FCC/MELLON NOV 16 1994

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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12-SAT-AMEND
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ellipso™

MOBILE COMMUNICATIONS HOLDINGS, INC.

AMENDMENT TO APPLICATION FOR AUTHORITY TO CONSTRUCT

ellipso™

AN ELLIPTICAL ORBIT MOBILE SATELLITE SYSTEM

November 16, 1994

EXECUTIVE SUMMARY

Mobile Communications Holdings, Inc. ("MCHI"), developer of the ELLIPSO™ satellite system, hereby amends its satellite system applications in accordance with the Report and Order in CC Docket No. 92-166, released October 14, 1994 ("Report and Order"). The amendment conforms the ELLIPSO™ applications, first filed in November 1990, to the new rules and policies adopted by the Commission in the Report and Order. MCHI is submitting a separate application, concurrently herewith, for authority to launch and operate the ELLIPSO™ system.

Four years ago, MCHI (and its subsidiary Ellipsat Corporation) initiated these proceedings by filing the first application to provide mobile voice services in the 1610-1626.5 MHz and 2483-2500 MHz frequency bands via small, low-Earth orbit satellites. During the intervening four years, MCHI and Ellipsat have participated actively in the numerous rulemaking proceedings leading up to adoption of spectrum allocations and licensing rules for the new MSS Above 1 GHz service.

Fundamental to the ELLIPSO™ vision, today and in 1990, is the provision of affordable, technologically advanced and ubiquitous mobile voice services. These public benefits are made possible through use of a unique elliptical orbit architecture. This architecture allows capacity to be tailored to demand, with satellite capacity efficiently deployed by geographical region and peak usage times to provide service when and where it is most needed.

In this amendment, MCHI provides updated information about the ELLIPSO™ satellite system and demonstrates compliance with the applicable technical, licensing and operational rules that were adopted in the Report and Order. In particular, the amendment demonstrates the following:

Global Coverage. Consistent with the Commission's Rules, the ELLIPSO™ satellite system has been configured to provide global coverage as defined by the Commission. At least one satellite will be visible between 55° south latitude and 70° north latitude at elevation angles of 5° for 18 hours every day. Indeed, ELLIPSO™ expects to surpass this minimal coverage standard, by providing service with elevation angles exceeding 15°. To ensure global coverage as required by the Report and Order, changes to ELLIPSO™'s orbit constellation have been made. The revised orbit architecture provides greater coverage of the world's population and land masses, in accordance with Commission requirements, while meeting and improving upon the required elevation angles.

The constellation design consists of two subconstellations, called Borealis and Concordia, consisting of 10 and 6 satellites respectively. The Borealis subconstellation serves primarily the northern temperate latitudes, with the

Concordia subconstellation providing enhanced coverage of the tropical and southern latitudes.

U.S. Coverage. ELLIPSO™ will provide continuous coverage of the United States, including Puerto Rico and the Virgin Islands. As designed, the system will exceed the Commission's requirement of visibility of one satellite 24 hours per day at a minimum 5° elevation angle.

Inter-Service Sharing. ELLIPSO™ will comply with all rules relating to inter-service sharing, including radio astronomy, GLONASS, radio aeronavigation and terrestrial fixed services. Consistent with the Commission's Rules, the ELLIPSO™ system is designed to operate under the transitional spectrum plan adopted by the Commission until the GLONASS situation is resolved.

Financial Qualifications. This amendment establishes that the applicant is financially qualified to construct, launch and operate for one year the ELLIPSO™ satellite system. Since the filing of an initial application in 1990, the ELLIPSO™ team has been expanded to include substantial strategic partners (and shareholders). These include Westinghouse Electric Corporation, Barclays de Zoete Wedd, Fairchild Space and Defense Company, Harris Corporation, Israel Aircraft Industries, IBM, InterDigital Corporation and Arianespace. Recently, a major global telecommunications company, Cable & Wireless, has acquired 50,000 shares representing approximately 2% of the common stock of

MCHI and an option to increase its participation by a further 600,000 shares and to participate in the operation of the ELLIPSO™ system in key markets.

Updated financial information is provided in this amendment, demonstrating that the applicant is financially qualified to proceed expeditiously with system implementation. This amendment provides evidence of internal funding, equity investments and vendor financing available to meet the estimated construction, launch and first-year operation costs.

In addition, financial institutions have expressed confidence that funding can successfully be raised in the public markets. Information is provided about the successful public offering in September 1994 of Spectrum, the parent of Ellipsat Australia, Australian distributor of ELLIPSO™ services.

Spectrum Sharing. The ELLIPSO™ application seeks authority to construct the system across the full L and S-Band allocations (1610-1626.5 MHz; 2483-2500 MHz) specified by the Commission. The system is designed, however, to operate in the United States in the uplink spectrum allocated for CDMA systems (i.e., 1610-1623 MHz).

Feeder Links. In its initial applications, MCHI specified the operation of feeder links in the same L and S-Band spectrum as the service links. In accordance with the Report and Order, this amendment requests assignment of frequencies in the 15.4 to 15.7 GHz band for uplink feeder links and 6725-7025 MHz for downlink feeder links in the reverse band working mode. MCHI requests that a conditional license be issued specifying the desired feeder link frequencies.

International Coordination. The ELLIPSO^{TM} system has been advanced published and Appendix 3 coordination information was submitted to the ITU in May 1994. MCHI intends to cooperate fully in international coordination activities relating to the ELLIPSO^{TM} satellite system.

Public Interest Benefits. Expeditious licensing of the ELLIPSO^{TM} satellite system will further important national policy goals and public interest objectives, including global telecommunications infrastructure development, promotion of U.S. leadership in aerospace/telecommunications products and services, and diversity in telecommunications services and service providers.

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- Appendix D: Document USTG 4/5-10 (Rev. 1)
- Appendix E: ELLIPSO^{TM} Waveforms, Link Budgets, and System Capacity

Exhibit 2 - LEGAL QUALIFICATIONS

Exhibit 3 - FINANCIAL QUALIFICATIONS*

- Appendix A: Projected Costs
- Appendix B: Sources of Funds

Exhibit 4 - ELLIPSO^{TM} MARKET AND SERVICES

Exhibit 5 - APPLICATION FOR LAUNCH AND OPERATION AUTHORITY

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* This exhibit is being submitted separately with a request for confidentiality pursuant to Commission Rule 0.459.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of MOBILE COMMUNICATIONS HOLDINGS, INC. Application For Authority To Construct ELLIPSO™, An Elliptical Orbit Mobile Satellite System in the 1610-1626.5 MHz and 2483.5-2500 MHz Bands	)))))))))))	File Nos. 11-DSS-P-91 (6) 18-DSS-P-91 (18)

AMENDMENT OF ELLIPSO™ APPLICATIONS

Mobile Communications Holdings, Inc. ("MCHI") hereby amends its pending applications to construct the ELLIPSO™ satellite system. This amendment is submitted in accordance with the Commission's Report and Order in CC Docket 92-166, 59 Fed. Reg. 53294 (October 21, 1994), which adopted rules governing the Mobile Satellite Service ("MSS") Above 1 GHz (the "Report and Order").

I. BACKGROUND

On November 5, 1990, MCHI and its subsidiary, Ellipsat Corporation, were the first to file an application in the 1610-1626.5 MHz and 2483-2500 MHz frequency bands seeking authority to provide mobile voice services via a constellation of small, elliptical low-Earth orbit ("LEO") satellites. Subsequently, in June 1991, a second ELLIPSO™ application was submitted to authorize an additional eighteen satellites.

In the intervening four years, the Commission conducted two rulemakings related to the MSS Above 1 GHz. In ET Docket No. 92-28, the Commission allocated spectrum for use by low-Earth orbit satellites in the 1610-1626.5 MHz and 2483-2500 MHz bands.[1] In CC Docket No. 92-166, the Commission adopted rules governing the licensing and operation of satellites in the Above 1 GHz MSS. MCHI assisted in the development of these regulations through the negotiated rulemaking process, submission of extensive comments in the record, and negotiation of a Joint Proposal and Settlement Agreement in which four of the six applicants, including MCHI, joined.

The Report and Order gave parties 30 days, until November 16, 1994, to file conforming amendments to their pending applications and to request launch and operation authority for the proposed satellite systems. MCHI's application for launch and operation authority is being submitted separately and concurrently herewith.

II. OVERVIEW OF AMENDMENT

In this amendment, MCHI provides updated information about the ELLIPSO™ satellite system and demonstrates compliance with the applicable

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[1] Report and Order, ET Docket No. 92-28, 9 FCC Rcd 536 (1994)

technical, licensing and operational rules that were adopted in the Report and Order. In particular, the amendment reflects changes in the system design that are required to comply with the newly adopted requirements, including coverage (global and United States); inter-service sharing; feeder links; spectrum sharing and financial qualifications.

As amended, the ELLIPSO™ satellite system will meet or exceed all applicable standards. In addition, MCHI has made changes of a minor nature to improve system performance, to maximize capacity in a frequency sharing environment, to ensure MCHI's ability to satisfy potential demand for its services and to take advantage of the substantial design work that ELLIPSO™ and its technology partners have undertaken in the past four years.

This amendment includes the following detailed information relating to the applicant's technical, legal and financial qualifications.

A. Technical Qualifications

Detailed technical information is provided in Exhibit 1 about the ELLIPSO™ system. This exhibit includes all technical information required by Commission rules including spacecraft and orbital design, ground segment components, RF plan, link budgets and performance characteristics. This amendment demonstrates that ELLIPSO™ complies with all requirements applicable to the MSS Above 1 GHz including global and U.S. coverage requirements and inter-service sharing.

In this amendment, MCHI is requesting authority to construct sixteen satellites. With sixteen satellites, ELLIPSO™ will fully comply with (and surpass) the Commission's coverage requirements, both in the U. S. and worldwide. In the initial ELLIPSO™ applications, a twenty-four satellite system was specified. Although the twenty-four satellites are not needed to meet the Commission's requirements, future market requirements may dictate the need for additional satellites. MCHI interprets the Report and Order to provide ELLIPSO™ with the opportunity to expand its constellation as originally envisioned at a later date.[2]

For the Commission's convenience, all relevant information about the system is restated in the amendment, whether or not there have been changes in the particular information. It is hoped that this will assist the Commission in reviewing the system proposal without the time-consuming need to refer to previous filings. If not superseded by this amendment, information submitted in the previous applications remains unchanged.

B. *Legal Qualifications*

MCHI continues to possess the requisite legal qualifications. To that end, MCHI is attaching, as Exhibit 2, an updated licensee qualification report on FCC Form 430. The updated report reflects changes in the stock ownership of the applicant.

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[2] See Report and Order at para.37.

C. *Financial Qualifications*

MCHI is financially qualified to proceed expeditiously with system implementation. MCHI has the requisite financial ability to construct, launch and operate for one year the proposed satellite system. Exhibit 3 details the estimated investment and first year operating costs for the system. In accordance with Commission Rules, the applicant intends to rely upon internal support from its shareholders (which include Barclays de Zoete Wedd, Westinghouse Electric Corporation and Fairchild Space), vendor financing (including committed funds from Arianespace in the form of convertible debentures) , equity investments and other committed funds to cover the expected system costs. Documentation relating to these funding sources is provided in Exhibit 3.

MCHI is also submitting in Exhibit 3 a letter from Barclays providing assurance that, if necessary, sufficient funding can be raised through public debt and equity offerings for the project. This is further evidenced by the successful public offering in September 1994 of Spectrum, the parent company of Ellipsat Australia, which has committed to provide substantial funding to MCHI in return for distribution rights in certain markets.

While MCHI thus has sufficient internal and external financing available for the project, the company will also generate revenues from the phased introduction of commercial service which can, in turn, be used to finance subsequent stages of development. As previously detailed in MCHI's Commission filings, the ELLIPSO™ system has a unique ability to provide commercial service with as few as six satellites.

Exhibit 3 is being submitted with a request for confidentiality pursuant to Rule 0.459 in order to protect sensitive commercial and financial information including the details of negotiated equity, debt and other business agreements and information relating to third party investors who have asked for confidentiality.

D. *Markets and Services*

In Exhibit 4, MCHI provides updated information about ELLIPSO™ markets and services, including revised market projections demonstrating a significant demand for this innovative service.

III. IMPLEMENTATION MILESTONES

MCHI expects to meet the implementation milestones established by the Report and Order, 58 Fed. Reg. at 53320-21, ¶188-89. These milestones require: (1) commence construction of first two satellites within one year of the unconditional grant of authorization; (2) complete construction of first two satellites within four years of grant; (3) commence construction of remaining authorized satellites within three years of initial authorization; and (4) entire authorized system operational within six years.

MCHI's business plans assume that system implementation will proceed rapidly. Under current projections, commercial service will be available in 1997.

IV. REGULATORY STATUS

MCHI elects to operate as a non-common carrier in accordance with the Report and Order. This election is consistent with MCHI's previous applications, in which MCHI (and its predecessor Ellipsat) proposed to structure offerings on a private carrier or shared private network basis. See ELLIPSO™ II Application at 47. MCHI still intends to offer service through Value-Added Partners (VAPs) who will purchase capacity at wholesale prices for resale to the end-user.

V. FEEDER LINKS

In Exhibit 1, MCHI includes a revised feeder link request: 15.4 to 15.7 GHz (uplink) and 6725 to 7025 MHz (downlink). A conditional authorization to use these frequency bands is hereby requested in accordance with the Report and Order.

VI. PUBLIC INTEREST BENEFITS

Expeditious grant of the ELLIPSO™ application will further important public interest goals.

The ELLIPSO™ system is highly innovative from a technical standpoint. The use of elliptical orbits, in particular, is a novel feature that will facilitate cost-effective global coverage. As detailed in Exhibit 1, the ELLIPSO™ system capacity is tailored by virtue of the elliptical orbit architecture to meet market demand, by geographical region and time of day.

The use of elliptical orbits also allows the number of satellites to be minimized, with the resulting savings in construction and launch costs. As a result of these economies, satellite-based mobile service can be provided to end-users at a price comparable to terrestrial cellular.

ELLIPSO™ is designed to target unserved areas and populations in the United States and worldwide, and to grow with and accommodate market demand in the future by adding additional satellites. ELLIPSO™ will provide mobile voice service to vehicular and handheld phones and can also provide fixed telephony (of particular interest to the developing world) through the use of wireless LANs. ELLIPSO™ thus contributes to development of the global information infrastructure that has been deemed a national priority by the Commission and the Executive Branch.[3]

Finally, by authorizing the ELLIPSO™ system, the Commission will further diversity and competition in the provision of communications services. Although a new entrant, and in 1990 a start-up company, MCHI has been able to add leading high technology and aerospace companies -- and recently a major global telecommunications provider -- to the ELLIPSO™ team. These companies have

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[3] Report and Order, 59 Fed. Reg. at 53294-5, para. 3-5.

publicly expressed support, in the Commission's proceedings, for the ELLIPSO™ market and technical approach and the opportunities it provides for defense conversion and for U.S. high technology leadership.

VII. WAIVERS

This submission reflects a serious and conscientious effort to comply with the MSS Above 1 GHz rules, including all information requirements, as fully and completely as presently possible. While the applicant believes that it has fully complied with all pertinent rules and policies, and has supplied all information, as appropriate, it hereby requests that, to the extent it has not satisfied the applicable requirements, a waiver be granted.

VIII. CERTIFICATIONS

MCHI hereby certifies that no party to its application is subject to a denial of federal benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. § 853.

MCHI certifies that the statements made in this amendment, including the attached exhibits, are true and correct to the best of its knowledge and belief, and are made in good faith.

IX. CONCLUSION

For reasons stated, expeditious licensing of the ELLIPSO^{TM} system will serve the public interest. Accordingly, MCHI requests that the Commission grant authority to construct, launch and operate the ELLIPSO^{TM} system as rapidly as possible.

Respectfully submitted,

MOBILE COMMUNICATIONS
HOLDINGS, INC.

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November 16, 1994

ENGINEERING CERTIFICATION

I hereby certify that the technical information in this Amendment was prepared by me or under my supervision; that I am a technically qualified person familiar with Part 25 of the Commission's rules; and that the engineering information submitted in this Amendment is accurate to the best of my knowledge and belief.

By: ______________________

John W. Brosius III
Chief Scientist
Mobile Communications Holdings, Inc.

Dated: November 16, 1994

Appendix A

ELLIPSO$^{\text{TM}}$ Satellite Design

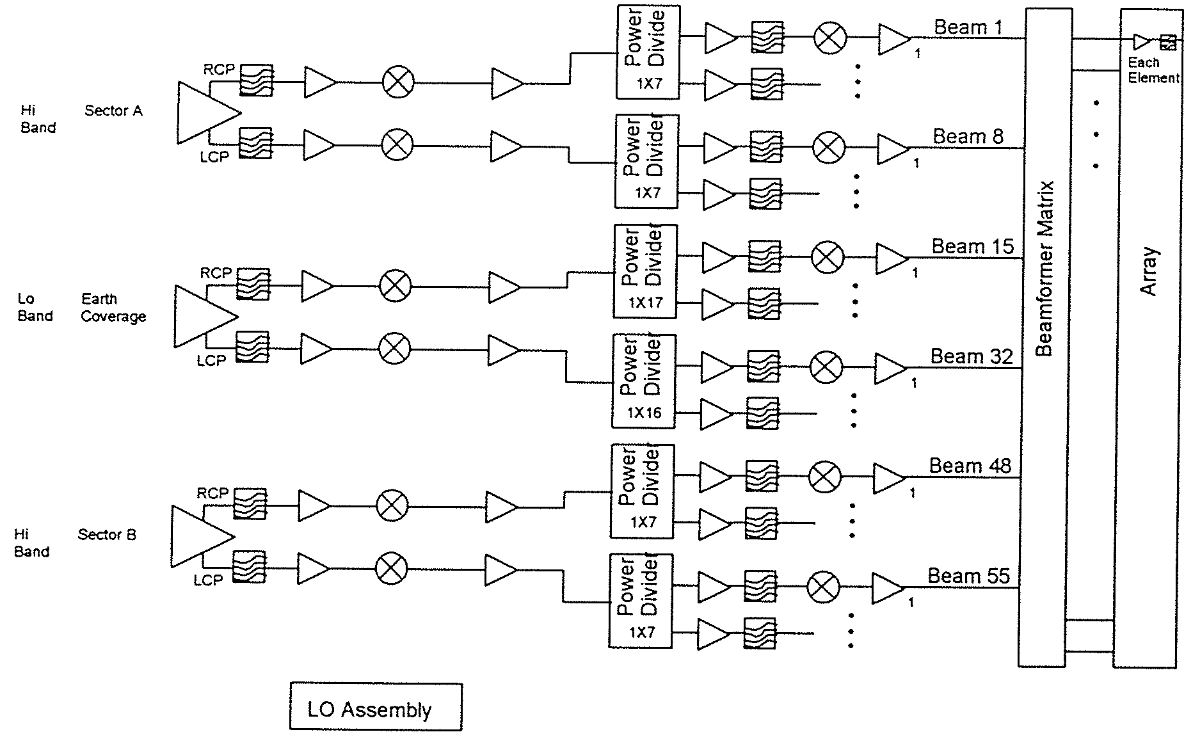

Figure A-1

Ellipso Satellite Forward Transponder Block Diagram

Redundancy and Channel Switching not Shown

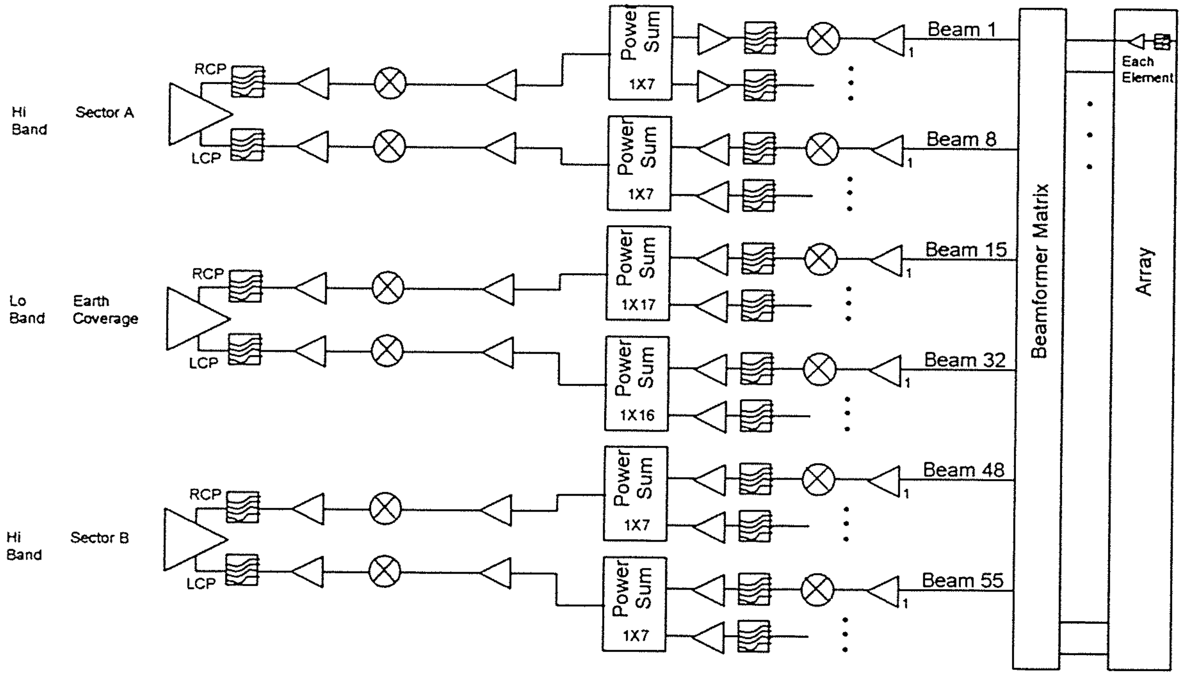

Figure A-2

Ellipso Satellite Return Transponder Block Diagram

Redundancy and Channel Switching not Shown

Table A-1
General Satellite Characteristics

Attitude	3-axis stabilization
Communications Payload	Fixed, phased array. Multiple transponders Nadir pointing
Attitude Control & Stationkeeping	Monopropellant hydrazine thrusters, Reaction Wheels
Thermal Control	Passive design with heaters
Solar Arrays	Gallium Arsenide
Batteries	Nickel Hydride

Table A-2
Ellipso Satellite Weight Budget

	Concordia Mass, kg	Borealis Mass, kg
Payload	160	167.6
S/C Bus	443	448
Propulsion	15	15
Attitude Control	37	37
TT&C	32	32
Array	86	86
Drive	12	12
Batteries	78	78
PC&DU	70	70
Thermal	20	20
Harness	16	16
Structure	75	80
Balance	2	2
Total	603	615
Propellant	22	35
Launch Mass	625	650

Table A-3
Ellipso Satellite Power Budget

	Concordia Maximum, W	Concordia Orbit Average, W	Borealis Maximum, W	Borealis Orbit Average, W
Forward	1812		2110	
Return	934		1088	
Subtotal	2745		3198	
Contingency	275		320	
Total Payload	3020	2023	3518	2357
Bus		219		232
Total S/c		2242		2589

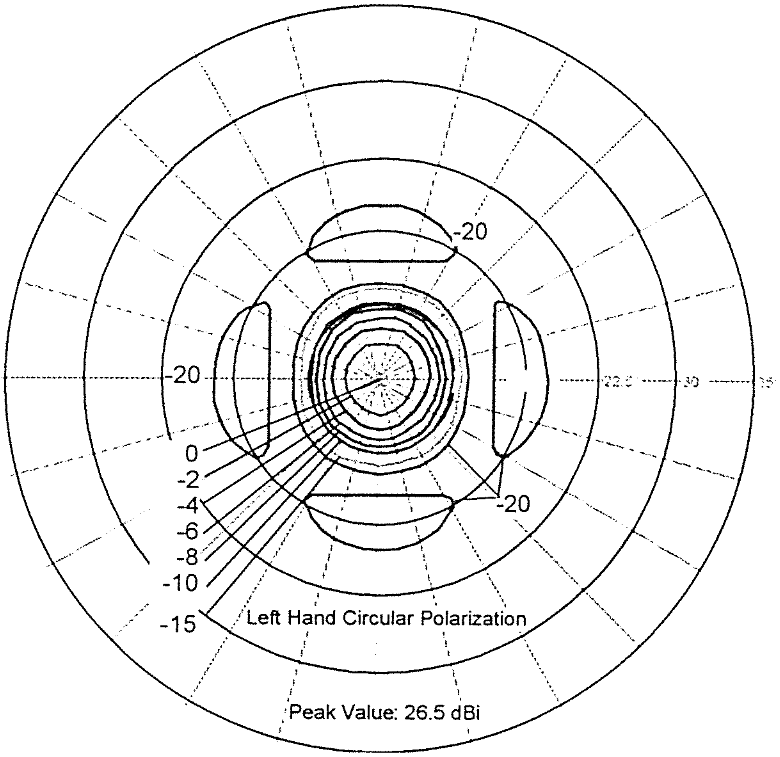

Figure A-3
Ellipso Center Beam Gain Contours

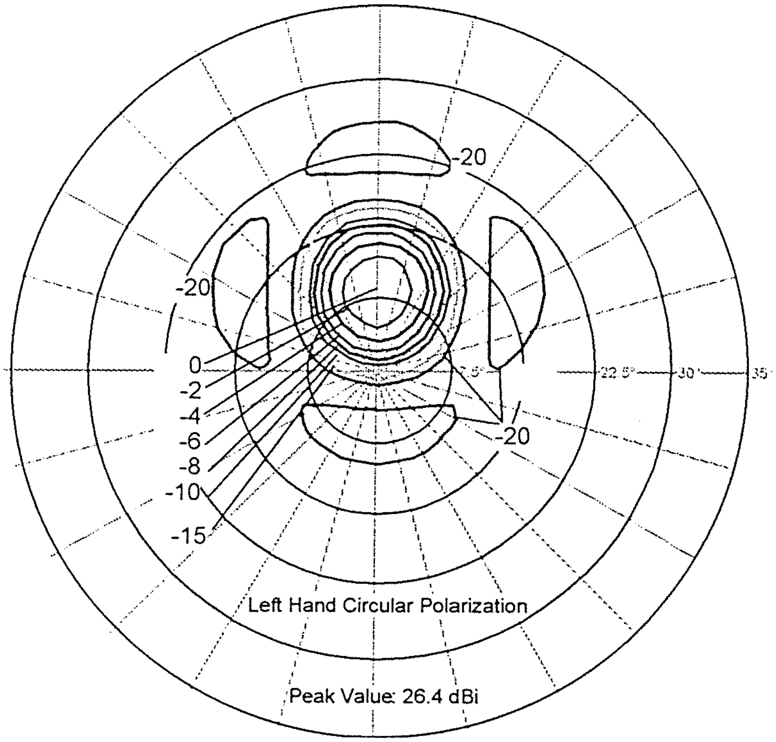

Figure A-4
Gain Contour for Beam in First Ring

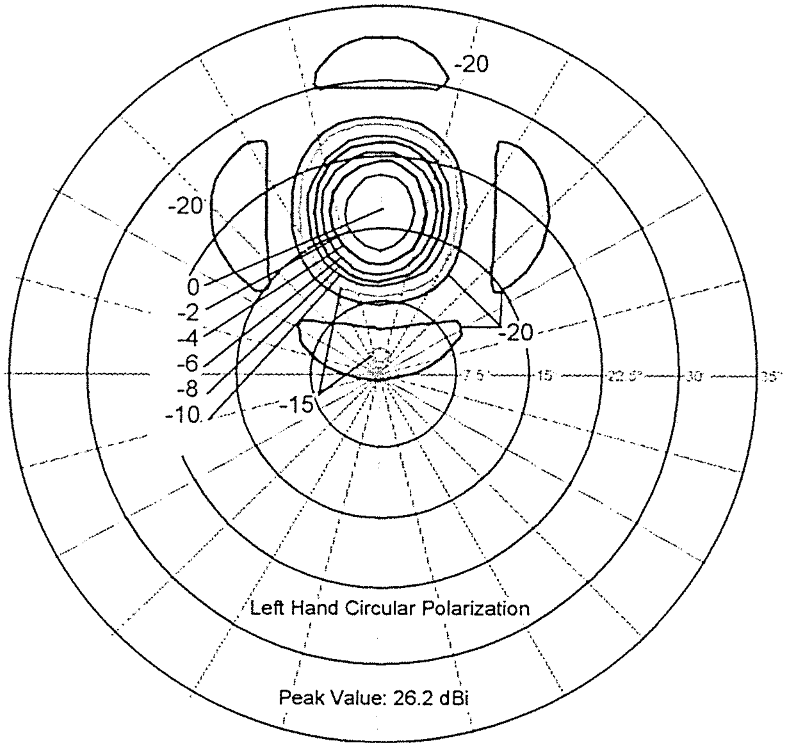

Figure A-5
Gain Contour for Beam in Second Ring

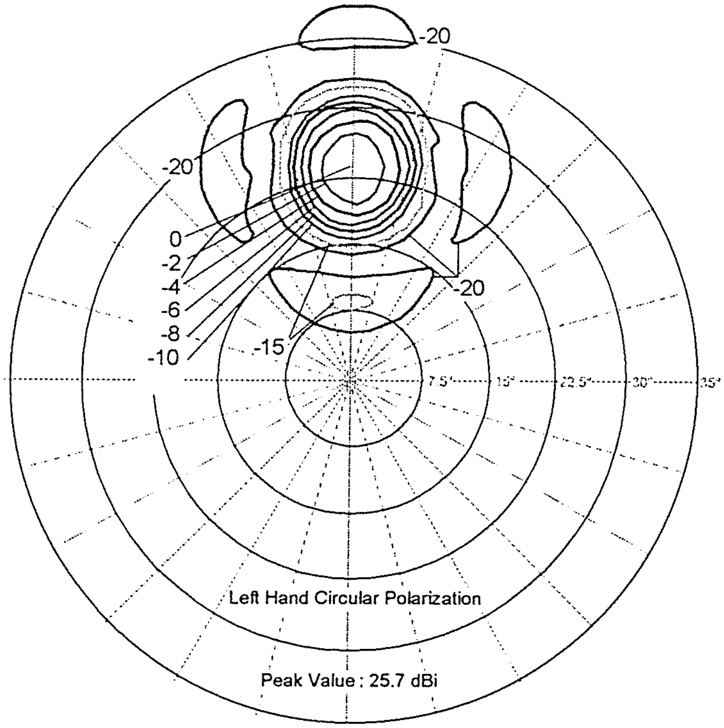

Figure A-6
Gain Contour for Beam in Third Ring

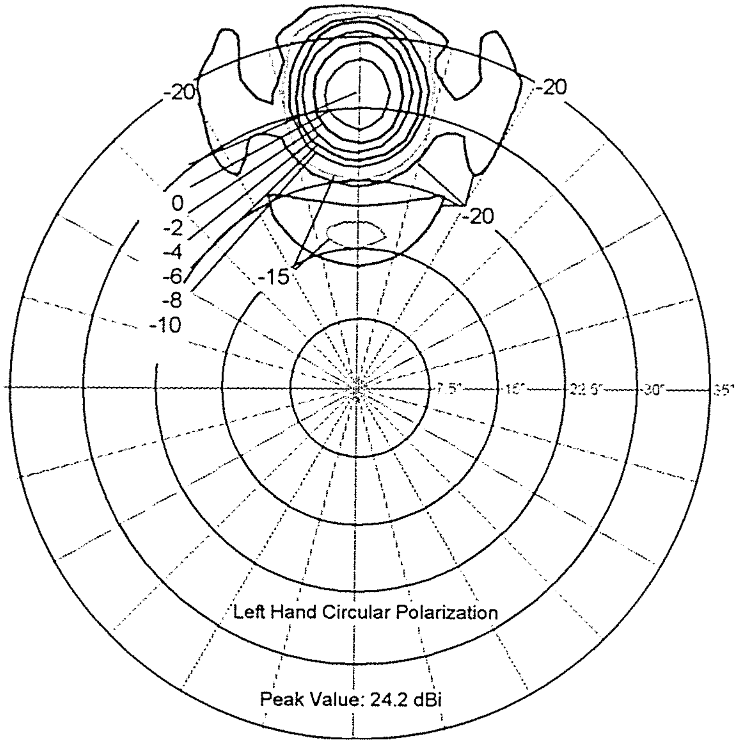

Figure A-7
Gain Contour for Beam in Fourth Ring

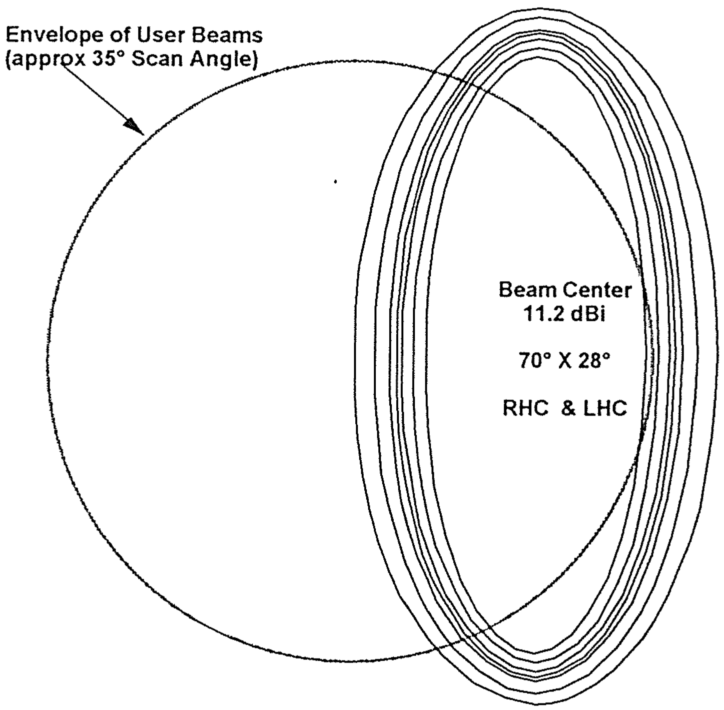

Figure A-8
Gain Contour for Outer Feeder Link Beam

Transponder Gains		
Forward (Ku to S Bands)	132 dB	
Return (L to C Bands)	132 dB	
Total Satellite Available RF Power:	500 watts	
RF Power per Beam	Variable	
L- and S-Band Antenna Design	Circular 127 Element Array	
L-Band Array Diameter	60 inches	
S-Band Array Diameter	40 inches	
L- and S-Band Antenna Gains and G/Ts	Gain	G/T
Inner	26.5 dBi	-0.3 dB/°K
First ring beam	26.4 dBi	-0.4 dB/°K
Second ring beam	26.2 dBi	-0.6 dB/°K
Third ring beam	25.7 dBi	-1.1 dB/°K
Fourth ring beam	24.8 dBi	-2.0 dB/°K
L- to S-Band Beam Pattern Mapping	Congruent mapping (identical coverages)	
L-Band Receiver Temperatures	475°K	
Feeder Link Antennas		
C-Band Antenna Design	Horn Antennas	
C-Band Antenna Beams	See Figures	
C-Band RF Power	50 watts	
Ku Band Antenna Design	Horn antennas	
Ku-Band Receiver Temperatures	600°K	
C and Ku Antenna Gains and G/Ts	Gain	G/T
Earth Coverage	8.5 dBi	-19.3 dB/°K
Elliptical Beam	11.2 dBi	-16.6 dB/°K
C- to Ku-Band Beam Pattern Mapping	Congruent mapping (identical coverages)	

Table A-3
Satellite RF Figures of Merit

Reliability of each satellite 5 year mission	0.82
Subsystem:	Reliability, at Five years
Communications payload	0.945
Power subsystem	0.964
Attitude control	0.964
Propulsion	0.977
TT&C	0.954

Table A-4
Satellite Reliability

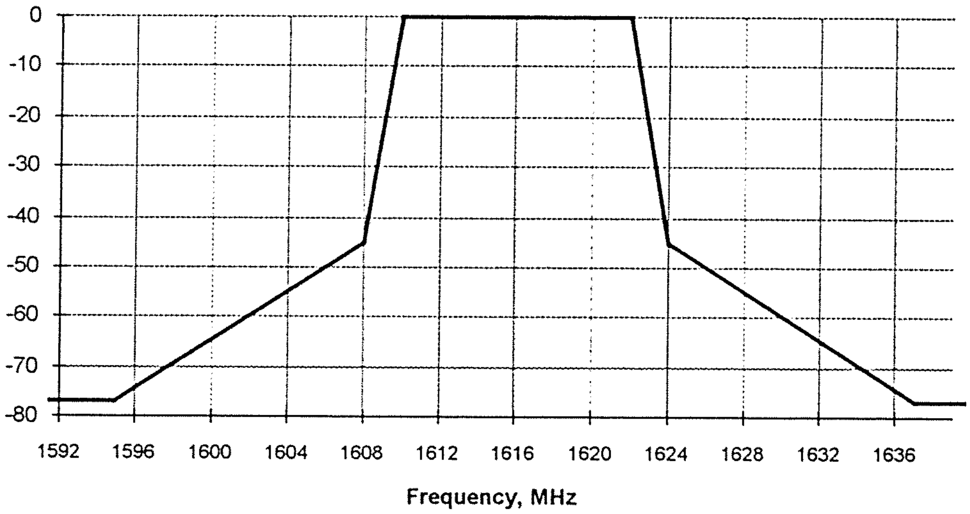

Figure A-9
Ellipso L- and S-Band Transponder Filter Masks

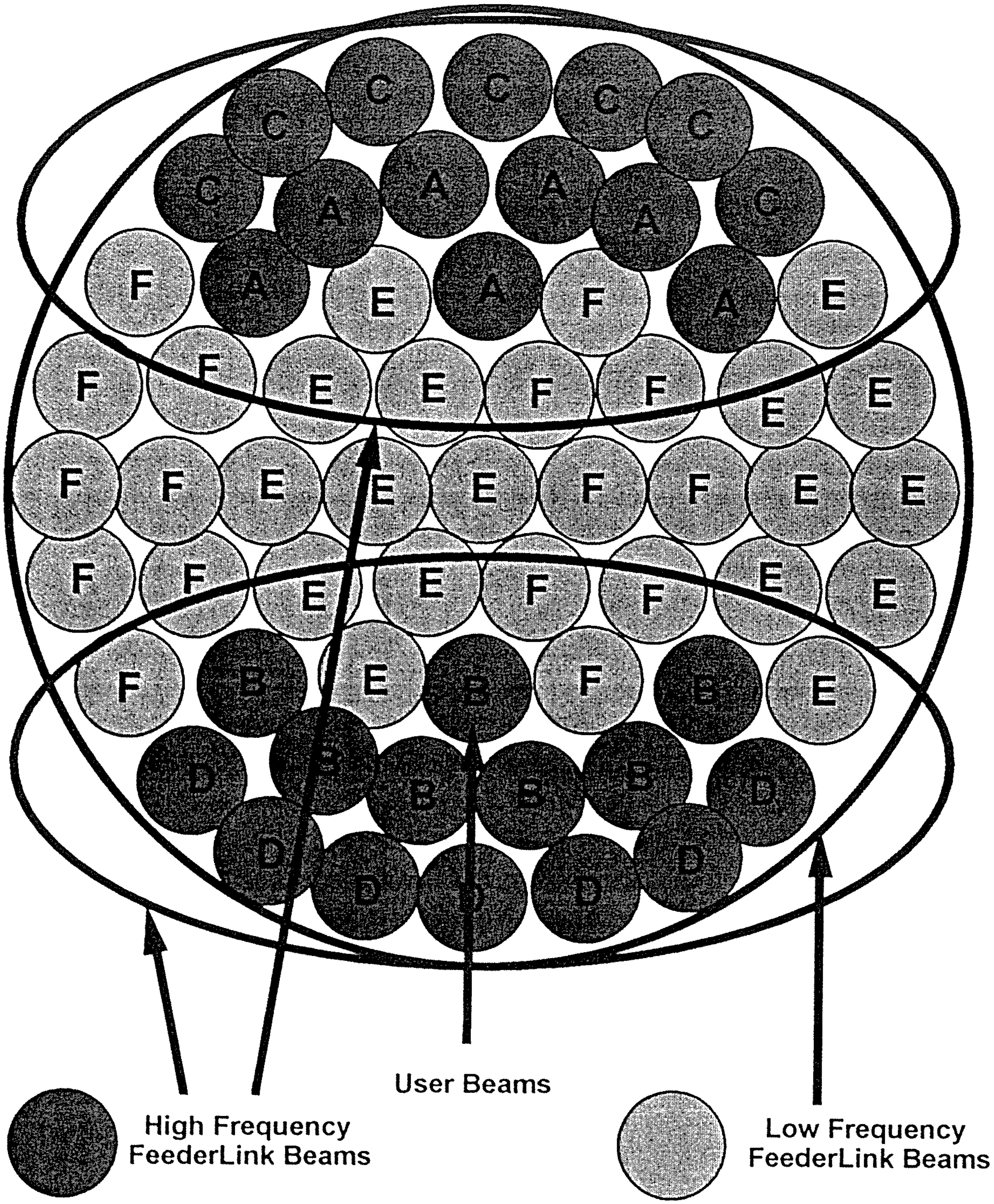

Figure A-10
Ellipso Satellite User Beam to Feeder Link Beam Mapping

Table A-5
User- to Feeder-Link Beam Mapping

User Beam Group	Feeder Link Beam No.	Feeder Link Beam Frequency	Feeder Link Beam Polarization
A	2	High	RCP
B	3	High	LCP
C	2	High	LCP
D	3	High	RCP
E	1	Low	RCP
F	1	Low	LCP

Table A-6
Feeder Link Frequencies

Feeder Link Beam Frequency	C Band	Ku Band
Low	6,725 - 6,935 MHz	15.4 - 15.61 GHz
High	6,935 - 7,025 MHz	15.61 - 15.7 GHz
Optional, some regions Low Only, EC antenna*	6,725 - 7,025 MHz	15.4 - 15.7 GHz

*Outer ring of user beams not active, inner beams assigned to EC antenna

Appendix B

Document USTG 4/5-15 (Rev. 1)

Documents
Radiocommunication
Study Groups

Document USTG 4/5-15 (Rev.1)
24 October 1994
Original: English only

UNITED STATES OF AMERICA

Working Document for WP 4A and Material for TG 4/5 Contribution to CPM'95 Report

Simulation Results on the Incidence of Intrusions by Other MSS Satellites into an MSS Feeder Link Main Beam

1. Introduction

Several Mobile Satellite Systems (MSSs) proponents have proposed to use C-band feeder links for their systems. Moreover, since there is no spectrum allocated at C or Ku band for MSS, and since it may not be possible to find adequate spectrum to grant each applicant its own feeder link spectrum, those MSS applicants proposing C-band for MSS feeder links have also proposed to share the same uplink and downlink feeder link spectrum.

However, no two MSS proposing to share C or Ku band feeder link spectrum have proposed the same constellation configuration, orbital altitude, or inclination for their satellites. Therefore, the satellites of any one MSS cannot maintain a given phase with the satellites of any other constellation. As a consequence, it is anticipated that from time to time a satellite of one MSS may pass through the main beam of the ground station of another MSS as the latter tracks one of its own satellites (referred to as main beam coupling). When and if this occurs, the ground station will not be able to reject the signal power of the interfering satellite using antenna discrimination[1]. The signal power of the interfering satellite will enter the ground station receiver and thereby add to the total noise environment within which the desired signal must be detected.

As a first approximation, and indeed quite possibly as a coordination requirement among operating mobile satellite systems, the spectral density of each system's uplink and downlink feeder link signals are taken to be the same. If so, main beam interference will have the effect of doubling the received interference environment from that due only to intra-system CDMA operations. Since typically CDMA MSS leave little margin for excess noise, since such excess margin reduces system capacity, a doubling of noise due to main beam coupling may reduce system performance below acceptable levels for as long as it lasts.

As a consequence, it is important to assess the frequency and duration of main beam coupling between mobile satellite systems in order to assess the feasibility of feeder link band sharing and the requirement for system design adjustments or interference avoidance procedures for mitigating the effects of main beam coupling.

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[1] Most MSS propose to reuse frequencies by using both orthogonal polarizations. Therefore, polarization isolation is not likely to be available to reduce the effect of main beam coupling.

2. Objective

The objective of this analysis is to obtain some preliminary statistics on the frequency and duration of main beam coupling between selected MSS system designs typical of those proposing to use C band feeder links, and to derive methods for minimizing interference from the feeder link of one mobile satellite system to the feeder link of another.

3. Description of Evaluated Systems

Three systems were evaluated for main beam coupling. The characteristics of the three systems is shown in Table 1. For analysis purposes, LEO E was used as the operating system, while each of the other two systems were evaluated in turn for the incidence of main beam coupling.

Table 1
Description of Evaluated Systems

	LEO E		LEO D	LEO F
	Inclined	Equatorial		
Total No of sats	10	6	48	10
Semimajor axis (km)	10,560	14,378	7,792	16,763
Eccentricity	0.346	0	0	0
Inclination (°)	116.565	0	52	45
RAAN @ epoch (°)	0/180	0	45n n=0,1,...,7	0/180
Argument of perigee (°)	270	NA	0	0
Phasing btwn planes (°)	45	NA	7.5	0

4. Analysis Methodology

A preliminary analysis of interference to one satellite in LEO E conducted for latitudes from 20 to 50 degrees North revealed that worst interference seemed to occur at 40 degrees North. On this basis, further, more detailed interference evaluations were undertaken for a ground station at 40° N. When evaluating interference involving LEO E's equatorial plane satellites, the analysis proceeded from the vantage point of a ground station at 10 degrees latitude.

The interference analysis evaluated two systems at a time for a week of simulated time to detect interference events due to main beam coupling (co-linear alignment of one satellite from each of the two systems with a ground station working one of them). These analyses produced main beam coupling statistics tabulated and graphed by duration of interference events and the intervals between them.

a. Orbital Software Characteristics

The software used to model the MSS constellations employs an oblate Earth model including the J-2 term of the standard Earth's gravitational field. Atmospheric drag, solar pressure, orbital maintenance burns, and gravitation from celestial bodies other than the Earth were not modeled. Higher order gravitational field components are not expected to have significant impact on long term beam coupling statistics, since they are very small and, for the most part, would only shift the times of occurrences rather than their magnitudes.

b. Approach

A multiple pass process was employed to analyze the interference between the feeder link beam of the satellite being tracked and any satellite belonging to another MSS constellation. Since two satellites are simultaneously tracked to provide service, the analysis was repeated for both the primary service satellite (satellite highest in the sky) as well as the secondary service satellite (satellite second highest in the sky).

The first pass of the process determined which satellite is highest and second highest in the sky. This pass modeled only one — the operating — MSS constellation (LEO E), and employed a one minute time step to ensure fast execution. The output of this pass was then used during the second pass for maintaining ground station track on the highest and second highest satellites in the sky at all times.

The second pass created a 1.25° half angle feeder link beam (characteristic of the angle between beam peak and the first null for a 4.5 meter dish at 5 GHz) and tracked the satellite according to the schedule from the first pass. Both MSS constellations were modeled, and if a satellite from the second MSS constellation entered the feeder link beam, the information was noted and written to disk. A five second time step was used in this pass to ensure that an interference event was not missed due to 'stepping over' the event with a large time step.

Finally, the third pass used the interference event time table to re-examine each event using a one-half second time step to measure the length of the interference.

After the interference event information was collected, additional software routines characterized the interference statistics of the recorded feeder link main beam couplings between the two MSS constellations. This process was repeated for each of the constellations modeled as interfering with the primary constellation.

To illustrate an example of interfering geometries, figure 1 shows an instance where a LEO D satellite (gh5) is in the feeder link beam tracking a LEO E Inclined satellite (b2). The ground station is located at 40°N latitude and 110°E longitude.

The same situation is shown from the ground station perspective in Figure 2. The circle represents the feeder link beam where the area inside the circle is within the first null. The LEO D satellite is clearly within the feeder link beam. The orbit tracks of both satellites are shown.

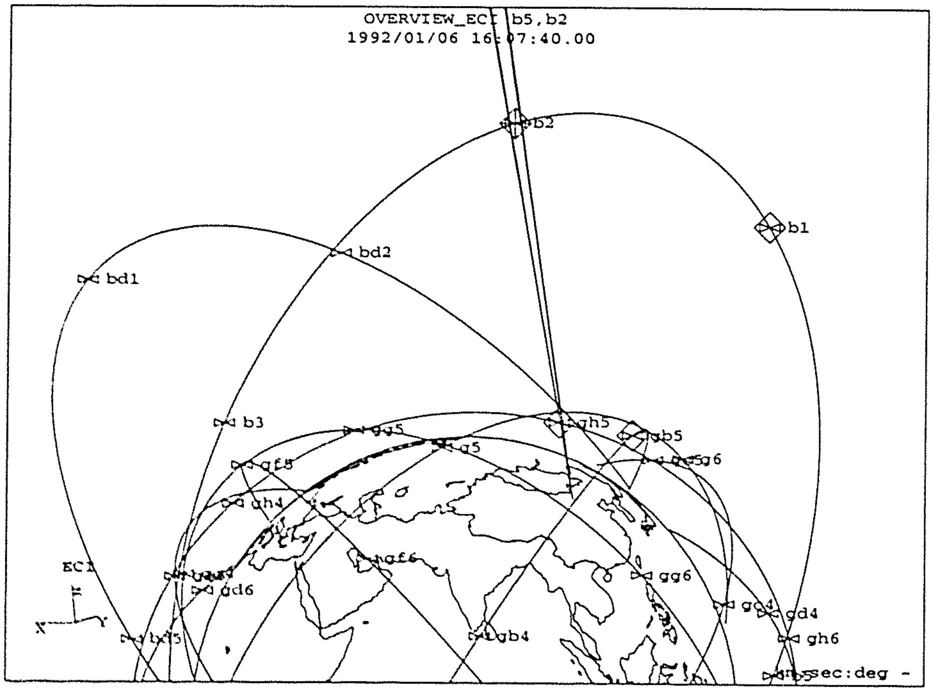

Figure 1
LEO E Inclined Feeder Link Beam With LEO D Satellite

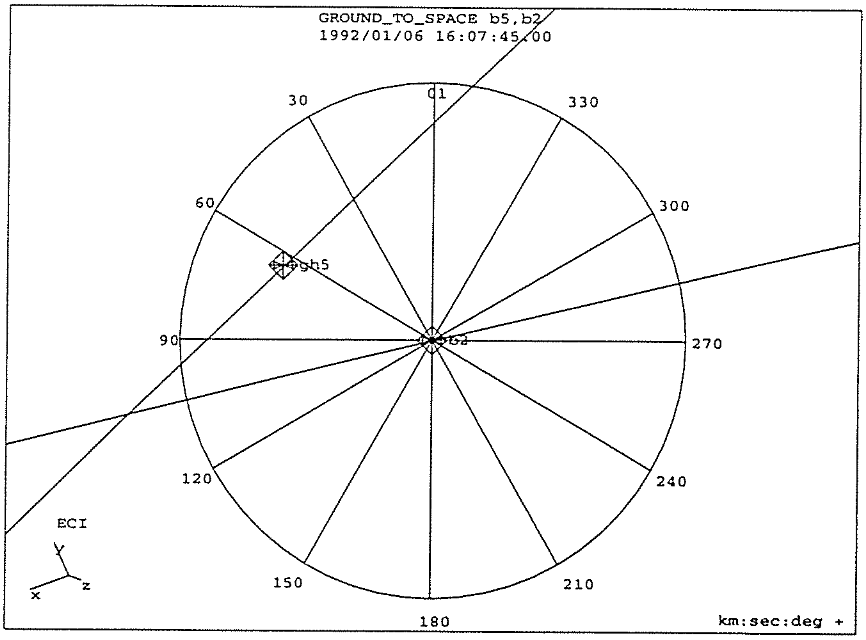

Figure 2
Feeder Link Beam View

5. Results

a. Interference Between LEO E Inclined Satellites and LEO D

In this analysis, a ground station at 40° North tracked the best and second best satellites in LEO E for one week. Since LEO E ground stations track and combine the signal from two satellites, a hit in either the primary satellite (highest in the sky) or the secondary satellite is defined as an interference event. There were no instances of simultaneous interference events in both the primary and secondary satellites.

The results of the analysis are summarized in Table 2.

Average hits per day, total	16.1
Primary Satellite, average hit duration, sec.	7.8
Secondary Satellite, average hit duration, sec.	12.4
Average hit duration, all hits	10.5
Total Interference Time, seconds	1194
Interference, % of total time	0.20%
Average delay until next interference, hours	1.44

Table 2
Summary of Interference Events
Between LEO E Inclined and LEO D

While the average delay until the next interference event was 1.4 hours, the shortest delay was extremely short at 75 seconds. Given that the simulation was for one week, it is conceivable that even shorter delays between interference events might occur during the course of a year. Figure 3 shows the distribution of the interference duration between the LEO E Inclined satellites and LEO D.

The analysis also examined the time delay between interference events. Figure 4 shows the distribution of these intervals. Ninety percent of all interference events occurred within three hours of the previous interference event. Occasionally there were quiescent periods lasting up to six hours during which no interference events occurred. Figure 5 presents more detailed statistics on intervals less than two hours.

At no time during the simulation were the highest and second highest satellites found to suffer interference events simultaneously. If the second satellite were available and used for path diversity, these results would indicate that the diversity satellite could continue to support MSS traffic unhindered until the interference event ended and two-satellite operation could continue.

b. Interference Between LEO E Equatorial Satellites and LEO D

This analysis also modeled the interference between a ground station at 10° latitude tracking one LEO E equatorial plane satellite and the LEO D satellites. The simulation continued for a period of 42.6 days. The results are shown in table 3.

Fig. 6 shows interference duration statistics for LEO E's equatorial plane when interfered with by LEO D. Ninety percent of all interference events last for less than 25 seconds. The most probable duration is ten to fifteen seconds.

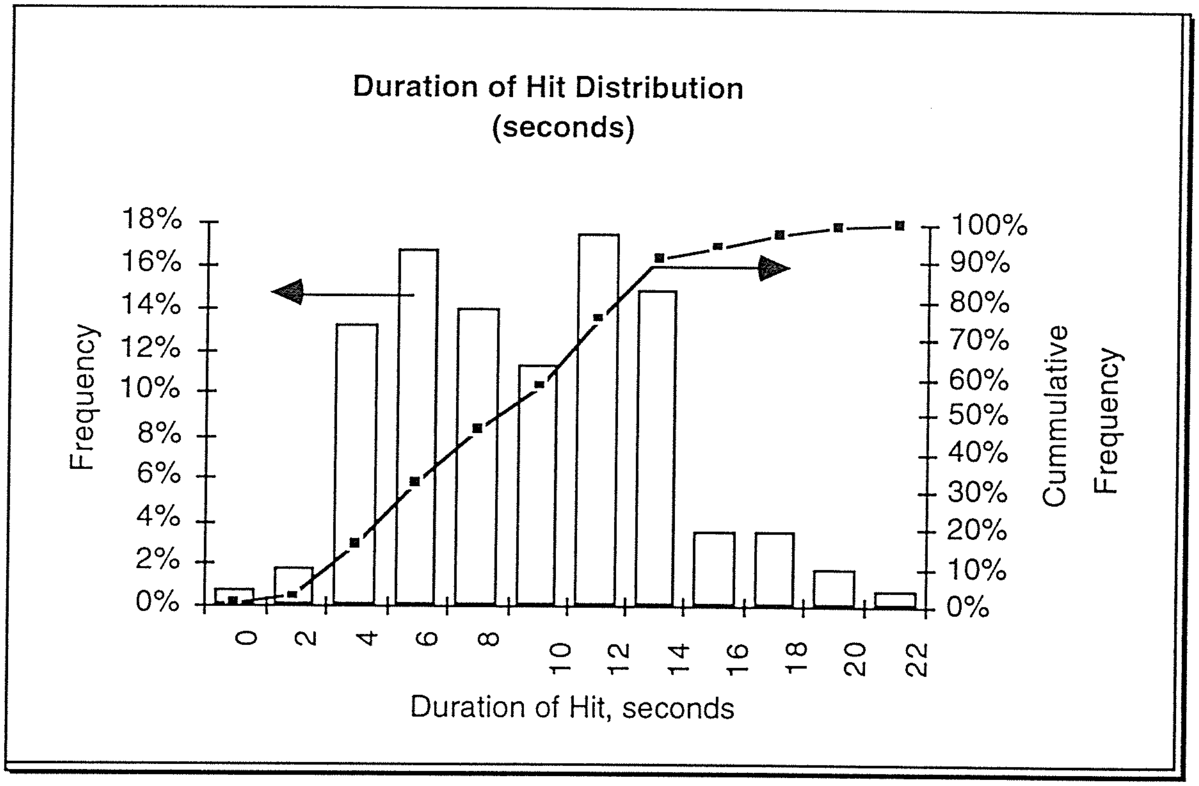

Fig. 3
Distribution of Interference Event Durations
LEO E Inclined/LEO D

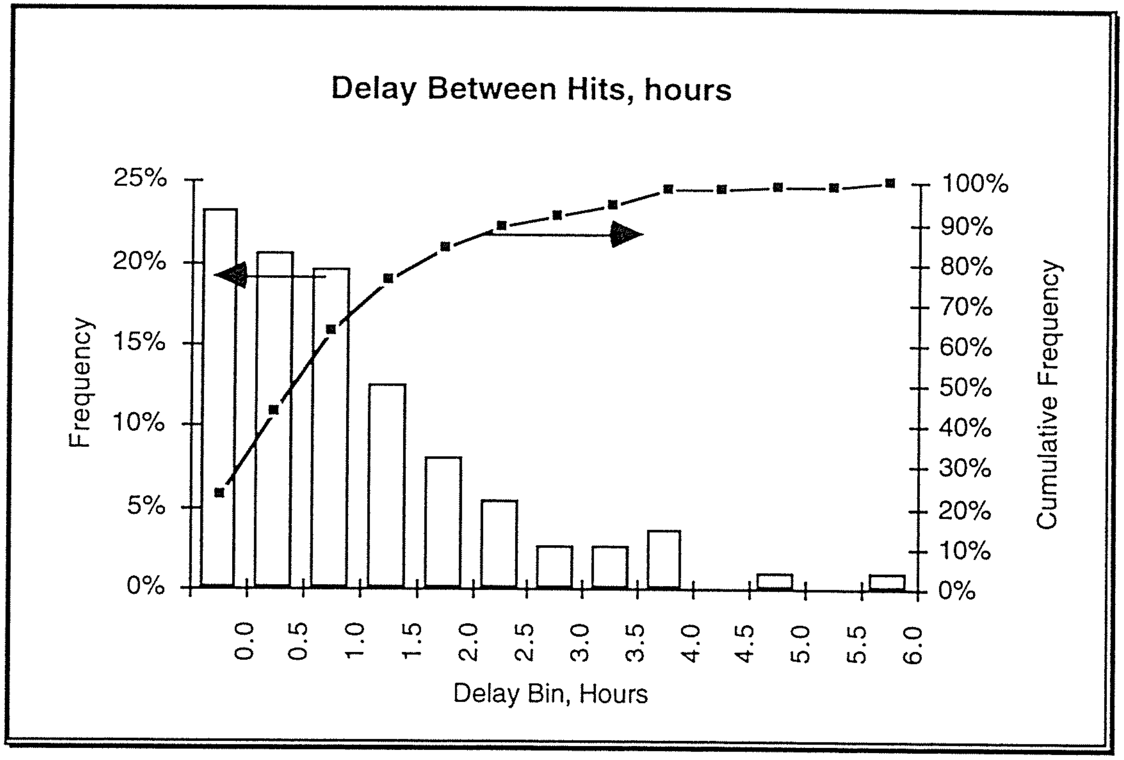

Fig. 4.
Distribution of Intervals between Interference Events
LEO E Inclined/LEO D

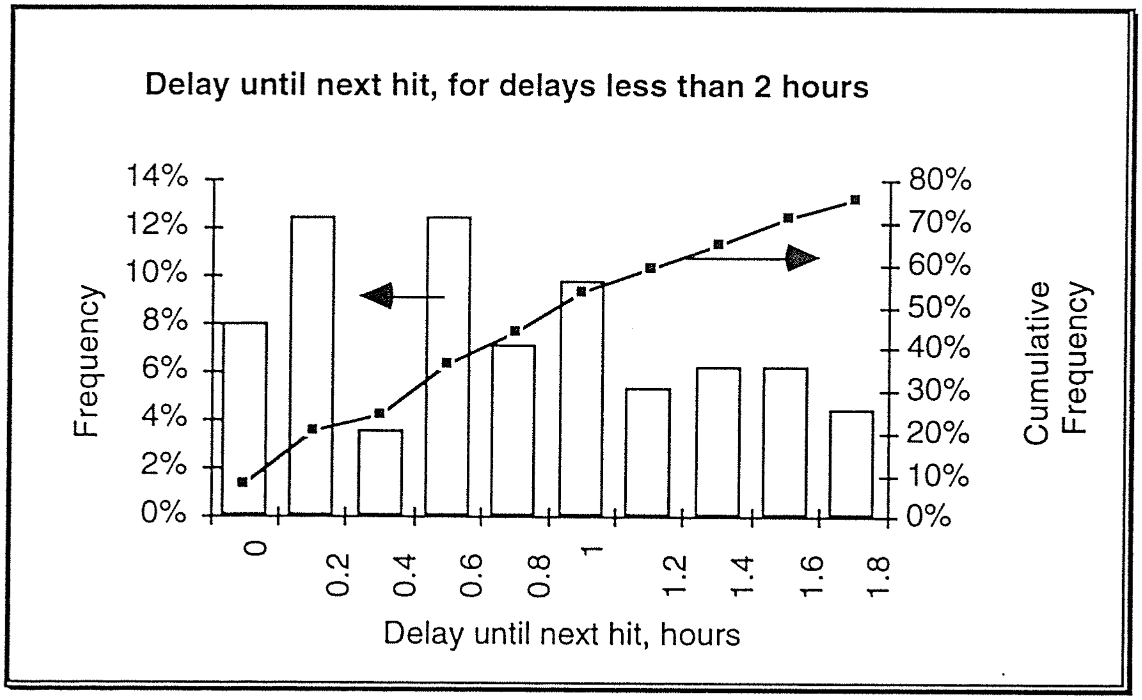

Fig. 5.
Distribution of Intervals < 2 hours between Interference Events
LEO E Inclined/LEO D

Measurement interval, days	42.6
Average duration, sec.	12.7
Total interference time, sec.	443.0
Interference % per satellite	0.012%
Interference for six satellites	0.072%
Number of hits	35
Hit rate, hits/day/satellite	0.82
Hit rate, hits/day for LEO E Equatorial	4.93

Table 3
Summary of Interference Events
Between LEO E Equatorial and LEO D

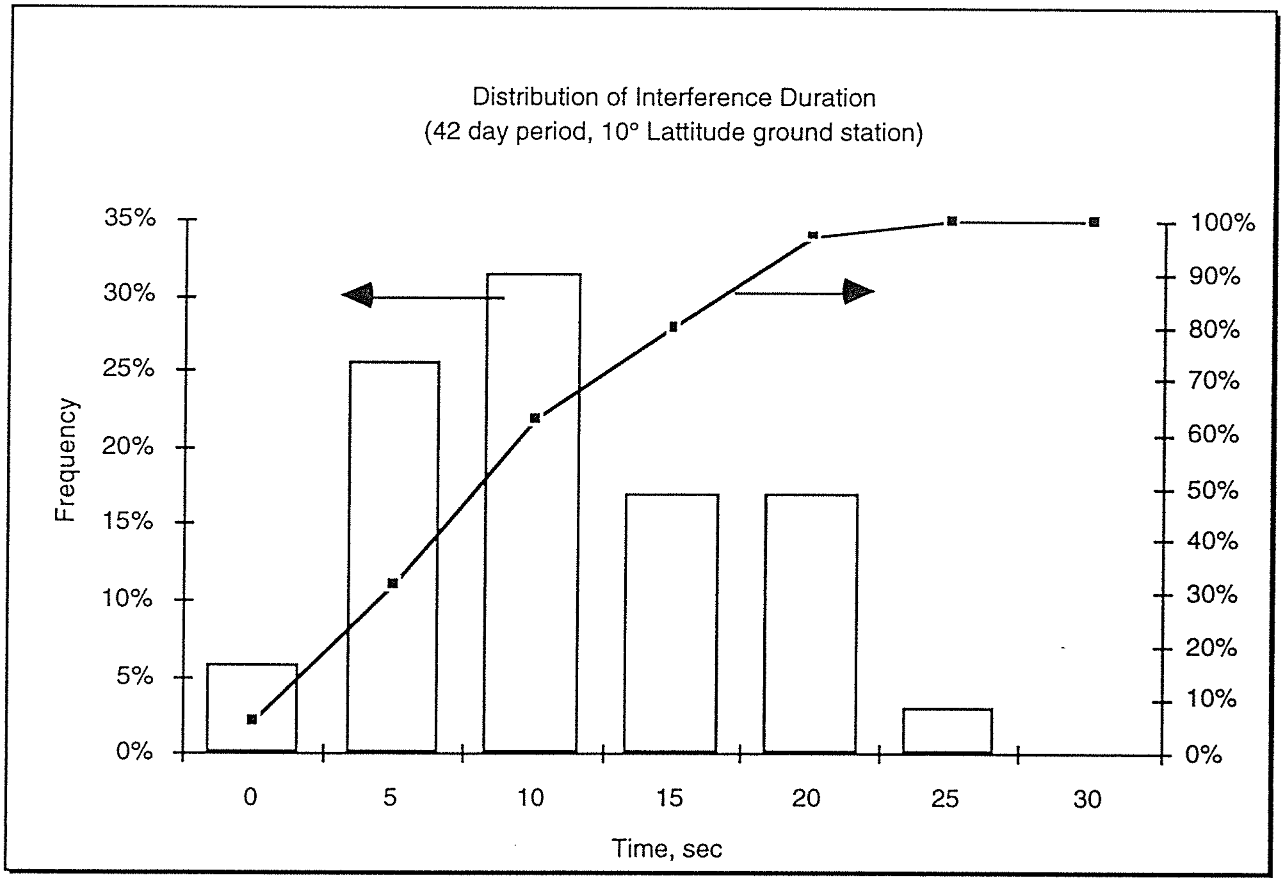

Fig. 6.
Distribution of Interference Event Durations
LEO E Equatorial

c. Interference between LEO E Inclined Satellites and LEO F

In this case, a ground station at 40° North tracked the two best satellites in view in LEO E's inclined orbits and monitored for interference events from satellites in LEO F for a simulation period of two weeks. Table 4 summarizes the results

Days simulated	14
Total hits	22
Hits per day	1.57
Total interference time, sec	542
Interference percentage	0.045
Week 1	
Total hits	19
Hits per day	2.71
Total interference time, sec	489
Interference percentage	0.081
Week 2	
Total hits	3
Hits per day	0.43
Total interference time, sec	53
Interference percentage	0.0088

Table 4
Summary of Interference Events
Between LEO E and LEO F

Many more interference events occurred during the first week of simulation than during the second week. At the start of the simulation, the lines of nodes (the line connecting the orbits' ascending and descending equatorial crossing points) for the two systems were aligned. This caused the orbits to closely overlie each other. As the simulation continued, LEO E's line of nodes precessed to follow the sun, since they are sun-synchronous orbits. LEO F's line of nodes precessed away from this sun-orientation. Consequently the orbits moved into a stronger crossing orientation, reducing the volume of space wherein an intersection occurs. This effect may explain the reduction of interference events seen in the second week. Since LEO E and LEO F both use repeating ground tracks, it may also be possible to phase the two constellations relative to each other in order to minimize the number of times a satellite from each system is in an orbital intersection area at the same time.

Figure 7 show statistics on intervals between interference events for this scenario and figure 8 shows statistics on durations of interference events.

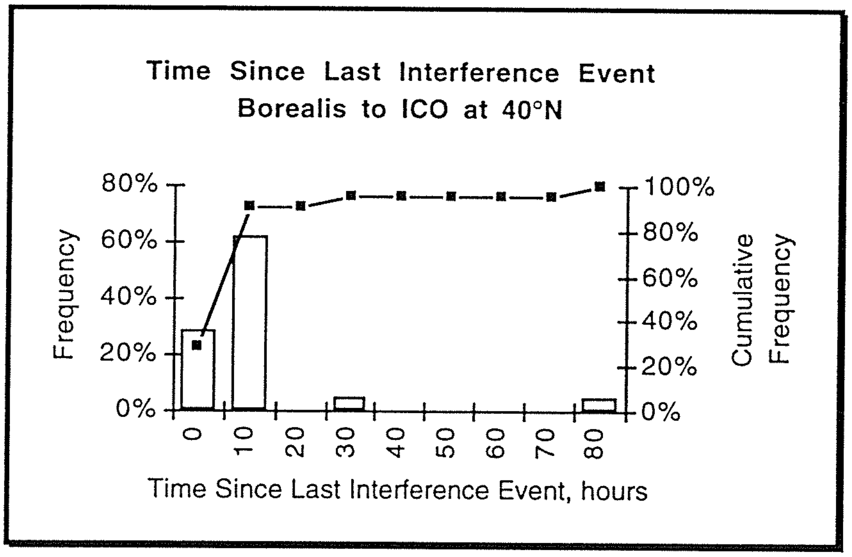

Figure 7
Distribution of Intervals between Interference Events
LEO E Inclined/LEO F

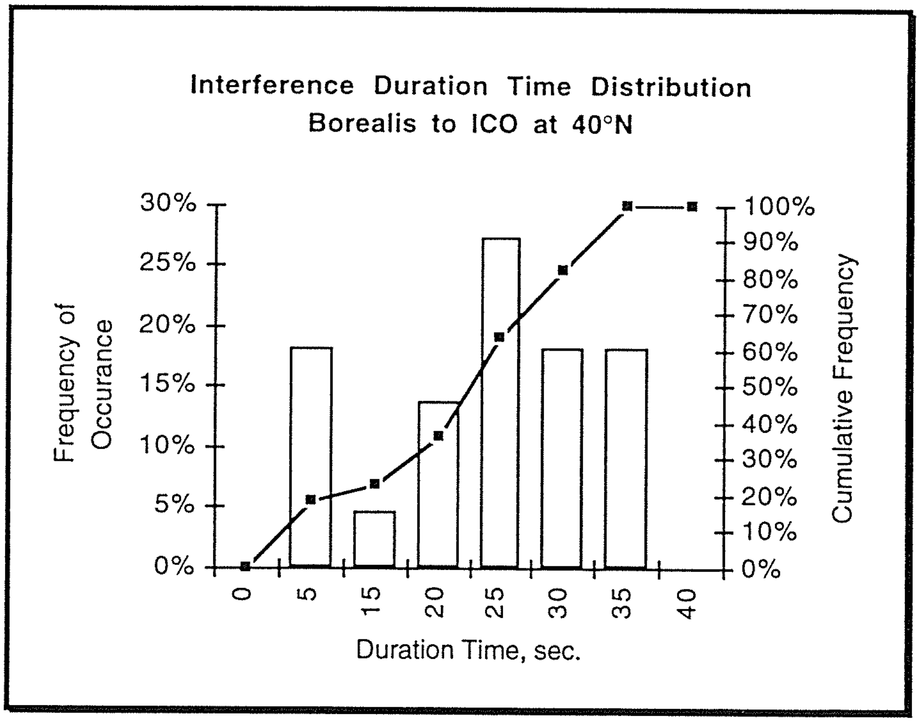

Figure 8
Distribution of Interference Event Durations
LEO E Inclined/LEO D

6. Interference Impact on Operations

Based on this preliminary analysis, the satellites belonging to system B will interfere with Inclined satellites in LEO E, and vice versa, often enough to have a significant impact on operations, if there were no means for mitigating the interference effects. Less interference was noted between satellites of LEO D and satellites in LEO E's equatorial plane. Satellites in LEO F interfere with LEO E much less often than those of LEO D. Moreover, interference between LEO E and LEO F seems to demonstrate a dependence on the orientation of the planes of the inclined orbits, apparently being higher when the lines of nodes are colinear. However, not enough analysis has been conducted to evaluate this latter dependency with any clarity.

Since LEO E's inclined orbit ground tracks repeat every 24 hours, while LEO D's orbits repeat every 47.5 hours, the two constellations will return to their starting configuration only after many days, perhaps as many as 48. As a consequence, it does not appear likely that locations can be found where interference between the two constellations is significantly reduced[2].

In contrast, LEO F's ground tracks also repeat every 24 hours. Therefore, there will be a small set of possible tracks taken by LEO F satellites from the vantage point of any ground station, increasing the likelihood that ground station locations and relative satellite mean anomalies can be found that will minimize the incidence of main beam coupling.

If more than two systems are operating, the total interference environment will be that due to the superposition of interference versus time and ground antenna from each one of the interfering systems. Since satellite periods, inclinations, precession, etc for each system are different, simultaneous interference will be very rare, and the total incidence of interference will essentially equal to the sum of the interference amounts from each system.

It appears that main beam coupling can be minimized if all MSS sharing a common feeder link band adopt orbits that have a low common time multiple for track repeats. Minimizing the overall number of ground tracks per system will also minimize the possible number of intersections between systems in azimuth/elevation space as seen from the ground stations. Such measures as these will facilitate finding combinations of relative orbit phasings and ground locations where main beam coupling events are minimized.

Most CDMA systems advertise double satellite coverage in order to provide diversity operation for the user. This minimizes outages due to shadowing and simplifies handovers. LEO E provides double satellite coverage in the northern temperate zones served by the inclined planes. In no case were both the primary and secondary satellites found to encounter main beam coupling at the same time. This

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[2] Each satellite pass has an associated interference scenario and associated ground sites where interference is minimized. If two constellations return to their starting configuration every day, there will be a limited set of interference scenarios, which may simplify the search for sites suffering minimal overall interference. If on the other hand, the two constellations do not return to their starting configuration until many days have passed, the total number of interference scenarios to be evaluated will be large, and the likelihood of finding a site with significantly fewer interference events will be smaller.

finding demonstrates that diversity operation provides the additional benefit of providing an opportunity to avoid the effects of main beam coupling by simply using the other serving satellite during the coupling event, disabling contribution from the satellite encountering interference for the duration of the interference event[3].

Ground station site diversity (the capability of transmitting and receiving from more than one ground location for a given ground station) will also minimize outages. When one antenna encounters interference from a collinear interfering satellite, operations can be switched to the second, diversity site for the duration of the interference event. Offsets on the order of 100 miles between the two antennas would appear to permit operation during most interference events.

Finally, this analysis demonstrates that, if possible, MSS should be designed to tolerate outages lasting upwards of 20 seconds with dropping a call, thereby minimizing the impact of any unmitigated main beam coupling event.

7. Conclusions

Main beam coupling will occur from time to time among MSS sharing a feeder link band and having characteristics similar to those modeled here. Outages can last up to 20 seconds and occur on the order of less than once per day to once per hour, depending on the geometries of the operating and interfering systems. Measures to reduce the impact of main beam feeder link coupling include:

Using path diversity for operation to the user terminals

Ensuring that all MSS sharing a feeder link band have ground track repeat times having relative least common multiples repetition intervals as small as possible. Daily would be good.

Using site diversity operation for ground stations, and

Ensuring that calls can tolerate outages common for main beam coupling events without dropping.

Not all of the above mitigating measures are required to minimize interference among MSS when sharing feeder link bands. Using some or all of these techniques, MSS can share feeder link bands without significant disruption from mutual feeder link interference.

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[3] This technique may be of reduced usefulness for terminals located far from the serving ground station, when at times the same two satellites may not offer simultaneous coverage of both the user terminal and the ground control station.

Appendix C

L-Band Channel Plan

Ellipso L-Band Channel Plans

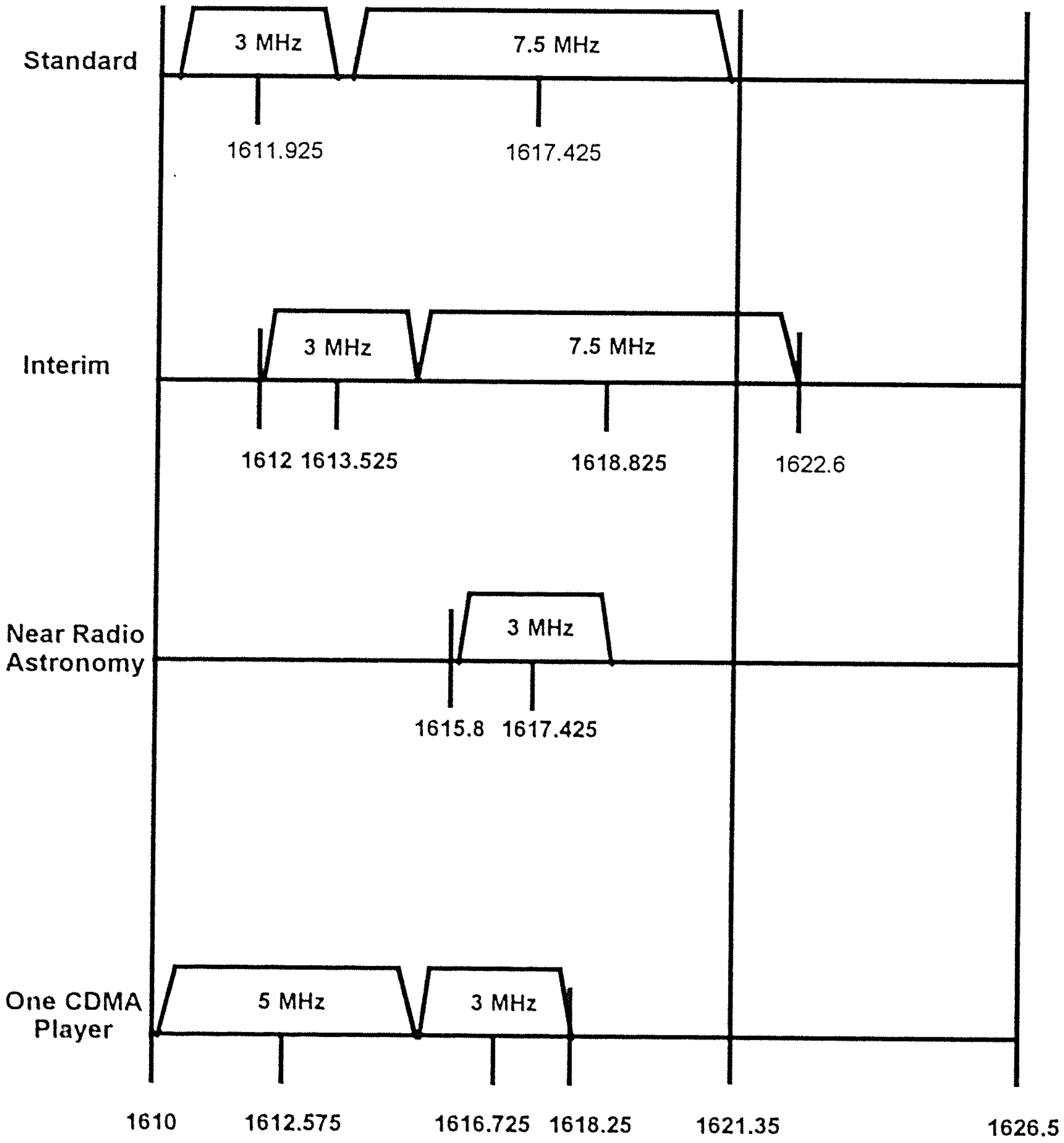

Figure C-1
Illustrative Ellipso Use of L-Band Spectrum in Conformance with Report and Order

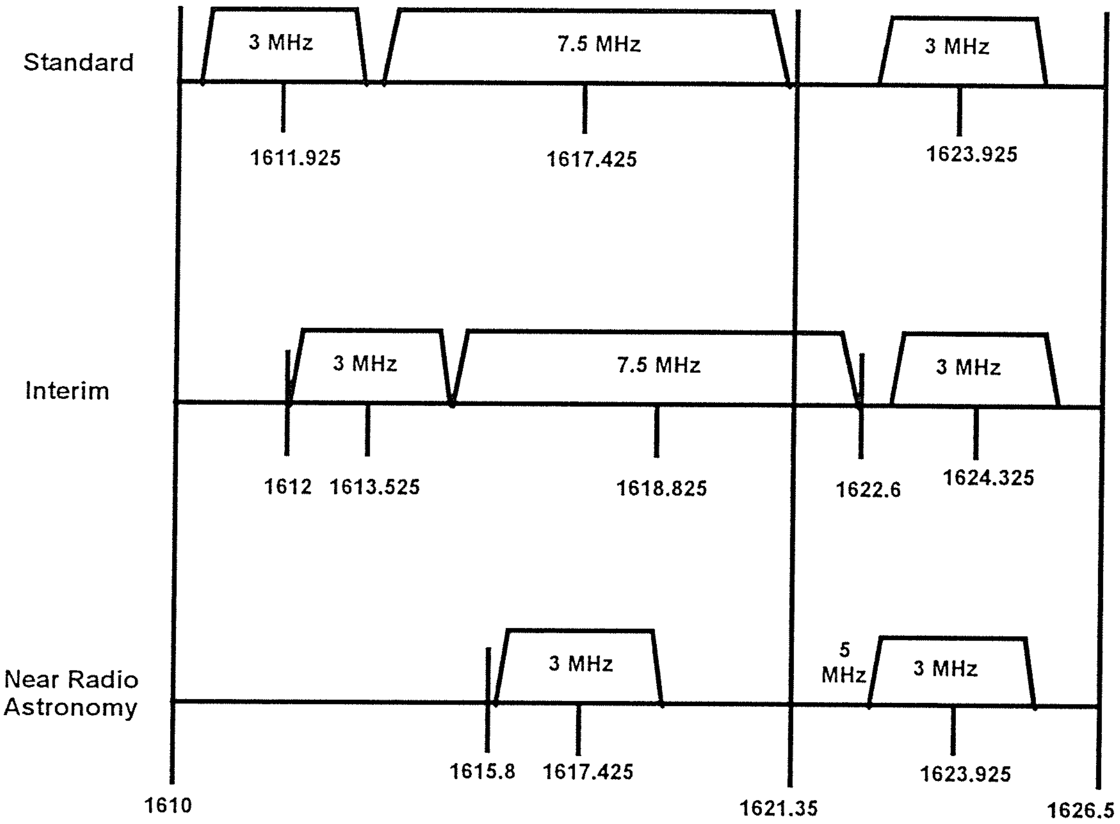

Figure C-2
Illustrative Ellipso Use of L-Band Spectrum
Showing Optional Spectrum Use if Available

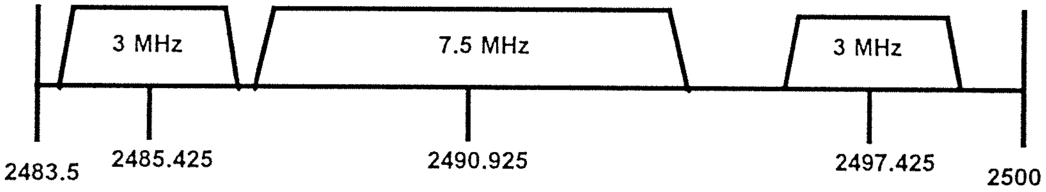

Figure C-3
Illustrative Ellipso Use of S-Band Spectrum
Map to corresponding Channels in L-Band

Appendix D

Document USTG 4/5-10 (Rev. 1)

Documents
Radiocommunication
Study Groups

Document USTG 4/5-10 (Rev.1)
21 October 1994
Original: English

UNITED STATES OF AMERICA

Characteristics of Some Equipment in the 15.4-15.7 GHz Band and Feasibility of Accommodating Earth-to-Space MSS Feeder Links in the Band

1. Introduction

This contribution presents a summary of the characteristics of some equipment operating in the 15.4-15.7 GHz band. The band is allocated to the aeronautical radionavigation service on a worldwide basis. RR 797 also allocates this band to the FSS if used in conjunction with the aeronautical radionavigation or aeronautical mobile service. This band has been identified in Doc. TG 4-5/TEMP/24 as a potential candidate for the accommodation of MSS feeder links.

2. United States Systems

In the U.S., the microwave landing system (MLS) is used for military aircraft. The MLS is a ground or ship-based transmitter which emits coded pulses that an airborne receiver decodes and uses to assist the aircraft pilot in remaining in the glide slope of an military airport runway or aircraft carrier flight deck. The shipborne version is installed on all aircraft carriers and is authorized to operate in all U.S. coastal waters. The ground based version is only authorized at a very limited number of locations. Both the ground and shipborne systems are technically similar. They operate with a peak power of 2.2 kW with an antenna gain of 25-32 dBi and an authorized bandwidth of either 2 or 18 MHz. The transmitted signal consists of a series of unmodulated pulses with a pulse width of 0.30 - 0.35 μsec and a pulse repetition rate (PRR) of 3334 pps. It should be noted that transponder systems of this type are more immune to noise-like interference produced by CDMA signals than a "skin-tracking" radar which receives reflections of radio waves.

There are also few frequency assignments for the portable instrument landing system (ILS) in this band. The portable ILS operate with a peak power of 28-36 Watts with a peak antenna gain of 19 dBi and an authorized bandwidth of 4.4 MHz. The signal consists of unmodulated pulses with a pulse width of 1.9 μsec and a pulse repetition rate (PRR) of ~200 pps.

A single assignment is held for one radiolocation mobile station. It operates with a peak power of 10 kW with an antenna gain of 30 dBi and an authorized bandwidth of 2.55 MHz. The signal consists of unmodulated pulses with a pulse width of 1.35 - 1.9 µsec and a pulse repetition rate (PRR) of 800 pps. The system is authorized to operate anywhere with the United States and Possessions (US&P).

Three assignments for the Microwave Scanning Beam Landing System (MSBLS). The system is only used when the Space Shuttle is due to land, so its use is for a short time a few times a year.

There are three operational assignments to commercial/civil stations. One is for a radionavigation land test station at Ft. Lauderdale, FL and two are for radionavigation land stations at Avon, CO and Aspen, CO.

There are 29 government and non-government assignments held for use by experimental stations. These experimental assignments are associated with equipment having various technical characteristics that are operated on a non-interference basis to systems operating in services to which the 15.4-15.7 GHz band is allocated.

3. International Usage

A <u>total</u> of 15 assignments exist worldwide. The all appear to be MLS assignments; six in the U.S. and nine in Spain. The locations in Spain are not known.

4. Feasibility of Sharing for Earth-to-Space Feeder Links

Few feeder link earth stations are needed in support of NGSO MSS systems that provide global coverage, and suitable sites can generally be selected with a tolerance of over 100 km. In, addition the e.i.r.p. density of the earth stations toward the horizon is low (e.g., -109 dBW/m^2/4kHz at the radio horizon of 16 km assuming a 15 m antenna height; the path loss drops off rapidly beyond this point due to a spherical earth and the feeder link earth stations will be located at least several tens of kilometers away from other systems operating in this band).

5. Summary

More work is needed to identify all of the equipment that occupies this band worldwide. Particular attention should be paid to the protection of aeronautical radionavigation systems. If the MSS feeder links can meet the established protection criteria and demonstrate sharing is possible with all of the services in the band, then it appears the 300 MHz available in the 15.4-15.7 GHz band may potentially be able to accommodate MSS feeder links.

Appendix E

ELLIPSO^{TM} Waveforms, Link Budgets, and System Capacity

Table E-1
Forward Link Calculations, Wideband Channel
Handheld Example

Parameter	Unit	Center	1st Ring	2nd Ring	3rd Ring	4th Ring
GENERAL						
Data Rate	bps	4800	4800	4800	4800	4800
RF Bandwidth	MHz	7.50	7.50	7.50	7.50	7.50
UPLINK						
Frequency	MHz	15550	15550	15550	15550	15550
EIRP/simult user	dBW	50.05	50.74	52.93	56.97	59.79
Transmit Power/simult user	W	0.30	0.35	0.58	1.47	2.81
Transmit Antenna Gain (4.5 m)	dBi	55.3	55.3	55.3	55.3	55.3
Free Space Loss	dB	-194.22	-194.62	-195.57	-197.61	-197.61
Range	km	7889	8262	9223	11655	11655
Atmospheric Losses	dB	0.50	0.50	0.50	0.50	0.50
Receive Antenna Gain	dBi	8.50	8.50	8.50	8.50	7.17
Received Power/simult user	dBW	-136.17	-135.88	-134.65	-132.64	-131.15
Thermal Noise Density	dBW/Hz	-200.82	-200.82	-200.82	-200.82	-200.82
Receiver Temperature	°K	600	600	600	600	600
Thermal Noise Power	dBW	-132.07	-132.07	-132.07	-132.07	-132.07
Uplink Signal to Noise Ratio (S/N)	dB	-4.10	-3.81	-2.58	-0.57	0.92
Transponder gain	dB	132.00	132.00	32.00	132.00	132.00
DOWNLINK						
Frequency	MHz	2490	2490	2490	2490	2490
EIRP/Channel	dBW	22.33	22.52	23.55	25.06	25.65
Net Signal Xmit Pwr/Simult user	W	0.38	0.41	0.54	0.86	1.22
Transmit Antenna Gain	dBi	26.50	26.40	26.20	25.70	24.80
Free Space Loss	dB	-178.26	-178.45	-179.09	-180.60	-181.70
Range	km	7846	8023	8631	10271	11655
Receive antenna gain	dBi	0.00	0.00	0.00	0.00	0.00
Power Control Margin	dB	4.10	4.10	4.50	4.50	4.50
Off-Boresight Gain Loss	dB	1.50	1.50	1.50	1.50	1.50
Power Control Uncertainty	dB	0.60	0.60	0.60	0.60	0.60
Power Control Pool	dB	2.00	2.00	2.40	2.40	2.40
Received signal power	dBW	-160.03	-160.03	-160.03	-160.04	-160.54
Thermal Noise spectral density	dBW/Hz	-203.16	-203.16	-203.16	-203.16	-203.16
User Term Rcvr Temp	°K	350	350	350	350	350
Thermal Noise Power	dBW	-134.41	-134.41	-134.41	-134.41	-134.41
Downlink Signal to Noise Ratio (S/N)	dB	-25.62	-25.62	-25.63	-25.63	-26.13
INTERFERENCE						
Receive Antenna Effective Area	dB-m^2	-29.37	-29.37	-29.37	-29.37	-29.37
Self Interference Spectral Density	dBW/Hz	-217.39	-217.39	-217.39	-217.39	-217.39
Interference PFD (4 kHz)	dBW/m^2	-142	-142	-142	-142	-142
Interference Factor Within Beam		0.00	0.00	0.00	0.00	0.00
Interference Factor For Adjacent Beams		0.10	0.10	0.10	0.10	0.10
Interference Density From Other Ellipsos	dBW/Hz	-207.39	-207.39	-207.39	-207.39	-207.39
Number of other Ellipso satellites		1.00	1.00	1.00	1.00	1.00
Interference PFD (4 kHz)	dBW/m^2	-142	-142	-142	-142	-142
Interference Factor		1.00	1.00	1.00	1.00	1.00
Interference Density From Other Systems	dBW/Hz	-213.41	-213.41	-213.41	-213.41	-213.41
Number of satellites		2	2	2	2	2
Interference PFD (4 kHz)	dBW/m^2	-142	-142	-142	-142	-142
Interference Factor		0.125	0.125	0.125	0.125	0.125
Total Interference Spectral Density	dBW/Hz	-206.09	-206.09	-206.09	-206.09	-206.09
Total Interference Power	dBW	-137.34	-137.34	-137.34	-137.34	-137.34
Downlink Signal to Interference Ratio (S/IF)	dB	-22.69	-22.69	-22.69	-22.70	-23.20
INTERMODULATION						
Downlink Carrier to Intermodulation Ratio (C/IM)	dB	15	15	15	15	15
Downlink Signal to Intermodulation Ratio (S/IM)	dB	-2.28	-2.29	-1.89	-1.90	-2.40
LINK PERFORMANCE						
Composite Signal to Noise Ratio (S/N+IF+IM)	dB	-27.44	-27.44	-27.44	-27.44	-27.94
Processing Gain	dB	31.94	31.94	31.94	31.94	31.94
Received Eb/No	dB	4.50	4.50	4.50	4.50	4.00
Required Eb/No	dB	4.50	4.50	4.50	4.50	4.00
Theoretical Eb/No (10^3 BER)	dB	2.00	2.00	2.00	2.00	2.00
Implementation Loss	dB	1.50	1.50	1.50	1.50	1.00
Multipath Loss	dB	1.00	1.00	1.00	1.00	1.00
Margin	dB	0.0	0.0	0.0	0.0	0.0

Table E-2
Forward Link Calculation, Narrow Band Channel
Fixed Terminal Example

Parameter	Unit	Center	1st Ring	2nd Ring	3rd Ring	4th Ring
GENERAL						
Data Rate	bps	4800	4800	4800	4800	4800
RF Bandwidth	MHz	3.00	3.00	3.00	3.00	3.00
UPLINK						
Frequency	MHz	15550	15550	5550	15550	15550
EIRP/simult user	dBW	43.39	44.08	45.86	49.88	53.20
Transmit Power/simult user	W	0.06	0.08	0.11	0.29	0.62
Transmit Antenna Gain (4.5 m)	dBi	55.3	55.3	55.3	55.3	55.3
Free Space Loss	dB	-194.22	-194.62	-195.57	-197.61	-197.61
Range	km	7889	8262	9223	11655	11655
Atmospheric Losses	dB	0.50	0.50	0.50	0.50	0.50
Receive Antenna Gain	dBi	8.50	8.50	8.50	8.50	7.17
Received Power/simult user	dBW	-142.82	-142.54	-141.71	-139.72	-137.74
Thermal Noise Density	dBW/Hz	-200.82	-200.82	-200.82	-200.82	-200.82
Receiver Temperature	°K	600	600	600	600	600
Thermal Noise Power	dBW	-136.05	-136.05	-136.05	-136.05	-136.05
Uplink Signal to Noise Ratio (S/N)	dB	-6.78	-6.49	-5.67	-3.68	-1.69
Transponder gain	dB	132.00	132.00	132.00	32.00	132.00
DOWNLINK						
Frequency	MHz	2490	2490	2490	2490	2490
EIRP/Channel	dBW	15.68	15.86	16.49	17.98	19.06
Net Signal Xmit Pwr/Simult user	W	0.08	0.09	0.11	0.17	0.27
Transmit Antenna Gain	dBi	26.50	26.40	26.20	25.70	24.80
Free Space Loss	dB	-178.26	-178.45	-179.09	-180.60	-181.70
Range	km	7846	8023	8631	10271	11655
Receive antenna gain	dBi	10.00	10.00	10.00	10.00	10.00
Power Control Margin	dB	2.10	2.10	2.10	2.10	2.10
Off-Boresight Gain Loss	dB	1.50	1.50	1.50	1.50	1.50
Power Control Uncertainty	dB	0.60	0.60	0.60	0.60	0.60
Power Control Pool	dB	0.00	0.00	0.00	0.00	0.00
Received signal power	dBW	-154.68	-154.69	-154.70	-154.72	-154.74
Thermal Noise spectral density	dBW/Hz	-205.59	-205.59	-205.59	-205.59	-205.59
User Term Rcvr Temp	°K	200	200	200	200	200
Thermal Noise Power	dBW	-140.82	-140.82	-140.82	-140.82	-140.82
Downlink Signal to Noise Ratio (S/N)	dB	-13.86	-13.87	-13.88	-13.90	-13.92
INTERFERENCE						
Receive Antenna Effective Area	dB-m^2	-19.37	-19.37	-19.37	-19.37	-19.37
Self Interference Spectral Density	dBW/Hz	-207.39	-207.39	-207.39	-207.39	-207.39
Interference PFD (4 kHz)	dBW/m^2	-142	-142	-142	-142	-142
Interference Factor Within Beam		0.00	0.00	0.00	0.00	0.00
Interference Factor For Adjacent Beams		0.10	0.10	0.10	0.10	0.10
Interference Density From Other Ellipsos	dBW/Hz	-197.39	-197.39	-197.39	-197.39	-197.39
Number of other Ellipso satellites		1.00	1.00	1.00	1.00	1
Interference PFD (4 kHz)	dBW/m^2	-142	-142	-142	-142	-142
Interference Factor		1.00	1.00	1.00	1.00	1.00
Interference Density From Other Systems	dBW/Hz	-203.41	-203.41	-203.41	-203.41	-203.41
Number of satellites		2	2	2	2	2
Interference PFD (4 kHz)	dBW/m^2	-142	-142	-142	-142	-142
Interference Factor (X-pol)		0.13	0.13	0.13	0.13	0.13
Total Interference Spectral Density	dBW/Hz	-196.09	-196.09	-196.09	-196.09	-196.09
Total Interference Power	dBW	-131.32	-131.32	-131.32	-131.32	-131.32
Downlink Signal to Interference Ratio (S/IF)	dB	-23.36	-23.37	-23.38	-23.40	-23.42
INTERMODULATION						
Downlink Carrier to Intermodulation Ratio (C/IM)	dB	15	15	15	15	15
Downlink Signal to Intermodulation Ratio (S/IM)	dB	-4.96	-4.96	-4.98	-5.00	-5.01
LINK PERFORMANCE						
Composite Signal to Noise Ratio (S/N+IF+IM)	dB	-23.96	-23.96	-23.96	-23.96	-23.96
Processing Gain	dB	27.96	27.96	27.96	27.96	27.96
Received Eb/No	dB	3.99	3.99	4.00	4.00	4.00
Required Eb/No	dB	4.00	4.00	4.00	4.00	3.50
Theoretical Eb/No (10^3 BER)	dB	2.00	2.00	2.00	2.00	2.00
Implementation Loss	dB	1.50	1.50	1.50	1.50	1.00
Multipath Loss	dB	0.50	0.50	0.50	0.50	0.50
Margin	dB	0.0	0.0	0.0	0.0	0.5

Table E-3
Return Link Calculations, Wide Band Channel
Handheld Terminal Example

Parameter	Unit	Center	1st Ring	2nd Ring	3rd Ring	4th Ring
GENERAL						
Data Rate	bps	4800	4800	4800	4800	4800
RF Bandwidth	MHz	7.50	7.50	7.50	7.50	7.50
UPLINK						
Frequency	MHz	1620	1620	1620	1620	1620
EIRP/Channel	dBW	-3.01	-3.01	-3.01	-3.01	-3.01
Transmit Power Per Channel	W	0.500	0.500	0.500	0.500	0.500
Transmit Antenna Gain	dBi	0.00	0.00	0.00	0.00	0.00
Free Space Loss	dB	-174.57	-174.97	-175.95	-177.61	-177.96
Range	km	7890	8260	9250	11190	11655
Receive Antenna Gain	dBi	23.80	23.60	23.50	25.50	24.80
Received Power	dBW	-153.78	-154.38	-155.47	-155.12	-156.17
Thermal Noise Density	dBW/Hz	-201.85	-201.85	-201.85	-201.85	-201.85
Receiver Temperature	K	473	473	473	473	473
Thermal Noise Power	dBW	-133.10	-133.10	-133.10	-133.10	-133.10
Uplink Signal to Noise Ratio (S/N)	dB	-20.68	-21.28	-22.36	-22.02	-23.07
Transponder gain	dB	132.00	132.00	132.00	132.00	132.00
DOWNLINK						
Frequency	MHz	6875	6875	6875	6875	6875
EIRP/simultaneous user signal only	dBW	-13.61	-14.21	-15.59	-15.55	-17.00
Free Space Loss	dB	-187.13	-187.53	-188.48	-190.52	-190.52
Range	km	7889	8262	9223	11655	11655
Atmospheric Losses	dB	1.00	1.00	1.00	1.00	1.00
Receive Antenna Gain	dBi	48.2	48.2	48.2	48.2	48.2
Received Signal Power	dBW	-153.53	-154.53	-156.87	-158.86	-160.31
Thermal Noise spectral density	dBW/Hz	-206.84	-206.84	-206.84	-206.84	-206.84
Receiver Temperature	K	150	150	150	150	150
Thermal Noise Power	dBW	-138.09	-138.09	-138.09	-138.09	-138.09
Downlink Signal to Noise Ratio (S/N)	dB	-15.56	-16.54	-18.84	-20.80	-22.25
INTERFERENCE						
Interf Factor For In-beam Channels		1.000	1.000	1.000	1.000	1.000
Interf Factor For Adj Beam Channels		0.50	0.50	0.50	0.50	0.50
Interf Factor For Users on Other Ellipso Sats		1.50	1.50	1.50	1.50	1.50
Interference Factor For Other Systems(X-pol)		0.250	0.250	0.250	0.250	0.250
Downlink Signal to Interference Ratio (S/IF)	dB	-22.04	-22.06	-21.70	-21.77	-22.31
INTERMODULATION						
Downlink Carrier to Intermodulation Ratio (C/IM)	dB	15	15	15	15	15
Downlink Signal to Intermodulation Ratio (S/IM)	dB	-10.28	-10.51	-10.77	-10.65	-11.43
LINK PERFORMANCE						
Composite Signal to Noise Ratio (S/N+IF+IM)	dB	-25.10	-25.46	-26.11	-26.45	-27.44
Processing Gain	dB	31.94	31.94	31.94	31.94	31.94
Received Eb/No	dB	6.84	6.48	5.82	5.49	4.50
Required Eb/No	dB	4.00	4.00	4.00	4.00	4.00
Theroetical Eb/No (10^3 BER)	dB	2.00	2.00	2.00	2.00	2.00
Implementation Loss	dB	1.00	1.00	1.00	1.00	1.00
Multipath Loss	dB	1.00	1.00	1.00	1.00	1.00
Margin	**dB**	**2.8**	**2.5**	**1.8**	**1.5**	**0.5**

Table E-4
Return Link Calculations, Narrow Band Channel
Fixed Terminal Example

Parameter	Unit	Center	1st Ring	2nd Ring	3rd Ring	4th Ring
GENERAL						
Data Rate	bps	4800	4800	4800	4800	4800
RF Bandwidth	MHz	3.00	3.00	3.00	3.00	3.00
UPLINK		0.018	0.020	0.023	0.060	0.110
Frequency	MHz	1620	1620	1620	1620	1620
EIRP/Channel	dBW	-3.01	-3.01	-3.01	-3.01	-3.01
Transmit Power Per Channel	W	0.050	0.050	0.050	0.050	0.050
Transmit Antenna Gain	dBi	10.00	10.00	10.00	10.00	10.00
Free Space Loss	dB	-174.57	-174.97	-175.95	-177.61	-177.96
Range	km	7890	8260	9250	11190	11655
Receive Antenna Gain	dBi	23.80	23.60	23.50	25.50	24.80
Received Power	dBW	-153.78	-154.38	-155.47	-155.12	-156.17
Thermal Noise Density	dBW/Hz	-201.85	-201.85	-201.85	-201.85	-201.85
Receiver Temperature	K	473	473	473	473	473
Thermal Noise Power	dBW	-137.08	-137.08	-137.08	-137.08	-137.08
Uplink Signal to Noise Ratio (S/N)	dB	-16.70	-17.30	-18.39	-18.04	-19.09
Transponder gain	dB	132.00	132.00	132.00	132.00	132.00
DOWNLINK						
Frequency	MHz	6875	6875	6875	6875	6875
EIRP/simultaneous user signal only	dBW	-13.61	-14.21	-15.59	-15.55	-17.00
Free Space Loss	dB	-187.13	-187.53	-188.48	-190.52	-190.52
Range	km	7889	8262	9223	11655	11655
Atmospheric Losses	dB	1.00	1.00	1.00	1.00	1.00
Receive Antenna Gain	dBi	48.2	48.2	48.2	48.2	48.2
Received Signal Power	dBW	-153.53	-154.53	-156.87	-158.86	-160.31
Thermal Noise spectral density	dBW/Hz	-206.84	-206.84	-206.84	-206.84	-206.84
Receiver Temperature	K	150	150	150	150	150
Thermal Noise Power	dBW	-142.07	-142.07	-142.07	-142.07	-142.07
Downlink Signal to Noise Ratio (S/N)	dB	-11.76	-12.70	-14.94	-16.88	-18.31
INTERFERENCE						
Interf Factor For In-beam Channels		1.000	1.000	1.000	1.000	1.000
Interf Factor For Adj Beam Channels		0.50	0.50	0.50	0.50	0.50
Interf Factor For Users on Other Ellipso Sats		0.25	0.25	0.25	0.25	0.25
Interference Factor For Other Systems(X-pol)		0.060	0.060	0.060	0.060	0.060
Downlink Signal to Interference Ratio (S/IF)	dB	-22.18	-22.20	-22.12	-22.12	-22.38
INTERMODULATION						
Downlink Carrier to Intermodulation Ratio (C/IM)	dB	15	15	15	15	15
Downlink Signal to Intermodulation Ratio (S/IM)	dB	-9.95	-10.07	-10.22	-10.14	-10.58
LINK PERFORMANCE						
Composite Signal to Noise Ratio (S/N+IF+IM)dB		-23.74	-23.95	-24.37	-24.56	-25.23
Processing Gain	dB	27.96	27.96	27.96	27.96	27.96
Received Eb/No	dB	4.22	4.01	3.59	3.40	2.73
Required Eb/No	dB	3.50	3.50	3.50	3.50	3.50
Theroetical Eb/No (10^3 BER)	dB	2.00	2.00	2.00	2.00	2.00
Implementation Loss	dB	1.00	1.00	1.00	1.00	1.00
Multipath Loss	dB	0.50	0.50	0.50	0.50	0.50
Margin	**dB**	**0.7**	**0.5**	**0.1**	**-0.1**	**-0.8**

Table E-5
Ellipso System Capacity in the United States
Voice Call Equivalents

No of Satellites of Other MSS Systems in Operation	Single Transponder Capacity (1 beam @ PFD -142)*	Ellipso Capacity @ PFD -142
0	405	5,200
1: X-pol	378	4,900
2 X-pol	350	4,600
3 2 X-pol, 1 co-pol	235	3,000
3 1 X-pol, 2 co-pol	188	2,400
4 2 X-pol, 2 co-pol	180	2,300

*slight variations possible among beams

Table E-6
Ellipso Waveform Characteristics

Aspect	Characteristic
Speech Encoding	Improved Multiband Excitation @ 4.8 kbs
User Data Rates	300 - 9,600 bps
FEC Coding	r = 1/3, K = 9
Forward Traffic PN Codes	Orthogonal Code Family Overlay
Forward Broadcast Channel PN Code	Short Repeating Code
Return Access Code	Short Repeating Code
Forward Link PN Modulation	QPSK
Return Link PN Modulation	Offset QPSK
Forward Link Data Modulation	BPSK
Return Link Data Demodulation	Costas Loop without Pilot
Interleaver	10 - 320 ms

EXHIBIT 1

Technical Information

1. Overview

A general overview of the ELLIPSO^{TM} system is given in **Figure 1**.

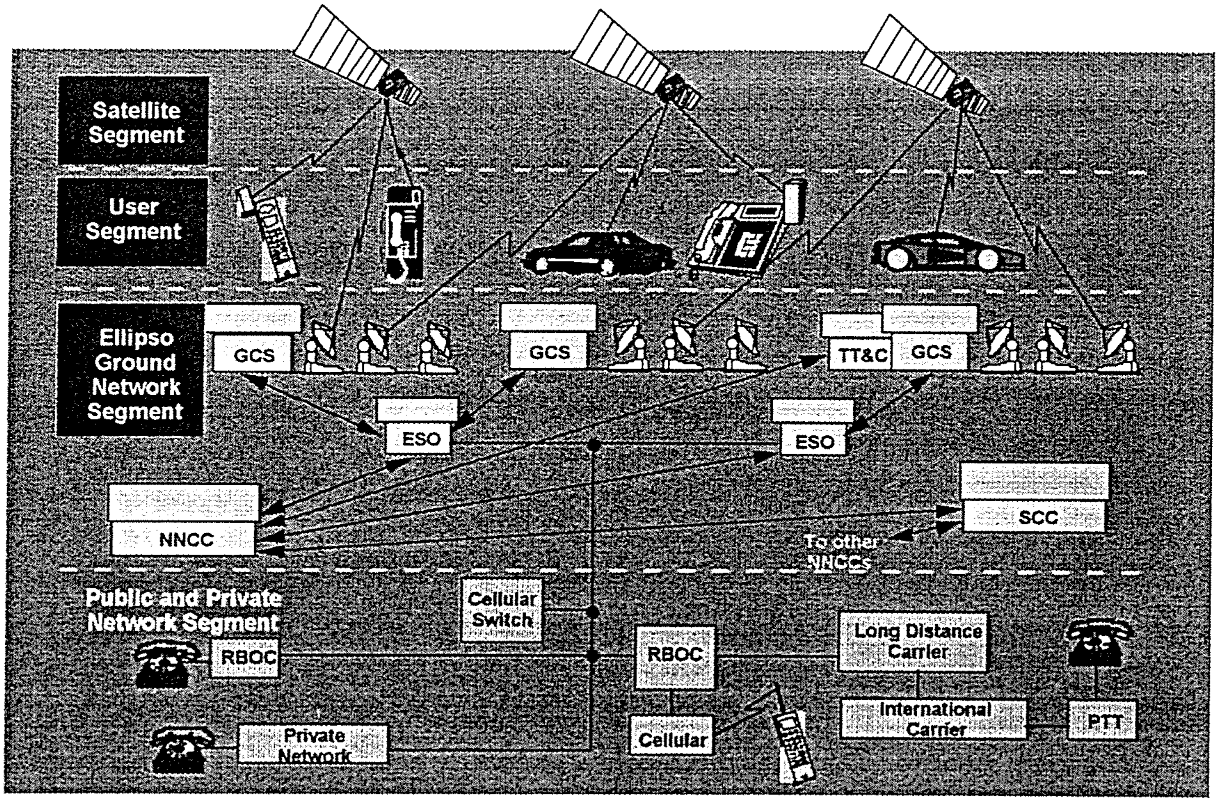

Figure 1 - ELLIPSO^{TM} System Overview

As can be seen from the figure the system breaks down into three discrete sections, they are:

1. Satellite Segment
2. Mobile User Ground Segment,
3. ELLIPSO^{TM} Ground Control Network, which connects the system to the public and private networks.

A brief overview of each section follows.

A. *Space Segment*

The space segment is made up of 16 satellites arranged in two sub-constellations, as illustrated in **Figure 2.**

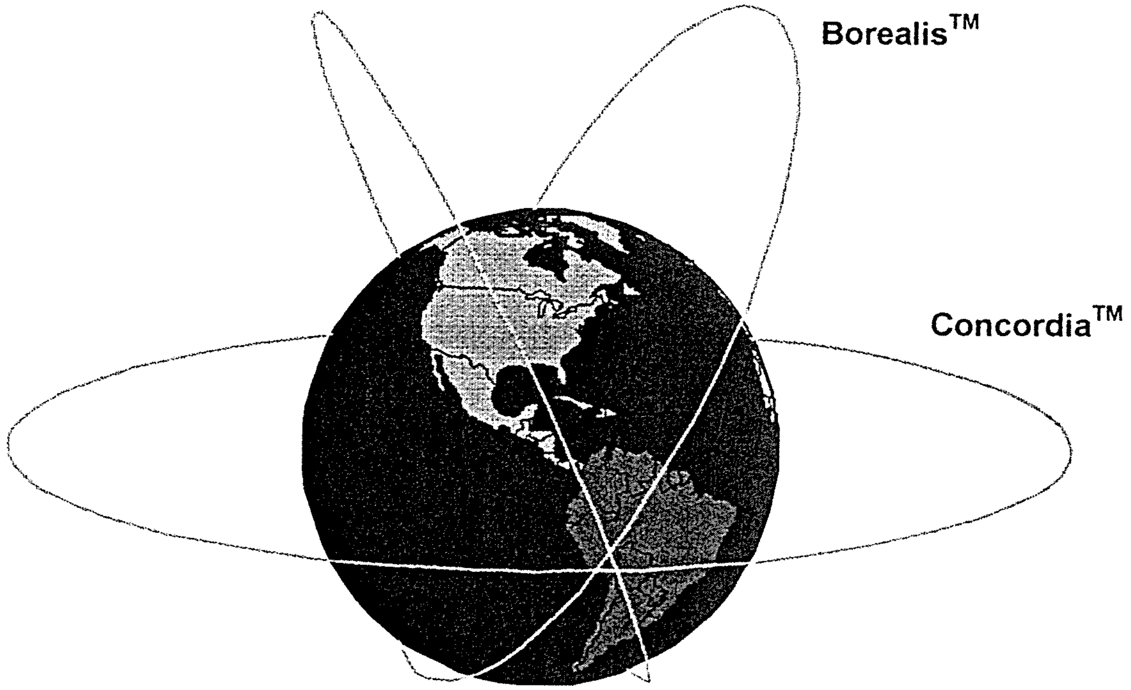

Figure 2 - The ELLIPSO™ Orbits

The first sub-constellation, called Borealis™ provides for two inclined elliptical orbits, with an apogee of 7846 km. and each containing five satellites. The Borealis™ sub-constellation provides full coverage from 90° N down to 20° N. The second sub-constellation called Concordia™, consists of a single circular equatorial orbital plane, at 8068 km. containing six satellites and providing coverage from 45° N to 55° S.

The satellites in the Borealis™ and the Concordia™ sub-constellations both utilize the mobile satellite service bands 1610-1626.5 MHz (earth-to-space) and

2483.5-2500 MHz (space-to-earth) with the service area coverage from each satellite being provided by the transmit and receive antennas, each having 61 beams. In the Borealis™ case, 37 beams are used at apogee with the full complement of 61 beams being used when the satellites are located lower than apogee, where the distance to the earth is reduced and service coverage needs to be maintained to the area served at apogee. Feeder links are specified in the 6725-7025 MHz (space-to-earth) and 15.4 to 15.7 GHz (earth-to-space) bands. The area of coverage for the satellite feeder links are essentially the same as for the service bands, but are formed by four contiguous beams.

The spacecraft communication subsystem is essentially a "bent-pipe" and other than frequency translation and amplification provides no processing of the signal. The transmission method used in both the forward and return direction is wideband CDMA. Specific frequency locations of the communication carriers in the service bands are set to meet the Commissions recommendation in the Report and Order and reflect the frequency locations of GLONASS, Radio Astronomy and the TDMA applicants' requirements. With the use of wideband CDMA, distinctive advantages are obtained in tolerance to interference; this permits many times frequency reuse. The ELLIPSO™ system frequency reuses each of the 61 spot beams, giving a 61 times frequency reuse of the service bands. This equates to a significant capacity capability on the satellite, with each satellite being capable of providing approximately 2500 channels.

B. *Mobile User Ground Segment*

The ground segment includes user terminals, handheld and vehicular terminals, operating in the mobile satellite service bands. The handheld terminals will use RF powers less than 1 watt with non-directional antennas. This enables users to utilize the terminals in the same manner as if operating with terrestrial cellular system. The ELLIPSO™ system also accommodates vehicular mobile terminals. These terminals are very similar to the handheld terminals in the performance characteristics, with differences in appearance to meet the particular application. In addition, the ELLIPSO™ system accommodates the use of transportable terminals, which are primarily used at fixed or temporary locations. These terminals are able to use a higher gain antenna, and therefore are less demanding on satellite power.

C. *ELLIPSO™ Ground Control Network*

The central ground stations, of which there are approximately four to cover the US, operate at the feeder link frequencies and provide all communications to the satellite. These stations connect the service uses of the system to the public and private networks via the ELLIPSO™ Switching Centers. Within this ground network, the selection of the correct operational satellite to be used from a particular ground site is made, and the terrestrial routing and the billing is accomplished. In addition, a selected number of these central ground stations will provide TT&C facilities for the in orbit satellites.

2. ELLIPSO™ System Design

A. *The ELLIPSO™ Space Segment*

The ELLIPSO™ space segment consists of 16 satellites in non-geosynchronous orbits placed to provide global service to all points of the earth from 55° South latitude to the North Pole. The ELLIPSO™ orbits have been carefully tailored and integrated to provide coverage quality and intensity that is proportional to the distribution of the world's population by latitude and that favors daytime (peak period) service over nighttime (off peak period) service. The satellites, moving in low to medium earth orbits, circle the earth 5 or 8 times per day, depending on the orbit. Since the demand on the satellite varies widely with satellite location and the local time of day in the area served, ELLIPSO™ satellites are designed for a high degree of flexibility in the real-time assignment of RF power to orbital locations and beams as required.

ELLIPSO™ satellites will employ both large and small launch vehicles in order to optimize launch strategy and minimize launch costs. After launching two ELLIPSO™ satellites into a Borealis™ orbit for final system test and proof purposes, the remaining ELLIPSO™ satellites will be launched in clusters of as many as eight per launch.

1. The ELLIPSO™ Constellation

The ELLIPSO™ constellations have been reconfigured to provide the level of global and United States coverage required by the Report and Order. The amended design facilitates good visibility for power-efficient service to user terminals over all significantly populated areas within the required coverage area. In addition, it permits dual satellite visibility, in the Borealis™ case, for increasing system efficiency and for facilitating feeder link band sharing among multiple MSS entrants.

Two inclined elliptical orbits of 5 satellites each comprise the Borealis™ subconstellation. This subconstellation provides service to the northern temperate latitudes of the globe, with part-time service possible in equatorial regions. Borealis™ orbital parameters are given in **Table 1**.

Table 1 - Borealis™ Orbital Parameters

	Noon Plane	**Midnight Plane**
Number of Planes	2 total	
Satellites per plane	5	5
Apogee	7846 km	7846 km
Perigee	520 km	520 km
Inclination	116.565°	116.565°
Argument of Perigee	280°	260°
RAAN	local solar noon (sun-synchronous)	local solar midnight (sun-synchronous)
Satellite spacing	72° Mean Anomaly	72° Mean Anomaly
Orbital Period	3 hours	3 hours
Phasing btwn planes	36° Mean Anomaly	

To complete global coverage, MCHI supplements Borealis^{TM} with a subconstellation of equatorial satellites providing tropical and southern latitude coverage around the globe. This subconstellation, referred to as "Concordia^{TM}", consists of six equally spaced satellites in a circular, equatorial orbit at an altitude approximately equal to the Borealis^{TM} apogee altitude. Concordia^{TM} orbital parameters appear in **Table 2**.

Table 2 - Concordia^{TM} Orbital Characteristics

Number of Satellites	6
Number of Planes	1
Apogee	8068 km
Perigee	8068 km
Inclination	0°
Argument of Perigee	NA
RAAN	NA
Satellite spacing	60° Mean Anomaly
Orbital Period	4.8 hours

Figure 3 shows the minimum and average elevation angle to the best satellite during any 24 hour period for both ELLIPSO^{TM} subconstellations by latitude. **Figure 3** clearly shows that north of 50° S the minimum elevation angle at all times is greater that 5°. At 55° S, the constellation provides service at elevation angles greater that 5° for 85% of the time. Therefore the ELLIPSO^{TM} system meets and

exceeds the requirement to provide MSS to all locations as far north as 70° latitude and as far south as 55° latitude for at least 75% of every 24-hour period. At least one satellite will be visible above the horizon at an elevation angle of at least 5° for at least 18 hours each day. In addition, at least one satellite will be visible above the horizon at an elevation angle of at least 5° at all times in CONUS, Puerto Rico, and the U.S. Virgin Islands.

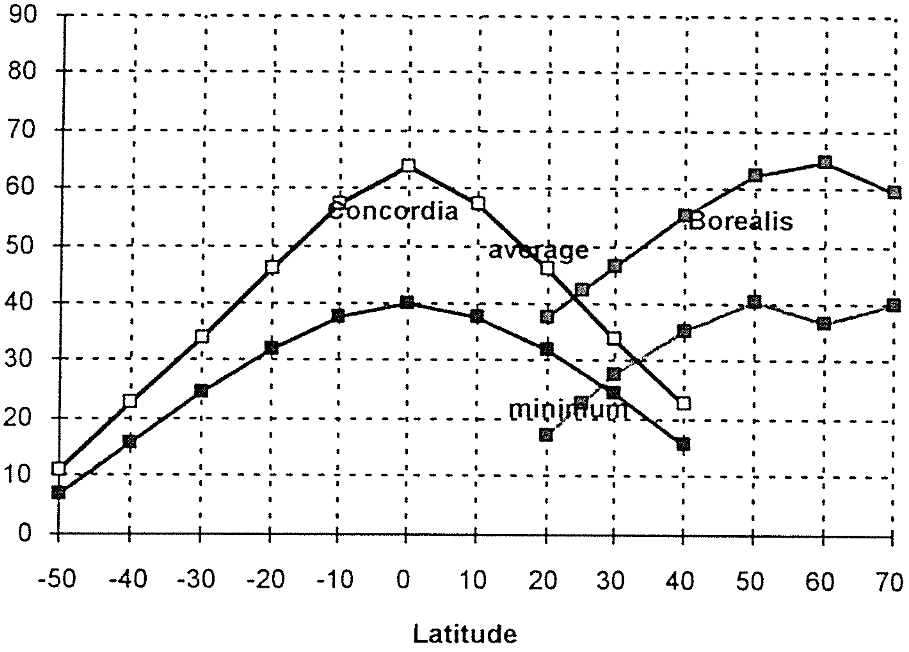

Figure 3 - Minimum and Average Elevation Angles to ELLIPSO^{TM} Satellites over a 24 hour period.

Minimum and average ELLIPSO^{TM} elevation angles are highest in the tropical latitudes, where demand is greatest, and reduce with progressively higher southern latitudes (and corresponding decreasing demand, given the Earth's overall layout of population). The service areas of the Borealis™ and Concordia™ subconstellations overlap between approximately 20° and 40° North latitudes, providing flexibility in the application of satellite resources in this highly populated latitude belt. In this manner, ELLIPSO™ resources are placed to provide optimal service at those latitudes where greatest demand exists.

Figure 4 shows an elevation angle trace with time to the best ELLIPSO™ satellite from a point at 55° South latitude. At this latitude, an ELLIPSO™ satellite is in view above 5° elevation angle for 85% of any 24 hour period, as shown in **Figure 5**. All latitudes north of 55° South latitude receive better elevation angle and percentage coverage. This performance exceeds the Commission's global service requirements.

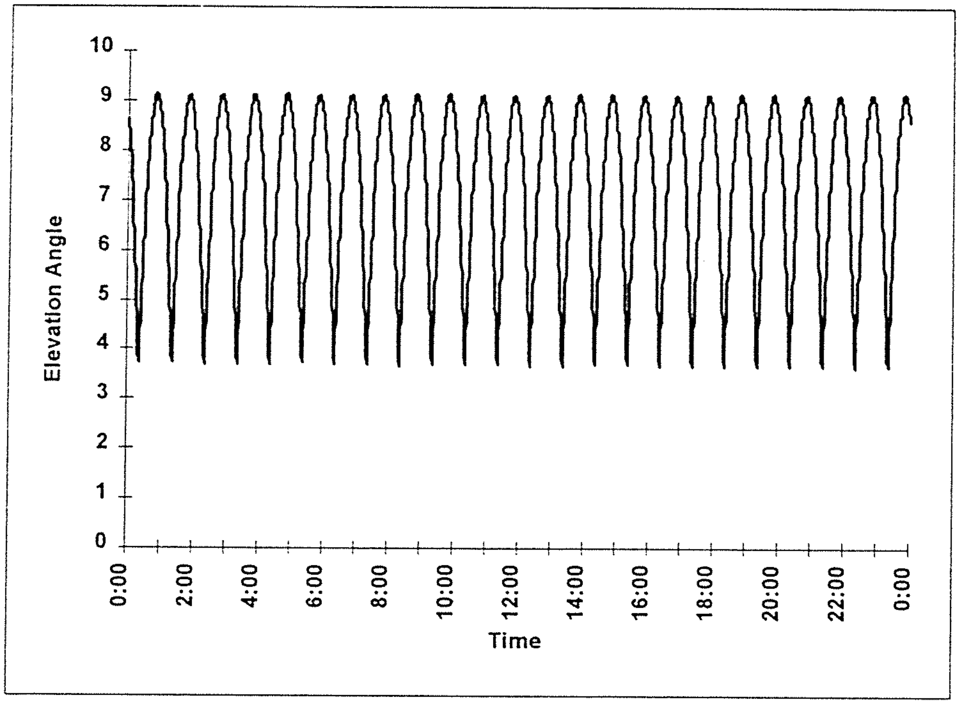

Figure 4 - Elevation Angles over 24 Hours to 55° South Latitude, Any Longitude

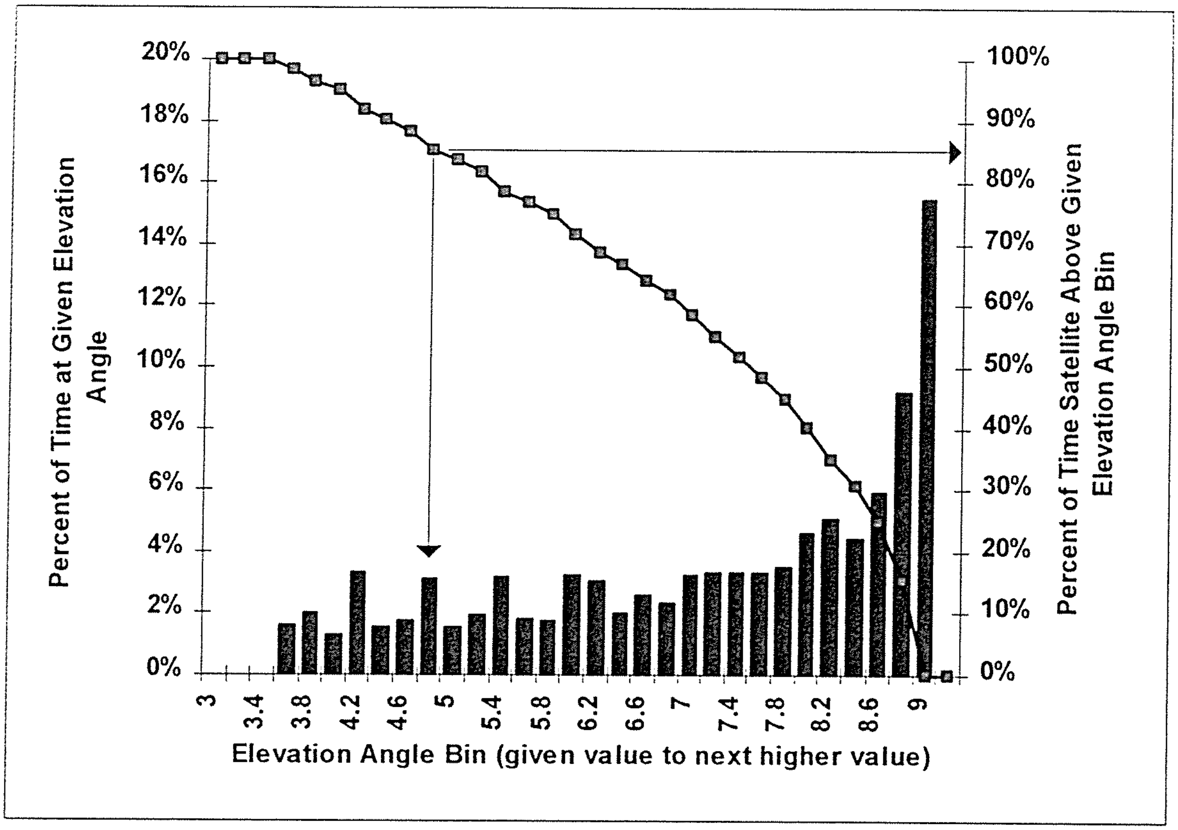

Figure 5 - Elevation Angle Statistics at 55° South Latitude, Any Longitude

Table 3 presents the tolerances to be maintained in the ELLIPSO™ Borealis™ and Concordia™ orbits.

Table 3 - Orbital Maintenance Tolerances

	Inclination	Pointing	Altitude	In Track
Borealis™	±0.05°	±0.5°	±20 km	±1°MA
Concordia™	±0.5°	±0.5°	±20 km	±1°MA

2. The ELLIPSO^{TM} Satellite

The ELLIPSO^{TM} satellite has been modified to conform to the technical changes mandated by the Report and Order, including global coverage that requires more power on the satellite in order to serve a larger area of the visible satellite footprint and to provide continuous coverage. Changes in feeder link frequencies and the CDMA sharing environment also have an impact on satellite design and power.

Figure 6 illustrates the overall appearance of the ELLIPSO^{TM} satellite.

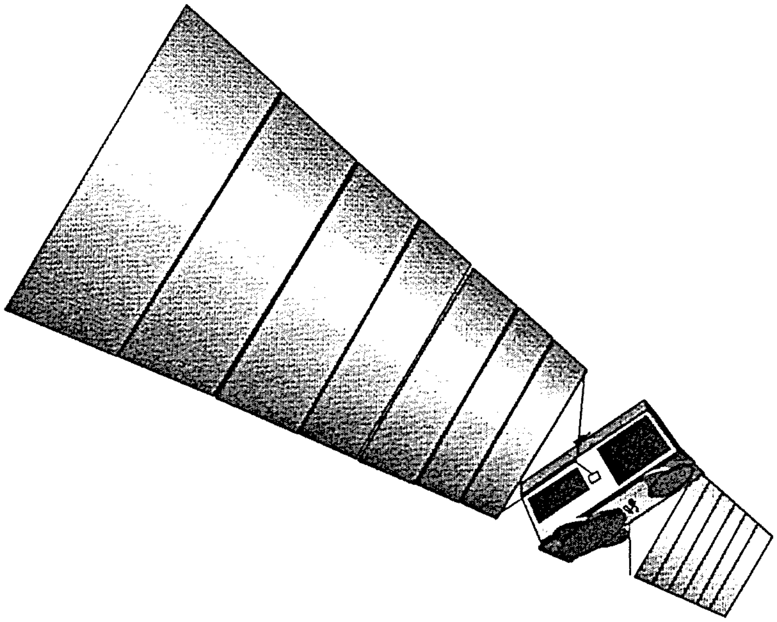

Figure 6 - The ELLIPSO^{TM} Satellite

a) *Satellite Power*

The Report and Order, paragraph 150 requires that mobile satellite systems conform to the PFD limits contained in RR 2566 within the S-band. In order to meet these design objectives total RF power available in the satellite is 500 watts. This will accommodate a reasonable PFD level (i.e., -142 dBw/m2/4kHz), and is consistent with the Default Coordination Values agreed on in the negotiated rulemaking process. The ELLIPSO™ satellites will conform to the requirements of Section 25.213(a)(3) regarding protection of the 4990 - 5000 MHz band.

b) Satellite User Link Antenna Design

ELLIPSO™ satellites placed in the new, conforming orbits operate at significantly higher altitudes than those shown for ELLIPSO™ I and II. From these altitudes the earth subtends a smaller solid angle from the satellite, and path loss has itself increased by more than seven decibels.

In addition, service to handheld transceivers is broadly held to be an important facet of personal communication services, such as mobile satellite service. This requirement affects the design of the satellite L and S band antennas, which must have enough gain to receive signals that a handheld transceiver is reasonably capable of emitting. In particular, we find that a realistic handheld transceiver is limited to around 0.5 watts of emitted RF power and no more than a 0 dBi antenna, given the size, weight, endurance, and health limits placed on handheld transceivers.

Given these constraints, MCHI hereby amends the ELLIPSO™ satellite design to increase the L and S band antenna size so as to accommodate handheld service. Since an increase in antenna size perforce decreases the beam footprint size of the antenna, MCHI increases the number of beams generated by the L and S band antennas as necessary to a number adequate to cover the visible earth from the satellite's operational altitudes, given required satellite antenna gains.

Figure 7 shows the distribution of the inner 37 beams (all but the outermost ring) over the earth as seen from an arbitrary point at an altitude of 7846 kilometers. At this altitude the outermost ring of beams is not used. **Appendix A** presents further details on satellite design, including satellite weight and power budgets, antenna beam contour plots, reliability derivations, power, e.i.r.p., gain, and receiver temperature information, payload and bus block diagrams, and transponder filter characteristics.

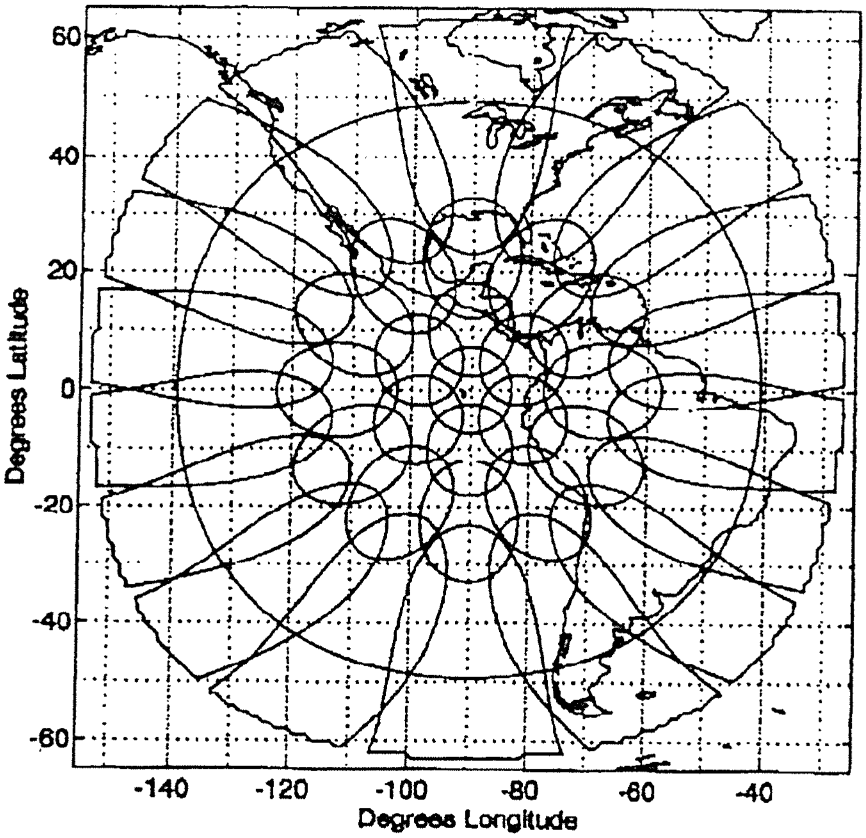

Figure 7 - ELLIPSO^{TM} Beam Footprints on the Earth from Apogee

B. *ELLIPSO™ Feeder Links*

The ELLIPSO™ satellite is a "bent pipe" transponding satellite that does not perform any signal processing on the satellite itself. Each L and S band user beam maps directly to a transponder, and in turn to a dedicated feeder link channel.

The ELLIPSO™ I and II satellites placed their feeder links in the L and S service bands, using one of the ten FDMA channels in each direction. However, the Commission has specified that feeder links may not be located in the primary service bands. In this amendment, MCHI requests that a conditional authorization (subject to any necessary frequency allocation) be granted for the 15.4 to 15.7 GHz band (downlink) and the 6725 to 7025 MHz band (uplink) in the reverse band mode.

MCHI has chosen a spectrum-efficient design for its feeder links featuring 3-fold feeder link frequency reuse per satellite. ELLIPSO™ satellites use 3-beam feeder link arrays in each feeder link direction. The central feeder link antenna forms an earth coverage beam and handles 33 user beams. This antenna operates in the lower portion of the respective feeder link spectrum. The other two feeder link antennas form sector patterns covering opposite sides of the visible earth. Both sector patterns covering opposite sides of the visible earth. Both sector beams use the same feeder link spectrum segments in the higher portion of the respective feeder link spectrum. Further technical details are contained in **Appendix A.**

Assuming MCHI is granted authority to use the requested feeder link bands, Ellipso satellite command and telemetry links will use the ELLIPSO^{TM} feeder link bands.

Appendix B reproduces a paper presented to United States Task Group 4/5 and to be presented to the International Telecommunication Union Task Group 4/5 and Working Party 4A on results of simulations investigating the feasibility of sharing feeder link spectrum among several mobile satellite systems. The paper concludes that while there are frequent interference events among mobile satellite systems sharing a feeder link band, relatively straightforward mitigation techniques, such as satellite path diversity or ground site diversity, virtually eliminate the interference problem. MCHI intends on implementing both these techniques, and may implement others outlined in the paper.

MCHI hereby certifies that in the event of feeder link operation in a shared frequency band with other licensed geostationary or non-geostationary satellite systems, the operations of its earth and space stations will conform to established coordination agreements between the ELLIPSO^{TM} space station operator, MCHI, and the operators of any other space stations licensed to use the band.

In the event ELLIPSO^{TM} is not authorized to use the requested feeder link bands, a shift to other bands may require adjustment of the ELLIPSO^{TM} satellite, channel structures, GCS, and Telemetry and Command designs.

C. *System Signals and Spectrum Requirements*

The ELLIPSO™ System continues to use code division multiple access (CDMA) for accommodating multiple user and system management signals simultaneously within a common bandwidth.[1] With this amendment, MCHI increases the bandwidths and center frequencies of the ELLIPSO™ spread signals, creating a revised channel plan to conform better to the Report and Order and to promote more efficient use of spectrum and system power.

The change to wider bandwidth ELLIPSO™ signals will act to reduce the signal levels required for communications. In general, the capacity of a CDMA system is proportional to the processing gain (i.e., signal bandwidth to user signal data rate ratio) of the signals sharing the band. Channels having larger bandwidths have more capacity, all else being equal. Since an MSS CDMA user sees all other users in his band as interferers rather than the nearest neighbor, his interference environment is the sum of all users. As the number of interfering users increases, the statistical variance of this sum reduces and the worst case interference level approaches the average interference level. This permits operation with correspondingly smaller margins while providing for worst case interference conditions, in turn reducing required signal levels per user. Wideband CDMA is

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[1] All Ellipso signals to and from the the Ellipso satellites are spread in bandwidth, using spreading codes unique to each signal, to occupy bandwidths exceeding a megaHertz. This spreading permits many such spread signals to occupy the same band at the same time, while still permitting detection of each signal using that signal's unique code.

also more tolerant of multipath than narrowband CDMA. This additional tolerance also reduces link margin requirements for multipath below those required in more narrowband CDMA systems.

MCHI applies for authority to construct its satellite to operate over 1610 - 1626.5 MHz in L band and 2483.5 - 2500 MHz in S band. In the United States, operation will be limited to the 1610 - 1622.6 MHz band (or 1610 - 1621.35 MHz if an interim plan is not required). **Appendix C** illustrates ELLIPSO™ channel plans within the 1610 - 1626.5 MHz band under standard, protection of Radio Astronomy, Interim Plan, and single CDMA applicant conditions within the United States. In the amended FDM channel plan, the ELLIPSO™ System uses two spreading bandwidths to carry its operational traffic: nominally 3 megaHertz ("narrowband") and 7.5 megaHertz ("wideband"). Typically, ELLIPSO™ operates with one channel of each bandwidth. Users are segregated into the two bands as required to support the ELLIPSO™ services and to meet MSS sharing requirements.

MCHI also requests assignment of 6725 to 7025 MHz for ELLIPSO™ feeder link uplinks operating in the reverse band working mode on a co-primary basis with other assignments in the band. These bands are lightly used nationally and internationally and offer an opportunity for several MSS operators to share these bands without adverse impact. MCHI refers to papers submitted before ITU Task Group 4/5 showing the feasibility of sharing uplink Allotment plan band spectrum with MSS feeder links in the reverse band working mode.

MCHI also requests assignment of 15.4 to 15.7 MHz for ELLIPSO^{TM} feeder link uplinks operating on a co-primary basis with other assignments in the band. This band is lightly used nationally and internationally and offers an opportunity for several MSS operators to share this band without adverse impact. **Appendix D** summarizes findings on the national and international occupancy of this band, together with conclusions on the feasibility of its application to MSS uplink feeder link.

The ELLIPSO^{TM} system design requires feeder link spectrum below 16 GHz. Feeder link spectrum above 16 GHz suffers an increasing amount of excess path loss attenuation due to absorption and scattering by atmospheric moisture and precipitation. At Ka band, satellites are unable to generate enough e.i.r.p. and G/T to overcome excess path loss without using high gain spot beam antennas. Spot beam antennas in turn constrain the number of ground stations on the visible earth to only that number supportable by the number of spot antennas on the satellite (around 3 high gain spots would be the maximum practical). Such a limitation on the number of ground stations would dramatically alter the capability of the ELLIPSO^{TM} system to accomplish its mission of extending national communications to unsupported users in countries worldwide, since most countries could not have a ground station. Using feeder links above 16 GHz, the ELLIPSO^{TM} System would be forced 1) to limit service to only a portion of the visible earth, 2) to implement satellite signal demodulation and switching (not considered feasible at this time using CDMA) together with satellite crosslinks, or 3) to accept significantly reduced satellite availability due to operation with feeder link margins inadequate to overcome frequent atmospheric outages.

D. *ELLIPSO™ Ground Station Design.*

MCHI amends its ground entry station (referred to as the ELLIPSO™ Ground Control Station or GCS) design to accommodate the revised ELLIPSO™ feeder links and other conforming changes in system operation.. The ELLIPSO™ GCS will transmit to ELLIPSO™ satellites in the 15.4 - 15.7 GHz band and receive from the ELLIPSO™ satellites in the 6725 - 7025 MHz band. Each GCS will typically employ three 4.5 meter dish antennas, using two to track each of two satellites and one to acquire the next satellite to become available. Additional antennas may be installed for backup.

Each ELLIPSO™ ground station will support all user beams operating in the region around the ground station. Although final siting of ELLIPSO™ GCSs is not yet complete, MCHI anticipates that four GCSs will suffice to serve the United States, including Alaska, Hawaii, Puerto Rico, and the U.S. Virgin Islands. **Table 4** furnishes additional detail on the ELLIPSO™ GCS.

Table 4 - ELLIPSO™ GCS Characteristics

Number of antennas (nominal)	3
Antenna Type	4.5 meter parabolic reflector
Operating Frequencies	
Uplink	15.4 - 15.7 GHz
Downlink	6725 - 7025 MHz
Antenna Gain	
C Band	48.2 dBi
Ku Band	55.3 dBi
G/T	26.4 dB/°K
Power per channel	10 - 60 watts
Total Power (nominal)	1 Kilowatt

The ELLIPSO™ GCS furnishes and accepts baseband digital streams incorporating user, call management, and system management information, between itself and an associated ELLIPSO™ Switching Office (ESO). The ESO handles all subscriber interface, call processing, and ground network interface functions. It may or may not be co-located with the GCS, depending on ground network design and constraints.

The ELLIPSO™ Regional Network Control Center manages the regional ELLIPSO™ network and ELLIPSO™ global resources allocated to the region, maintains call records and subscriber records, assists in international call processing, and administers the regional ELLIPSO™ system for the region supported. It is anticipated that North America will have one RNCC at a convenient location within the continental United States.

E. *The ELLIPSO™ User Terminal*

ELLIPSO™ uses two classes of terminals: Mobile and Fixed.

The ELLIPSO™ mobile terminal transmits between one-quarter and one-half watt into a hemispheric coverage antenna having a gain of 0 dBi above 15° elevation angle. ELLIPSO™ mobile terminals may be handheld, portable, or installed in a vehicle. They may offer simple voice "plain old telephone" service or may also include advanced call features and support data, facsimile, message, geolocation service, and other services. The combinations of services implemented in a particular terminal are left to the regional service provider. A mobile terminal may also provide only data, message, paging, geolocation, or facsimile service without voice in some circumstances. A low rate call alerting/paging channel will be available to all terminals in order to maximize the probability of call receipt in the presence of path blockage.

The ELLIPSO™ fixed terminal transmits a similar e.i.r.p. through a higher gain antenna, having around 10 dBi gain. Since the fixed terminal antenna is sited to avoid obstruction, the fixed terminal link requires less operating margin. Its higher gain antenna increases the terminal's G/T, which in turn increases its performance on the forward path. Its more directive antenna also reduces signal energy transmitted in other directions, reducing interference to other satellites or other systems sharing the band.

All ELLIPSO™ terminals will conform to the requirements of Section 25.213 of Title 47 of the Code of Federal Regulations. ELLIPSO™ terminals will not operate within the designated protection zones around radio astronomy sites within the frequency limits specified in Rules 25.213(a)(1)(i)-(iv) during periods of observation. ELLIPSO™ will use its geopositioning feature, or an GPS receiver imbedded within the user terminal, to geolocate user terminals in order to conform to the requirements of 25.213(a)(1)(vi).

All ELLIPSO™ terminals will conform to the requirements of Rule 25.213(b)-(d). ELLIPSO™ terminals will meet the requirements of ITU RR 731E and F, which requires MSS terminals keep emissions below -15 dBw/4KHz below 1616 MHz. ELLIPSO™ terminals normally operate at a level of around -30 dBw/4KHz in the 3 MHz and -35 dBw/4 KHz in the 7.5 MHz channels. Power control may increase these figures by as much as 10 decibels. At no time will any ELLIPSO™ terminal exceed the emission levels specified in RR 731F.

F. *ELLIPSO™ Link Performance and Capacity*

The foregoing changes to the ELLIPSO™ System result in significantly increased performance. ELLIPSO™ System capacity in the United States is increased to 5200 simultaneous calls, while elevation angles to the best ELLIPSO™ satellite never drop below 25 degrees.

ELLIPSO™ signals employ forward error correction coding, interleaving, and several spreading waveforms to form the final transmitted signal. ELLIPSO™ carriers are modulated using QPSK in both the forward and return directions. Both short and long spreading codes permit rapid acquisition as well as good interference protection from user to user.

Appendix E presents additional detail on ELLIPSO™ waveforms, link budgets, and system capacity.

The ELLIPSO™ system complies with all inter-service sharing criteria in Rule 25.213, including GLONASS, aeronautical radio navigation, radioastronomy, and terrestrial fixed services.

Appendix E

ELLIPSO^{TM} Waveforms, Link Budgets, and System Capacity

Table E-1
Forward Link Calculations, Wideband Channel
Handheld Example

Parameter	Unit	Center	1st Ring	2nd Ring	3rd Ring	4th Ring
GENERAL						
Data Rate	bps	4800	4800	4800	4800	4800
RF Bandwidth	MHz	7.50	7.50	7.50	7.50	7.50
UPLINK						
Frequency	MHz	15550	15550	15550	15550	15550
EIRP/simult user	dBW	50.05	50.74	52.93	56.97	59.79
Transmit Power/simult user	W	0.30	0.35	0.58	1.47	2.81
Transmit Antenna Gain (4.5 m)	dBi	55.3	55.3	55.3	55.3	55.3
Free Space Loss	dB	-194.22	-194.62	-195.57	-197.61	-197.61
Range	km	7889	8262	9223	11655	11655
Atmospheric Losses	dB	0.50	0.50	0.50	0.50	0.50
Receive Antenna Gain	dBi	8.50	8.50	8.50	8.50	7.17
Received Power/simult user	dBW	-136.17	-135.88	-134.65	-132.64	-131.15
Thermal Noise Density	dBW/Hz	-200.82	-200.82	-200.82	-200.82	-200.82
Receiver Temperature	°K	600	600	600	600	600
Thermal Noise Power	dBW	-132.07	-132.07	-132.07	-132.07	-132.07
Uplink Signal to Noise Ratio (S/N)	dB	-4.10	-3.81	-2.58	-0.57	0.92
Transponder gain	dB	132.00	132.00	132.00	132.00	132.00
DOWNLINK						
Frequency	MHz	2490	2490	2490	2490	2490
EIRP/Channel	dBW	22.33	22.52	23.55	25.06	25.65
Net Signal Xmit Pwr/Simult user	W	0.38	0.41	0.54	0.66	1.22
Transmit Antenna Gain	dBi	26.50	26.40	26.20	25.70	24.80
Free Space Loss	dB	-178.26	-178.45	-179.09	-180.60	-181.70
Range	km	7846	8023	8631	10271	11655
Receive antenna gain	dBi	0.00	0.00	0.00	0.00	0.00
Power Control Margin	dB	4.10	4.10	4.50	4.50	4.50
Off-Boresight Gain Loss	dB	1.50	1.50	1.50	1.50	1.50
Power Control Uncertainty	dB	0.60	0.60	0.60	0.60	0.60
Power Control Pool	dB	2.00	2.00	2.40	2.40	2.40
Received signal power	dBW	-160.03	-160.03	-160.03	-160.04	-160.54
Thermal Noise spectral density	dBW/Hz	-203.16	-203.16	-203.16	-203.16	-203.16
User Term Rcvr Temp	°K	350	350	350	350	350
Thermal Noise Power	dBW	-134.41	-134.41	-134.41	-134.41	-134.41
Downlink Signal to Noise Ratio (S/N)	dB	-25.62	-25.62	-25.63	-25.63	-26.13
INTERFERENCE						
Receive Antenna Effective Area	dB-m^2	-29.37	-29.37	-29.37	-29.37	-29.37
Self Interference Spectral Density	dBW/Hz	-217.39	-217.39	-217.39	-217.39	-217.39
Interference PFD (4 kHz)	dBW/m^2	-142	-142	-142	-142	-142
Interference Factor Within Beam		0.00	0.00	0.00	0.00	0.00
Interference Factor For Adjacent Beams		0.10	0.10	0.10	0.10	0.10
Interference Density From Other Ellipsos	dBW/Hz	-207.39	-207.39	-207.39	-207.39	-207.39
Number of other Ellipso satellites		1.00	1.00	1.00	1.00	1.00
Interference PFD (4 kHz)	dBW/m^2	-142	-142	-142	-142	-142
Interference Factor		1.00	1.00	1.00	1.00	1.00
Interference Density From Other Systems	dBW/Hz	-213.41	-213.41	-213.41	-213.41	-213.41
Number of satellites		2	2	2	2	2
Interference PFD (4 kHz)	dBW/m^2	-142	-142	-142	-142	-142
Interference Factor		0.125	0.125	0.125	0.125	0.125
Total Interference Spectral Density	dBW/Hz	-206.09	-206.09	-206.09	-206.09	-206.09
Total Interference Power	dBW	-137.34	-137.34	-137.34	-137.34	-137.34
Downlink Signal to Interference Ratio (S/IF)	dB	-22.69	-22.69	-22.69	-22.70	-23.20
INTERMODULATION						
Downlink Carrier to Intermodulation Ratio (C/IM)	dB	15	15	15	15	15
Downlink Signal to Intermodulation Ratio (S/IM)	dB	-2.28	-2.29	-1.89	-1.90	-2.40
LINK PERFORMANCE						
Composite Signal to Noise Ratio (S/N+IF+IM)	dB	-27.44	-27.44	-27.44	-27.44	-27.94
Processing Gain	dB	31.94	31.94	31.94	31.94	31.94
Received Eb/No	dB	4.50	4.50	4.50	4.50	4.00
Required Eb/No	dB	4.50	4.50	4.50	4.50	4.00
Theoretical Eb/No (10^3 BER)	dB	2.00	2.00	2.00	2.00	2.00
Implementation Loss	dB	1.50	1.50	1.50	1.50	1.00
Multipath Loss	dB	1.00	1.00	1.00	1.00	1.00
Margin	dB	0.0	0.0	0.0	0.0	0.0

Table E-2
Forward Link Calculation, Narrow Band Channel
Fixed Terminal Example

Parameter	Unit	Center	1st Ring	2nd Ring	3rd Ring	4th Ring
GENERAL						
Data Rate	bps	4800	4800	4800	4800	4800
RF Bandwidth	MHz	3.00	3.00	3.00	3.00	3.00
UPLINK						
Frequency	MHz	15550	15550	15550	15550	15550
EIRP/simult user	dBW	43.39	44.08	45.86	49.88	53.20
Transmit Power/simult user	W	0.06	0.08	0.11	0.29	0.62
Transmit Antenna Gain (4.5 m)	dBi	55.3	55.3	55.3	55.3	55.3
Free Space Loss	dB	-194.22	-194.62	-195.57	-197.61	-197.61
Range	km	7889	8262	9223	11655	11655
Atmospheric Losses	dB	0.50	0.50	0.50	0.50	0.50
Receive Antenna Gain	dBi	8.50	8.50	8.50	8.50	7.17
Received Power/simult user	dBW	-142.82	-142.54	-141.71	-139.72	-137.74
Thermal Noise Density	dBW/Hz	-200.82	-200.82	-200.82	-200.82	-200.82
Receiver Temperature	°K	600	600	600	600	600
Thermal Noise Power	dBW	-136.05	-136.05	-136.05	-136.05	-136.05
Uplink Signal to Noise Ratio (S/N)	dB	-6.78	-6.49	-5.67	-3.68	-1.69
Transponder gain	dB	132.00	132.00	132.00	132.00	132.00
DOWNLINK						
Frequency	MHz	2490	2490	2490	2490	2490
EIRP/Channel	dBW	15.68	15.86	16.49	17.98	19.08
Net Signal Xmit Pwr/Simult user	W	0.08	0.09	0.11	0.17	0.27
Transmit Antenna Gain	dBi	26.50	26.40	26.20	25.70	24.80
Free Space Loss	dB	-178.26	-178.45	-179.09	-180.60	-181.70
Range	km	7846	8023	8631	10271	11655
Receive antenna gain	dBi	10.00	10.00	10.00	10.00	10.00
Power Control Margin	dB	2.10	2.10	2.10	2.10	2.10
Off-Boresight Gain Loss	dB	1.50	1.50	1.50	1.50	1.50
Power Control Uncertainty	dB	0.60	0.60	0.60	0.60	0.60
Power Control Pool	dB	0.00	0.00	0.00	0.00	0.00
Received signal power	dBW	-154.68	-154.69	-154.70	-154.72	-154.74
Thermal Noise spectral density	dBW/Hz	-205.59	-205.59	-205.59	-205.59	-205.59
User Term Rcvr Temp	°K	200	200	200	200	200
Thermal Noise Power	dBW	-140.82	-140.82	-140.82	-140.82	-140.82
Downlink Signal to Noise Ratio (S/N)	dB	-13.86	-13.87	-13.88	-13.90	-13.92
INTERFERENCE						
Receive Antenna Effective Area	dB-m^2	-19.37	-19.37	-19.37	-19.37	-19.37
Self Interference Spectral Density	dBW/Hz	-207.39	-207.39	-207.39	-207.39	-207.39
Interference PFD (4 kHz)	dBW/m^2	-142	-142	-142	-142	-142
Interference Factor Within Beam		0.00	0.00	0.00	0.00	0.00
Interference Factor For Adjacent Beams		0.10	0.10	0.10	0.10	0.10
Interference Density From Other Ellipsos	dBW/Hz	-197.39	-197.39	-197.39	-197.39	-197.39
Number of other Ellipso satellites		1.00	1.00	1.00	1.00	1
Interference PFD (4 kHz)	dBW/m^2	-142	-142	-142	-142	-142
Interference Factor		1.00	1.00	1.00	1.00	1.00
Interference Density From Other Systems	dBW/Hz	-203.41	-203.41	-203.41	-203.41	-203.41
Number of satellites		2	2	2	2	2
Interference PFD (4 kHz)	dBW/m^2	-142	-142	-142	-142	-142
Interference Factor (X-pol)		0.13	0.13	0.13	0.13	0.13
Total Interference Spectral Density	dBW/Hz	-196.09	-196.09	-196.09	-196.09	-196.09
Total Interference Power	dBW	-131.32	-131.32	-131.32	-131.32	-131.32
Downlink Signal to Interference Ratio (S/IF)	dB	-23.36	-23.37	-23.38	-23.40	-23.42
INTERMODULATION						
Downlink Carrier to Intermodulation Ratio (C/IM)	dB	15	15	15	15	15
Downlink Signal to Intermodulation Ratio (S/IM)	dB	-4.96	-4.96	-4.96	-5.00	-5.01
LINK PERFORMANCE						
Composite Signal to Noise Ratio (S/N+IF+IM)	dB	-23.96	-23.96	-23.96	-23.96	-23.96
Processing Gain	dB	27.96	27.96	27.96	27.96	27.96
Received Eb/No	dB	3.99	3.99	4.00	4.00	4.00
Required Eb/No	dB	4.00	4.00	4.00	4.00	3.50
Theoretical Eb/No (10^3 BER)	dB	2.00	2.00	2.00	2.00	2.00
Implementation Loss	dB	1.50	1.50	1.50	1.50	1.00
Multipath Loss	dB	0.50	0.50	0.50	0.50	0.50
Margin	dB	0.0	0.0	0.0	0.0	0.5

Table E-3
Return Link Calculations, Wide Band Channel
Handheld Terminal Example

Parameter	Unit	Center	1st Ring	2nd Ring	3rd Ring	4th Ring
GENERAL						
Data Rate	bps	4800	4800	4800	4800	4800
RF Bandwidth	MHz	7.50	7.50	7.50	7.50	7.50
UPLINK						
Frequency	MHz	1620	1620	1620	1620	1620
EIRP/Channel	dBW	-3.01	-3.01	-3.01	-3.01	-3.01
Transmit Power Per Channel	W	0.500	0.500	0.500	0.500	0.500
Transmit Antenna Gain	dBi	0.00	0.00	0.00	0.00	0.00
Free Space Loss	dB	-174.57	-174.97	-175.95	-177.61	-177.96
Range	km	7890	8260	9250	11190	11655
Receive Antenna Gain	dBi	23.80	23.60	23.50	25.50	24.80
Received Power	dBW	-153.78	-154.38	-155.47	-155.12	-156.17
Thermal Noise Density	dBW/Hz	-201.85	-201.85	-201.85	-201.85	-201.85
Receiver Temperature	K	473	473	473	473	473
Thermal Noise Power	dBW	-133.10	-133.10	-133.10	-133.10	-133.10
Uplink Signal to Noise Ratio (S/N)	dB	-20.68	-21.28	-22.36	-22.02	-23.07
Transponder gain	dB	132.00	132.00	132.00	132.00	132.00
DOWNLINK						
Frequency	MHz	6875	6875	6875	6875	6875
EIRP/simultaneous user signal only	dBW	-13.61	-14.21	-15.59	-15.55	-17.00
Free Space Loss	dB	-187.13	-187.53	-188.48	-190.52	-190.52
Range	km	7889	8262	9223	11655	11655
Atmospheric Losses	dB	1.00	1.00	1.00	1.00	1.00
Receive Antenna Gain	dBI	48.2	48.2	48.2	48.2	48.2
Received Signal Power	dBW	-153.53	-154.53	-156.87	-158.86	-160.31
Thermal Noise spectral density	dBW/Hz	-206.84	-206.84	-206.84	-206.84	-206.84
Receiver Temperature	K	150	150	150	150	150
Thermal Noise Power	dBW	-138.09	-138.09	-138.09	-138.09	-138.09
Downlink Signal to Noise Ratio (S/N)	dB	-15.56	-16.54	-18.84	-20.80	-22.25
INTERFERENCE						
Interf Factor For In-beam Channels		1.000	1.000	1.000	1.000	1.000
Interf Factor For Adj Beam Channels		0.50	0.50	0.50	0.50	0.50
Interf Factor For Users on Other Ellipso Sats		1.50	1.50	1.50	1.50	1.50
Interference Factor For Other Systems(X-pol)		0.250	0.250	0.250	0.250	0.250
Downlink Signal to Interference Ratio (S/IF)	dB	-22.04	-22.06	-21.70	-21.77	-22.31
INTERMODULATION						
Downlink Carrier to Intermodulation Ratio (C/IM)	dB	15	15	15	15	15
Downlink Signal to Intermodulation Ratio (S/IM)	dB	-10.28	-10.51	-10.77	-10.65	-11.43
LINK PERFORMANCE						
Composite Signal to Noise Ratio (S/N+IF+IM)	dB	-25.10	-25.46	-26.11	-26.45	-27.44
Processing Gain	dB	31.94	31.94	31.94	31.94	31.94
Received Eb/No	dB	6.84	6.48	5.82	5.49	4.50
Required Eb/No	dB	4.00	4.00	4.00	4.00	4.00
Theroetical Eb/No (10^3 BER)	dB	2.00	2.00	2.00	2.00	2.00
Implementation Loss	dB	1.00	1.00	1.00	1.00	1.00
Multipath Loss	dB	1.00	1.00	1.00	1.00	1.00
Margin	**dB**	**2.8**	**2.5**	**1.8**	**1.5**	**0.5**

Table E-4
Return Link Calculations, Narrow Band Channel
Fixed Terminal Example

Parameter	Unit	Center	1st Ring	2nd Ring	3rd Ring	4th Ring
GENERAL						
Data Rate	bps	4800	4800	4800	4800	4800
RF Bandwidth	MHz	3.00	3.00	3.00	3.00	3.00
UPLINK		0.018	0.020	0.023	0.060	0.110
Frequency	MHz	1620	1620	1620	1620	1620
EIRP/Channel	dBW	-3.01	-3.01	-3.01	-3.01	-3.01
Transmit Power Per Channel	W	0.050	0.050	0.050	0.050	0.050
Transmit Antenna Gain	dBi	10.00	10.00	10.00	10.00	10.00
Free Space Loss	dB	-174.57	-174.97	-175.95	-177.61	-177.96
Range	km	7890	8260	9250	11190	11655
Receive Antenna Gain	dBi	23.80	23.60	23.50	25.50	24.80
Received Power	dBW	-153.78	-154.38	-155.47	-155.12	-156.17
Thermal Noise Density	dBW/Hz	-201.85	-201.85	-201.85	-201.85	-201.85
Receiver Temperature	K	473	473	473	473	473
Thermal Noise Power	dBW	-137.08	-137.08	-137.08	-137.08	-137.08
Uplink Signal to Noise Ratio (S/N)	dB	-16.70	-17.30	-18.39	-18.04	-19.09
Transponder gain	dB	132.00	132.00	132.00	132.00	132.00
DOWNLINK						
Frequency	MHz	6875	6875	6875	6875	6875
EIRP/simultaneous user signal only	dBW	-13.61	-14.21	-15.59	-15.55	-17.00
Free Space Loss	dB	-187.13	-187.53	-188.48	-190.52	-190.52
Range	km	7889	8262	9223	11655	11655
Atmospheric Losses	dB	1.00	1.00	1.00	1.00	1.00
Receive Antenna Gain	dBi	48.2	48.2	48.2	48.2	48.2
Received Signal Power	dBW	-153.53	-154.53	-156.87	-158.86	-160.31
Thermal Noise spectral density	dBW/Hz	-206.84	-206.84	-206.84	-206.84	-206.84
Receiver Temperature	K	150	150	150	150	150
Thermal Noise Power	dBW	-142.07	-142.07	-142.07	-142.07	-142.07
Downlink Signal to Noise Ratio (S/N)	dB	-11.76	-12.70	-14.94	-16.88	-18.31
INTERFERENCE						
Interf Factor For In-beam Channels		1.000	1.000	1.000	1.000	1.000
Interf Factor For Adj Beam Channels		0.50	0.50	0.50	0.50	0.50
Interf Factor For Users on Other Ellipso Sats		0.25	0.25	0.25	0.25	0.25
Interference Factor For Other Systems(X-pol)		0.060	0.060	0.060	0.060	0.060
Downlink Signal to Interference Ratio (S/IF)	dB	-22.18	-22.20	-22.12	-22.12	-22.38
INTERMODULATION						
Downlink Carrier to Intermodulation Ratio (C/IM)	dB	15	15	15	15	15
Downlink Signal to Intermodulation Ratio (S/IM)	dB	-9.95	-10.07	-10.22	-10.14	-10.58
LINK PERFORMANCE						
Composite Signal to Noise Ratio (S/N+IF+IM)	dB	-23.74	-23.95	-24.37	-24.58	-25.23
Processing Gain	dB	27.96	27.96	27.96	27.96	27.96
Received Eb/No	dB	4.22	4.01	3.59	3.40	2.73
Required Eb/No	dB	3.50	3.50	3.50	3.50	3.50
Theroetical Eb/No (10^3 BER)	dB	2.00	2.00	2.00	2.00	2.00
Implementation Loss	dB	1.00	1.00	1.00	1.00	1.00
Multipath Loss	dB	0.50	0.50	0.50	0.50	0.50
Margin	**dB**	**0.7**	**0.5**	**0.1**	**-0.1**	**-0.8**

Table E-5
Ellipso System Capacity in the United States
Voice Call Equivalents

No of Satellites of Other MSS Systems in Operation	Single Transponder Capacity (1 beam @ PFD -142)*	Ellipso Capacity @ PFD -142
0	405	5,200
1: X-pol	378	4,900
2 X-pol	350	4,600
3 2 X-pol, 1 co-pol	235	3,000
3 1 X-pol, 2 co-pol	188	2,400
4 2 X-pol, 2 co-pol	180	2,300

*slight variations possible among beams

Table E-6
Ellipso Waveform Characteristics

Aspect	Characteristic
Speech Encoding	Improved Multiband Excitation @ 4.8 kbs
User Data Rates	300 - 9,600 bps
FEC Coding	r = 1/3, K = 9
Forward Traffic PN Codes	Orthogonal Code Family Overlay
Forward Broadcast Channel PN Code	Short Repeating Code
Return Access Code	Short Repeating Code
Forward Link PN Modulation	QPSK
Return Link PN Modulation	Offset QPSK
Forward Link Data Modulation	BPSK
Return Link Data Demodulation	Costas Loop without Pilot
Interleaver	10 - 320 ms

EXHIBIT 2

Legal Qualifications

FCC 430

FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

Approved by OMB
3060-0105
Expires 2/28/96

LICENSEE QUALFICATION REPORT

See reverse side for information regarding public burden statement.

INSTRUCTIONS

. The "Filer" of this report is defined to include: (1) An applicant, where this report is submitted in connection with applications for common carrier and satellite radio authority as required for such applications; or (2) A licensee or permittee, where this report is required by the Commission's Rules to be submitted on an annual basis.

. Submit an original and one copy (sign original only) to the Federal Communications Commission, Washington, DC 20554. If more than one radio service is listed in Item 6, submit an additional copy for each such additional service. If this report is being submitted in connection with an application for radio authority, attach it to that application.

. Do not submit a fee with this report.

. Business Name and Address (Number, Street, State and ZIP Code) of Filer's Principal Office:

Mobile Communications Holdings, Inc.
1120 19th Street, N.W. Suite 460
Washington, D.C. 20036

2. (Area Code) Telephone Number: (202) 466-4488

3. If this report supercedes a previously filed report, specify its date: August 1994

. Filer is (check one):
☐ Individual ☐ Partnership ☒ Corporation
☐ Other (Specify):

5. Under the laws of what State (or other jurisdiction) is the Filer organized? Delaware

. List the common carrier and satellite radio services in which Filer has applied or is a current licensee or permittee:

Above 1 GHz MSS

(a) Has the Filer or any party to this application had any FCC station license or permit revoked or had any application for permit, license or renewal denied by this Commission? *If "YES", attach as Exhibit I a statement giving call sign and file number of license or permit revoked and relating circumstances.* ☐ Yes ☒ No

(b) Has any court finally adjudged the Filer, or any person directly or indirectly controlling the Filer, guilty of unlawfully monopolizing or attempting unlawfully to monopolize radio communication, directly or indirectly, through control of manufacture or sale of radio apparatus, exclusive traffic arrangement, or other means of unfair methods of competition? *If "YES", attach as Exhibit II a statement relating the facts.* ☐ Yes ☒ No

(c) Has the Filer, or any party to this application, or any person directly or indirectly controlling the Filer ever been convicted of a felony by any state or Federal Court? *If "YES", attach as Exhibit III a statement relating the facts.* ☐ Yes ☒ No

(d) Is the Filer, or any person directly or indirectly controlling the Filer, presently a party in any matter referred to items 7(b) and 7(c)? *If "YES", attach as Exhibit IV a statement relating the facts.* ☐ Yes ☒ No

. Is the Filer, directly or indirectly, through stock ownership, contract or otherwise, currently interested in the ownership or control of any other radio stations licensed by this Commission? *If "YES", submit as Exhibit V the name of each such licensee and the licensee's relation to the Filer.* ☐ Yes ☒ No

If Filer is an individual (sole proprietorship) or partnership, answer the following and Item 11:

(a) Full Legal Name and Residential Address (Number, Street, State and ZIP Code) of Individual or Partners:

(b) Is individual or each member of a partnership a citizen of the United States? ☐ Yes ☐ No

(c) Is individual or any member of a partnership a representative of an alien or of a foreign government? ☐ Yes ☐ No

EXHIBIT VI

The entities owning and/or voting MCHI's voting stock and the percentages held are identified below.

	No. of Shares	% Voting Stock
DC Limited Partnership 1120-19th Street, N.W. Washington, D.C. 20036	1,864,395	71.12
Venture First Associates 201 Allen Road Suite 410 Atlanta, Georgia 30328	255,198	9.73
Barclays de Zoete Wedd, Ltd. Ebbgate House 2 Swan Lane London EC4R3TS England	150,000	5.72
Israel Aircraft Industries Ben Gurion International Airport 70100 Israel	100,000	3.81
Fairchild Space and Defense Company 20301 Century Boulevard Germantown, Maryland 20874	50,000	1.91
Westinghouse Electric Corporation Box 1897 Baltimore, Maryland 21203	50,000	1.91
Cable & Wireless 124 Theobalds Road London WC1X8RX England	50,000	1.91
Harris Corporation 1000 Perimeter Road Palm Bay, Florida 32905	25,000	0.95

Spectrum Network Systems Limited 50 Margaret Street GPO Box 5121 Sydney NSW 2000 Australia	25,000	0.95
AEC-Able Engineering Company Inc. 93 Castilian Drive Goleta, California 93117	25,000	0.95

All of the stockholders of MCHI are United States corporations with the exception of the following: Barclays (United Kingdom); Cable & Wireless (United Kingdom); Spectrum (Australia), IAI (Israel).

Cable & Wireless has an option to acquire 600,000 shares of MCHI common stock. Arianespace has convertible debentures for approximately 330,000 shares.

EXHIBIT VII

The officers and directors of MCHI are listed below. Each is a United States citizen. Jacob Weiss holds dual United States/Israeli citizenship.

David Castiel
Mobile Communications Holdings, Inc.
1120-19th Street, N.W.
Suite 480
Washington, DC 20036

Michael Stone
1818 N Street, N.W.
Washington, DC 20036

J. Douglass Mullins
Venture First Associates
1901 South Harbor City Boulevard
Suite 501
Melbourne, Florida 32901

Larry Yermack
Fairchild Space and Defense Co.
20301 Century Boulevard
Germantown, Maryland 20874

Jacob Weiss
Israeli Aircraft Industries
Ben Gurion International Airport
70100 Israel

EXHIBIT VIII

MCHI is controlled by DC Limited Partnership (DCLP), a Delaware corporation. The address of DCLP is 1120-19th Street, N.W., Washington, D.C. 20036. Its primary business is telecommunications investment.

The stockholders owning 10% or more of DCLP stock, all of which are U.S. citizens, are as follows: David Castiel (56.88%)

The president and directors of MCHI are David Castiel and Michael Stone, whose address is 1120-19th Street, N.W., Washington, D.C. 20036.

EXHIBIT 3

Financial Qualifications

This Exhibit is being submitted separately under Request for Confidentiality.

EXHIBIT 4

ELLIPSO^{TM} Market and Services

ELLIPSO^{TM} Markets and Services

The ELLIPSO^{TM} service offerings are constructed to address the growing global demand for accessible telecommunications. As demonstrated in the cellular communications market, global demand for wireless communications is rapidly expanding. Geographic and functional profiles have been considered in tailoring the service offerings. For developed regions, ELLIPSO^{TM} provides continuous coverage, augmenting areas unserved by cellular. For developing regions, ELLIPSO^{TM} provides opportunities for rapid deployment of the infrastructure necessary to support continued development. Services are designed to support mobile travelers, business users, the trucking industry, maritime, and remote monitoring through Supervisory Control And Data Acquisition (SCADA) systems.

Demand for ELLIPSO^{TM} voice and data services can be paralleled to the expanding global cellular market. In the US market alone, the total cellular subscriber count is approximately 19 million subscribers, with more than 3 million new subscribers being added in the first six months of 1994. With exponential growth, the global cellular subscriber quantities have increased by 25% in 1991, 42% in 1992, and 49% in 1993 to reach a total at the beginning of this year of 33.9 million. With the territorial coverage of cellular expected to reach only between 45 and 65 percent of the continental US by the end of the century, there are strong opportunities for other cost-effective means of mobile communication. The MSS market is expected to take a similar growth path. As shown in Figure 1, ELLIPSO^{TM}

with conservative estimates of a 7% share of the global $20 Billion market for mobile satellite services, ELLIPSO™ will reach between 1.35 to 1.75 million subscribers.

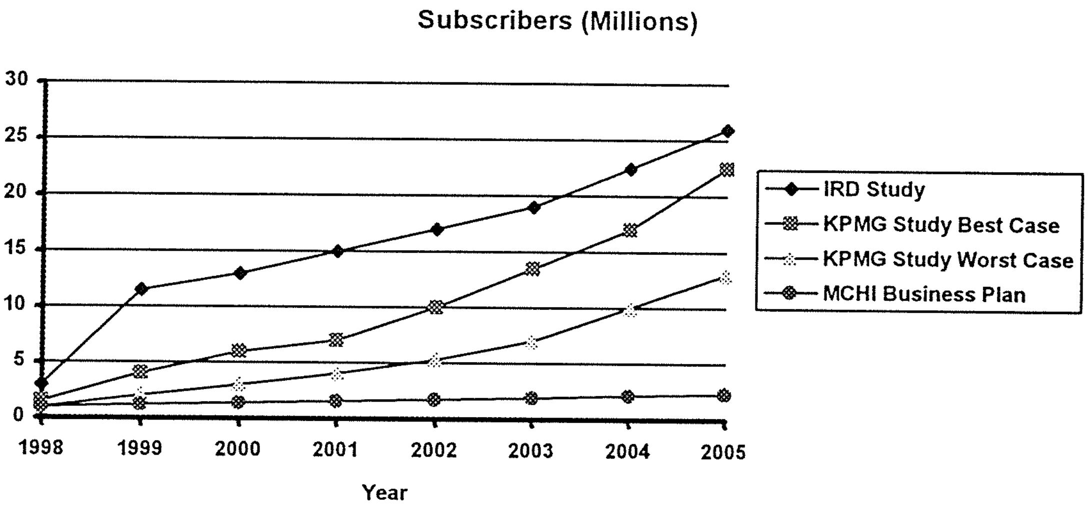

Figure 1. Global Mobile Satellite Communications Market, Growing 51% annually

ELLIPSO™ voice and value added data services are designed to serve a range of large markets and complement existing terrestrial telecommunications systems. Voice users include those unreachable by terrestrial communications services, and travelers requiring ubiquitous coverage. Data services include geolocation, messaging, fax, packet, and circuit switched data. Business travelers benefit from global access to communications. The US trucking industry, with a market of over 17 million commercial and government trucks and 30 million personal use trucks, of which less than 3 percent has been reached by mobile communications systems, can be served by the competitive equipment and service pricing offered by ELLIPSO™. The inexpensive offering of voice, geolocation, faxing and messaging are of great assistance to the trucking industry. Remote monitoring and SCADA systems benefit from access to communications services for monitor and control; economic and environmental improvements result. Government applications include support for law enforcement and emergency services. The financial services sector, particularly in developing countries, has strong requirements for rapid deployment of communications services into newly developing areas. Through the services offered by ELLIPSO™, opportunities for new economic growth and investment can thrive.

ELLIPSO™ will serve the international market to help extend the National Information Infrastructure (NII) into a Global Information Infrastructure (GII). With constellations designed to reach all major populous areas, ELLIPSO™ serves two types of regions (1) those with unserved rural users; and (2) well developed areas with roamers into unserved areas. Large, well developed countries, such as the US, are experiencing rapid growth in the population of cellular users, with approximately 35 to 55 percent of the country not likely to be covered by the cellular systems within this century. The ELLIPSO™ dual-mode (cellular/MSS) terminals provide these users with ubiquitous coverage throughout the region. Developing countries, such as China, India, and Russia, have large segments of their populations unreached by their existing telecommunications infrastructure. ELLIPSO™ offers services that meet the requirements of the developing nations:

rapid service deployment, wide access, and access to real-time information, in a well-managed network.

By providing a rich set of voice and data services, with ubiquitous coverage at competitive equipment and service rates, ELLIPSO™ extends communications to new users. ELLIPSO™ services are consistent with the goals expressed by Reed Hundt, FCC chairman. By providing communication to unserved areas, ELLIPSO™ can facilitate economic growth, better health care, education, and sustainable development. With large pools of potential subscribers in both developed and developing nations, ELLIPSO™ can easily meet its target subscription/usage rates. In conservative estimates of less than 7% of the global LEO market, the system will serve an anticipated user community that will reach between 1.35 and 1.75 million subscribers by 2005.

Each user will be equipped with a terminal capable of providing position location and voice/data services from any location within the coverage area as required by the report and order (CC Docket No. 92-166) which includes the entire United States and her territories/possessions. Terrestrial or other mobile terminations throughout the world are then reached via the existing terrestrial telecommunications infrastructure. The user terminal segment consists of User Terminals (UT) of which there are several varieties: hand-held, land mobile, maritime, and fixed site. Each of these varieties may be equipped to provide the planned ELLIPSO™ services. The ELLIPSO™ services include voice, circuit switched data, packet switched data, facsimile, dual-mode cellular interoperability, and messaging/paging. Any one UT may be equipped to provide from one to all of the planned service types depending on the requirements of the individual user. ELLIPSO™ will offer virtually world-wide, satellite based mobile voice and data services. Current and future subscribers of mobile telecommunications services who roam beyond their coverage area and unserved rural users are expected benefit the most from ELLIPSO™ services. For instance, current cellular users may elect to retain their cellular telephone service and augment it with ELLIPSO™ service by purchasing a cellular interoperable ELLIPSO™ User Terminal. Thus, with a single telephone directory number the subscriber may be reached via the satellite or terrestrial cellular network. The target retail purchase price of a user terminal is in the few hundred dollar range depending on the features purchased.

ELLIPSO™ will offer direct and transparent interconnection with terrestrial cellular services providing end-users with the benefits of "seamless" roaming. These highly innovative services are built into the system design. Among the other benefits of the system to users are: (1) highly competitive equipment and service charges; (2) equipment design that ranges from hand-held User Terminals, to land mobile/maritime, to fixed site rural telephony terminals that provide for ease of installation and operation in their intended environments; and (3) a wide range of voice and data services including voice, circuit switched data, packet switched data, facsimile, and paging/messaging.

The ELLIPSO^{TM} ground network design is based on the advanced Global System for Mobility (GSM) standards. These standards offer advanced features such as identification, short messaging, plus all of the standard features that mobile subscribers are demanding.

EXHIBIT 5

Application for Launch and Operation Authority

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In re Application of	)		
	)		
	)		
MOBILE COMMUNICATIONS	)		
HOLDINGS, INC.	)	File Nos.	11-DSS-P-91(6)
	)		18-DSS-P-91(18)
	)		
For Authority to Launch and	)		
Operate the ELLIPSO^{TM} Mobile	)		
Satellite System	)		

APPLICATION TO LAUNCH AND OPERATE THE ELLIPSO^{TM} SATELLITE SYSTEM

Mobile Communications Holdings, Inc. ("MCHI") hereby requests authority to launch and operate the ELLIPSO^{TM} satellite system consisting of sixteen elliptical low-Earth orbit satellites in the Above 1 GHz Mobile Satellite Service ("MSS"). MCHI's applications requesting authority to construct the ELLIPSO^{TM} satellite system were submitted in November 1990 and June 1991, respectively. An amendment to the applications is being submitted concurrently herewith in accordance with the Commission's Report and Order in CC Docket 92-166, 59 Fed. Reg. 53294 (October 21, 1994).

This application for launch and operation authority is being filed separately in order to comply with the Commission's application fee schedule which clearly treats construction permit and launch applications as two distinct filings, with separate procedural requirements and fees.[1] For purposes of Commission consideration, however, the two applications should be considered as one integrated filing and the particulars of system operation, as set forth in MCHI 's construction applications, as amended on November 16, 1994, are hereby incorporated by this reference.

Implementation of the **ELLIPSO**™ satellite system will provide significant public benefits, including the implementation of new, innovative and publicly beneficial global satellite services. MCHI therefore requests that its applications be granted as expeditiously as possible.

Respectfully submitted,

MOBILE COMMUNICATIONS HOLDINGS, INC.

David Castiel
Chairman and CEO
1120 19th Street, N.W.
Washington, D.C. 20036
(202) 466-4488

Of Counsel:

Jill Abeshouse Stern
Shaw, Pittman, Potts & Trowbridge
2300 N Street, N.W.
Washington, D.C. 20037
(202) 663-8000

November 16, 1994

---

[1] Satellite construction permits and launch authority are distinct authorizations. See Report and Order, CC Docket No. 92-76, 8 FCC Rcd 8450, 8454, n. 29 (1993) ("The applicant's space station construction permit and its subsequent launch and operating license, while embodied in the same document, are distinct authorizations.") While MCHI is confident that this approach complies fully with the letter and intent of Commission rules, it requests a waiver to the extent that one may be required.

CERTIFICATION

The undersigned hereby certifies individually and on behalf of MCHI that no party to this application is subject to a denial of federal benefits pursuant to Section 5301 of the Anti-drug Abuse Act of 1988, 21 U.S.C. § 853.

Respectfully submitted,

David Castiel
Chairman and CEO
Mobile Communications Holdings, Inc.
1120-19th Street, N.W.
Washington, D.C. 20036

Dated: November 16, 1994

MILLER & HOLBROOKE
1225 NINETEENTH STREET, N. W.
WASHINGTON, D. C. 20036

TELEPHONE (202) 785-0600
TELECOPIER (202) 785-1234

MICHAEL D. BERG
WILLIAM W. BURRINGTON***
LARRINE S. HOLBROOKE
ELDRED INGRAHAM**
TILLMAN L. LAY
NICHOLAS P. MILLER
KAREN HOCHSTEIN NEUMAN
BARBARA D. RANAGAN
JILL ABESHOUSE STERN

WILLIAM R. MALONE
OF COUNSEL
BETTY ANN KANE*
FEDERAL RELATIONS ADVISOR

*NOT ADMITTED TO THE BAR
**ADMITTED IN PENNSYLVANIA ONLY
***ADMITTED IN WISCONSIN ONLY

June 3, 1991

Federal Communications Commission
Common Carrier Domestic Satellites
P.O. Box 358160
Pittsburgh, PA 15251-5160

Dear Sir or Madam:

On behalf of Ellipsat Corporation, I am transmitting herewith an original and nine copies of its application for authority to construct ELLIPSO™II, consisting of eighteen elliptical orbit satellites. In addition to a comprehensive system proposal, eighteen separate applications are included, one for each satellite to be constructed. Ellipsat previously filed an application for ELLIPSO™I, the first phase of the ELLIPSO™ constellation, consisting of six satellites (FCC File No. 11-DSS-P-91(6)). The eighteen ELLIPSO™II satellites described in this filing will extend and enhance ELLIPSO™ service.

The ELLIPSO™ satellite system will operate in the 1610-1626.5 MHz (uplink) and 2483.5-2500 MHz (downlink) bands, and will provide radiodetermination satellite services. Mobile cellular services will be provided on an ancillary basis. Because the proposed system utilizes state-of-the-art technology that is readily available, it can be rapidly implemented thereby providing the benefits of nationwide coverage on an expeditious and cost effective basis. Ellipsat anticipates that initial commercial service could be available in less than twenty-four months from grant of construction authority. The system will utilize CDMA technology, which provides such public interest benefits as superior technical quality, "seamless" roaming, ability to accommodate multiple systems within the same frequency allocation, and interconnection with the telephone network.

A check for $36,540 is enclosed to cover the filing fee for eighteen satellites, along with a fee processing form (FCC Form 155). It is requested that a date-stamped copy of the transmittal letter be returned. A stamped, addressed envelope is provided for this purpose.

Should there be any questions concerning this matter, kindly communicate with the undersigned.

Sincerely yours,

Jill Abeshouse Stern.

Jill Abeshouse Stern
Counsel to Ellipsat Corporation

JAS/rlc
Enclosures
FCC-PA.1(0261)

MILLER & HOLBROOKE
1225 NINETEENTH STREET. N. W.
WASHINGTON, D. C. 20036

MICHAEL D. BERG
WILLIAM W. BURRINGTON***
LARRINE S. HOLBROOKE
ELDRED INGRAHAM**
TILLMAN L. LAY
NICHOLAS P. MILLER
KAREN HOCHSTEIN NEUMAN
BARBARA D. RANAGAN
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TELEPHONE (202) 785-0600
TELECOPIER (202) 785-1234

WILLIAM R. MALONE
OF COUNSEL
BETTY ANN KANE*
FEDERAL RELATIONS ADVISOR

*NOT ADMITTED TO THE BAR
**ADMITTED IN PENNSYLVANIA ONLY
***ADMITTED IN WISCONSIN ONLY

June 3, 1991

Federal Communications Commission
Common Carrier Domestic Satellites
P.O. Box 358160
Pittsburgh, PA 15251-5160

Dear Sir or Madam:

Ellipsat Corporation is today filing its application, under separate cover, to construct eighteen elliptical orbit satellites comprising the ELLIPSO™II system. The application includes a comprehensive system proposal and eighteen individual satellite applications. A check for $36,540 accompanied the applications to meet the filing fee requirements.

Although a total fee of $36,540 accompanied the Ellipsat applications, it is requested that the Commission grant a waiver pursuant to Section 1.1115 of the Rules and issue a partial refund to Ellipsat Corporation in the amount of $32,480. This amount represents the difference between the amount paid and the appropriate fee of $4,060. See Letter to Albert Halprin, Esquire, dated August 13, 1990.

A refund is appropriate because the eighteen satellite applications are identical, and the fee paid is far in excess of the Commission's processing cost. The Commission's primary task is to determine whether Ellipsat is qualified to construct the satellites, and whether the satellites are properly designed. This task requires the same amount of time whether one satellite or eighteen satellites is being reviewed.

The FCC has previously granted waivers of filing fee requirements in order to ensure that the levy more accurately reflects the average cost of the Commission's processes involved in disposing of the matter subject to the fee requirement. See Letter to Joseph Godly and Sharon Pavlos, dated December 21, 1987 (Equatorial); letter to Peter Tanenwald, dated March 28, 1988 (IDB).

Most recently, the FCC granted a refund in the amount of $36,000 to Orbital Communications Commission, waiving the filing fee for 20 of the 22 satellites it proposed. See Letter to Albert Halprin, supra. Although the FCC drew a distinction in that letter between applications filed before and after May 21, 1990, the present circumstances justify a waiver regardless of the application filing date. As noted, the technical specifications of the eighteen satellites are identical in all respects. Moreover, imposition of a filing fee for each of the individual satellite applications in inconsistent with and could thwart the FCC's domestic satellite policies by discouraging open entry and the innovative technological developments it fosters, particularly for small satellite proposals which often involve new entrants and large numbers of small satellites in each system. Imposition of separate, multiple fees is also inconsistent with Appendix B of Space Station Application Filing Procedures, 48 Fed. Reg. 40256 (September 6, 1983), which provides for filing of a system proposal and applications for each proposed space station as one "application."

For the above reasons, it is requested that a partial refund of $32,480 be granted to Ellipsat Corporation as expeditiously as possible.

Very truly yours,

Jill Abeshouse Stern

Jill Abeshouse Stern
Counsel to Ellipsat Corporation

JAS/rlc
cc: Marilyn McDermett
Fern Jarmulnek

FCC-PA.2(0261)

Approved by OMB
3060-0440
Expires 12/31/90

FEDERAL COMMUNICATIONS COMMISSION

FEE PROCESSING FORM

FOR FCC USE ONLY

FCC/MELLON JUN 04 1991

06-05-91 212419 001

Please read instructions on back of this form before completing it. Section I MUST be completed. If you are applying for concurrent actions which require you to list more than one Fee Type Code, you must also complete Section II. This form must accompany all payments. Only one Fee Processing Form may be submitted per application or filing. Please type or print legibly. All required blocks must be completed or application/filing will be returned without action.

SECTION I

APPLICANT NAME (Last, first, middle initial)
Ellipsat Corporation

MAILING ADDRESS (Line 1) (Maximum 35 characters - refer to Instruction (2) on reverse of form)
c/o Jill Abeshouse Stern

MAILING ADDRESS (Line 2) (if required) (Maximum 35 characters)
1225 19th Street, N.W., Suite 400

CITY
Washington,

STATE OR COUNTRY (if foreign address)	ZIP CODE	CALL SIGN OR OTHER FCC IDENTIFIER (if applicable)
D.C.	20036	

Enter in Column (A) the correct Fee Type Code for the service you are applying for. Fee Type Codes may be found in FCC Fee Filing Guides. Enter in Column (B) the Fee Multiple, if applicable. Enter in Column (C) the result obtained from multiplying the value of the Fee Type Code in Column (A) by the number entered in Column (B), if any.

	(A) FEE TYPE CODE	(B) FEE MULTIPLE (if required)	(C) FEE DUE FOR FEE TYPE CODE IN COLUMN (A)	FOR FCC USE ONLY
(1)	B B Y	1 8	$ 36,540.00	2030^{00}

SECTION II — To be used only when you are requesting concurrent actions which result in a requirement to list more than one Fee Type Code.

	(A) FEE TYPE CODE	(B) FEE MULTIPLE (if required)	(C) FEE DUE FOR FEE TYPE CODE IN COLUMN (A)	FOR FCC USE ONLY
(2)			$	
(3)			$	
(4)			$	
(5)			$	

ADD ALL AMOUNTS SHOWN IN COLUMN C, LINES (1) THROUGH (5), AND ENTER THE TOTAL HERE. THIS AMOUNT SHOULD EQUAL YOUR ENCLOSED REMITTANCE. →

TOTAL AMOUNT REMITTED WITH THIS APPLICATION OR FILING	FOR FCC USE ONLY
$ 36,540.00	$36,540^{00}$

This form has been authorized for reproduction.

FCC Form 155
May 1990