
Federal Communications Commission
2025 M Street, N.W.
Room 5002
Washington, D.C. 20554

Ruth Milkman
Federal Communications Commission
1919 M Street, N.W.
Room 544
Washington, D.C. 20554

Julia Kogan
Federal Communications Commission
1919 M Street, N.W.
Room 5202
Washington, D.C. 20554

Kathleen M. Birch

Kathleen M. Birch

D28457.1

Spectrum Allocations and Their Impact on Microwave Relocations:

An Analysis Based on the New York BTA.

Sponsored by:

Cablevision, Inc.

May 24, 1994

Comsearch • 11720 Sunrise Valley Drive • Reston, Virginia 22091 • (703) 620-6300

Table of Contents

Table of Contents i

List of Figures iii

1.0 Introduction 1
- 1.1 Background 2

2.0 Assumptions 4
- 2.1 Spectrum Allocation 4
- 2.2 Study Area 4
- 2.3 Minimum Spectrum Availability 5
- 2.5 Microwave System Parameters 5
- 2.6 PCS System Parameters 7
- 2.7 Other Assumptions 8
  - 2.7-2 Analog Interference Criteria 9
  - 2.7-3 Digital Interference Criteria 10
- 2.7-4 Existing Fade Margin Considerations 12
  - 2.7-5 Polarization 14

3.0 Technical Approach and Results 16
- 3.1 Parameter Selection 16
- 3.2 Analysis Procedure 23
- 3.3 Existing Spectrum Allocation - 1.25 MHz CDMA 26
  - 3.3.1 1850-1865/1930-1945 MHz Allocation - CDMA 26
  - 3.3.2 1865-1880/1945-1960 MHz Allocation - CDMA 29
  - 3.3.3 1880-1890/1960-1970 MHz Allocation - CDMA 32
- 3.4 Proposed Three 30 MHz Allocations - 1.25 MHz CDMA 35
- 3.5 Proposed Four 20 MHz Allocations - 1.25 MHz CDMA 38
- 3.6 Existing Spectrum Allocation - 200 kHz TDMA 45
  - 3.6.1 1850-1865/1930-1945 MHz Allocation - TDMA 45
  - 3.6.2 1865-1880/1945-1960 MHz Allocation - TDMA 46
  - 3.6.3 1880-1890/1960-1970 MHz Allocation - TDMA 47
- 3.7 Proposed Three 30 MHz Allocations - 200 kHz TDMA 48
- 3.8 Proposed Four 20 MHz Allocations - 200 kHz TDMA 49

4.0 Comment on Results 50

List of Figures

Figure 2.5-1 Two Microwave Antenna Gains versus Azimuth 6
Figure 2.5-2 IF Selectivity for SP2001 and FL1-02 Microwave Receivers - 120 Channel Analog 6
Figure 2.7-3.1 Threshold-to-Interference Curve for the DR2D-2 192 Channel Microwave Receiver 10
Figure 2.7-3.2 Threshold-to-Interference Curve for the DR2E-2 384 Channel Microwave Receiver 11
Figure 2.7-3.3 Maximum Allowable Interference vs Frequency Separation for a 192 and 384 Channel Digital Microwave Receivers 12
Figure 2.7-5.1 Antenna Gain vs Azimuth for Co-Polarized and Cross-Polarized Cases, A24501 14
Figure 2.7-5.2 Antenna Gain vs Azimuth for Co-Polarized and Cross-Polarized Cases, P24100 15
Figure 3.1-1 Comsearch Spectrum Sharing Tool Opening Screen 16
Figure 3.1-2 Load New Project Screen: Coordination Distance, Area Selection 17
Figure 3.1-3 PCS Technical Parameter Selections 18
Figure 3.1-4 Cell Layout Screen 19
Figure 3.1-5 Spectrum Allocation Selection 20
Figure 3.1-7 Edit Links - All Display 21
Figure 3.1-8 Edit Links - Selected Display 22
Figure 3.1-9 Edit Links - Owners 22
Figure 3.1-10 Edit Links - Frequency 22
Figure 3.2-1 NY BTA, 50 km Coordination Distance, All Microwave Links 1850-1990 & 2130-2150/2180-2200 MHz 25
Figure 3.3.1-1 New York BTA, 1.25 MHz CDMA, 1850-1865/1930-1945 MHz, No Links Removed 27
Figure 3.3.1-2 New York BTA, 1.25 MHz CDMA, 1850-1865/1930-1945 MHz, 33 Links Removed, 25 % Clear 28
Figure 3.3.2-1 New York BTA, 1.25 MHz CDMA, 1865-1880/1945-1960 MHz, No Links Removed 30
Figure 3.3.2-2 New York BTA, 1.25 MHz CDMA, 1865-1880/1945-1960 MHz, 65 Links Removed, 25 % Clear 31
Figure 3.3.3-1 New York BTA, 1.25 MHz CDMA, 1880-1890/1960-1970 MHz, No Links Removed 33
Figure 3.3.3-2 New York BTA, 1.25 MHz CDMA, 1880-1890/1960-1970 MHz, 49 Links Removed, 25 % Clear 34
Figure 3.4-1 New York BTA, 1.25 MHz CDMA, 1880-1895/1960-1975 MHz, No Links Removed 36
Figure 3.4-2 New York BTA, 1.25 MHz CDMA, 1880-1895/1960-1975 MHz, 52 Links Removed, 25 % Clear 37
Figure 3.5-1 New York BTA, 1.25 MHz CDMA, 1850-1860/1930-1940 MHz, No Links Removed 39

Figure 3.5-2 New York BTA, 1.25 MHz CDMA, 1850-1860/1930-1940 MHz, 21 Links Removed 40
Figure 3.5-3 New York BTA, 1.25 MHz CDMA, 1860-1870/1940-1950 MHz, No Links Removed 41
Figure 3.5-4 New York BTA, 1.25 MHz CDMA, 1860-1870/1940-1950 MHz, 52 Links Removed 42
Figure 3.5-5 New York BTA, 1.25 MHz CDMA, 1870-1880/1950-1960 MHz, No Links Removed 43
Figure 3.5-6 New York BTA, 1.25 MHz CDMA, 1870-1880/1950-1960 MHz, 45 Links Removed 44

Figure 3.6.1-1 New York BTA, 200 kHz TDMA, 1850-1865/1930-1945 MHz, No Links Removed 46
Figure 3.3.1-2 New York BTA, 1.25 MHz CDMA, 1850-1865/1930-1945 MHz, 33 Links Removed, 25 % Clear 47
Figure 3.3.2-1 New York BTA, 1.25 MHz CDMA, 1865-1880/1945-1960 MHz, No Links Removed 30
Figure 3.3.2-2 New York BTA, 1.25 MHz CDMA, 1865-1880/1945-1960 MHz, 65 Links Removed, 25 % Clear 31
Figure 3.3.3-1 New York BTA, 1.25 MHz CDMA, 1880-1890/1960-1970 MHz, No Links Removed 33
Figure 3.3.3-2 New York BTA, 1.25 MHz CDMA, 1880-1890/1960-1970 MHz, 49 Links Removed, 25 % Clear 34
Figure 3.4-1 New York BTA, 1.25 MHz CDMA, 1880-1895/1960-1975 MHz, No Links Removed 36
Figure 3.4-2 New York BTA, 1.25 MHz CDMA, 1880-1895/1960-1975 MHz, 52 Links Removed, 25 % Clear 37
Figure 3.5-1 New York BTA, 1.25 MHz CDMA, 1850-1860/1930-1940 MHz, No Links Removed 39

1.0 Introduction

This study presents the results of an analysis of the interference from a Personal Communication Services (PCS) system into the existing private Operational Fixed (OFS) microwave systems in and around the New York Basic Trading Area (BTA[1].) The purpose of the study is to examine the effect of three different PCS spectrum allocation schemes on the number of microwave relocations required to begin offering PCS services within the New York BTA. The minimum spectrum required to start a PCS system is defined as 25 % of the spectrum allocation. This study determines the number of microwave links that need to be relocated in order to have 25 % of the allocated spectrum available throughout the BTA.

This study was commissioned by Cablevision, Inc. to determine if there is a significant difference between the number of microwave relocations required for three different PCS spectrum allocation plans. The following allocation plans were examined:

1) Existing PCS Allocation - (Two 30 & One 20 MHz)	1850-1865/1930-1945 MHz 1865-1880/1945-1960 MHz 1880-1890/1960-1970 MHz
2) Three 30 MHz Allocations -	1850-1865/1930-1945 MHz 1865-1880/1945-1960 MHz 1880-1895/1960-1975 MHz
3) Four 20 MHz Allocations -	1850-1860/1930-1940 MHz 1860-1870/1940-1950 MHz 1870-1880/1950-1960 MHz 1880-1890/1960-1970 MHz.

The Comsearch Spectrum Sharing Tool was used to determine the number of microwave links that would need to be relocated to make 25 % of the allocated spectrum available for each of the spectrum blocks. This study also used both leading PCS technologies, code division multiple access (CDMA) and time division multiple access (TDMA), to determine if there was a difference in the number of microwave relocations required based on PCS system technology. The New York BTA study is an interim delivery for a project that will also examine the three PCS allocation plans in the Boston and San Francisco BTAs.

---

[1] Basic Trading Area and Major Trading Areas copyrighted by Rand McNally. Used by permission. For internal purposes only, resale, licensing or other distribution of the product or derivative works created from the product is prohibited. Note: The FCC has mandated certain changes to the 487 basic trading areas and 47 major trading areas (as defined by Rand McNally) for purposes of granting certain FCC licenses. These changes may vary depending on the specific license type. user should contact the FCC for details on its particular license type, if applicable.

1.1 Background

The Federal Communications Commission (FCC) is currently in the process of reviewing petitions to reconsider a number of decisions contained in the PCS Second Report and Order[2]. The size and number of spectrum allocations for PCS are included in the issues under reconsideration. This study was performed to determine if there is a difference in the number of microwave relocations required between the three spectrum allocation plans discussed in Section 1.0.

The Federal Communications Commission (FCC) has reallocated the spectrum currently used by the OFS microwave users for the use by the new wireless communication services, PCS. However, the PCS spectrum is currently occupied by OFS microwave users who will have to be moved to another frequency band or transmission media. This analysis focuses on the interference from a PCS system into the existing microwave systems to evaluate the number of microwave links that will have to be relocated.

To perform this analysis, a number of assumptions need to be made. These assumptions include items such as PCS System Technology, PCS Base Station transmit power, Radio Frequency (RF) Propagation Model, and number and distribution of PCS cells. Other assumptions also need to be made concerning the interference criteria and objectives to determine what level of RF power received from the PCS system constitutes 'harmful' interference. This analysis presents the results of many different assumptions to show the sensitivity of the results to the parameters selected and to display the flexibility of the Comsearch Spectrum Sharing Tool.

Comsearch has developed a PCS Spectrum Sharing Tool to analyze the interference from proposed PCS systems into the existing OFS microwave systems. The FCC has reallocated the 1850-1990 MHz and 2130-2150/2180-2200 MHz bands from OFS microwave to PCS. The existing microwave users must relocate to other frequency bands or transmission media at the expense of the PCS system operators. Due to the high cost (estimates vary from $100,000 to $250,000 per link) and length of time required to relocate existing microwave, PCS operators need the capability to begin offering services before all the microwave links are relocated. The PCS operators would also like to minimize the number of relocations to conserve capital. The Comsearch Spectrum Sharing Tool allows the user to determine the effects of various PCS system design and interference parameters on the number of microwave links to be relocated. The tool also identifies the owner of the various links, their capacity and system characteristics, and identifies the market area affected by the microwave links. This will allow the user to identify the links that need to be relocated and assign a priority to them. By determining the market areas affected by the existing microwave systems, the user can design his system to minimize the number of relocations required by varying base station locations and coverage areas.

---

[2] **Second Report and Order**, General Docket No. 90-314, Federal Communications Commission, Washington, DC, September 23, 1993, Appendix A: Final Rules, pg. 31.

The study is based on the assumption that a PCS operator can begin operating with less than 100 % of the allocated spectrum. This assumes that to compete in the wireless communication market, the PCS provider will want to offer service as quickly as possible and not wait until all the microwave users have been relocated. Under this assumption, this study determines the number of existing microwave users that need to be relocated to provide 25 % of the allocated spectrum **everywhere** in the BTA. The 30 MHz allocations will provide twelve 1.25 MHz CDMA channels and seventy five 200 kHz TDMA channels. The 20 MHz allocations provide eight 1.25 MHz CDMA channels and fifty 200 kHz TDMA channels. (All channelizations assume frequency division duplex (FDD) operation - bases and mobiles each require separate channels.) The following minimum spectrum availabilities are required, based on the 25 % goal:

- 30 MHz:	CDMA-	3 Channels
	TDMA-	19 Channels (18.75 rounded up)
- 20 MHz	CDMA-	2 Channels
	TDMA-	13 Channels (12.75 rounded up.)

The 25 % spectrum availability goal represents the minimum amount of clear spectrum that a PCS operator would need to begin offering services to the public. The 25 % figure is only an estimate and is not based on any frequency reuse or specific traffic capacity requirements. The minimum spectrum availability requirement has been used in a number of previous Comsearch spectrum sharing reports.

The analysis determines the number of microwave links that need to be relocated to meet these objectives everywhere in the BTA. If a particular microwave link prevents a single cell within the market area from meeting the spectrum availability objective, it is relocated. This is a very conservative requirement, but it is applied consistently throughout the study. In actual practice, microwave links that interfere with a single cell may be designed around using antenna patterns and coverage 'holes' rather than relocating microwave links.

2.0 Assumptions

This section provides a discussion of the assumptions used in performing this analysis.

2.1 Spectrum Allocation

This study uses the following PCS spectrum allocation plans:

1) Existing PCS Allocation - (Two 30 & One 20 MHz)	1850-1865/1930-1945 MHz 1865-1880/1945-1960 MHz 1880-1890/1960-1970 MHz
2) Three 30 MHz Allocations -	1850-1865/1930-1945 MHz 1865-1880/1945-1960 MHz 1880-1895/1960-1975 MHz
3) Four 20 MHz Allocations -	1850-1860/1930-1940 MHz 1860-1870/1940-1950 MHz 1870-1880/1950-1960 MHz ←1880-1890/1960-1970 MHz.

Within these allocations, the PCS Base Stations operate in the 1930-1970 MHz band and the PCS Mobile Stations operate in the 1850-1890 MHz band. For the spectrum sharing analysis, all microwave links within +/- 10 MHz of the selected spectrum are included in the analysis. For example, in an analysis of the 1865-1880/1945-1960 MHz allocation all microwave links with at least one receiver in the 1855-1890/1935-1970 MHz band were included. This is done to account for the adjacent channel interference. Microwave systems operating in the 1840-1850 MHz range were not included because the National Telecommunication Information Agency (NTIA) has not yet released the requested information.

2.2 Study Area

This study uses the New York BTA as the study area. All PCS cells are located within the boundaries of the New York BTA. The number of microwave links used in the study depends on the coordination distance specified. A coordination distance of 0 km would result in a study that only considered microwave links that are completely contained within the BTA or have one terminal of the link located within the BTA. As the coordination distance is increased, the number of microwave links considered in the analysis increases. The coordination distance is applied to the rectangular extents (points that define the smallest rectangle that completely contains the BTA) of the study area and results in a larger area than a scaled increase in the actual BTA boundary. This is done to minimize the problem of accurately scaling an irregularly shaped polygon. By only applying the coordination distance to the rectangular extents the number of microwave links considered in the analysis is increased.

2.3 Minimum Spectrum Availability

This study requires that 25 % of the allocated spectrum be available **everywhere** in the BTA to meet the minimum spectrum availability requirement. If a microwave link causes a single PCS cell to fail this test, the link is relocated. This percentage was selected to illustrate the problem of a PCS provider trying to offer wireless communication services before all the microwave links are relocated.

2.4 Microwave Paths Included in the Analysis

Microwave links are included in the analysis if they have at least one terminal within the boundaries of the study area. As discussed in 2.2, the study area can be expanded by a user specified coordination distance. This study uses a 50 km coordination distance in order to reduce the total number of microwave links in the analysis to a manageable number. The actual coordination distance that should be considered, based on the Second Report and Order would be 164 to 190 km depending on PCS transmit power and base station antenna height. Using a 0 km coordination distance would include 115 microwave links in the study. The 50 km coordination distance reduced the number of microwave links in the analysis to 378. A 100 km coordination distance increased the number of microwave links to 554. The 50 km coordination distance was selected as a reasonable compromise between computer run time and the total number of microwave links considered in the analysis.

2.5 Microwave System Parameters

The following microwave system parameters are considered in the analysis:

1) Antenna Characteristics

- Azimuth: This determines which direction the antenna is pointing
- Gain: This determines the antenna gain in a specific direction
- Antenna Centerline: This is how high the antenna is mounted above the ground
- Ground Elevation: This is the height of the ground.

2) Microwave Receiver Characteristics

- Interference Objective: For each specific receiver an interference objective has been calculated. This is based on the specific filter characteristics. An objective is calculated for 0, +/- 2.5 MHz, +/- 5.0 MHz, and +/- 10.0 MHz around the center frequency of the microwave receiver.

3) System Characteristics

- Fixed Losses: These are the losses between the transmitter and the antenna.

The Comsearch Spectrum Sharing Tool uses the manufacturer supplied antenna patterns for over 2,000 different antenna makes and models. The difference between individual antenna models can be significant at certain azimuths. Figure 2.5-1 shows the difference between two 31.2 dBi gain antennas. This shows that for particular azimuths there can be a significant difference between two antennas with the same nominal gain.

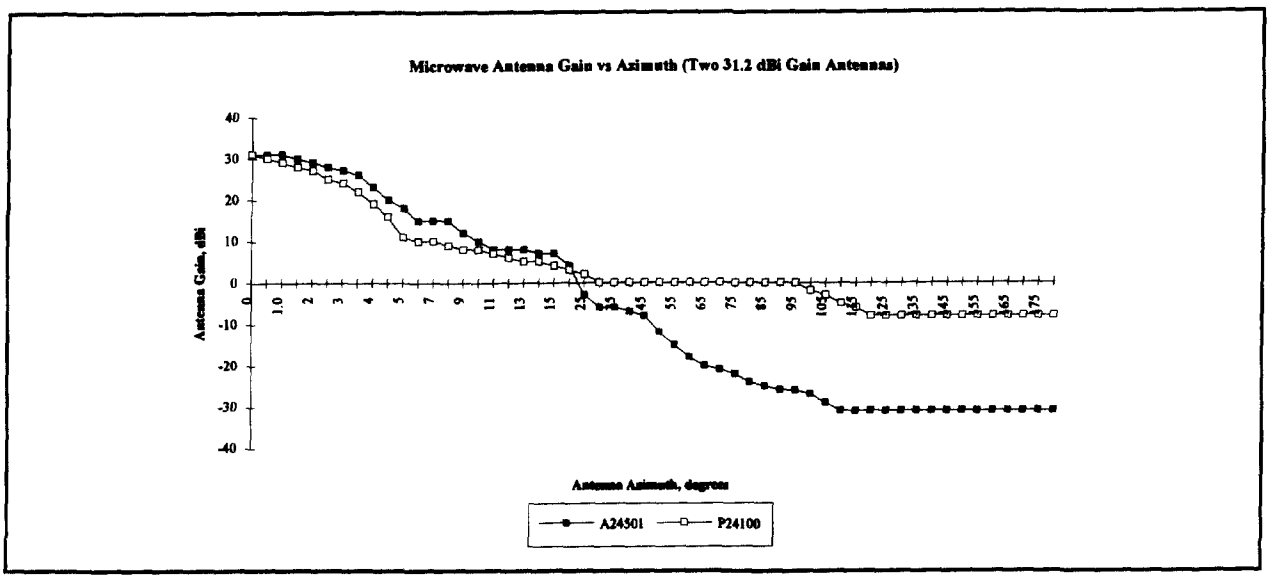


Figure 2.5-1 Two Microwave Antenna Gains versus Azimuth

The Comsearch Spectrum Sharing Tool also uses the manufacturer's intermediate frequency (IF) selectivity curves and threshold-to-interference (T/I) curves in determining the interference objectives for each microwave receiver. Figure 2.5-2 shows the difference between the IF selectivity of two 120 channel microwave receivers that can be found in the 1850-1990 MHz band. This example shows how much two microwave receivers can vary and still meet the same FCC rules. However, for this analysis both receivers would have the same IF selectivity due to the +/- 10 MHz restriction on adjacent channel microwaves considered.

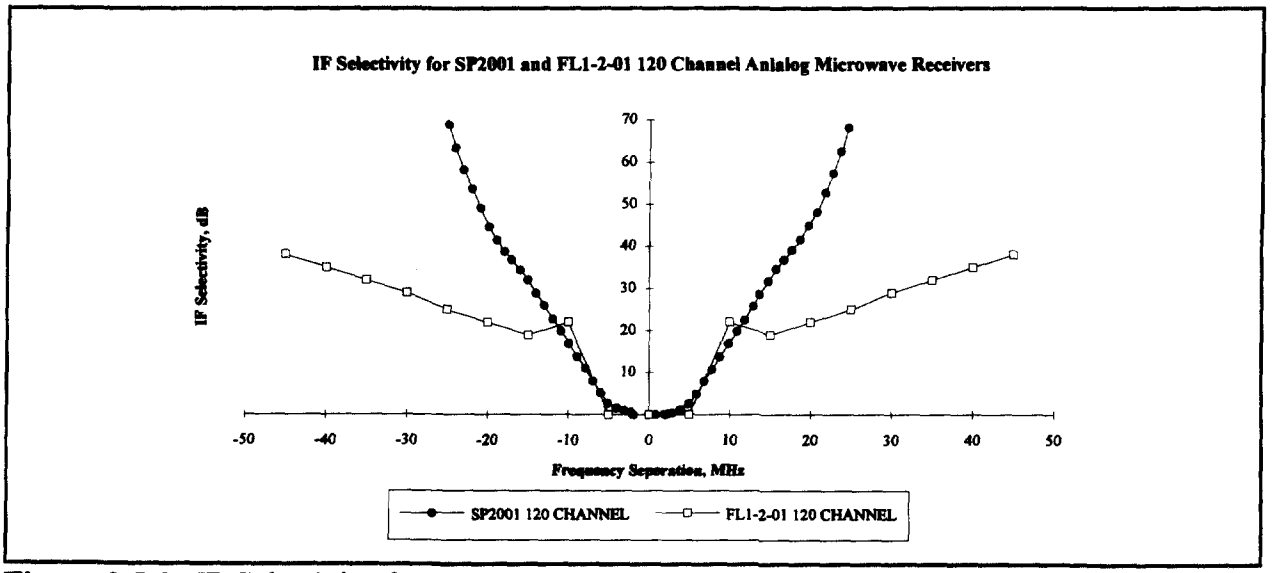


Figure 2.5-2 IF Selectivity for SP2001 and FL1-02 Microwave Receivers - 120 Channel Analog

The antenna information is used to determine the receive signal level (RSL) from the PCS system. The antenna centerline and ground elevation are used to determine the distance to the radio horizon between the microwave receiver and the PCS cells. The microwave receiver information is used to determine if the PCS system is causing harmful interference into the microwave receiver. The fixed losses are from the cable (or waveguide) attenuation between the microwave transmitter and the microwave antenna. These losses reduce the amount of PCS interference received and should be considered.

2.6 PCS System Parameters

In order to perform the PCS to microwave spectrum sharing study, the PCS technical parameters need to be selected. These selections have a major impact on the study results. This study used a high power, high capacity type of PCS system. The study also used a uniform distribution of 2.4 km radius cells and assumed that each cell would provide service to 20 mobile users. The New York BTA required 1,628 of the 2.4 km radius cells and would support 32,560 simultaneous users. The following PCS System Parameters were considered in the analysis:

1) Base Station EIRP	40.4 dBm (CDMA), 34.8 dBm (TDMA)
2) Base Station Antenna Height	30.48 m
3) Mobile Station EIRP	40 dBm (CDMA), 31.8 dBm (TDMA)
4) Mobile Station Height	1.6 m
5) Uniform Cell Size	2.4 km
6) Frequency Division Duplex (FDD)	Base Station Transmit on High
7) 1.25 MHz CDMA	64 PN chips/modulation symbol
8) CDMA processing gain	18 dB
9) TDMA processing gain	6 dB
10) Mobile Distribution	Closest Point.

When using the Uniform Cell Distribution, the entire study is covered using cells of the same radius. This results in a very large number of cells depending on the radius selected. For the New York BTA, the 2.4 km radius cell distribution requires 1,628 cells and a 5.0 km radius cell distribution would require 364 cells to completely cover the area. No operator would build a PCS based on either of these criteria. The small radius cell system places a great number of cells in very rural areas. The large radius cell system reduces the number of cells in the rural area, but places very few cell in the heavily populated areas.

The choice of FDD operation was based on the typical operating systems considered. In an FDD system the spectrum allocation is divided to provide the same number of channels in the lower part of the allocation as in the upper part of the allocation. The PCS channels consist of a channel from the lower part (for mobile use) and a channel from the upper part (for base station use.) Both parts of the channel must be available to create a single useable PCS channel.

The processing gain of the CDMA signal is used as an interference mitigation factor for analog microwave systems. The CDMA system operates as a spread spectrum digital signal and this

factor reduces the amount of interference into an analog microwave system. Because of the spreading of the signal, the interference effect on the analog microwave receiver is reduced. The amount of the reduction is taken from the number of PN chips per modulation symbol, which is an approximation to the actual processing gain of the system. This factor is not applied to digital microwave receivers because the assumption of reduced interference from digital interferer is not valid. A similar argument can be made for the TDMA signal, but the reduction is smaller because of the smaller bandwidth of the TDMA.

The Mobile Distribution selection deals with where the mobile units are located within the cell for the analysis. The actual distribution would be a random distribution with a bias toward roads, public buildings, and private homes. For the purposes of this type of analysis, their exact location cannot be determined and an assumption is required. All the mobiles are assumed to be at the edge of cell along the line that connects the microwave receiver under study and the particular base station involved (if the microwave receiver is located within the cell, the mobiles are all placed at the base station.) This places the mobiles as close to the microwave receiver as possible and requires the use of the highest power possible. This makes for a very conservative assumption, but because the mobiles are located so close to the ground, 1.6 m, their contribution to total interference is very small and limited to the areas directly around the microwave receiver.

2.7 Other Assumptions

Besides the microwave and PCS parameters discussed in the previous sections, a number of other assumptions are required. These include the following items:

1) Propagation Model	TR 14/11
2) Analog Interference Criteria	6 dB below threshold
3) Digital Interference Criteria	Receive Threshold - T/I
4) Existing Fade Margin	None
5) Polarization	Co-polarization.

2.7.1 Propagation Model

The propagation model in this study is based on the combination of Hata up to the horizon and Forward Scatter Loss beyond the horizon presented in the Telecommunications Industry Association Telecommunications Systems Bulletin 10-F, "Interference Criteria for Microwave Systems.[3] This is not the Longley-Rice ver 1.2.2 specified by the FCC in the PCS 2nd Report and Order, but it does use the 3 arc second digital terrain to determine the elevation of the center of each cell. The PCS Base Station height and the microwave receiver height are used to

[3] "Interference Criteria for Microwave Systems," TSB-10-F, Telecommunications Industry Association, Washington, DC, Annex F, January 27, 1994.

determine where the distance to the radio horizon between each point. For the TR 14/11 propagation model, the distance to the horizon between a microwave receiver and a PCS Base Station is determined by the frequency and the height of the two points. The height of the PCS Base Station is determined by the PCS Base Station Antenna Height and the ground elevation of the center of the cell. The ground elevations for the PCS system are obtained from 3 arc-second digitized terrain. The elevation for the microwave receivers is determined from the microwave information file.

2.7-2 Analog Interference Criteria

The Analog Interference Criteria determines the maximum allowable interference power for an analog microwave receiver. The 6 dB below threshold refers to how far below the microwave receiver's threshold interference must stay to pass the threshold degradation test. In this case, the microwave receiver threshold is defined as the receive signal level that will produce a 30 dB signal-to-noise ratio (SNR) in the worst channel. An interference level of 6 dB below threshold is called a 1 dB threshold degradation. The following example will illustrate the principle for the 6 dB below threshold case:

Microwave Receiver Threshold:	-80 dBm	(10^{-8} mW)
Interference Power:	+ -86 dBm	(2.5×10^{-9} mW)
	---	---
	= -79 dBm	(12.5×10^{-9} mW.)

A similar calculation for a 10 dB below threshold criteria shows the following:

Microwave Receiver Threshold:	-80 dBm	(10^{-8} mW)
Interference Power:	+ -90 dBm	(10^{-9} mW)
	---	---
	= -79.6 dBm	(11×10^{-9} mW.)

There are a number of conflicting opinions concerning the use of 6 or 10 dB below threshold for microwave coordination purposes. The small difference in threshold degradation (0.6 dB) comes at the cost of reducing allowable interference by 4 dB. The 6 dB threshold degradation has been used extensively in the coordination of existing OFS microwave and is used exclusively in this study.

2.7-3 Digital Interference Criteria

The maximum allowable interference for a digital microwave receiver is determined by using the manufacturer's threshold-to-interference curves. These curves are defined to show the amount of interference that would drop a digital microwave receiver's bit error rate (BER) from 10^{-6} to 10^{-5}. This assumes that the receiver under test is operating at its rated threshold and that the interference is the same type of signal. Figures 2.7-3.1 and 2.7-3.2 show the T/I curves for two specific microwave receivers. The T/I curves are used to determine the maximum allowable interference by adding the T/I figure to the receiver's threshold. For example, for the 192 channel DR2D-2 radio the threshold is -78 dBm. The T/I for a cochannel interferer (0 MHz separation) is 28 dB (from Figure 2.7-3.1). This gives a maximum allowable interference of -106 dBm for cochannel interference. This is the figure used in the Spectrum Sharing Tool in determining the amount of spectrum available.

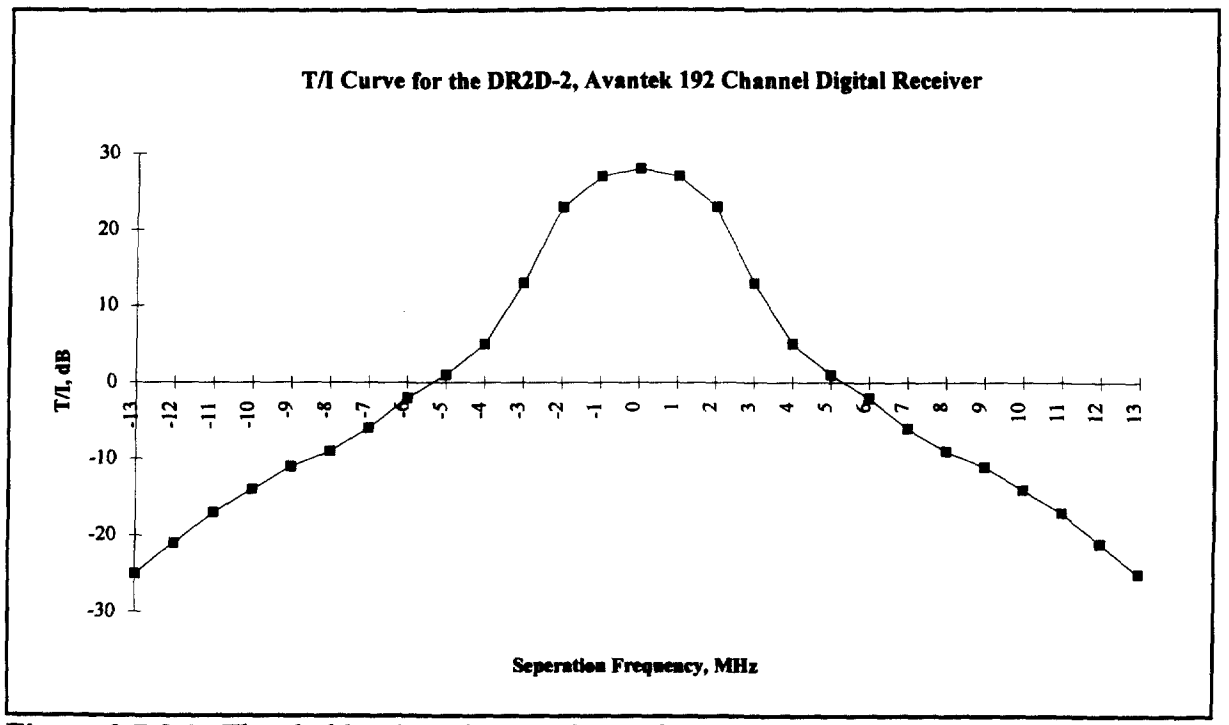


Figure 2.7-3.1 Threshold-to-Interference Curve for the DR2D-2 192 Channel Microwave Receiver

Figure 2.7-3.2 shows the same curve for a 384 channel digital radio from the same manufacturer. This radio has a threshold of -77 dBm and a cochannel T/I of 30 dB. This gives a maximum allowable interference for cochannel interference of -107 dBm.

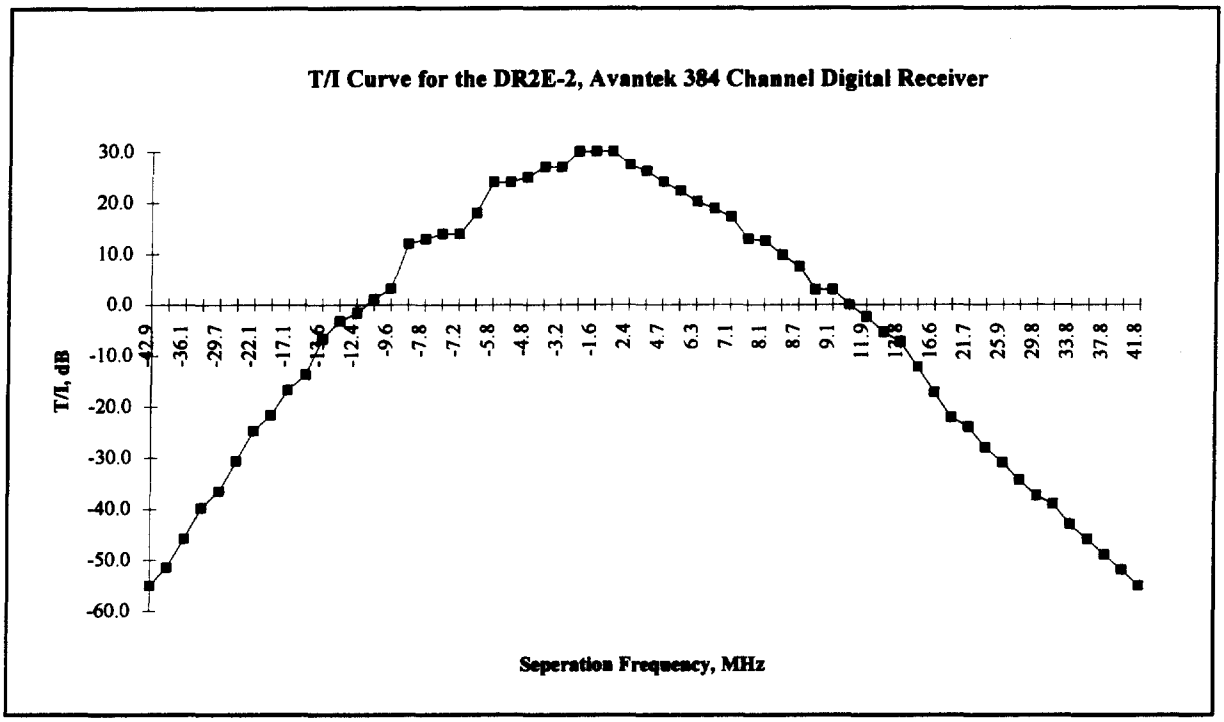


Figure 2.7-3.2 Threshold-to-Interference Curve for the DR2E-2 384 Channel Microwave Receiver

Figure 2.7-3.3 shows the difference in the maximum allowable interference for two digital microwave receivers. This was calculated by adding the microwave receiver's threshold and the T/I for the receiver. The cochannel maximum allowable values of -106 dBm and -107 dBm (192 channel and 384 channel, respectively) are comparable, but there is a 22 dB difference between the two at 5 MHz of separation and 14.1 dB of difference at 10 MHz. The higher capacity systems (digital and analog) will have a greater effect on proposed PCS systems because their receiver bandwidths are much larger than the smaller capacity systems. The high capacity (384 channels or more) digital microwave systems cause the greatest problems with trying to share the spectrum between the existing microwave users and the new PCS systems. The cochannel maximum allowable interference levels are so low (-107 dBm for example) that the PCS system operators cannot operate anywhere near one of these receivers. Assuming free space loss, a 31.2 dBi microwave antenna gain, 2 dB of fixed losses, and a 100 mW PCS handset, a single PCS handset could cause harmful interference for 811 km.

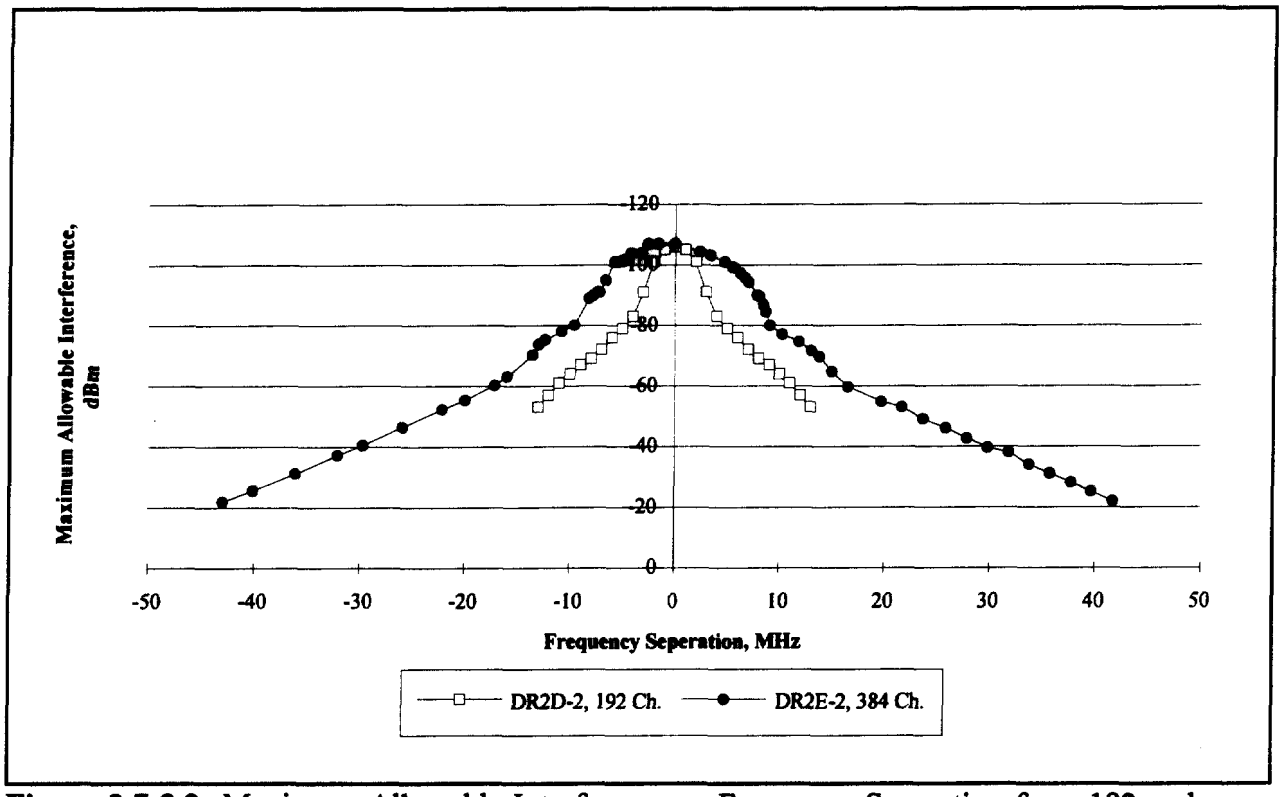


Figure 2.7-3.3 Maximum Allowable Interference vs Frequency Separation for a 192 and 384 Channel Digital Microwave Receivers

2.7-4 Existing Fade Margin Considerations

Microwave communication links are typically designed with higher receive signal levels than required by the fixed and path losses. This is intended to provide a margin above the minimum operating signal to compensate for variations in propagation losses along the path or equipment aging. The dominant variable is the variation in propagation losses that can be caused by a number of anomalous RF propagation conditions. This extra receive signal level is known as the fade margin, and offers the system protection against short duration propagation fades. The amount of required fade margin depends on the level of reliability required for the particular link. The reliability requirement is usually expressed as the percentage of time the link is available. A 99.999 % reliability indicates that the link is designed to have no more than 315 seconds per year of unavailability (365 days/yr x 24 hrs/day x 3600 sec/hr x (100 % - 99.999 %) = 315.36 seconds per year). A 99.9999 % reliability implies that the link can only tolerate 31.5 seconds of outage per year. These figures are commonly called 5 9's and 6 9's reliability. The 5 9's reliability is the recommended target, except for special case where exceptional reliability is required, then the 6 9's is recommended.

The existing fade margin can be calculated by determining the receive signal level (RSL) and determining how far the RSL is above the receiver's threshold. The 5 9's and 6 9's fade margins are calculated using an equation that is a function of the climate, terrain roughness, frequency, and the path length.[4] These fade margins are functions of the cube of the path length (D^3.) This means that short microwave paths can be designed with less fade margin since the probability of fading is low. The Comsearch Spectrum Sharing Tool can evaluate the effect of considering the microwave link availability by comparing the existing fade margin with these calculated fade margins. The 99.999 % and 99.9999 % fade margins are calculated using an average climate and terrain roughness factors for every microwave link in the PCS band. The existing fade margin is also calculated assuming free space loss, and using the actual antenna gains, fixed losses, and transmit powers of each microwave link. The fade margin analysis assumes that existing fade margins that exceed the calculated 99.999 % or 99.9999 % can be used for additional interference. To provide some minimum level of fade margin protection to the shortest microwave paths, a minimum fade margin of 13 dB is assumed. The following example illustrates the process:

Existing Fade Margin:	45 dB
99.999 % Fade Margin:	- 22 dB
Extra Fade Margin =	23 dB
Minimum Fade Margin =	- 13 dB
Excess Fade Margin =	10 dB.

The 10 dB Excess Fade Margin in this example would be used to increase the maximum allowable interference for the particular microwave receiver. This analysis is interesting in that it shows that interference problem for very short links can be minimized, but it does not accurately model the total interference problem. **The Comsearch Spectrum Sharing Tool used in this analysis does not yet consider the C/I objectives for the microwave links**. This can lead to misleading results, especially when applying the 5 9's and 6 9's fade margin criteria. The hazard is particularly acute where the microwave path length is very short. These links require almost no fade margin to meet the 5 9's and 6 9's requirements. If the 5 9's fade margin requirement is 0 dB, the entire existing fade margin (less 13 dB) will be available for interference. This will produce C/I ratio of 13 dB, which is not acceptable. As the C/I objectives for all the microwave radio types become available, the Comsearch Spectrum Sharing Tool will implement this additional requirement. No consideration of fade margin is used in this study.

---

[4] Vigants, A., "Space-Diversity Engineering," **Bell System Technical Journal**, January 1975, pp. 103-142.