ORIGINAL

WALTER SONNENFELDT & ASSOCIATES
Telecommunications Policy Consulting
4904 Ertter Drive
Rockville, Maryland 20852
Telephone: 301-770-3299
Telecopier: 301-881-1861

RECEIVED

SEP 15 1992

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

September 15, 1992

ORIGINAL FILE

Ms. Donna Searcy
Secretary
Federal Communications Commission
Room 222
1919 M Street, N.W.
Washington, D.C. 20054

Re: General Docket No. 90-314
Request For Pioneer's Preference of
Spatial Communications, Inc. (File No.
PP 73)

Dear Ms. Searcy:

Transmitted herewith for inclusion in the records of the above-referenced rulemaking and the associated request for pioneer's preference in the Personal Communications Services ("PCS") licensing process is the September 1992 Quarterly Experimental Report of Spatial Communications Inc. ("SCI"). SCI's report is submitted pursuant to condition number three of SCI's experimental license. See File No. 3187-EX-AL-92, Call Sign KK2XAL.

SCI's pioneer's preference request demonstrated conclusively the technical feasibility of implementing SCI's pioneering Spatial Division Multiple Access ("SDMA") technology in the PCS operating environment. Additional testing conducted by SCI since filing its request for pioneer's preference on May 4, 1992 further confirms the technical feasibility of SCI's SDMA technology. The results of this additional testing are documented in SCI's quarterly experimental report.

If there are any questions concerning this submission, kindly contact the undersigned.

Very truly yours,

Walter H. Sonnenfeldt
Counsel to Spatial
Communications, Inc.

No. of Copies rec'd 0+9
List A B C D E

cc: See attached service list

SPATIAL COMMUNICATIONS, INC.
QUARTERLY EXPERIMENTAL REPORT

September 14, 1992

Status of SDMA Experimentation

Pursuant to Spatial Communications experimental authorization (File No. 3187-EX-AL-92, Call Sign KK2XAL), SCI is conducting a range of experimentation in the area of PCS. A major focus of SCI's PCS experimental program is the application of Spatial Division Multiple Access ("SDMA") technology in the PCS operating environment. Testing of the SDMA technology is proceeding on schedule and the experimental results are extremely encouraging. The Appendix attached hereto provides details of the most recent experimentation concluded July 2, 1992. SDMA or *intelligent antennas* clearly represents the next generation of RF technological development. Although a few companies have challenged the SDMA concept, such challenges are a result of misinformation or a basic failure to understand the technology. Not only does SDMA offer system flexibility (higher capacity, improved RF *transmission*), it is the only new technology offering a realistic long-term solution to the co-primary sharing issue.

Status of Field Trials/Micro cellular Platform Testing

Motorola CT2 equipment operating at 901-902 MHz has been installed at Pier 18 at the Port of Seattle. Pier 18 is operated by Stevedoring Services of America.

The objective of the Pier 18 installation is to test the equipment in an environment wherein the *landscape* is continually changing and which is highly RF reflective in nature. The test is expected to run approximately 60 days, after which the equipment will be installed at View Ridge Elementary School for tests in conjunction with Viacom Cable. To date, the tests have found the metallic environment fairly hostile to the low power RF transmission from the Motorola CT2 equipment.

Motorola personal base stations have also been installed at various residences to test the robustness of the system in various residential environments. Additional tests of the public CT2 equipment from Motorola is planned for the fall of 1992 in the Seattle Sheraton. The purpose of the test is to determine optimum base station placement and propagation characteristics in an office tower environment. Upon completion of the test the equipment will be installed at View Ridge Elementary.

The purpose of the View Ridge Elementary installation is to evaluate the residential environment and to test the use of a CATV network for transport of voice signals. The CATV network being used in the experiment is operated by Viacom Cable. The test will

last 6 to 9 months and will include a market survey. Viacom and One World Telecommunications, Inc., a parent company of SCI, are working cooperatively on a range of other PCS experimental activities including work in the area of SDMA technology. As a result, SCI's and Viacom's experimental efforts have been enhanced through sharing of technical expertise.

DECLARATION

I, Dr. Arogyaswami Paulraj, do hereby declare as follows:

1. I have a Ph.D. in Electrical Engineering from Indian Institute of Technology, New Delhi, India.
2. I am presently Principal Scientist of Spatial Communications, Inc. (SCI)
3. I am the co-developer of a proprietary advanced spectrum access management technology known as spatial division multiple access ("SDMA").
4. I have either prepared or reviewed the technical information contained in the SCI's September 1992 Quarterly Experimental Report, and in the Appendix thereto entitled, "SDMA Multiple Signal Transmission in the PCS Environment" The technical facts contained in the above-mentioned documents are accurate to the best of my knowledge and belief.

Under the penalties of perjury, the foregoing is true and correct.

Sep. 14 1992

Date

Dr. Arogyaswami J Paulraj

Appendix to the September 1992 Quarterly Experimental Report

SDMA Multiple Signal Transmission in the PCS Environment Experimental Results

14 September 1992

Spatial Communications, Inc.

Appendix to the
September 1992 Quarterly Experimental Report

Spatial Communications, Inc.

14 September 1992

CONTENTS

1. Introduction 1

2. Overview of SDMA Signal Transmission 1

3. Experimental Apparatus 2

4. Experimental Results 4

1. Introduction

This document describes additional experimental results on the application of Spatial Division Multiple Access (SDMA) technology to Personal Communication Systems (PCS) for improving spectral efficiency and signal quality. SDMA technology employs *smart antennas* to selectively receive and transmit signals based on their spatial location. SDMA technology can significantly increase the spectral efficiency (*i.e.* allow larger number of communication channels within the allocated spectrum) and improve signal quality in PCS network. SDMA technology can also improve dramatically the ability of PCS systems to share spectrum with existing users.

SDMA technology uses an array of antennas to estimate the directions-of-arrival (DOAs) of multiple co-channel signals and *separate* the impinging signals and their corresponding information streams. Likewise, using an array of transmit antennas, multiple co-channel signals are radiated from an SDMA antenna array such that the RF energy carrying each information stream is selectively directed toward the intended receiver and with negligible energy radiated towards unwanted receivers. Such unwanted receivers may include other co-channel PCS users in the cell as well as other users and services sharing spectrum with PCS. SDMA transmission thus greatly reduces the degree of mutual RF interference within a PCS network and between PCS and other band sharing co-primary users such as point-to-point microwave systems.

A discussion of recent SDMA transmission experiments conducted as a follow on of previous computer simulation testing of SDMA technology is described herein. An overview of the basic methodology and a description of the experimental apparatus is followed by a summary of the results obtained. The results of the experiments documented in the report confirm earlier findings relating to the ability of SDMA technology to enhance capacity and signal quality in a PCS system and to expand PCS's ability to share spectrum with existing users.

2. Overview of SDMA Signal Transmission

The basis of SDMA PCS technology is the ability to dynamically locate and track the direction of the handset requiring service and then receive and transmit in a directionally selective manner. Here we address the transmission technique wherein we simultaneously transmit *different* signal waveforms on the same carrier frequency to multiple spatially distributed receivers, keeping *cross-talk* below acceptable thresholds so that each receiver can successfully decode its intended waveform. Though this may seem difficult, the

results of tests described herein verifies the practicality of SDMA technology as indicated by previous computer simulation studies.

Given estimates of the receiver locations, the objectives in the design of the SDMA PCS transmitter are to:

1. ensure that a sufficient RF energy containing the information signal intended for a given receiver is directed thereto,

2. ensure that the RF energy leakage towards unintended receivers is kept below an acceptable level,

3. provide for a sufficient amount of *robustness* with respect to environmental and system parameter variations,

4. and to otherwise *minimize the total transmitted power* so as the keep unwanted RF emissions (pollution) to a minimum.

SDMA technology is applicable to environments where the receivers may be distributed in both azimuth and elevation. In the PCS environment, the spatial distribution of users is likely to be concentrated in close proximity to the earth's surface. For this reason, an array of SDMA sensors should be designed to have maximum selectivity in the horizontal direction.

In the next section, the experimental apparatus is briefly described, followed by the results of the data processing performed to assess the performance of the SDMA transmission system.

3. Experimental Apparatus

This section summarizes results of further testing of SCI's SDMA transmission technology. The tests described herein were conducted in an anechoic chamber so as to have sufficient control over the RF environment to allow a quantitative evaluation of system performance. The overall system configuration for the SDMA transmit experiments is shown in Figure 3-1.

The SDMA Processor consisted of a digital signal processor (DSP) with a 12-channel digital-to-analog converter (DAC). A i486 based personal computer was used to control the DSP and DAC and provide related computational support. The DAC ouputs were sent to a multichannel transmitter that consisted of six (6) single-sideband (SSB) upconvertors with appropriate filtering and power amplification subunits. The transmit channel outputs were fed to six simple dipole elements. The transmitted power level

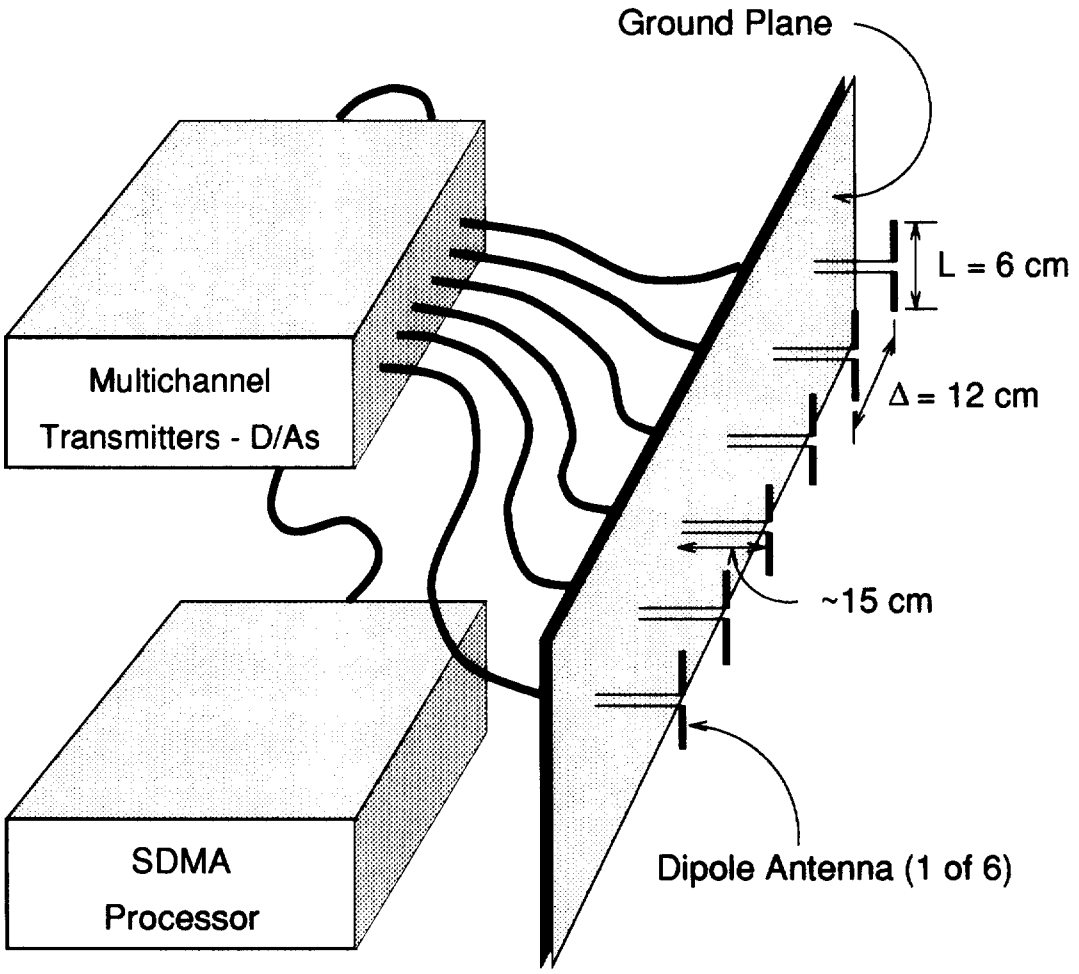

Figure 3-1: SDMA Transmit Experimental Apparatus

was set to approximately 10 dBm for each of the six elements. The transmit frequency was chosen to be 850 MHz to suit availability of test equipment. However, the results obtained are equally valid in other frequency bands that are may be allocated for PCS.

4. Experimental Results

The transmission beam response was evaluated by placing a single channel receiver in the far field of the array. The receiver output was down converted and digitized for processing.

The transmitted signals consisted of continuous wave (CW) and binary phase-shift-keyed (BPSK) waveforms that were single sideband modulated on the RF carrier. The CW tones frequencies were 10 kHz and 20 kHz, and the BPSK waveform was a 2000 bit random binary sequence cyclically read out and modulated on a 20 kHz sub-carrier. In the tests the two directions for transmit (handsets directions) were chosen to be at 270° and 225°. This separation of 45° or approximately 1.2 Rayleigh beamwidths resulted in each direction being at the peak of the first sidelobe of a conventional beam directed in the other direction. Equal transmit power was used for both signals.

Consistent with previous computer simulation results, an SDMA transmitter with an six element antenna array was found to require approximately only 1/6 the power needed from a single antenna transmitter to achieve the same signal level at the receiver. This reduction in total transmitted power represents a direct reduction in RF pollution.

The spatial distribution of RF energy for the sinusoidal transmission tests is given in Figures 4-1 through 4-3. In Figure 4-1, only a single 20 kHz tone was directed at 270°, with suppression at 225° desired. Due to imperfect absorption in the anechoic chamber wall containing the door to the chamber, and the fact that the main beam was directed at this wall when the response near 225° was being measured, some degree of scattering was present. This accounts for the fact that only 20 dB of rejection was observed around 225°. This suppression is, however, still adequate to allow satisfactory reception of the BPSK waveform.

In Figure 4-2, only a single 20 kHz tone was directed at 225°, with suppression at 270° desired. Since in this case the main beam was directed at the opposite wall of the chamber, there was little scattering and the measured radiation pattern shows strong 50 dB nulls close to the desired direction. The small apparent error in the direction of the null is due to positioning errors in the turntable control system.

In Figure 4-3, two CW tones were transmitted simultaneously, the first a 20 kHz tone directed at 270° with suppression at 225° desired, and the second a 10 kHz tone directed at 225° with suppression at 270° desired. The figure contains plots of power

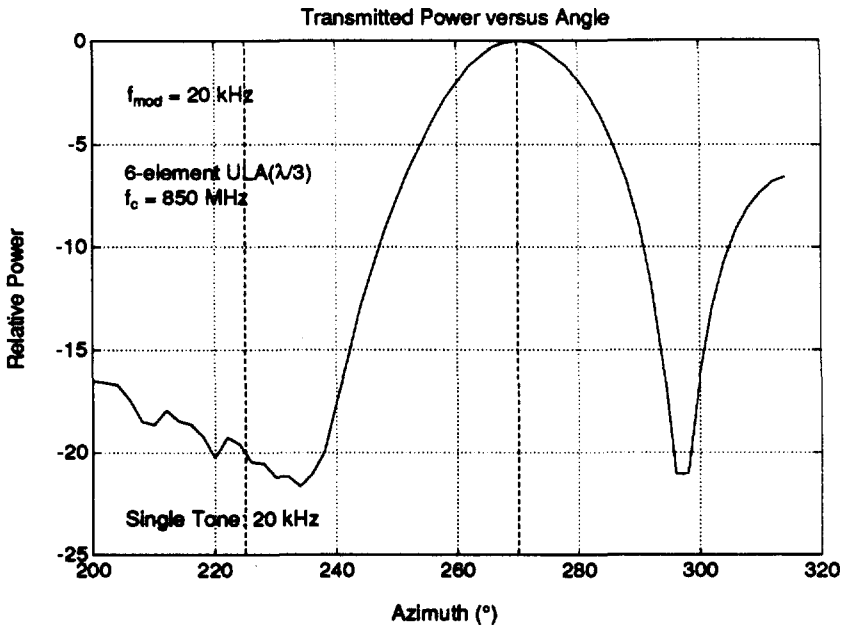

Figure 4-1: Measured Spatial Directivity for a Single 20 *kHz* Tone Directed to 270° with Rejection at 225°

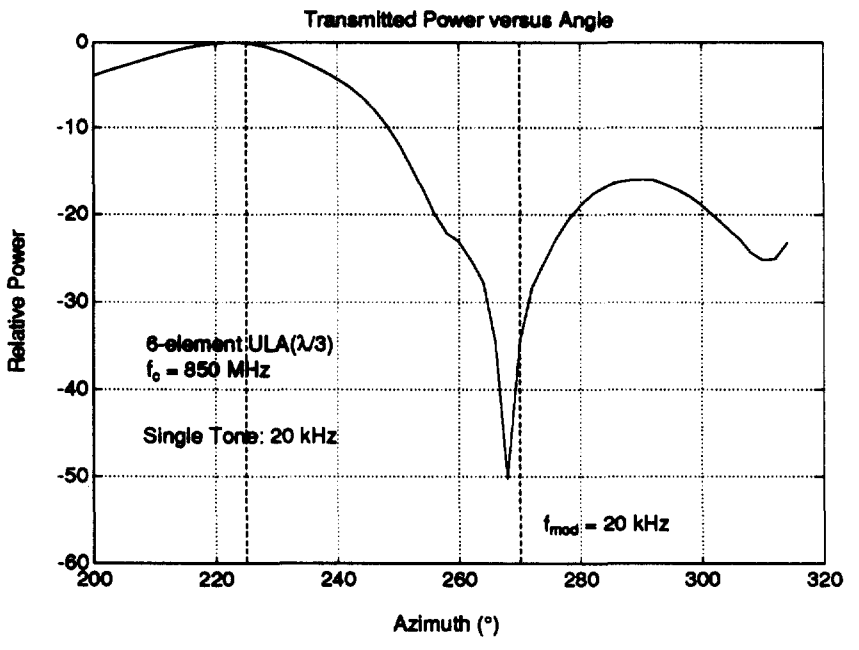

Figure 4-2: Measured Spatial Directivity for a Single 20 *kHz* Tone Directed to 225° with Rejection at 270°

at the appropriate modulation frequency as a function of azimuthal angle. The desired directivity was clearly achieved. Figure 4-4 is a contour plot of the same data showing array directivity as a function of both azimuth and frequency. (The ridges therein are the curves in the previous two figures.)

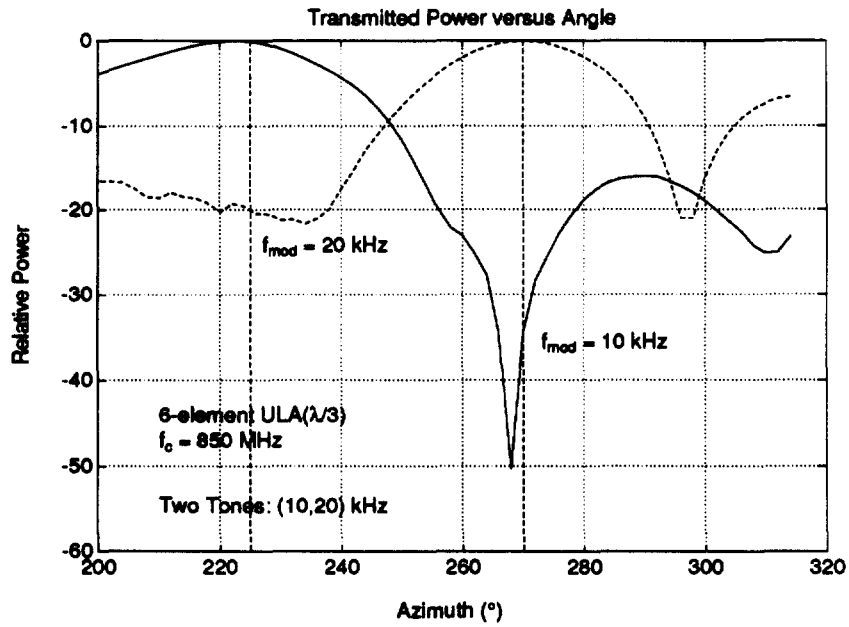

Figure 4-3: Measured Spatial Directivity for 10 *kHz* and 20 *kHz* Tones Directed to 225° and 270° Respectively

These experimental results clearly confirm findings of previously conducted simulations and thus establishes that it is possible to simultaneously transmit different information signals on the same carrier to spatially separated receivers with adequate mutual signal isolation.

In the second set of tests, the two BPSK waveforms described above were transmitted using the same parameters as in the two sine wave experiment. Different random sequences were used for the two directions. The results are shown in Figures 4-5 through 4-7. In Figure 4-5, successful demodulation with no bit errors is manifest over a 12° sector centered about the intended transmit direction. The effects of a decreasing C/I ratio are evident at azimuth 274°.

In Figure 4-6, successful demodulation with no bit errors is manifest over a 6° sector about the intended transmission azimuth. Consistent with the previous observations concerning the breadth of the null achievable at 225°, there is no discernible performance degradation over the azimuth interval. Further evidence of the breadth of the null is given in Figure 4-7 wherein successful demodulation is shown out to 240°. That successful

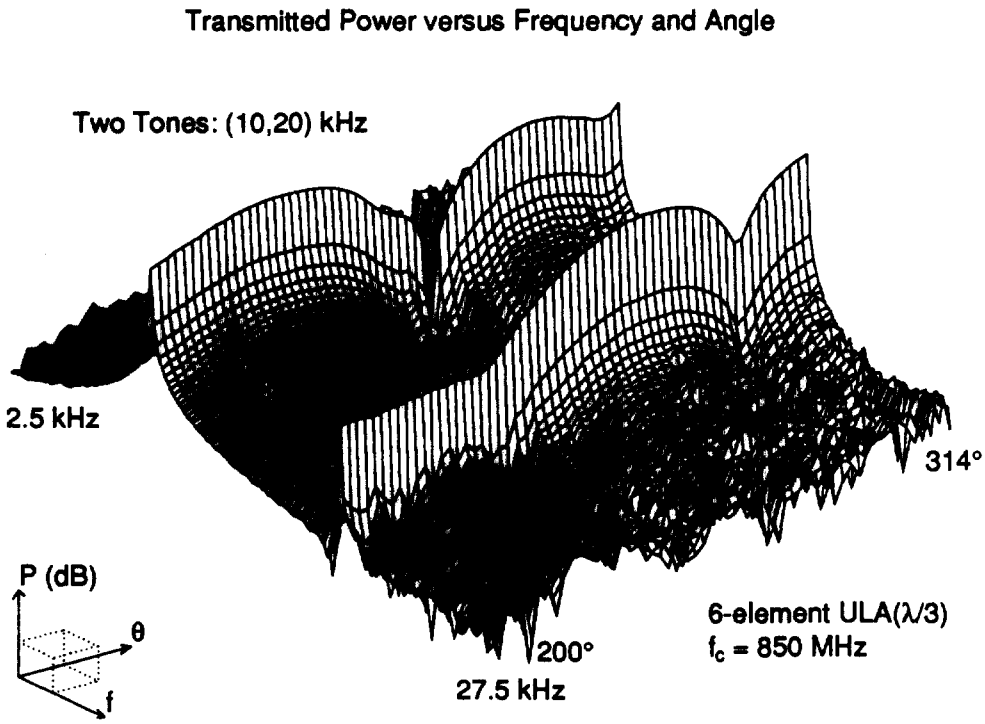

Figure 4-4: Measured Spatial and Frequency Directivity for 10 *kHz* and 20 *kHz* Tones Directed to 225° and 270° Respectively

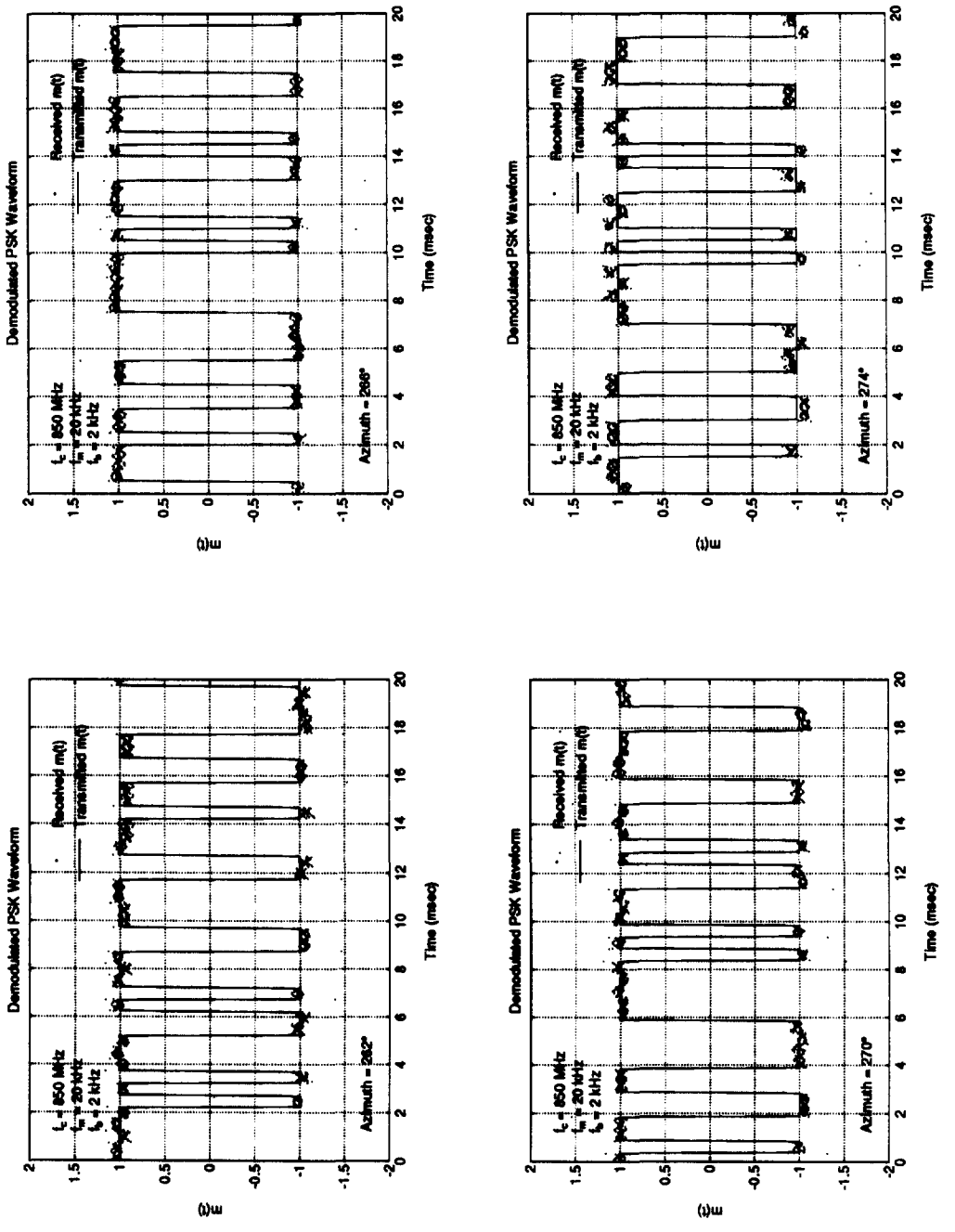

Figure 4-5: BPSK Transmitted and Received Bit Sequences Around 270°

demodulation is not always achievable is evidenced by the attempts to do so at 250° and 300°. The larger variance manifest therein is due to the significantly reduced power transmitted in those directions.

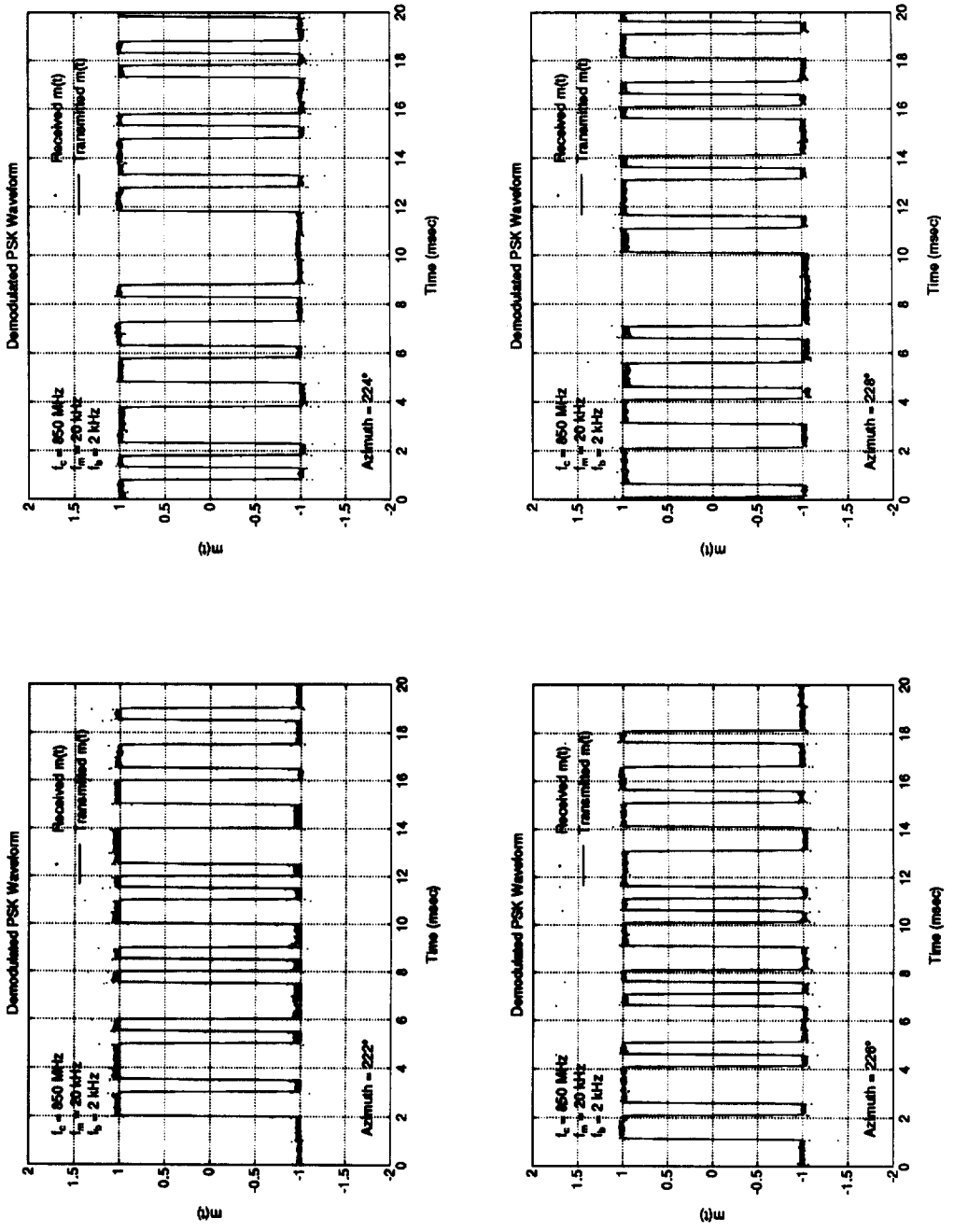

Figure 4-6: BPSK Transmitted and Received Bit Sequences Around 225°

These tests reaffirm results of earlier computer simulations demonstrating the ability of SDMA technology to function in a complex PCS type propagation environment and

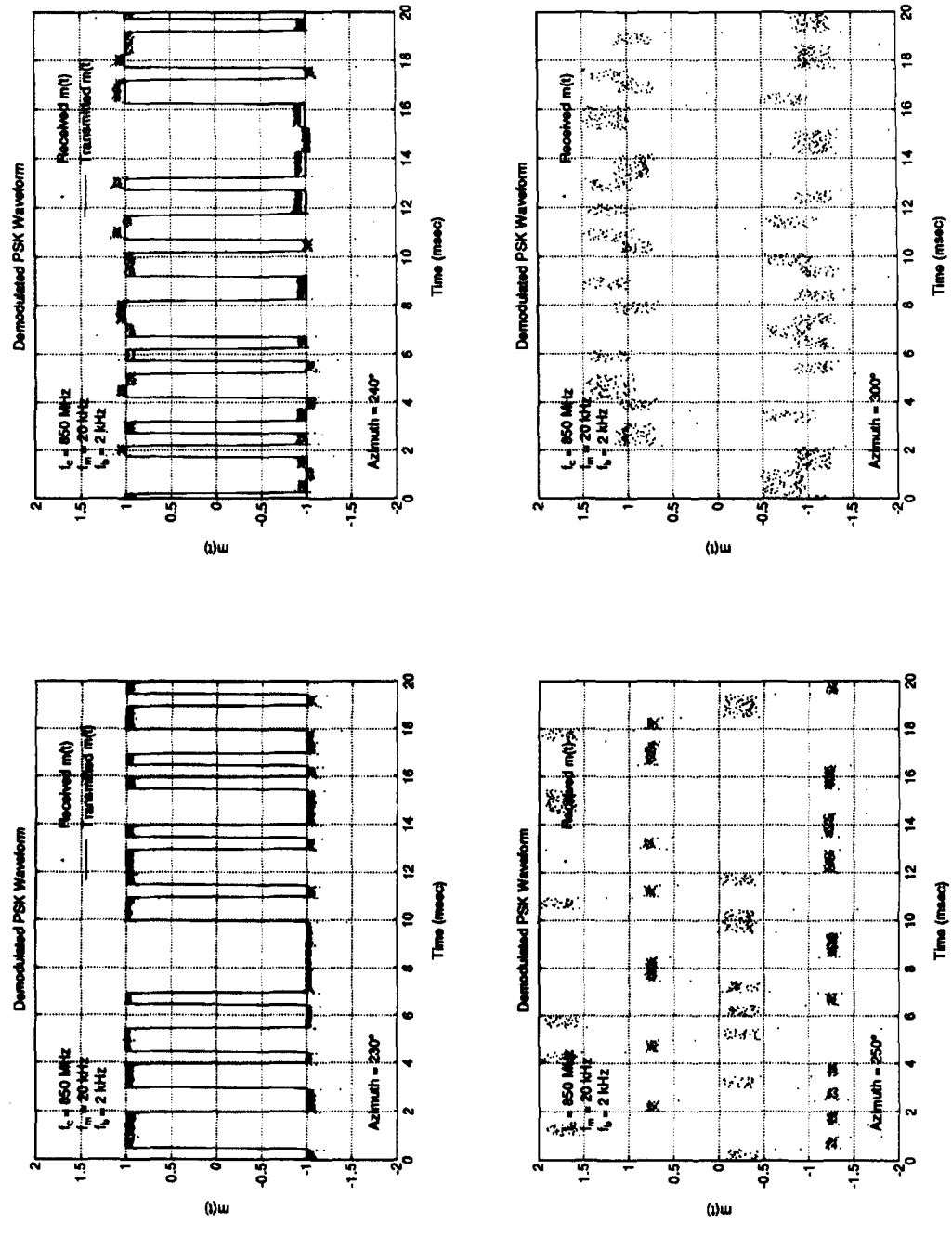

Figure 4-7: Received/Demodulated Message Sequences at Various Azimuths

to use spatially selective beams to transmit multiple co-channel information signals while dramatically reducing interference into other cochannel systems. Thus, SDMA technology results in improved PCS network capacity and quality, while also greatly enhancing possibilities for coexistence with other users sharing the same spectrum.

CERTIFICATE OF SERVICE

I, Walter H. Sonnenfeldt do hereby certify that on this 15th day of September, 1992, a copy of the foregoing "Quarterly Experimental Report of Spatial Communications, Inc." has been mailed by United States first class mail, postage prepaid, to the following:

Mr. J. Barclay Jones Vice President of Engineering 1025 Connecticut Ave., N.W. Washington, D.C. 20036	American Personal Communications (PP-6)
Jonathan D. Blake, Esq. Kurt A. Wimmer, Esq. Ellen K. Snyder, Esq., N.W. Covington & Burling P.O. Box 7566 Washington, D.C. 20044	American Personal Communications (PP-6)
Richard Rubin, Esq. Fleischman and Walsh 1400 16th Street, N.W., Suite 600 Washington, D.C. 20036	Associated PCN Company (PP-8)
Randall B. Lowe, Esq. John E. Hoover, Esq. Jones, Day, Reavis & Pogue 1450 G Street, N.W., Suite 700 Washington, D.C. 20005	LiTel Telecommunications Corporation (PP-13)
Mr. Thomas E. Martinson Vice President PCN America, Inc. 153 East 53rd Street, Suite 2500 New York, NY 10022	PCN America, Inc. (PP-15)
Mr. Dennis R. Patrick President and CEO Time Warner Telecommunications 1776 Eye Street, N.W. Washington, D.C. 20006	Time Warner Telecommunications, Inc. (PP-27)
Ms. Lisa A. Hook Chief Operating Officer Time Warner Telecommunications 1776 Eye Street, N.W. Washington, D.C. 20006	Time Warner Telecommunications, Inc. (PP-27)

Stuart F. Feldstein, Esq. Fleischman and Walsh 1400 16th Street, N.W., Suite 600 Washington, D.C. 20036	Adelphia Communications (PP-41)
Randall D. Fisher, Esq. General Counsel Adelphia Communications Corp. 5 West Third Street Coudersport, PA 16915	Adelphia Communications (PP-41)
Daniel V. Liberatore, P.E. Vice President of Engineering Adelphia Communications Corp. 5 West Third Street Coudersport, PA 16915	Adelphia Communications (PP-41)
Mr. Jimmy K. Omura Chairman 110 South Wolfe Road Technologies, Inc. 82 Devonshire Street, R25D Boston, MA 02109	Digital Spread Spectrum Technologies, Inc. (PP-42)
Francine J. Berry, Esq. David P. Condit, Esq. Seth S. Gross, Esq. Room 3244J1 295 North Maple Avenue Basking Ridge, NJ 07920	American Telephone and Telegraph Company (PP-43)
Mr. Robert R. Gray American TeleZone 13103 N. Moss Creek Cypress, TX 77429	American TeleZone (PP-44)
JoAnne G. Bloom, Esq. Suite 3900 30 South Wacker Drive Chicago, Illinois 60606	Ameritech (PP-45)
Mark S. Fowler, Esq. James H. Barker, Esq. Latham & Watkins Suite 1300 1001 Pennsylvania Ave., N.W. Washington, D.C. 20004	Bell Atlantic Personal Communications, Inc. (PP-46)
Dennis F. Begley, Esq. Corporation 1818 N Street, N.W., Suite T20 Washington, D.C. 20036	Broadband Communications (PP-47)

James F. Ireland, Esq. Cole, Raywid & Braverman 1919 Pennsylvania Avenue, N.W. Washington, D.C. 20006-3458	Cable USA, Inc. (PP-48)
Peter Casciato, Esq. Law Offices of Peter Casciato Roundhouse Plaza 1500 Sansome Street, Suite 201 San Francisco, CA 94111	Cellular Service, Inc. (PP-49)
Judith St. Ledger-Roty, Esq. W. Theodore Pierson, Jr., Esq. Nancy J. Thomas, Esq. Reed Smith Shaw & McClay 1200 18th Street, N.W. Washington, D.C. 20036	Cellular Service, Inc. (PP-49)
Mr. John D. Lockton Managing Partner Corporate Technology Partners 520 S. El Camino Real San Mateo, CA 94010	Corporate Technology Partners (PP-51)
Werner Hartenberger, Esq. Laura Phillips, Esq. Dow, Lohnes & Albertson 1255 23rd Street, N.W., Suite 500 Washington, D.C. 20037	Cox Enterprises, Inc. (PP-52)
David C. Jatlow, Esq. Young & Jatlow 2300 N Street, N.W., Suite 600 Washington, D.C. 20037	Ericsson Business Communications, Inc. (PP-53)
Robert S. Foosaner Lawrence R. Krevor Suite 700 1450 G Street, N.W. Washington, D.C. 20005	Fleet Call, Inc. (PP-54)
Harold Mordkofsky, Esq. Blooston, Mordkofsky, Jackson & Dickens 2120 L Street, N.W. Washington, D.C. 20037	Freeman Engineering Associates, Inc. (PP-54)
David A. Reams, Esq. General Counsel and President Grand Broadcasting Corporation 27019 Shawnee Perrysburg, OH 43551	Grand Broadcasting Corp. (PP-56)

James U. Troup, Esq. Arter & Hadden 1801 K Street, N.W., Suite 400K Washington, D.C. 20006	Iowa Network Services, Inc. (PP-57)
Mr. Douglas G. Smith President Omnipoint Corporation 7150 Campus Drive Colorado Springs, CO 80920	Omnipoint Communications (PP-58)
Mr. Tom Alberg Executive Vice-President 5400 Carillon Point Kirkland, WA 98033	McCaw Cellular Communications (PP-59)
Mr. Douglas G. Smith President Omnipoint Corporation 7150 Campus Drive Colorado Springs, CO 80920	Omnipoint Corporation (PP-59)
Mr. Richard Brass President Oracle Data Publishing, Inc. 500 108th Avenue, N.E., Suite 1750 Bellevue, WA 98004-5500	Oracle Data Publishing (PP-59)
Stuart F. Feldstein, Esq. Fleischman and Walsh 1400 16th Street, N.W., Suite 600 Washington, D.C. 20036	Omnipoint Mobile Data Co. (PP-60)
James P. Tuthill, Esq. Betsy Stover Granger Room 1529 140 New Montgomery Street San Francisco, CA 94105	Pacific Bell (PP-61)
James L. Wurtz, Esq. 1275 Pennsylvania Avenue Washington, D.C. 20004	Pacific Bell (PP-61)
Carl W. Northrop, Esq. Bryan Cave Suite 700 700 13th Street, N.W. Washington, D.C. 20005	Pactel Corporation (PP-62)
Mark A. Stachiw, Esq. PacTel Corporation 1221 Merit Drive, Suite 800 Dallas, TX 75251	Pactel Corporation (PP-62)

Jeffrey Blumenfeld, Esq. Glenn B. Manishin, Esq. Blumenfeld & Cohen 1615 M Street, N.W., Suite 700 Washington, D.C. 20036	PageMart, Inc. (PP-63)
Caressa D. Bennet, Esq. Blooston, Mordkofsky, Jackson & Dickens 2120 L Street, N.W. Washington, D.C. 20037	Panhandle Telephone (PP-64)
Mr. Richard G. Tomlinson PCN communications 2906 Main Street Glastonbury, CT 06033	PCN Communications, Inc. (PP-65)
A. Thomas Carroccio, Esq. Santarelli, Smith & Carroccio 1155 Connecticut Ave., N.W. Washington, D.C. 20036-4308	Pulson Communications Corp. (PP-67)
Mr. Kevin J. Kelly Albert Shuldiner, Esq. Nixon, Hargrave, Devans & Doyle One Thomas Circle, N.W. Washington, D.C. 20005	Qualcomm Incorporated (PP-68)
Peter Tannenwald, Esq. Arent, Fox, Kintner, Plotkin & Kahn 1050 Connecticut Avenue, N.W. Washington, D.C. 20036-5339	Radio Telecom and Technology, Inc. (PP-69)
James F. Ireland, Esq. Cole, Raywid & Braverman 1919 Pennsylvania Avenue, N.W. Washington, D.C. 20006-3458	SATCOM, Inc. (PP-70)
Donald L. Schilling President SCS Mobilecom, Inc. 85 Old Shore Road, Suite 200 Port Washington, NY 11050	SCS Mobilecom, Inc. (PP-71)
Mr. Sanjay B. Moghe President SM Tek, Inc. 1021 Warwick Circle Hoffman Estates, IL 60194	SM Tek, Inc. (PP-72)
Victor J. Toth, Esq. Law Offices, Victor J. Toth 2719 Soapstone Drive Reston, VA 22091	SM Tek, Inc. (PP-72)

Henry M. Rivera, ESq. Larry S. Solomon, Esq. Ginsburg, Feldman & Bress Suite 800 1250 Connecticut Avenue, N.W. Washington, D.C. 20036	The Suite 12 Group (PP-74)
James E. Meyers, Esq. Baraff, Koerner, Olender & Hochberg, P.C. Suite 300 5335 Wisconsin Avenue, N.W. Washington, D.C. 20015	Tele-Communications, Inc. (PP-75)
Mr. Terrence P. McGarty President Telmarc Telecommunications Company 265 Franklin Street Boston, MA 02110	Telmarc Telecommunications Company (PP-76)
Raymond G. Bender, Jr., Esq. Michael D. Basile, Esq. Deborah R. Broughton, Esq. Dow, Lohnes & Albertson 1255 23rd Street, N.W. Washington, D.C. 20037	TRX Transportation Telephone Company (PP-77)
Barbara C. Anderson, Esq. Vice President and General Counsel 6 Thorndal Circle Darien, CT 06820	Executone Information Systems
Leonard J. Baxt, Esq. Leonard J. Kennedy, Esq. Laura H. Phillips, Esq. Dow, Lohnes & Albertson 1255 23rd Street, N.W. Washington, D.C. 20037	Personal Communications Service
Caressa D. Bennet, Esq. Blooston, Mordkofsky, Jackson & Dickens 2120 L Street, N.W. Washington, D.C. 20037	Paramount Wireless Limited Partnership Middle Georgia Personal Communications, Inc. Tri-Star Communications
Mr. Charles L. Davis Vice President Advanced Product Development Protocol Systems, Inc. 8500 SW Creekside Place Beaverton, OR 97005	Protocol Systems, Inc.

Russell H. Fox, Esq. Gardner, Carton & Douglas Suite 900, East Tower 1301 K Street, N.W. Washington, D.C. 20006	All Star Communications Data & Voice of America
William J. Franklin, Esq. Pepper & Corazzini 1776 K Street, N.W., Suite 200 Washington, D.C. 20006	Wireless Communication Services
Kenneth E. Hardman, P.C. Suite 800 1255 23rd Street, N.W. Washington, D.C. 20037-1170	Advanced Tel., Inc. Reserve Communications and Computer Corp.
John W. Hunter, Esq. McNair Law Firm, P.A. 1155 Fifteenth Street, N.W. Washington, D.C. 20005	Rock Hill Telephone Company
James F. Ireland, Esq. Cole, Raywid & Braverman 1919 Pennsylvania Avenue, N.W. Washington, D.C. 20006-3458	TeleCable Corporation
Frederick M. Joyce, Esq. Christine McLaughlin, Esq. Joyce & Jacobs 2300 M Street, N.W., 8th Floor Washington, D.C. 20037	LDH International, Inc. Goeken Custom Communications, Inc.
David J. Kaufman, Esq. Brown, Finn & Nietert, Chartered 1920 N Street, N.W., Suite 660 Washington, D.C. 20036	Greenline, Inc.
Albert H. Kramer, Esq. Keck, Mahin & Cate 1201 New York Avenue, N.W. Washington, D.C. 20005-3919	Tele-Financing Corp. Inc.
Randall B. Lowe, Esq. Jones, Day, Reavis & Pogue 1450 G Street, N.W. Washington, D.C. 20005-2088	Capital Network Systems
Mr. Bernard C. Nelson President 35 Toni Drive Englewood Cliffs, NJ 07632	Cerberus Consulting Corp.