187-SAT-P/LA-97
COPY

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

Application Of
Iridium LLC

To Launch And Operate

The MACROCELL Satellite System

26 September 1997

EXECUTIVE SUMMARY

Iridium herein applies for authority to launch and operate the MACROCELL MSS system, a 21st Century state-of-the-art personal communications system providing millions of users in the United States and throughout the world with universal access to advanced digital mobile communications. The MACROCELL system will employ a constellation of 96 low earth orbit satellites circling the globe in 8 near-polar orbital planes some 850 kilometers above the earth. These satellites will be connected by means of Ka band radio intersatellite links and gateway earth stations to form a global satellite network capable of providing two-way voice and data communications using handheld, mobile, and transportable subscriber user units anywhere in the world and interconnecting such subscriber units to the Public Switched Telephone Networks ("PSTNs") around the world.

The MACROCELL system will be composed of four segments: (1) a space segment comprising a constellation of LEO satellites; (2) a system control segment that provides centralized telemetry, tracking, and command ("TT&C") over the satellite constellation; (3) a gateway segment consisting of earth stations and associated facilities distributed throughout the world to support both voice and digital data via PSTN interconnection; and (4) a subscriber segment that will feature a range of subscriber equipment, including dual mode (satellite/terrestrial cellular-compatible) user units (voice and data units).

To provide its proposed range of services, the MACROCELL system will employ both code division multiple access ("CDMA") and time division multiple access ("TDMA") technologies, using frequency division multiple access

("FDMA")/TDMA and FDMA/CDMA channels on every satellite. Thus, a variety of user services will be supported by the most appropriate signal architecture. With this planned TDMA/CDMA/FDMA architecture incorporated into the MACROCELL system, Iridium will meet the diverse personal communications needs projected for the twenty-first century.

The MACROCELL system will be designed to operate over the 1980-2025 MHz band for subscriber unit uplinks and over the 2160-2200 MHz band for subscriber unit downlinks. In the US, the MACROCELL system will use frequencies in the band 1990-2025 MHz for subscriber unit uplinks, and frequencies in the band 2165-2200 MHz for subscriber unit downlinks.

The MACROCELL system will be owned and operated by Iridium, a unique, internationally owned company that includes among its investors many of the major telecommunications and satellite service providers and manufacturers in the world. Iridium owns the space-related portion of the IRIDIUM® system and will manage its commercial operations. Iridium has already fully funded the construction, launch, and initial operating expenses of the IRIDIUM system through commencement of commercial service. The first 29 satellites of the IRIDIUM system have already been launched, and the system is expected to commence global commercial operations in September, 1998. Iridium's experience developing the IRIDIUM system and its broad and diverse ownership give it the knowledge and resources to design and implement the MACROCELL global mobile satellite system in a manner that will serve important world telecommunications needs.

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FCC 312
Main Form

FEDERAL COMMUNICATIONS COMMISSION

APPLICATION FOR SATELLITE SPACE AND EARTH STATION AUTHORIZATIONS

Approved by OMB 3060-0678
Est. Avg Burden Hours Per Response: 10 Hrs

FCC Use Only
File Number:
Call Sign:

PAYOR AND FILING FEE INFORMATION

a. Payor Name			b. Daytime Telephone Number
Iridium LLC			202-408-3800
c. Mailing Street Address or P.O. Box			d. FCC Account Number
1575 Eye Street, N.W., Suite 500			0521984342
e. City	f. State	g. Zip Code	h. Country Code (if not U.S.A.)
Washington	DC	20005	

i. Payment Type Code	j. Quantity	k. Fee Due for Payment Type Code in (i)	l. Total Amount Paid	FCC Use Only
CLW	1	$255,080.00	$255,080.00	

APPLICANT INFORMATION

1. Legal Name of Applicant	2. Voice Telephone Number
Iridium LLC	202-408-3800
3. Other Name Used for Doing Business (if any)	4. Fax Telephone Number
	202-408-3801

5. Mailing Street Address or P.O. Box	6. City	
1575 Eye Street, N.W., Suite 500	Washington	
ATTENTION: F. Thomas Tuttle, Esq./Patricia A. Mahoney, Esq.	7. State / Country (if not U.S.A.) DC	8. Zip Code 20005

9. Name of Contact Representative (If other than applicant)	10. Voice Telephone Number
James P. Riley, Esq./Frank R. Jazzo, Esq./Eric Fishman, Esq.	703-812-0400
11. Firm or Company Name	12. Fax Telephone Number
Fletcher, Heald & Hildreth, P.L.C.	703-812-0486

13. Mailing Street Address or P.O. Box	14. City	
1300 North 17th Street - 11th Floor	Rosslyn	
ATTENTION:	15. State / Country (if not U.S.A) VA	16. Zip Code 22209

CLASSIFICATION OF FILING

17. Place an "X" in the box next to the classification that applies to this filing for both questions a. and b. Mark only one box for 17a and only one box for 17b.

- [ ] a1. Earth Station
- [X] a2. Space Station

- [X] b1. Application for License of New Station
- [ ] b2. Application for Registration of New Domestic Receive-Only Station
- [ ] b3. Amendment to a Pending Application
- [ ] b4. Modification of License or Registration
- [ ] b5. Assignment of License or Registration
- [ ] b6. Transfer of Control of License or Registration
- [ ] b7. Notification of Minor Modification
- [ ] b8. Other (Please Specify):

18. If this filing is in reference to an existing station, enter:	19. If this filing is an amendment to a pending application enter:	
Call sign of station:	(a) Date pending application was filed:	(b) File number of pending application:
N/A	N/A	

TYPE OF SERVICE

20. NATURE OF SERVICE: This filing is for an authorization to provide or use the following type(s) of service(s): Place an "X" in the box(es) next to all that apply.

☐ a. Fixed Satellite ☒ b. Mobile Satellite ☐ c. Radiodetermination Satellite ☐ d. Earth Exploration Satellite ☐ e. Other (please specify) _____

21. STATUS: Place an "X" in the box next to the applicable status. Mark only one box.

☐ a. Common Carrier ☒ b. Non-Common Carrier

22. If earth station applicant, place an "X" in the box(es) next to all that apply.

☐ a. Using U.S. licensed satellites ☐ b. Using Non-U.S. licensed satellites N/A

23. If applicant is providing INTERNATIONAL COMMON CARRIER service, see instructions regarding Sec. 214 filings. Mark only one box. Are these facilities:

☐ a. Connected to the Public Switched Network ☐ b. Not connected to the Public Switched Network N/A

24. FREQUENCY BAND(S): Place an "X" in the box(es) next to all applicable frequency band(s).

☐ a. C-Band (4/6 GHz)

☐ b. Ku-Band (12/14 GHz) ☒ c. Other (Please specify) 2 GHz-Band (subscriber links) & Ka-Band (intersatellite and feeder links)

TYPE OF STATION

25. CLASS OF STATION: Place an "X" in the box next to the class of station that applies. Mark only one box.

☐ a. Fixed Earth Station ☐ b. Temporary-Fixed Earth Station ☐ c. 12/14 GHz VSAT Network ☐ d. Mobile Earth Station ☒ e. Space Station ☐ f. Other (Specify) _____

If space station applicant, go to Question 27.

26. TYPE OF EARTH STATION FACILITY Mark only one box.

☐ a. Transmit/Receive ☐ b. Transmit-Only ☐ c. Receive-Only N/A

PURPOSE OF MODIFICATION OR AMENDMENT

27. The purpose of this proposed modification or amendment is to: Place an "X" in the box(es) next to all that apply.

N/A

☐ a -- authorization to add new emission designator and related service
☐ b -- authorization to change emission designator and related service
☐ c -- authorization to increase EIRP and EIRP density
☐ d -- authorization to replace antenna
☐ e -- authorization to add antenna
☐ f -- authorization to relocate fixed station
☐ g -- authorization to change assigned frequency(ies)
☐ h -- authorization to add Points of Communication (satellites & countries)
☐ i -- authorization to change Points of Communication (satellites & countries)
☐ j -- authorization for facilities for which environmental assessment and radiation hazard reporting is required
☐ k -- Other (Please Specify)

_____

ENVIRONMENTAL POLICY

28. Would a Commission grant of any proposal in this application or amendment have a significant environmental impact as defined by 47 CFR 1.1307? ☐ YES ☒ NO
If YES, submit the statement as required by Sections 1.1308 and 1.1311 of the Commission's rules, 47 C.F.R. §§ 1.1308 and 1.1311, as Exhibit A to this application.

A Radiation Hazard Study must accompany all applications as Exhibit B for new transmitting facilities, major modifications, or major amendments. Refer to OET Bulletin 65.

ALIEN OWNERSHIP

29. Is the applicant a foreign government or the representative of any foreign government?	☐ YES	☒ NO
30. Is the applicant an alien or the representative of an alien?	☐ YES	☒ NO
31. Is the applicant a corporation organized under the laws of any foreign government?	☐ YES	☒ NO
32. Is the applicant a corporation of which more than one-fifth of the capital stock is owned of record or voted by aliens or their representatives or by a foreign government or representative thereof or by any corporation organized under the laws of a foreign country?	☒ YES	☐ NO
33. Is the applicant a corporation directly or indirectly controlled by any other corporation of which more than one-fourth of the capital stock is owned of record or voted by aliens, their representatives, or by a foreign government or representative thereof or by any corporation organized under the laws of a foreign country?	☐ YES	☒ NO
34. If any answer to questions 29, 30, 31, 32 and/or 33 is Yes, attach as Exhibit C an identification of the aliens or foreign entities, their nationality, their relationship to the applicant, and the percentage of stock they own or vote.		

BASIC QUALIFICATIONS

35. Does the applicant request any waivers or exemptions from any of the Commission's Rules? If Yes, attach as Exhibit D, copies of the requests for waivers or exceptions with supporting documents.	☒ YES	☐ NO
36. Has the applicant or any party to this application had any FCC station authorization or license revoked or had any application for an initial, modification or renewal of FCC station authorization, license, or construction permit denied by the Commission? If Yes, attach as Exhibit E, an explanation of the circumstances.	☐ YES	☒ NO
37. Has the applicant, or any party to this application, or any party directly or indirectly controlling the applicant ever been convicted of a felony by any state or federal court? See Exhibit E	☒ YES	☐ NO
38. Has any court finally adjudged the applicant, or any person directly or indirectly controlling the applicant, 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 any other means or unfair methods of competition?	☐ YES	☒ NO
39. Is the applicant, or any person directly or indirectly controlling the applicant, currently a party in any pending matter referred to in the preceeding two items? See Exhibit E	☐ YES	☒ NO
40. By checking Yes, the undersigned certifies, that neither the applicant nor any other party to the application is subject to a denial of Federal benefits that includes FCC benefits pursuant to Section 5301 of the Anti-Drug Act of 1988, 21 U.S.C. Section 862, because of a conviction for possession or distribution of a controlled substance. See 47 CFR 1.2002(b) for the meaning of "party to the application" for these purposes.	☒ YES	☐ NO

41. Description. (Summarize the nature of the application and the services to be provided).

Application for authority to launch and operate a non-geostationary low earth orbit mobile satellite system in the 2 GHz band, with satellites interconnected by radio links in the Ka band and connected to fixed earth stations by feeder links in the Ka band, to provide worldwide advanced digital mobile two-way voice and data communications between mobile user units and interconnection of mobile user units to the Public Switched Telephone Networks, to resellers on an individually tailored wholesale basis as a non-common carrier.

CERTIFICATION

The Applicant waives any claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise, and requests an authorization in accordance with this application. The applicant certifies that grant of this application would not cause the applicant to be in violation of the spectrum aggregation limit in 47 CFR Part 20. All statements made in exhibits are a material part hereof and are incorporated herein as if set out in full in this application. The undersigned, individually and for the applicant, hereby certifies that all statements made in this application and in all attached exhibits are true, complete and correct to the best of his or her knowledge and belief, and are made in good faith.

42. Applicant is a (an): (Place an "X" in the box next to applicable response.)

☐ a. Individual ☐ b. Unincorporated Association ☐ c. Partnership ☐ d. Corporation ☐ e. Governmental Entity ☒ f. Other (Please specify) Limited Liability Company

43. Typed Name of Person Signing	44. Title of Person Signing
F. Thomas Tuttle	Vice President and General Counsel

45. Signature	46. Date
F. Thomas Tuttle	26 September 1997

WILLFUL FALSE STATEMENTS MADE ON THIS FORM ARE PUNISHABLE BY FINE AND/OR IMPRISONMENT (U.S. Code, Title 18, Section 1001), AND/OR REVOCATION OF ANY STATION AUTHORIZATION (U.S. Code, Title 47, Section 312(a)(1)), AND/OR FORFEITURE (U.S. Code, Title 47, Section 503).

Interests Owned And Voted by Aliens

More than one-fifth of Iridium LLC's membership interests are owned by entities organized under the laws of a foreign country. These membership interests are listed below.

Name of Member	% of Membership Interests	Country of Organization
Iridium Africa Corporation	3.2%	British Virgin Islands
Iridium Andes-Caribe, Ltd.	3.1%	British Virgin Islands
Iridium Brasil S/A	2.0%	Brazil
Iridium Canada, Inc.	3.7%	Canada
Iridium China (Hong Kong) Ltd.	3.7%	China (Hong Kong)
Iridium India Telecom Limited	3.7%	India
Iridium Italia S.p.A.	3.9%	Italy
Iridium Middle East Corporation	4.2%	British Virgin Islands
Iridium World Communications Ltd.	8.5%	Bermuda
Khrunichev State Research and Production Space Center	4.3%	Russian Federation
Nippon Iridium (Bermuda) Limited	11.2%	Bermuda
Pacific Electric Wire & Cable, Co., Ltd.	3.7%	Taiwan
SK Telecom	3.7%	Korea
South Pacific Iridium Holdings Limited	2.7%	British Virgin Islands
South Pacific Iridium Holdings II Limited	2.7%	British Virgin Islands
Thai Satellite Telecommunications Co., Ltd.	3.7%	Thailand

Request for Waiver of 47 CFR § 25.258(c)

Iridium LLC ("Iridium") hereby requests a waiver of Section 25.258(c) of the Commission's rules. This section requires non-geostationary ("NGSO") MSS satellites with feeder link earth stations in the 29.25-29.50 GHz band, such as Iridium's MACROCELL system, to "compensate for nodal regression due to the oblate shape of the Earth, and thus maintain constant successive sub-satellite ground tracks on the surface of the Earth." Motorola Satellite Communications, Inc. ("Motorola"), has petitioned the Commission to reconsider its adoption of Section 25.258(c), demonstrating that the Commission erred in adopting this requirement. It is, thus, quite possible that the section will not be included in the version of the rules that ultimately becomes final. Iridium agrees with the points made by Motorola in its Petition and responsive filings and incorporates the Motorola Petition herein by reference. In light of the possibility that Section 25.258(c) will be deleted from the rules upon reconsideration, and the uncertainty engendered by the Motorola Petition, a waiver of or exception to the section is warranted, at least until the Commission acts upon the Motorola Petition.

In its "Petition For Partial Reconsideration" of the First Report and Order and Fourth Notice of Proposed Rulemaking , in CC Docket No. 92-297, FCC 96-311, 61 Fed. Reg. 44,177 (Aug. 28, 1996), filed September 27, 1996 ("Motorola Petition"), Motorola convincingly demonstrated that Section 25.258(c) would impose unnecessary technical constraints on NGSO MSS operations without guaranteeing that the purpose of the section -- sharing with geostationary ("GSO") fixed satellite service ("FSS") systems in the 29.25-29.50 GHz band -- would be accomplished. Indeed, Motorola demonstrated that

the purpose of the rule would be thwarted, because it would create a standard that is unworkable for more than one NGSO MSS system.

Motorola also pointed out that, in fact, Task Group 4/5 of the ITU and the Conference Preparatory Meeting to WRC-95 had rejected this method as a means of facilitating sharing in the feeder link bands. Motorola further predicted in its petition that U.S. adoption of the section would have the effect of reducing NGSO MSS systems to de facto secondary status in the band, notwithstanding the fact that the ITU and the Commission had both recently granted NGSO MSS systems co-primary status in the band, in recognition of the shortage of essential feeder link spectrum for global MSS.

Accordingly, good cause exists for grant of this requested waiver of Section 25.258(c) of the rules.

In the event the Commission denies reconsideration of the adoption of Section 25.258(c), Iridium will take such steps as are necessary to ensure compliance of Iridium's MACROCELL system with this section of the rules, including possible demonstration that the intent of the rule is satisfied by other technical means.

Basic Qualifications

Iridium LLC has never been convicted of a felony by any state or Federal Court. Information regarding Motorola Inc., which together with its affiliates is the owner of a 19.6% membership interest in Iridium LLC, is provided in the current Licensee Qualification Report, FCC Form 430, dated June 12, 1997, for Motorola Global Communications, Inc., a subsidiary of Motorola Inc., filed on July 15, 1997 as Appendix E to the application by Motorola Global Communications, Inc., for authority to construct, launch, and operate the Celestri Multimedia LEO System.

TABLE OF INFORMATION REQUIRED BY 47 CFR Part 25

I. INTRODUCTION

The MACROCELL mobile satellite system will be a 21st Century state-of-the-art personal communications system providing millions of users in the United States and throughout the world with universal access to advanced digital mobile communications. The MACROCELL system will employ a constellation of 96 LEO satellites circling the globe in 8 near-polar orbital planes at some 850 kilometers above the earth.[1] These satellites will be connected by means of Ka band radio intersatellite links and gateway earth stations to form a global satellite network that will be capable of providing two-way voice and data communications between handheld, mobile, and transportable subscriber user units anywhere in the world, using both CDMA and TDMA access technologies, and interconnecting such subscriber units to the Public Switched Telephone Networks ("PSTNs") around the world.

The MACROCELL system is intended to be separate and distinct from, but interoperable with, the IRIDIUM® System, for which Motorola Satellite Communications, Inc. has received authority from the Commission to construct, launch, and operate in the 1.6 GHz band (File Nos. 9-DSS-P.91 (87); CSS-91-010, as amended 15-SAT-PLA-95 and 16-SAT-AMEND-95) (the "IRIDIUM® System"). The MACROCELL system will provide greater capacity than the IRIDIUM system and will offer complementary enhanced voice and data services, including higher data rates than those offered by the IRIDIUM System and other first generation global

[1] As is discussed below, the FCC has not yet resolved certain technical issues that may affect the system's design. Accordingly, this application may be amended in the future to revise specific details of the system.

MSS systems. The MACROCELL system is designed to satisfy the projected growth in overall demand for terrestrial and satellite-delivered wireless services, meet evolving user expectations for improvements in voice transmission quality, provide access to services requiring higher and variable-rate data capabilities, and enable greater integration of satellite services with the terrestrial wireline and wireless networks.

The MACROCELL system will be owned and operated by Iridium. Iridium is a unique, internationally-owned company that includes among its investors many of the major telecommunications and satellite service providers and manufacturers in the world. Iridium's experience and broad representation give it the knowledge and resources to design and implement a global mobile satellite system that will serve important segments of the world's telecommunications needs.

This application proposes the use of frequencies that have been recently allocated by the Commission for MSS. The FCC has issued a First Report and Order and Further Notice of Proposed Rule Making ("FNPRM"), in ET Docket No. 95-18, 12 FCC Rcd 7388 (1997), in which it has allocated for MSS use the frequencies specified in Iridium's application.[2] The FCC's FNPRM raises, but does not resolve, a number of issues, including whether the proposed new bands should be limited exclusively to geostationary ("GEO") satellite or low earth orbit ("LEO") satellite use. Also, the FNPRM specifically defers consideration of licensing criteria and procedures for these bands.

[2] It is noted that the global allocation for MSS operations near 2 GHz is not consistent, and licensees adhering to any rules and standards adopted by the Commission for frequency utilization in the United States may have to modify their operations outside the United States. Iridium expects the Commission will address this issue when it adopts final licensing rules.

Iridium recognizes that the Commission faces significant challenges in accommodating the needs of applicants and incumbent users in these bands and related feeder link bands. While at the present time it is not yet known how many proposed systems there will be and what kinds of services they will propose, Iridium believes and intends that its MACROCELL system can coexist with other MSS systems that will operate in the 2 GHz band. Iridium has intentionally incorporated flexibility into its system design and is prepared to work with industry partners, other applicants, and the FCC to find technical solutions for accommodating the maximum number of qualified applicants in the 2 GHz licensing process.

Iridium encourages the Commission to be flexible in adopting licensing policies to advance the principles of free trade in telecommunications, as embodied in the World Trade Organization (WTO) Agreement on Basic Telecommunications Services, and in order to ensure competition among all qualified GMPCS providers, including Iridium, Globalstar, ICO, etc.

Iridium notes that portions of the 2 GHz band, including portions at issue in the FNPRM, have been identified for use on a world-wide basis for administrations wishing to implement Future Public Land Mobile Telecommunications Systems ("FPLMTS"), also referred to as IMT-2000, a proposed world-wide third generation digital mobile personal communications service concept. The standards for FPLMTS and FPLMTS-compatible satellite systems, and other so-called "third generation" terrestrial wireless service concepts, such as Universal Mobile Telephone Services ("UMTS"), are still being developed. Iridium encourages the Commission to consider the status of FPLMTS/IMT-2000 and other third generation standards when it adopts

licensing rules and requirements for the 2 GHz band. Iridium plans to participate actively in developing those standards and currently anticipates that MACROCELL services will be compatible with the general principles of FPLMTS/IMT-2000/UMTS.

Because the final rules and standards for the 2 GHz band have not yet been established, and in accordance with Commission practice, Iridium is prepared to amend this application in the future as necessary to comply with whatever rules, policies, and standards are ultimately established by the Commission for the implementation of MSS at 2 GHz.

II. INFORMATION IN SUPPORT OF APPLICATION

Iridium notes that no licensing provisions have been adopted by the Commission or even proposed for MSS operations at 2 GHz. Nonetheless, for ease of reference this application generally follows the format of Section 25.114 of the Commission's Rules, 47 CFR §25.114, where appropriate, as well as the guidance provided by Public Notice Report No. SPB-95 (released August 13, 1997). Accordingly, the following information is submitted:

A. Contact Information (47 CFR §25.114(c)(1)-(2))

1. Name, Address, And Telephone Number Of Applicant

Iridium LLC
1575 Eye Street, NW, Suite 500
Washington, D.C. 20005
Tel: (202) 408-3800
Fax: (202) 408-3801

2. Name, Address, And Telephone Number Of Contact Persons

Correspondence concerning this Application should be directed to:

F. Thomas Tuttle, Vice President and General Counsel
Patricia A. Mahoney, Senior Counsel, Regulatory Matters
Iridium LLC
1575 Eye Street, N.W., 8th Floor
Washington, D.C. 20005
Tel: (202) 408-3800
Fax: (202) 408-3801

with a copy to counsel:

Thomas J. Keller
Julian L. Shepard
Verner, Liipfert, Bernhard,
McPherson and Hand, Chartered
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Washington, D.C. 20005
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Fax: (202) 371-6279

James P. Riley
Frank R. Jazzo
Eric Fishman
Fletcher, Heald & Hildreth, PLC
1300 N. 17th Street, 11th Floor
Rosslyn, Virginia 22209
Tel: (703) 812-0400
Fax: (703) 812-0486

B. Type Of Authorization Requested (47 CFR §25.114(c)(3))

Iridium is requesting authorization from the Commission to launch and operate a global MSS system, including 96 non-geostationary mobile satellite service space stations, in-orbit spares, and additional replacement satellites.

C. General Description Of Overall System, Facilities, Operations And Services (47 CFR §25.114(c)(4))

The MACROCELL NGSO MSS system will be a state-of-the-art, global personal communications system designed to provide millions of users with advanced, digital, mobile voice and data communications capability in the United States and worldwide. The MACROCELL system will include a constellation of 96 interconnected LEO satellites circling the globe in 8 near polar orbital planes at about 850 kilometers above the earth. The information contained in this satellite system application applies equally to each space station in the MACROCELL system. The technical appendix attached hereto, entitled "The MACROCELL System," provides

detailed information regarding system characteristics.

The MACROCELL satellites will provide continuous communications to and from points all over the world, including the polar regions. The MACROCELL system will be capable of providing two-way voice and data communications between handheld, mobile, and transportable subscriber units anywhere in the world, and interconnecting any such subscriber unit to the world's PSTNs. The MACROCELL system is designed to provide MSS services on an international basis and on a domestic basis within various countries.

The MACROCELL system will offer a variety of features, including variable on-demand bit rates used to provide digital voice and data services. These services will be offered worldwide with consumer-oriented enhancements such as global roaming and interoperability with terrestrial wireless networks.

The MACROCELL system will be composed of four segments: (1) a space segment comprising a constellation of LEO satellites; (2) a system control segment that provides centralized control over the satellite constellation; (3) a gateway segment consisting of earth stations and associated facilities distributed throughout the world to support both voice and digital data via PSTN interconnection; and (4) a subscriber segment that will feature a range of subscriber equipment, including dual mode (satellite/terrestrial cellular-compatible) user units (voice and data).

The MACROCELL system will be designed to operate over the 1980-2025 MHz band for subscriber unit uplinks, and over the 2160-2200 MHz band for subscriber unit downlinks. Within the U.S., Iridium seeks authority to operate the MACROCELL system in the 1990-2025 MHz band for subscriber unit uplinks, and in

the 2165-2200 MHz band for subscriber unit downlinks. Iridium expects that other qualified applicants will be seeking licenses to provide mobile satellite services under the rules to be adopted as the result of this proceeding. Therefore it is anticipated that the actual frequencies authorized by the Commission to support these services will reflect the characteristics of the orbits proposed and the modulations to be employed, as well as the number of qualified applicants.

For its service offerings, the MACROCELL system will employ both TDMA and CDMA access technologies. While Iridium requests authority to operate in the entire available MSS 2 GHz bands, Iridium recognizes that the exact amount of spectrum that will be available for MACROCELL TDMA and CDMA services and their location within the service link bands will be determined as a result of Commission actions following review of all applications. In considering the frequency assignments for the different types of systems, note must be taken of the fact that the allocation of spectrum for MSS in the 2 GHz bands is not uniform throughout the world. Similarly, the effective date for access to all bands identified for MSS is not uniform in ITU Region 2.

The MACROCELL system will employ intersatellite links in the 23.18-23.38 GHz and 24.45-24.75 GHz bands. Downlink feeder and TT&C operations will use frequencies in the 19.3-19.7 GHz band, while uplink feeder and TT&C operations will employ frequencies in the 29.1-29.5 GHz band. Assuming that there will be other applicants for MSS licenses proposing these bands, Iridium is also considering other bands (e.g., C, Ku, V bands) for its feeder link and intersatellite link requirements. Iridium will amend its request for feeder link, intersatellite link and TT&C frequencies,

as necessary, to comply with whatever rules and allocations are adopted by the Commission.

The MACROCELL system will incorporate the latest technologies to allow: efficient use of spectrum and RF power (employing both TDMA and CDMA access technologies); RF levels in subscriber units compliant with international health standards; reliable communications in nearly all environments and terrain; and minimal user unit size, weight and cost.

D. Technical Description Of Radiofrequency Aspects Of System (47 CFR §25.114(c)(5))

A detailed description of the radio frequencies, access technology, polarization plan, power, antenna characteristics and other aspects of the technical design of the proposed satellite system is set forth in the Appendix ("App."). See App. at A4-5.

E. Information Regarding Orbital Planes (47 CFR §25.114(c)(6))

Information regarding the number of space stations and the orbital planes is set forth in the Appendix. See App. at A6-9.

F. Space Station Antenna Gain Contour (47 CFR §25.114(c)(7))

Information regarding the space station antenna gain contours is set forth in the Appendix. See App. at A18-27.

G. Description Of Types Of Services To Be Provided (47 CFR §25.114(c)(8))

The MACROCELL system will offer a range of services, consistent with current expectations for third-generation terrestrial wireless systems, including a variety of voice and data applications. These services will be provided globally. Included in the Appendix, hereto, App. at A5, A12-14, A28, A31-34, A42-50, are: a

description of the transmission characteristics and performance objectives for each type of proposed service; details of the link noise budget; typical or baseline earth station parameters; modulation parameters; and overall link performance analysis for these proposed services.

H. Power Flux Density (47 CFR §25.114(c)(10))

Information on power flux density is set forth in the Appendix. See App. at A44-48, A50-51.

I. Tracking, Telemetry And Control (47 CFR §25.114(c)(11))

Information on tracking, telemetry and control is set forth in the Appendix. See App. at A27.

J. Physical Characteristics Of Space Stations (47 CFR §25.114(c)(12))

Information on the physical characteristics of the space stations is set forth in the Appendix. See App. at A28-31.

K. Regulatory Status (47 CFR §25.114(c)(14))

Iridium does not intend to provide services over the MACROCELL system directly to the public. Iridium intends instead supply MACROCELL space segment capacity on a wholesale basis to resellers and will tailor its offerings to the individual requirements of these resellers. The resellers in turn may provide services to end users or sell capacity in bulk to service providers or do both. Thus, Iridium proposes to operate as—and requests that it be regulated as—a non-common carrier.

L. Construction And Launch Milestones (47 CFR §25.114(c)(15))

Iridium's proposed milestones are set forth below. It is Iridium's intention to construct its system, launch its satellites, and initiate commercial operations within

four years of a final order granting its application unconditionally. Nevertheless, in view of the many issues yet to be resolved, including issues concerning relocation of existing users of the 2 GHz bands allocated for MSS, Iridium has set out its proposed milestones in terms of years after unconditional grant.

Construction and Launch Milestones

Commence construction of first two satellites	Within one year of unconditional grant
Commence construction of remaining authorized operating satellites	Within three years of of unconditional grant
Complete construction of first two satellites	Within four years of unconditional grant
Launch of first satellite	Within four years of unconditional grant
Entire system to be operational	Within six years of unconditional grant

M. Public Interest Considerations (47 CFR §25.114(c)(16))

Grant of this application will serve the public interest by providing additional opportunities for new and competitive telecommunications and information services and technologies to the public, particularly persons outside the range of existing wireless and wireline networks and/or living in rural and remote areas of the United States and other parts of the world. The MACROCELL system will introduce significant technological advances in signal processing, digital switching, and semi-conductor fabrication. The development and implementation of the MACROCELL system will have the added benefit of stimulating economic development and fostering the creation of high technology jobs in the United States.

The MACROCELL system will provide spectrum efficiency, service flexibility, and global coverage. It will directly support the FCC's statutory mandates to make available to everyone in the U.S. a rapid, efficient, nationwide, and worldwide wire and radio communications service with adequate facilities at reasonable charges for the purpose of promoting safety of life and property and to encourage the provision of new technologies and services to the public.

With its global coverage, the MACROCELL system will bring the benefits of digital mobile voice and data service to individuals in the United States and abroad who are currently in need of reliable telephone communications. The digital technology of the MACROCELL system and its innovative intersatellite radio links will enable users to receive most types of mobile telecommunications voice and data services anywhere in the world. These services will be accessible on a 24-hour basis, seven days a week, and available in any country that authorizes the provision of such services. In order to protect and respect national sovereignty, the MACROCELL system is designed to be capable of deactivating various frequencies and limiting the types of offerings to any country that may limit the MACROCELL system's authority to operate.

Persons living or traveling in remote areas of the U.S. or in other areas of the world where landline and mobile radio service are unreliable or currently nonexistent will be able to use a MACROCELL subscriber unit to communicate with anyone in the world who has a MACROCELL subscriber unit or who is connected to the terrestrial wireline and wireless networks. In addition, the MACROCELL system will offer to subscribers, no matter where they are located, immediate access to reliable voice

and messaging capabilities. By providing immediate communications access, the MACROCELL system's worldwide wireless system will be invaluable to medical emergency and disaster relief efforts.

The MACROCELL system may also be used by the aeronautical, maritime, and land transportation industries as a primary and backup communications system during emergency or distress situations, such as for missing planes and for accident location information. The ability to provide complete global coverage will enable the MACROCELL system to offer advanced services to the aeronautical industry (for which polar coverage will become an increasingly important requirement), the maritime industry, and other industries that have demands in areas that typically are outside of traditional equatorial orbit coverage or beyond the range of terrestrial networks.

The MACROCELL system will include the latest technological advances contemplated for telecommunications and information services applications. The system will provide reliable communications in nearly all environments and terrain and will feature minimal user unit size, weight, and cost.

As discussed in other sections of this application, specific frequencies near 2 GHz, including the bands under consideration in ET Docket No. 95-18, have been identified for use on a world-wide basis for administrations wishing to implement FPLMTS/IMT-2000, a world-wide third generation digital mobile personal communications service concept. Iridium anticipates that the MACROCELL system will be compatible with the overall objectives of FPLMTS/IMT-2000 and other third

generation wireless service concepts.[3]

Also, the MACROCELL system will be designed for efficient use of spectrum and RF power, employing both TDMA and CDMA access technologies. The use of both TDMA and CDMA technologies is consistent with national and international goals to apply the most efficient spectrum management techniques possible in the provision of telecommunications services. The use of TDMA modulation techniques assures high quality voice communications. The MACROCELL system will need exclusive use of the frequencies that it uses for services provided using TDMA access technology. Use of CDMA technology for those non-voice services requiring either higher or variable data rates allows the MACROCELL system to share some spectrum with other MSS systems.

The MACROCELL system will also include priority preemptive capabilities designed to be consistent with the requirements for the Global Maritime Distress and Safety System (GMDSS) and the Aeronautical Mobile Satellite (Route) Service (AMS(R)S).

Iridium is especially qualified to bring the benefits of low earth orbit mobile satellite technology to the public. Based in the U.S., Iridium is a company that is owned by many of the world's leading satellite and telecommunications manufacturers and service providers. Because of its international ownership structure, Iridium is positioned to understand the world's mobile telecommunications

[3] Iridium expects the FCC will address the rules and policies for FPLMTS/IMT-2000 and consider the status of FPLMTS standards when it adopts licensing rules and requirements for the 2 GHz band and that it may be necessary for Iridium to amend its application to comply with rules and standards adopted.

needs and resources and to construct a system that meets those needs and utilizes those resources.

Moreover, Iridium will have the added benefit of experience with the IRIDIUM® system, which will be very useful in its development and operation of the MACROCELL system. Iridium owns the space-related portion of the IRIDIUM® system and will manage its commercial operations. Iridium has already fully funded the construction, launch, and initial operating expenses of the IRIDIUM system through commencement of commercial service. The first 29 satellites of the IRIDIUM system have already been launched, and the system is expected to commence operations in 1998.

Finally, with its ubiquitous coverage, the MACROCELL system will foster the international communications, universal service, and information policy goals of the United States. Unlike most other wireless systems, the MACROCELL system will offer 100% continuous global coverage. Thus, the MACROCELL system will have the ability to bring modern digital telecommunications to underserved areas of the world, thereby playing an integral role in the development and achievement of the national and global information infrastructures ("NII/GII"). Iridium fully supports the goals of the NII/GII initiative and has been an active participant in domestic proceedings and international fora, such as the ITU's World Telecommunication Development Conference and World Telecommunication Policy Forum, in which these policy goals are being discussed and implemented.

Iridium is also supporting these goals with innovative solutions of its own. For example, Iridium is the only global handheld MSS provider that has announced and

is implementing programs providing for broad participation and opportunities for developing countries. These programs will include opportunities for direct equity ownership by nationally designated entities. Programs are also intended to include free or discounted phones and minutes of use to provide access anywhere in a participating country and special arrangements to facilitate disaster-related communications.

Iridium's **N**ational **O**wnership, **M**obile **A**ccess and **D**isaster Communications ("NOMAD") program, will be offered to up to 187 nations classified by the World Bank as low or middle-income nations. Eligible countries will have the opportunity to become investors in Iridium, through the purchase, on favorable terms, of shares of Iridium World Communications Ltd. In addition, the program will allow eligible countries to offer discounted equipment and communications services to users in areas which—for economic or other reasons—have been unserved or underserved by terrestrial networks. Lastly, the NOMAD program will provide countries with free use of equipment and communications services in the event of national emergencies or natural disasters (e.g., earthquakes, hurricanes, typhoons). To the extent that such mobile access and disaster-related services will still be required in many parts of the world in the next decade, Iridium intends to offer similar opportunities to developing countries with its MACROCELL system.

N. Markets and Demand for Services

1. Overview

Global demand for voice and data mobility is evolving rapidly, both in terms of the overall size of the market as well as in terms of user demands for enhanced

services. Increasingly, industry analysts are predicting that the market for mobile satellite services may follow similar growth patterns to that of its terrestrial counterpart, the cellular market. Bear Stearns & Co. has predicted that the market for MSS voice subscribers may reach over 30 million by the year 2006,[4] with an increasing emphasis on sophisticated services and performance. This market is expected to exceed the capacity of first generation mobile satellite systems within the first few years of the 21st century.[5] The MACROCELL system is designed to work with other wireless services in the United States and around the world to meet this growing demand for expanded capacity and new services.

2. Market Trends

The growth trend of the communications marketplace is expected to continue well into the next decade, driven largely by on-going technology enhancements and increasing user demands. Key trends include overall growth of wireless usage, expanded use of data communications and content applications, and increased network integration. In addition, users are likely to expect an increasing level of service portability among terrestrial wireless, MSS wireless, and wireline services.

As shown in Figure 1, the mobile phone market is expected to triple between 1996 and 2002, with a total of approximately 600 million subscribers worldwide at the end of that period.[6] Using a conservative annual growth rate of 15%, the number of wireless subscribers will increase to over one billion by 2006. The United States

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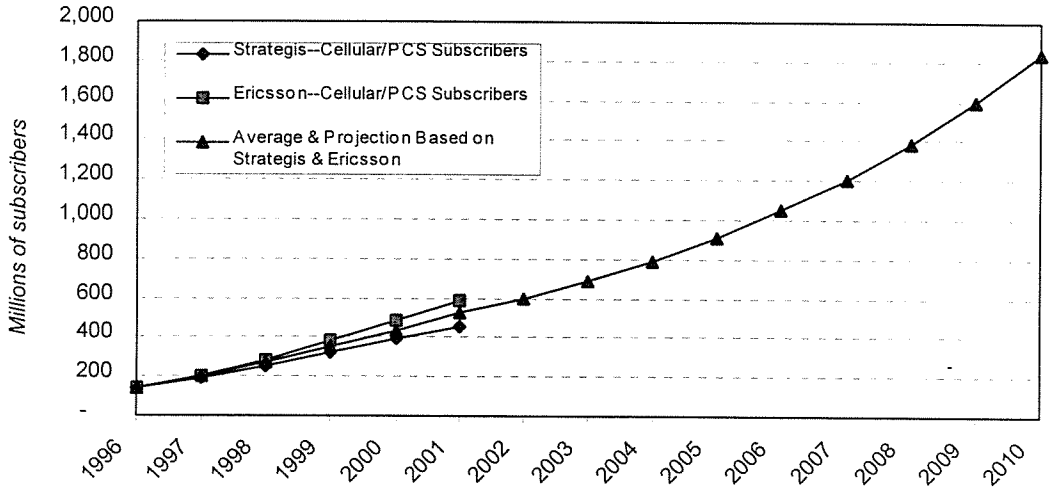
[4] Bear, Stearns & Co. Inc. estimates, "Satellite Communications - Instant Infrastructure," Nov. 5, 1996, p. 36.
[5] See "An $8 Billion Global MSS Opportunity?" *Global Mobile*, Dec. 12, 1996, p. 3.
[6] Cellular subscriber projections based data from the Strategis Group (1995-2002) and Ericsson (1996-2001). Forecasts beyond 2002 are calculated according to an annual growth rate assumption of 15%.

Figure 1: Growth of Wireless Market 1995-2010



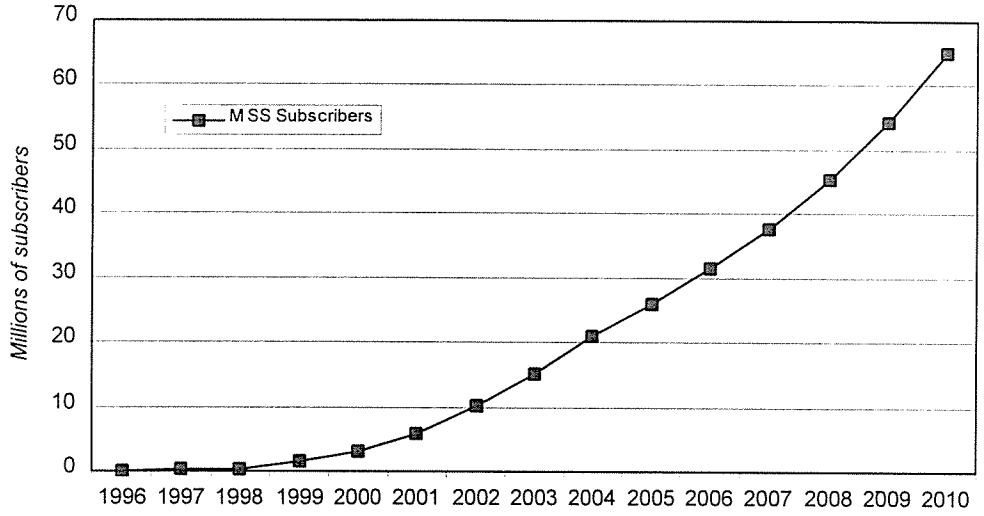
Source: Ericsson, Strategis Group

leads the world in demand for wireless services, boasting over a third of total subscribers in 1996.

A similarly rapid pace of growth is projected for MSS services (Figure 2).[7] Additional penetration of this large addressable market depends on the ability of service providers to offer adequate capacity and high-quality services. As noted above, the size and service demands of this global market are expected to exceed the total available capacity of first generation global handheld mobile satellite systems (e.g., the IRIDIUM, Globalstar, and Odyssey systems) by the middle of the next decade.

[7] MSS subscriber data based on projections by Bear, Stearns & Co., Inc. for period 1996-2006. Projections beyond 2006 are calculated according to a year-on-year growth rate assumption of 20 percent.

Figure 2: MSS Market 1996-2010



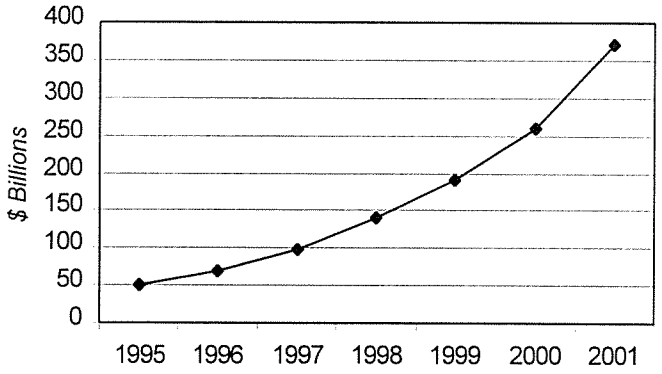
Source: Bear, Stearns & Co. Inc. (1996-2006) and ILLC estimates (2007-2010).

Growth in wireless data communications is expected to be equally significant in coming years. By the year 2000, the U.S. market for wireless data is expected to reach 9 million subscribers, an increase of over 13 times its size in 1995.[8] A 1996 survey by Ovum forecast a ten-fold increase in the use of data services offered over GSM digital cellular networks in Western European countries by the end of this decade.[9] Figure 3 shows the potential growth of worldwide revenues from increased data use. Figure 4 indicates that most customers for wireless data are expected to use applications that are available on cellular/PCS or paging subscriber products.

[8] Giga Information Group.

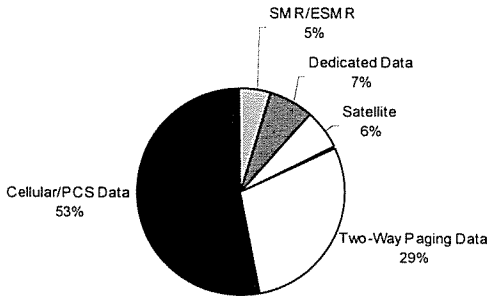
[9] "Data Over GSM," Ovum, September 1996. The survey looked at 17 Western European countries, and concluded that use of data offered over GSM is expected to grow from 319,000 subscribers in

Figure 3: World Market for High Data Rate Communications



Source: BCC, 1996

Figure 4: US Wireless Data Installed Base--Year 2000
Total Subscribers: 9.1 Million



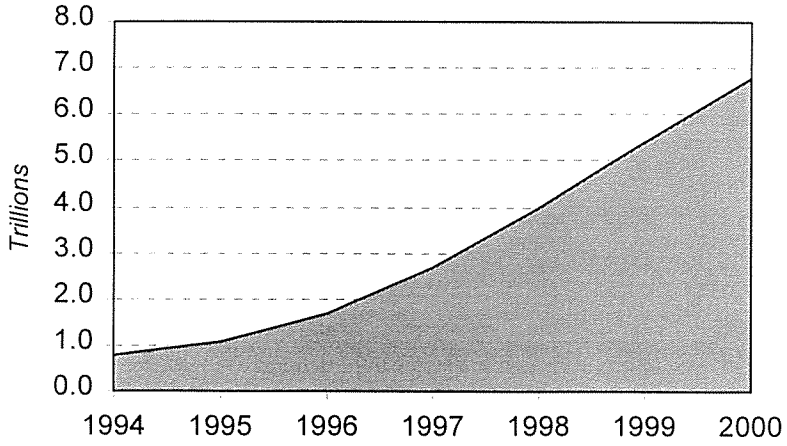
Source: Giga Information Group

Within the cellular/PCS world, planners designing service concepts for so-called third-generation wireless systems expect that a large share of the growth will be in the area of mobile data applications such as wireless fax, e-mail, file transfer, and Internet access. These services are essential tools for productive communications outside of the office and have a collective installed base of over 200

1996 to over 3,000,000 subscribers in the year 2000. Not included in the Ovum forecast were the additional data services that will be provided over paging or other non-cellular wireless data networks.

million subscribers on current wireline networks.[10] The explosive growth of e-mail (Figure 5) has created demand for more advanced data transfers, thus fueling the overall expansion of data communications. The Internet growth rate for subscribers currently exceeds 25%-50% per month and shows no signs of slowing. Use of all of these services is expected to shift rapidly from wireline to wireless, as mobile communications consumers increasingly consider these services to be fundamental and indispensable means of communication. Mobile subscribers will expect not only access to these services, but also transmission rates that are comparable to wireline.

Figure 5: Number of E-mail Messages



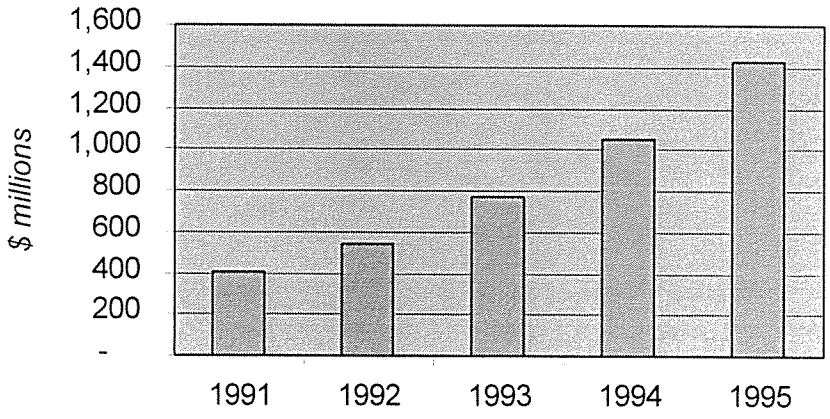
Source: Willkofsky Gruen Associates, as presented by MMTA

Global network integration is moving quickly, with alliances forming among worldwide telecommunications providers who are increasing their efforts to expand interoperability and services. A 1996 survey of business leaders identified "seamless

[10] ITU, *World Telecommunication Development Report*, 1996/97, *and The BT/MCI Global Communications Report* 1996/97.

global capability" as among the top three critical telecommunications performance factors necessary for successful business operations.[11] Roaming among cellular networks is expected to increase as quickly as capabilities permit. Revenue from roaming within the United States alone more than tripled within the last five years (Figure 6). Expectations for widespread and seamless availability of roaming are evidenced -- and in turn increased -- by the appearance of cross-protocol roaming services. These include currently available services, such as GTE's GlobalRoam® service, which allows roaming between North American AMPS cellular networks and European GSM networks, and others soon to be implemented, including the IRIDIUM system, which will allow one-number, one bill roaming between satellite and cellular networks, as well as between cellular networks of unlike protocols.

Figure 6:
U.S. Cellular Roamer Services Revenue ($ millions)



Source: Cellular Telecommunications Industry Association

[11] *The BT/MCI Global Communications Report* 1996/97.

Perhaps the most significant trend for MSS providers is the growing shift of services from wireline to mobile systems. Users increasingly expect the level of quality and types of service offerings available on wireline (including applications requiring higher data rates) to be replicated by mobile service providers. As mobile providers look toward offering such services to subscribers in the future, adequate bandwidth at competitive prices must be available to ensure transmission rates acceptable to the increasingly sophisticated and demanding end user. It is expected that mobile providers will move towards offering variable on-demand bit rates as the most cost-effective way to provide digital voice and data services.

The trends described above define the environment for future mobile service offerings. In an effort to keep pace with the those trends, terrestrial wireless operators and equipment suppliers are already defining applications and technologies for their third-generation systems (including FPLMTS/IMT-2000, UMTS and others) which are expected to be deployed as early as 2001-2002. Current expectations for these systems include the ability to provide some or all of the following:[12]

- Flexible service definition
- Personal mobility in fixed and mobile networks
- Support for multi-system terminals
- Capability for international roaming and internetwork roaming
- Flexible charging, including pre-payment and electronic purse systems
- Comprehensive real time charging information to the user
- Integrated mailbox-service for voice, fax, text and other formats
- Personal Assistant and intelligent agent support
- New multimedia and on-line services access
- Flexible call routing

[12] GSM MoU, "UMTS Service Requirements and Concepts," Permanent Reference Document TG-21, MoU DOC 28/97, January 9, 1997.

Iridium intends for the MACROCELL system to be capable of interconnectivity with terrestrial wireless networks that are expected to offer such services by early in the next decade. As such, the MACROCELL system is intended to be compatible and/or interoperable with UMTS, FPLMTS/IMT-2000, and other third-generation wireless service concepts.

3. Proposed Services

a. Service Concept:

The MACROCELL system will serve as a global extension of and complement to terrestrial networks, offering the quality and diversity of services envisioned for third-generation wireless systems. In coordination with terrestrial wireless offerings, the MACROCELL system will provide subscribers with one phone, one number, and one bill for nearly all of their communications needs. The MACROCELL system will offer a range of voice and data services, consistent with current expectations for third-generation terrestrial wireless systems, including a combination of voice, data, facsimile transfer, Internet services, e-mail, voice mail, paging, and messaging applications.

i. *Voice services:*

Digital voice services will continue to be the driver of mobile communications needs. Users will demand voice quality levels comparable to wireline transmission, with low levels of blocked and dropped calls. In addition, usage of call management tools, such as voice conferencing and call forwarding, is expected to increase in mobile services at the same rapid pace witnessed in wireline systems. The

MACROCELL system will provide digital voice services consistent with the expectations of third generation cellular subscribers.

ii. *Data and Messaging services:*

As defined by third-generation wireless systems, user requirements in the 2002-2010 timeframe will range from basic e-mail retrieval and facsimile transfer to video and Internet usage and a variety of one-way and two-way messaging services. As an extension of terrestrial wireless systems, the MACROCELL system will provide data and messaging services to address this demand.

The phenomenal growth of paging around the globe stems directly from the efficiency it offers as a supplement to voice services. End users increasingly choose to balance their use of real time voice communications with numeric and alphanumeric paging options. It is anticipated that, as experience with paging services grows, demand for longer messages, acknowledgment paging, and two-way paging will evolve. The MACROCELL system messaging services will include globally-available paging applications to address this demand.

b. Service and Application Characteristics:

The ability to meet user demand for new services will require new spectrum and significantly more efficient use of bandwidth than that which is expected to be available from first generation MSS systems. The MACROCELL system will employ spectrally efficient coding, access, transmission and modulation schemes in order to maximize the capacity available for the range of services described above, as well as meet user expectations for exceptional performance and toll-quality voice. In order to accommodate the variety of transmission rates required by these different services--

from 4.6 kbps for basic voice and data to significantly higher data rates (e.g., 384 kbps) for the high peak bit rate demands of Internet use and large file transfers—the MACROCELL system design may employ scalable data rates, bandwidth-on-demand, and/or asymmetric data transmissions. The flexibility of the MACROCELL system allows channels to be optimized for whatever type of data is being transmitted or received.

c. Service Devices:

The above voice, data, and messaging services will be available to end users in the form of multi-mode handheld phones and mobile/transportable subscriber units. All devices are expected to be fully interoperable with major terrestrial wireless standards, including GSM, IS-41, and emerging third-generation systems. Products offering then state-of-the-art services required for aeronautical and maritime services are also expected to be offered.

4. Target Market Segments

As noted above, the addressable market for MSS enhanced wireless services is expected to include more than 30 million voice subscribers by 2006. There is an additional addressable market for stand-alone data services such as paging. Current projections for the MSS wireless market suggest that demand for satellite-delivered voice and data services may exceed the total capacity of the first generation MSS systems likely to be in place by early next decade. If demand for enhanced services and data is considered, capacity saturation may occur more quickly.

Iridium plans to use the MACROCELL system to target two key areas of this future wireless marketplace:

- Roamers: Mobile users whose roaming needs extend between and/or beyond existing terrestrial wireless coverage areas; and
- Remote Users: Mobile users who reside or spend large amounts of time outside of terrestrial wireless coverage (including aeronautical and maritime users).

Roamers traveling between and beyond existing wireless networks are expected to constitute a large portion of the market for MACROCELL services. These users tend to be well versed in today's terrestrial wireless technology and accustomed to the efficiency it provides. Within the next decade, it is expected that these same subscribers will demand seamless universal coverage for an expanded range of communications needs. These subscribers are likely to expect one-stop shopping for all business communications requirements, variable service offerings, and flexible billing options.

Remote Users are subscribers who live or spend a significant amount of time either traveling to or working in areas that are beyond existing terrestrial wireless coverage. These include residents in rural and remote areas, domestic travelers, remote site workers, maritime users, and aeronautical users. Research indicates that, in spite of the significant cellular build-out in most countries, there are many mobile users whose needs are not met when circumstances require them to operate in areas beyond urban coverage areas. While such users are large in number, their dispersion around the globe greatly reduces the opportunity for them to be served economically by terrestrial wireless service providers. Thus, this market is ideal for MACROCELL voice and data services. While the users in this group spend more

time outside of existing wireless coverage than the "roamer"-defined portion of the market, their requirements for communications are no less sophisticated. This market segment includes users who are based in major urban areas and are familiar with the quality and service offerings of both wireline and future generations of cellular. Their expectations for quality and performance are rigorous and are expected eventually to exceed the capabilities of first generation MSS systems.

Also included among remote users are users of aeronautical and maritime services. Within the 2002-2010 timeframe, the desired data transmission rate for both aeronautical passengers and cockpit users is expected to increase significantly. Similarly, while demand by maritime users may not grow dramatically in size over the next decade, the demand for enhanced services is expected to keep pace with requirements defined by other segments of the market. For example, access to Internet data and value-added services may prove critical for maritime users.

5. Geographic Coverage:

Unlike most other wireless systems, the MACROCELL system will offer 100% continuous global coverage. This coverage range will provide three unique advantages. First, the MACROCELL system provides terrestrial wireless providers with an inexpensive way to expand globally and integrate their coverage areas for their customers. Second, its continuous global coverage affords the MACROCELL system the ability to offer end-to-end service with opportunities for flexible billing and enhanced quality of transmission. Third, the MACROCELL system is able to offer advanced services to the aeronautical market (for which polar coverage will become an increasingly important requirement), the maritime market, and the emergency

services market—all of which have demands in areas that typically are outside of traditional equatorial orbit coverage.

Appendix

The MACROCELL System

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INTRODUCTION

This Appendix provides detailed information on the non-geostationary (low Earth orbit, or NGSO) mobile satellite system proposed by Iridium LLC for conducting mobile-satellite services (MSS)[1] from space and operating in the 2 GHz frequency bands. This MSS system, called the MACROCELL system, will be a NGSO MSS global communications system designed to provide users with advanced personal communications from a constellation of 96 interconnected low Earth orbit (LEO) satellites. The technical information contained herein applies equally to each space station in the MACROCELL system and therefore satisfies the requirement of 47 CFR Part 25.114(d).

Section 1. SYSTEM DESCRIPTION

A. GENERAL SYSTEM OVERVIEW

The MACROCELL system is designed to satisfy the projected growth in overall demand for terrestrial and satellite-delivered wireless services, provide access to services requiring higher and variable-rate data capabilities, and enable greater expansion and integration of satellite services with the terrestrial fixed and wireless networks. To meet these goals, the MACROCELL system satellites will provide continuous communications to and from points all over the world. The MACROCELL system will be capable of providing two-way voice and data communications between a

[1] Mobile-Satellite Service. A Radiocommunication service: (1) between mobile earth stations and one or more space stations, or between space stations used by this service; or (2) between mobile earth stations by means of one or more space stations.

variety of subscriber units anywhere in the world, and interconnecting any such subscriber unit to the public switched telephone network (PSTN) and other networks. This includes global roaming and interoperability with terrestrial wireless networks. Iridium intends to provide these services on a non-common carrier basis.

To provide this range of services, the MACROCELL system will employ both TDMA and CDMA access technologies, with FDMA/TDMA and FDMA/CDMA channels operating on every satellite. This architecture incorporated into a single system meets the diverse personal communications needs projected for wireless users in the twenty-first century and provides efficient spectrum utilization for a variety of service offerings.

Four segments comprise the MACROCELL system: (1) a space segment consisting of a constellation of 96 operational satellites in low Earth orbit (LEO)[2]; (2) a System Control Segment that provides centralized Telemetry, Tracking and Command (TT&C) over the satellite constellation; (3) a Gateway Segment consisting of earth stations and associated facilities that include the infrastructure for service distribution; and (4) a Subscriber Segment that features a variety of subscriber units, to include dual mode (satellite/terrestrial cellular compatible) user subscriber units.

Figure 1 depicts these segments and their major elements.

[2] Low Earth Orbit (LEO) is generally defined as an orbit below 2000-km altitude.

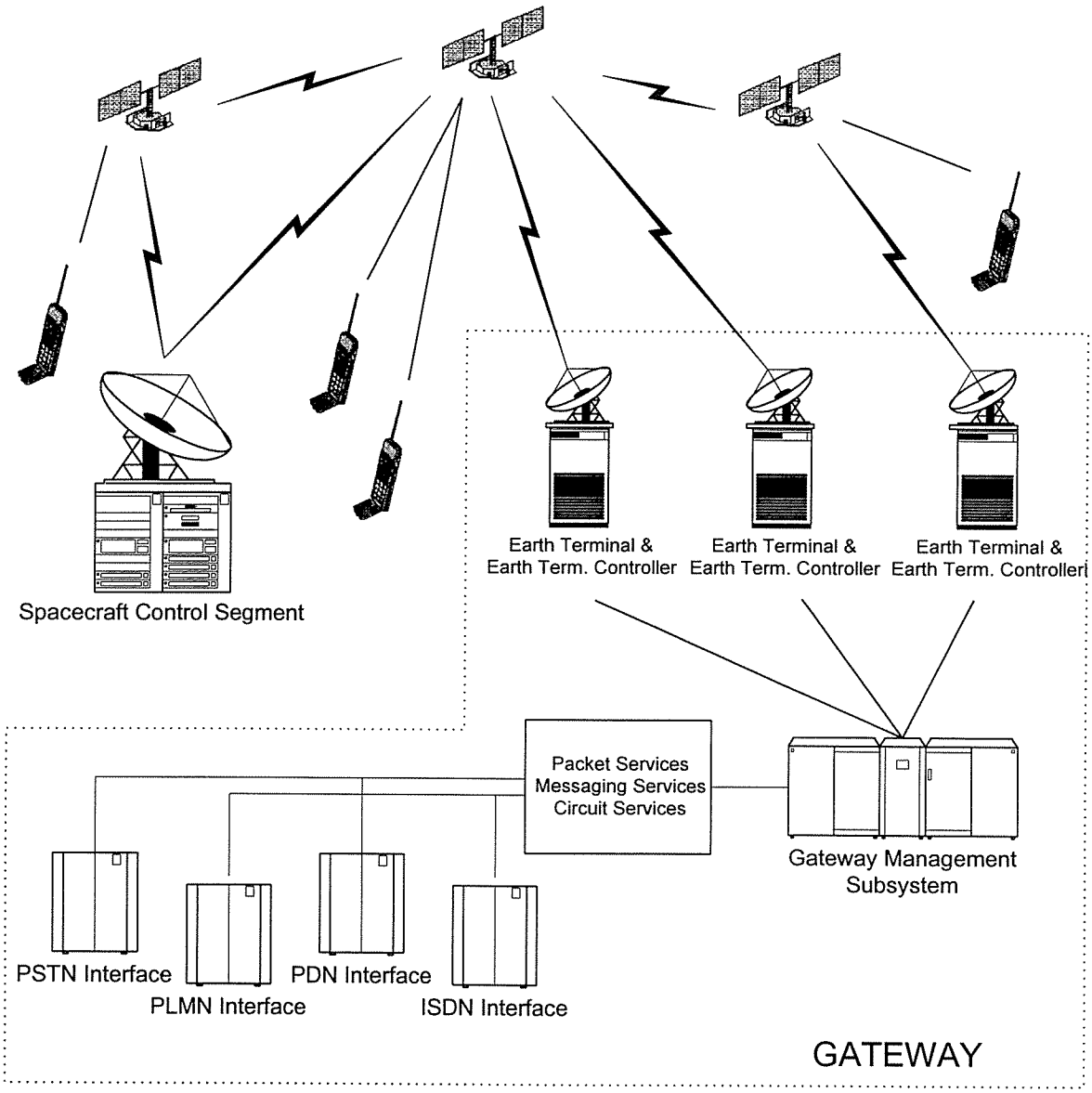


Figure 1. Major Elements in the MACROCELL System

1. Radio Frequency Plan

The MACROCELL system will be designed to operate over the 1980 - 2025 MHz frequency band for subscriber unit uplinks, and over the 2160 - 2200 MHz frequency band for subscriber unit downlinks. Iridium hereby requests authority to operate the MACROCELL system in those bands, recognizing that such operations in the U.S. will be limited to the 1990 - 2025 MHz and 2165 - 2200 MHz frequency bands. Iridium proposes there is ample evidence to support using the entire MSS 2 GHz frequency band for its service offerings. However, the exact amount of spectrum that will be used for MACROCELL system TDMA and CDMA services and their frequency assignments within the service link bands will be determined by the Commission. In considering the frequency assignments the Commission is expected to consider that: 1) the allocation of spectrum for MSS in the 2 GHz frequency band is not uniform throughout the world; and 2) the effective date for access to all frequency bands identified for MSS is not uniform in ITU Region 2.

The MACROCELL system will employ intersatellite links in the 23.18 - 23.38 GHz and 24.45 - 24.75 GHz bands. Downlink feeder and TT&C operations will use frequencies in the 19.3 - 19.7 GHz band, while uplink feeder and TT&C operations will employ frequencies in the 29.1 - 29.5 GHz band.

Iridium expects to be able to amend its proposed feeder link, intersatellite link and TT&C frequencies, as necessary, to comply with the rules and requirements established by the Commission.

The frequency and polarization plan for the system is shown in Table 1.

Table 1. Proposed MACROCELL System Frequency and Polarization Plan

Link	Subscriber Uplink	Subscriber Downlink	Feeder Uplink	Feeder Downlink	Intersatellite Links
Frequency	1980-2025 MHz[3]	2160-2200 MHz[4]	29.1-29.5 GHz	19.3-19.7 GHz	23.18-23.38 24.45-24.75 GHz
Emission Designators	TDMA: 27K2Q7E CDMA: 1M25G7D	TDMA: 27K2Q7E CDMA: 1M25G7D	25M0G7W	25M0G7W	25M0G7W
Polarization	RHCP	RHCP	RHCP	LHCP	RHCP/LHCP

[3] Except in the U.S., where the band 1990-2025 MHz will be used.

[4] Except in the U.S., where the band 2165-2200 MHz will be used.

B. ORBIT CONSIDERATIONS

1. Requested Orbits

The MACROCELL system consists of a constellation of 96 LEO satellites in 8 near-polar orbits, with 12 satellites equally spaced in each orbital plane (not including spares).

2. Orbit Selection

The orbit selection criteria, each of which is vital to the commercial service provision and technological feasibility of the system, were as follows:

a) The need to provide global coverage over the entire surface of the Earth at all times;

b) The requirement that the relative spacing and line-of-sight relationships to neighboring satellites be fixed or slowly changing, thus allowing simplification of the on-board subsystems that control intersatellite links;

c) The desire to minimize the cost of the entire constellation; and

d) The effects of altitude on hardware costs (i.e., tradeoffs considering a high-altitude radiation environment significantly increases costs, whereas low altitudes require more fuel and station-keeping maneuvers).

The selected satellite constellation (detailed in Table 2) provides coverage over the entire surface of the Earth with single coverage provided at the Equator and increasing levels of coverage as the satellites move toward the poles (due to individual satellite coverage beginning to overlap).

Iridium reserves the right to optimize the MACROCELL system constellation to meet conditions that may change as a result of evolving regulatory requirements.

Table 2. Orbital Parameters

Parameter	Mission Orbit
Number of Satellites	96
Number of Orbital Planes	8
Inclination	98.8 deg
Orbital Period	6119.6 sec
Apogee altitude	862.4 km
Perigee altitude	843.5 km
Arguments of Perigee	270°
Active Service Arc(s)	N/A - Global Coverage Area
Right Ascension of Ascending Nodes	160°, 183.5°, 207°, 230.5°, 254°, 277.5°, 301°, 324.5°

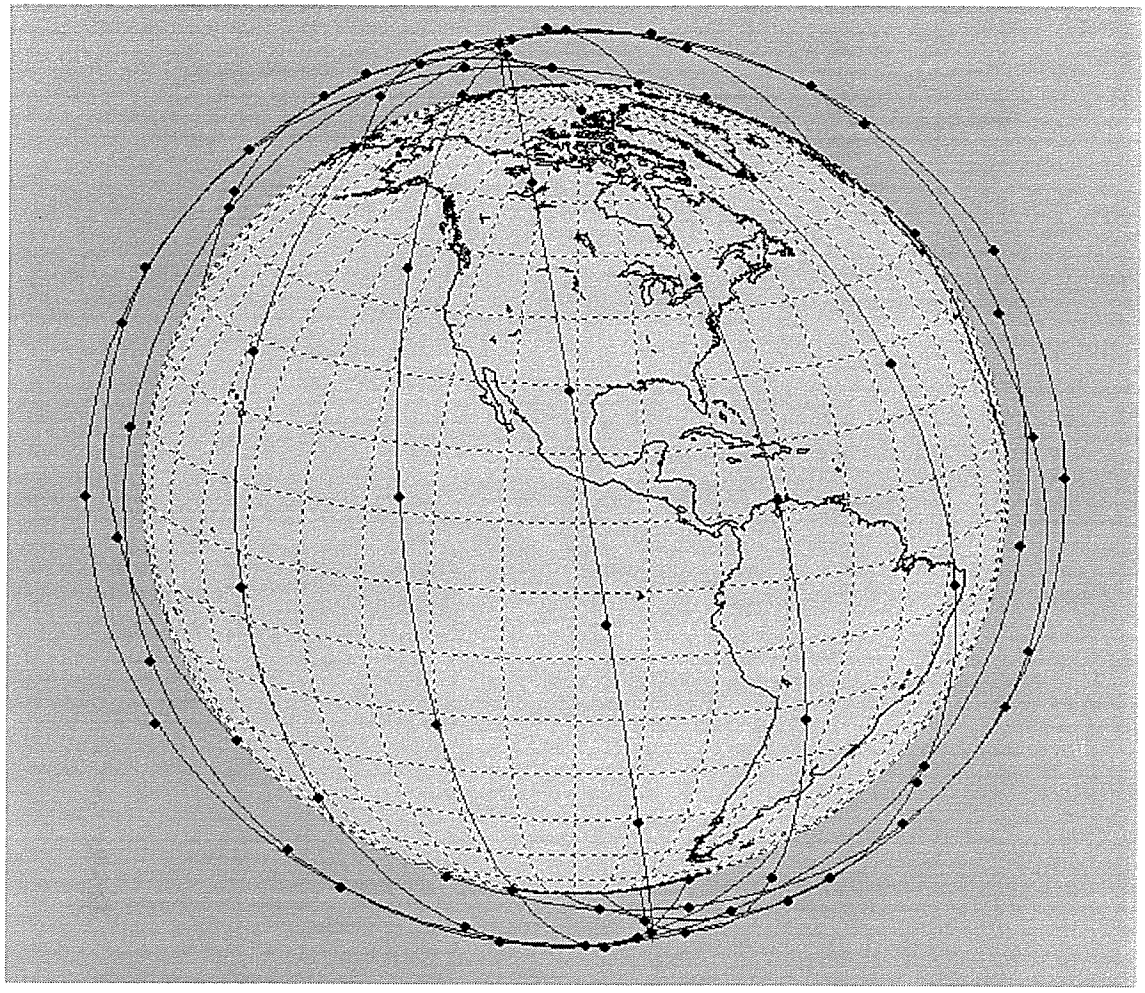


Figure 2. Service Coverage

Figure 3. Single Satellite Service Coverage Region, 853 km, 15 degree elevation

C. SPACE SEGMENT

The 96 satellites of the MACROCELL system space segment will provide unlimited service through global coverage from space.

These 96 satellites will be networked together as a switched digital communications system and will use the principles of cellular diversity to provide

maximum frequency reuse. Each satellite will use spot beams to form cells on the surface of the earth. These multiple, relatively small beams provide high satellite antenna gains and reduce the RF power required in both the satellite and the user subscriber terminals. The major communications characteristics of each satellite are shown in Table 3. Optimizations of the system performance will continue and the number of beams may be adjusted.

Table 3. Major Communications Characteristics of Each Satellite

Number of beams	228
Number of intersatellite links	4-6
Minimum Elevation Angle for User	15 degrees
Signal Processing	Baseband Processor[5]

The spatial separation of the beams allows increased spectral efficiency via time/frequency reuse within multiple cells, enabling many simultaneous user messages.

Projections of the satellites' individual cells on the Earth's surface are analogous to a terrestrial cellular telephone system. Figure 4 depicts a sector of the spot beam coverage of a single satellite. Three identical sectors form the Earth surface coverage pattern of a single satellite.

[5] Because the satellites do not operate as transponders and use active antennas, the Section 25.114(c)(5) requirement for saturation flux density, gain of each transponder channel and other characteristics do not apply herein.

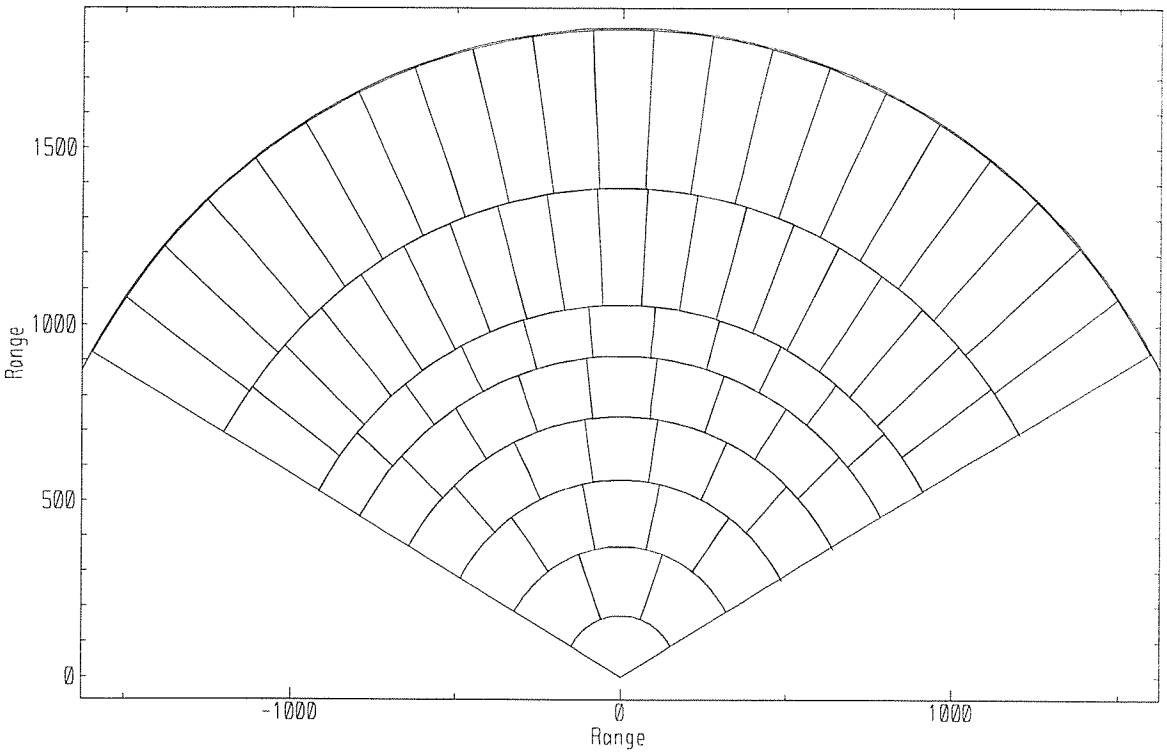


Figure 4. One Sector (of three total) of Coverage by a Single Satellite

The global attribute of the MACROCELL system is made possible by the use of intersatellite links to create a global network. These links operate in the Ka-band and provide connectivity within and across orbital planes. The fore- and aft-looking links are used to communicate with the adjacent satellites in the same orbital plane. Two in-plane and up to four cross-plane links may be used to connect satellites in adjacent planes. The narrow beams of these intersatellite links never intercept the Earth's surface.

Additionally, each satellite has the capability, via feeder links, to establish links with Earth-based Gateways that employ high-gain antennas. The system can accommodate a large number of independent Gateways.

1. Communications Subsystem

The MACROCELL system provides both voice and data services in full-duplex communications as follows: 1) 2 GHz service links between the satellites and subscriber units, 2) Ka-band feeder link communications between each satellite and earth station facilities (either Gateway or TT&C facilities), and 3) Ka-band intersatellite links from satellite to satellite. Additionally, for TT&C, each satellite has a dedicated backup secondary link via a near-omni antenna.

a) 2 GHz Subscriber Terminal Links

The communications subsystem consists of two separate satellite/user air interfaces: one that is TDMA-based, and one that is CDMA-based. Both interfaces use a frequency plan with individual carriers separated in a basic FDMA scheme. Partitioning between the TDMA and CDMA operations will be optimized to maximize system effectiveness.

CDMA systems can have high spectral efficiency where power control techniques are effective at keeping all users at similar power levels. However, satellite systems suffer from relatively long path delays that impede the effectiveness of power control feedback loops. Where power control is ineffective, CDMA's spectral efficiency is reduced.

Therefore, in applications in which the environment and hence the signal level change rapidly, e.g., for voice, Iridium is proposing a TDMA structure. For applications such as data services in which the environment is more slowly changing and power control can be effective, Iridium is proposing a CDMA structure. This dual implementation for the MACROCELL system allows both user types to be supported optimally.

The 2 GHz TDMA service links provide approximately 15 dB of fade margin in the presence of shadowing along the propagation path in order to meet or exceed

availability requirements at the 15-degree minimum user elevation angle. The 2 GHz CDMA links encompass a wide range of data rates, with link margins appropriate to the specific services.

The representative link budgets for voice and data subscriber uplinks and downlinks, with and without shadowing (link impairment due to objects in the radio link path, or reflections causing fading) are given in Section 3 (see Tables 12 - 15).

b) 2 GHz FDMA/TDMA Satellite-to-User Air Interface

The FDMA/TDMA individual voice channels are each transmitted at a 34.545 kbps burst rate, each occupying a bandwidth of 27.17 kHz using quaternary phase shift keyed (QPSK) modulation. This permits a peak density per beam of 147 voice channels per megahertz, and 184 voice channels per 1.25 MHz. The MACROCELL system requires dedicated spectrum for this service.

Key parameters for the FDMA/TDMA scheme are summarized in Table 4.

Table 4. FDMA/TDMA Voice Channel Characteristics

Voice time slots/Frame	4
Burst Rate	34.545 kbps
Channel Spacing	27.17 kHz
Information Rate	4 kbps
FEC (integrated w/vocoder)	Rate=2/3
Modulation Type	QPSK

c) 2 GHz FDMA/CDMA Satellite-to-User Air Interface

The design divides the 2 GHz frequency band into 1.25 MHz sub-bands. Within each sub-band, CDMA is used, allowing multiple users to share the spectrum. The spectrum at 2 GHz can be reused on each beam of the multi-beam antennas on each satellite, resulting in a large frequency reuse factor for this CDMA subsystem. The

CDMA links will provide variable user data rates up to 64 kbps, as well as very low-speed, high Eb/No[6] links for in-building penetration for data messaging services.

The CDMA air interface is based on the cellular industry IS-95 standard,[7] a 1.25 MHz bandwidth and direct-sequence spread spectrum signal. The peak channel bit rate is 9.6 kbps. The radio interface uses rate 1/3 convolutional encoding for the uplink, and rate 1/2 encoding for the downlink. A power control channel is added to each link using a punctured convolutional code.

Key parameters are summarized in Table 5.

Table 5. FDMA/CDMA Data Channel Characteristics

Subframes/Frame	2
Spreading Rate	1.228 Mbps
Channel Spacing	1.25 MHz
Information Rate	0.048 to 9.6 kbps
FEC	Rate=1/2 dn; 1/3 up
Modulation Type	QPSK

A data link using multiple channels can provide data services at 64 kbps or higher (e.g. 384 kbps).

d) Intersatellite Links

To provide full-duplex intersatellite communications, the system will use an independent dual-frequency Ka-band network of links in two frequency bands: 23.18 -

[6] Eb/No, energy per bit to noise density ratio, is a measure of received link quality in digital transmission systems.

[7] IS-95 is an emerging U.S. TIA CDMA standard.

23.38 GHz and 24.45 - 24.75 GHz. Each satellite operates two in-plane links that operate continuously, and up to four cross-plane links that operate during the interval that the satellite is located between approximately 70° S and 70° N latitudes. TDMA and CDMA uplink signals are demodulated on-board the satellite and are reconstituted in common format for transmission on the intersatellite links using QPSK modulation.

The intersatellite links support a packet-switched network using TDMA. When heavily loaded and within the latitude band defined above, all intersatellite links on a particular satellite may transmit continuously.

The intersatellite link design satisfies the maximum allowable power flux density requirements of Section 25.208(c) of the Commission's Rules. The main beams never intercept the Earth's surface.

e) Feeder Links

The feeder links connect the satellites to the fixed earth stations used by the System Control and Gateway segments. The System Control Segment uses the feeder links to support TT&C functions for the individual satellites and the overall constellation. The Gateway Segment feeder link function provides the signaling and trunking connections for the subscriber communications services.

The feeder links are conventional satellite/earth-terminal links operating at Ka-band. Each satellite has multiple feeder link connections. The uplink (Earth-to-space) uses up to 400 MHz bandwidth in the 29.1 - 29.5 GHz band and the downlink (space-to-Earth) uses up to 400 MHz bandwidth in the 19.3 - 19.7 GHz band. Each of these bands is frequency- and time-divided for channel assignment and interference control.

The high-rate feeder links will operate in FDMA/TDMA mode and transmit using QPSK modulation with forward error correction coding. This design not only provides significant random error correction capability but also mitigates the effects of rain outages and other burst error conditions.

Uplink and downlink K-band interference will be minimized by the use of active power control, limiting power to 3 dB above the value required for a bit error rate (BER) of 10^{-7}.

Under normal operating conditions, the feeder link design satisfies the maximum allowable power flux density for all elevation angles, as illustrated in Table 6. However, on very infrequent occasions, the maximum allowable flux density may be exceeded. This could occur when the downlink effective isotropic radiated power (EIRP) is increased to compensate for rain attenuation and an interfered-with station has no propagation losses. Mitigation techniques will be employed for these conditions.

Table 6. Maximum Flux Density for Feeder Downlinks

Elevation Angle, degrees	Feeder Link Flux Density with power control	Maximum Feeder Link Flux Density**	TT&C Link Flux Density with power control	Maximum TT&C Link Flux Density**	Secondary Link Flux Density	Maximum Allowable Power Spectral Flux Density
5*	-134.8	-124.8	-135.1	-118.8	-137.0	-135.0
10*	-132.8	-122.8	-133.1	-116.8	-135.7	-128.0
15	-130.8	-120.8	-131.1	-114.8	-134.4	-115.0
20	-130.8	-119.6	-131.1	-113.6	-133.2	-108.0
25	-130.8	-118.6	-131.1	-112.5	-132.1	-105.0
90	-130.8	-112.8	-131.1	-106.8	-126.4	-105.0

All flux densities are in units of $dBW/m^2/MHz$

*Minimum operating elevation angle is 15°, radiated power at lower angles due to off-axis emission except for secondary link.

**Assumed worst-case rain conditions at desired station and zero attenuation for interfered-with station.

2. Antenna Subsystem

a) Subscriber Unit Link (2 GHz) Antenna Subsystem

The 2 GHz service link requirement for communicating with subscriber units is supported on the satellite by an antenna subsystem. This antenna complex forms cellular-like beams.

This subsystem is composed of a set of two phased-array antennas on the satellite, one for transmit and one for receive, to support the 2 GHz uplink and downlink. Transmit and receive phased array antenna pairs produce nearly identical and congruent uplink and downlink beams. The footprint of each satellite is divided into clusters of beams in order to facilitate channel reuse.

Any of the beam ports of the transmitting antenna can be simultaneously activated by exciting it with one or more carrier signals. Each beam is dynamically assigned a set of channels corresponding to specific frequency and time slot assignments in the 2 GHz service link frequency band commensurate with the number

and usage of subscriber units being served. To efficiently accommodate variations in traffic, hardware allows the number of connections per beam to adapt automatically to the demand.

Beams also can be turned on or off, as appropriate, to accommodate traffic conditions and changing overlap of coverage. For example, to minimize possible interference from overlapping satellite footprints and to conserve satellite power, the system will employ a cell management architecture that turns beams off as each satellite traverses from the Equator toward the Polar regions.

The service link antenna subsystem is fixed to the satellite body and its pointing accuracy is dependent upon the satellite attitude control stabilization system.

Figure 5 through Figure 12 illustrate the antenna gain contours of the Satellite Antenna Subsystem. Representative beam patterns are shown for beams at nadir (Type 1) and at the farthest out of the eight rings (Type 8).

Figure 5. Antenna Gain Contours – Service Uplink and Downlink – Type 1 Beam (Magnified)

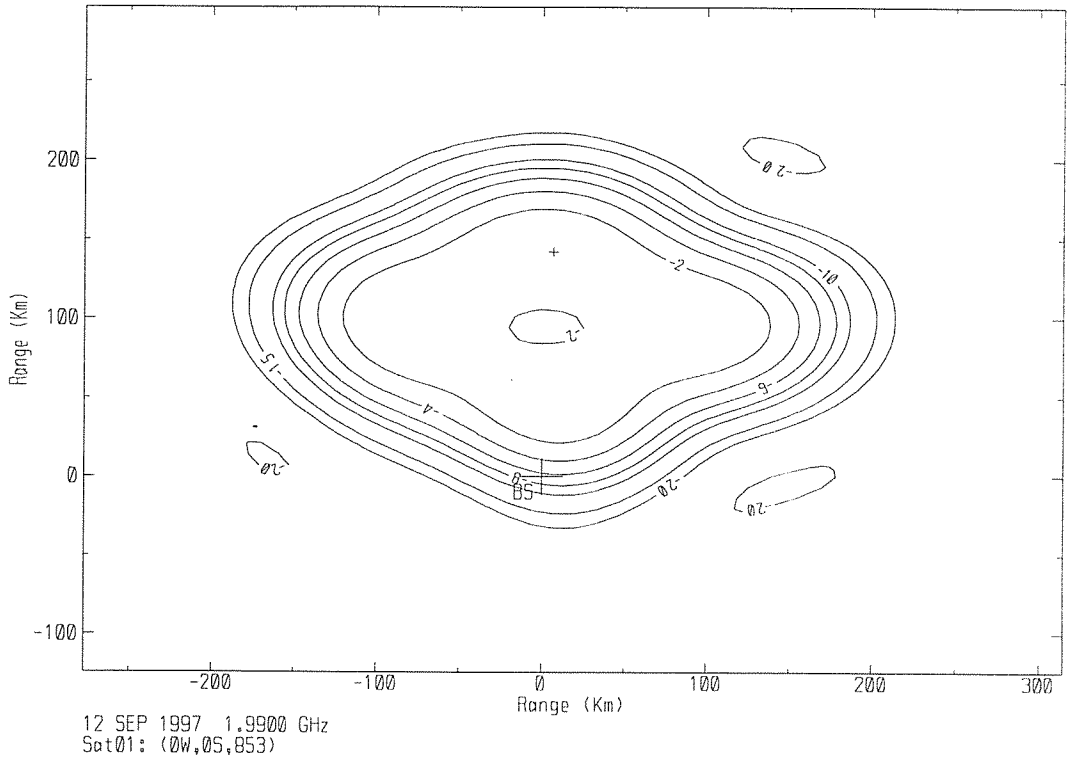


Figure 6. Antenna Gain Contours – Service Uplink and Downlink – Type 2 Beam

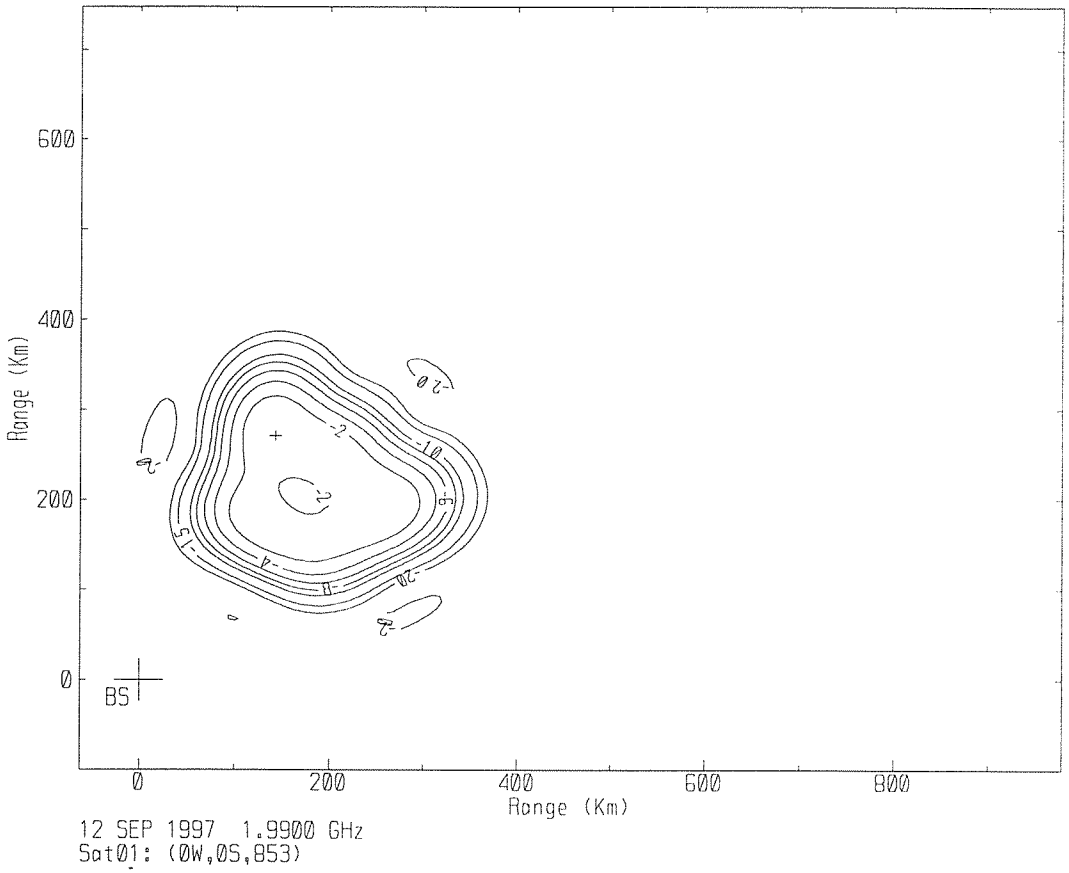


Figure 7. Antenna Gain Contours – Service Uplink and Downlink – Type 3 Beam

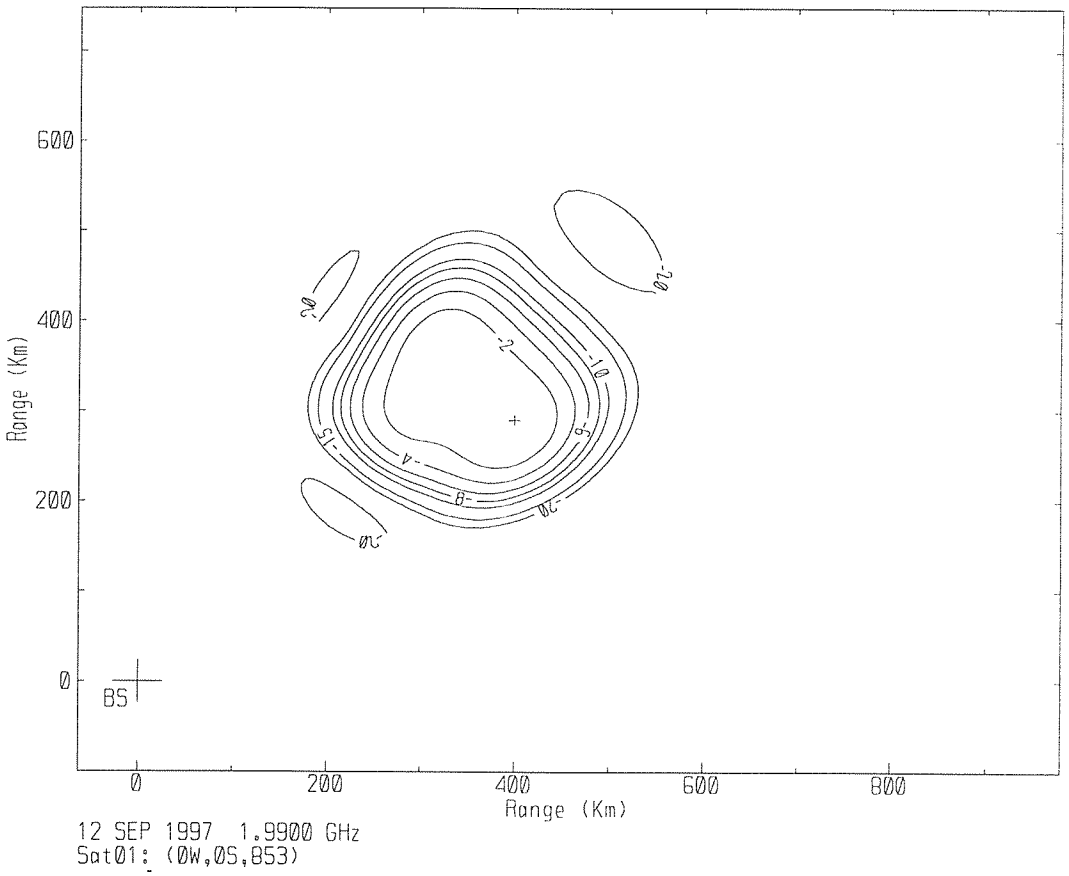


Figure 8. Antenna Gain Contours – Service Uplink and Downlink – Type 4 Beam

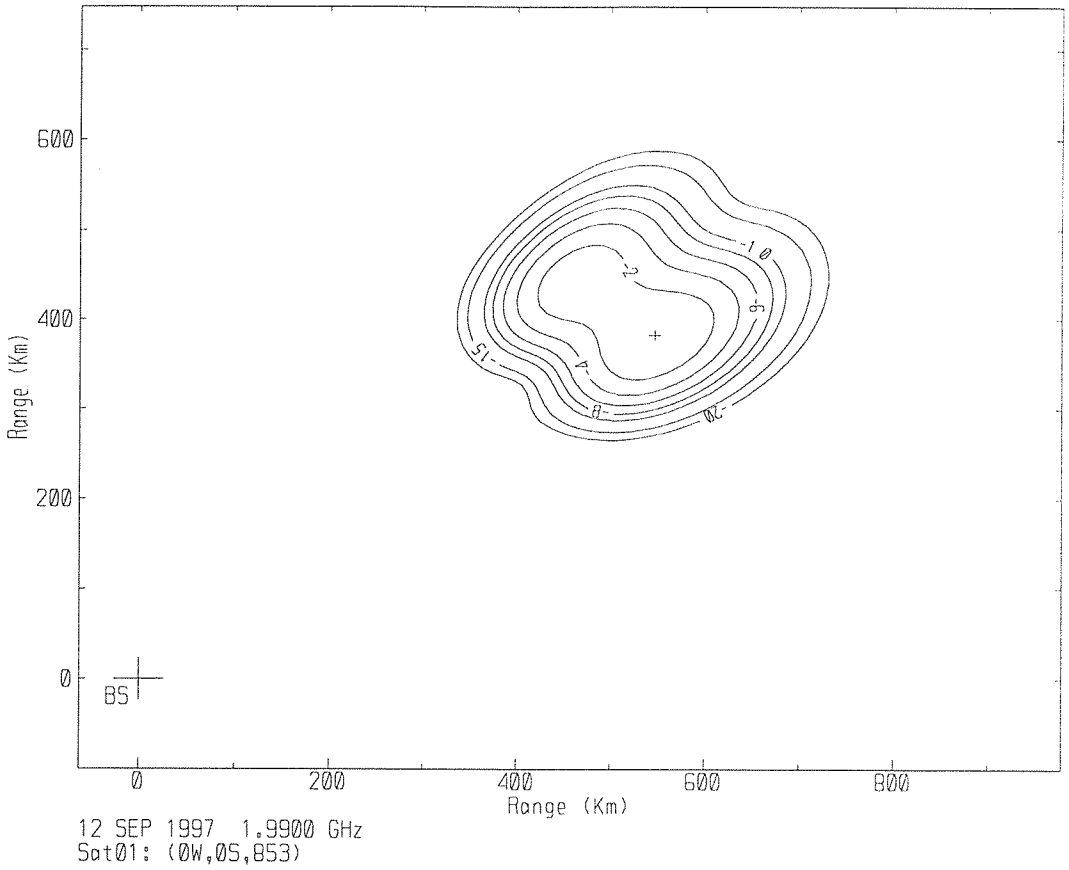


Figure 9. Antenna Gain Contours – Service Uplink and Downlink – Type 5 Beam

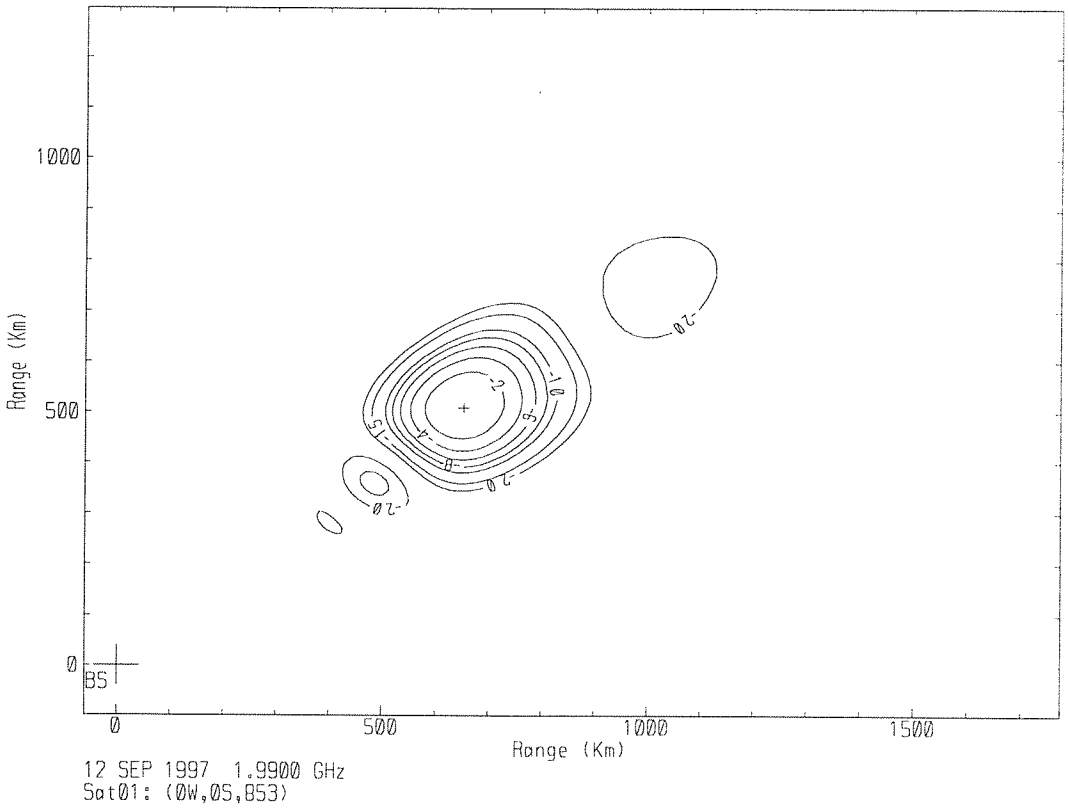


Figure 10. Antenna Gain Contours – Service Uplink and Downlink – Type 6 Beam

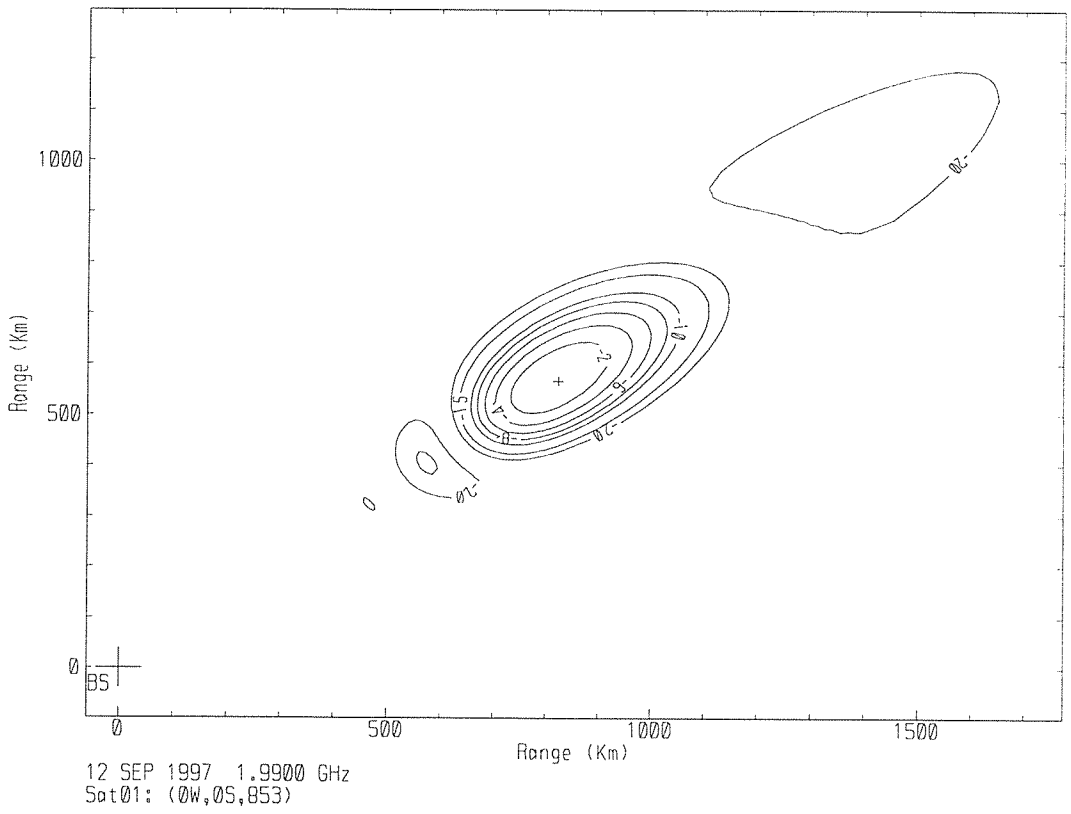


Figure 11. Antenna Gain Contours – Service Uplink and Downlink – Type 7 Beam

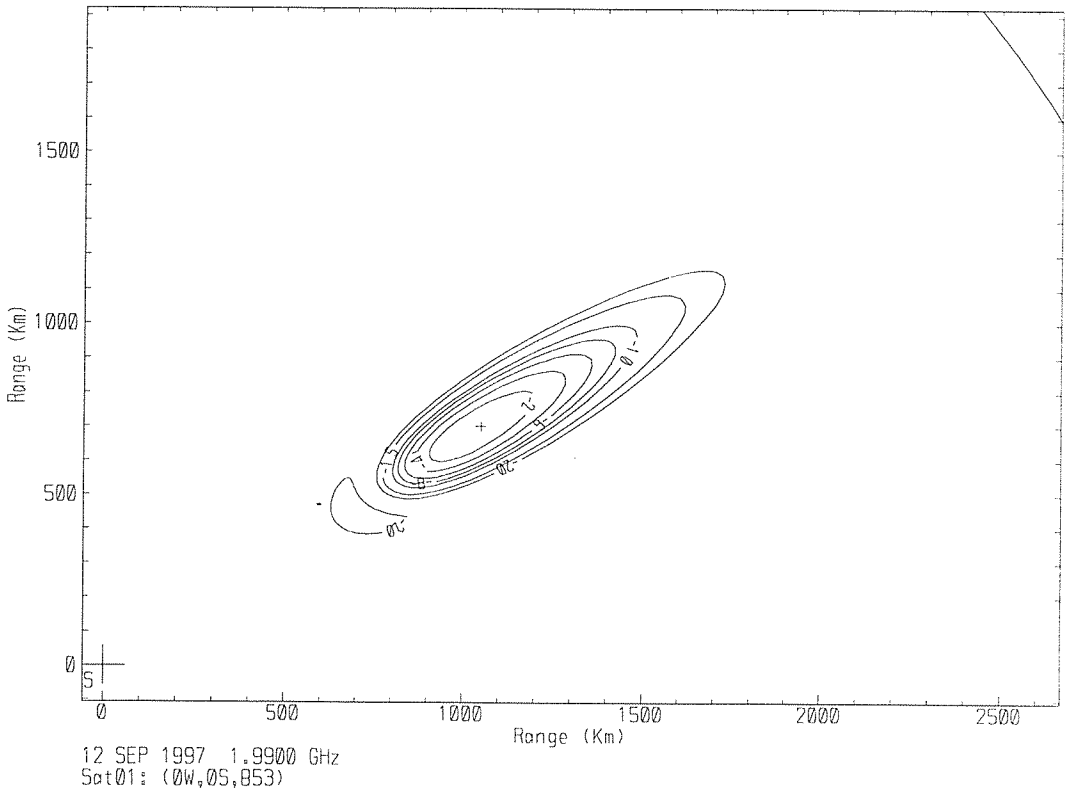
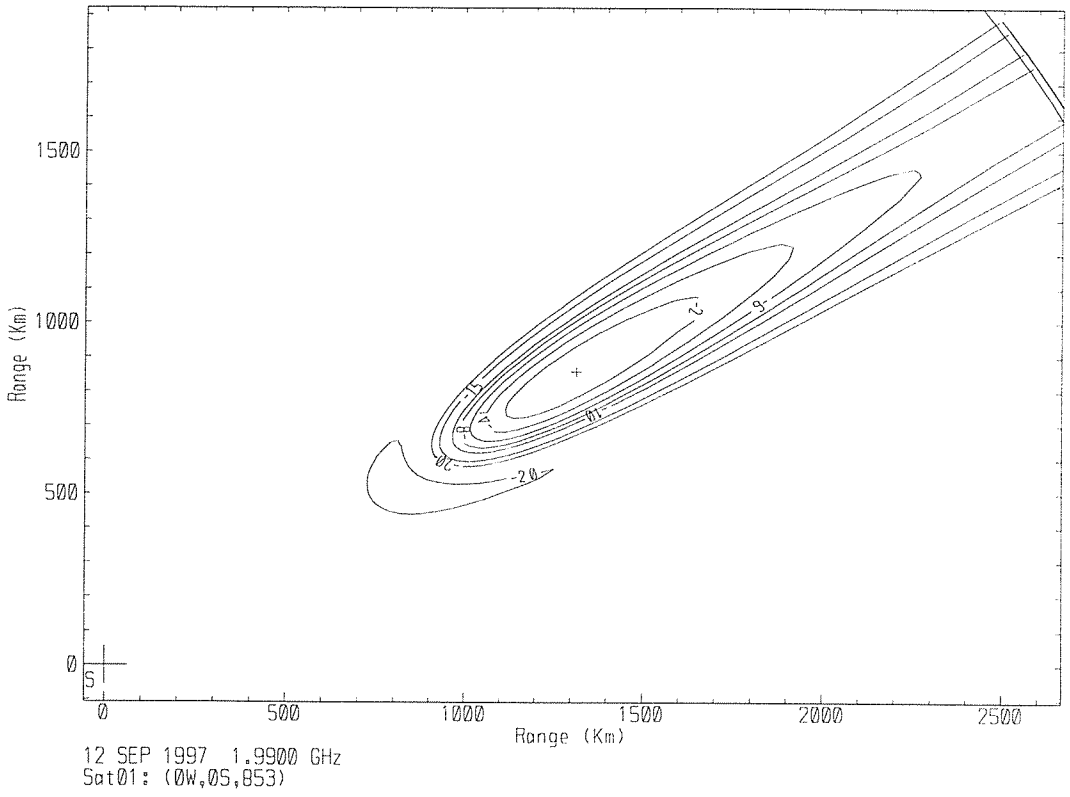


Figure 12. Antenna Gain Contours -- Service Uplink and Downlink – Type 8 Beam



b) Telemetry, Tracking, and Command (TT&C) Antenna Subsystem

The Ka-band Gateway and satellite feeder link antennas are used for primary TT&C and, on the satellite, a near-omnidirectional antenna is used for the secondary TT&C.

c) Intersatellite Link Antennas

The intersatellite links will use four or six independent antennas. Right- and left-

hand circular polarization will be used to increase isolation between spatially isolated links operating at the same frequency.

3. Telemetry, Tracking and Command Links

The TT&C[8] links operate at Ka-band under the control of Iridium. These high-gain, low data rate links between the satellites and the TT&C ground station operate in the 19.4 - 19.6 GHz band (space-to-Earth) and the 29.1 - 29.3 GHz (Earth-to-space) feeder link band. These links transmit telemetry and commands at 3.15 Mbps with forward error correction coding. The primary TT&C links will be under power control, which minimizes interference. The high-gain link is the primary communications link between the satellites and the TT&C ground stations.

The MACROCELL system constellation also uses the intersatellite links for command and telemetry. Therefore, each satellite can be continuously commanded and its data can be continuously received using a single TT&C ground station.

Secondary TT&C communication links provide access in the early orbit checkout phase of satellite deployment. These narrowband channels are circularly polarized and use low directivity satellite antennas to permit direct communications with the TT&C ground station regardless of the attitude of the satellite. This link also provides on-orbit backup communications capability, as required, during on-orbit operations.

When the narrowband transmission mode is in operation, all of the TT&C data and control signals are transmitted in digital form at a rate of 1.0 kbps without coding.

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[8] TT&C operations control and monitor a satellite's electrical function and orbit from a fixed-earth station and allow information to be transmitted to the satellite that can alter the electrical function of the satellite and, if necessary, adjust that orbit. TT&C functions may be conducted in bands allocated to the space operation service or in the band on which the underlying service is being provided. *See* 47 C.F.R. § 2.1.

Large signal margins and binary phase shift keyed pulse modulation (BPSK/PM) are used to minimize the effects of anticipated antenna pattern irregularities and grating lobes which are characteristic of the satellite omnidirectional antennas. Power control is not implemented on the secondary link, but the power flux density is within Part 25 required limits.

Table 7 provides a comparison of the TT&C communications performance for all TT&C links.

Table 7. TT&C Satellite Transmission Characteristics

	Secondary	Primary
Frequency Band	19.4-19.6 GHz	19.4-19.6 GHz
Ant. Polarization	LHCP	LHCP
EIRP (operational)	3.2 dBW	11.5 - 27.8 dBW
Modulation	BPSK/PM	QPSK
Data Rate	1 kbps	3.125/12.5 Mbps
	(Total Feeder Link/Intersatellite link data rate)	

4. Satellite Physical Characteristics

The basic on-orbit configuration of the satellite is a large Earth-facing panel, containing all receive and transmit phased arrays, with the payload electronics, propulsion, attitude control equipment, and batteries mounted in the main support frame. The solar arrays are deployed on booms to provide the necessary fields of view for proper orientation to the Sun.

When deployed, the satellite body is a rectangular prism, with the earth-facing panel 2.6 meters wide by 3.8 meters long by 0.4 meters deep. The earth-facing panel contains the phased array antennas. The solar arrays total 21 square meters, and are deployed on a 4-meter boom.

The thermal design of the satellites is based entirely on space-proven technology

and hardware. The coupling of conduction and radiation techniques to such conventional devices as satellite structure and heat pipes will suffice to transfer the heat and maintain the temperatures of the electronic devices well within their operating regimes.

The satellites use a monopropellant hydrazine subsystem to provide all propulsive functions. This subsystem applies external torques and forces to the satellite to perform the functions of orbit insertion, orbit adjustment, maintenance, reaction control, and de-orbit. Table 8 provides the propellant budget for the satellites.

Table 8. Propellant Budget

Function	**Propellant Mass** (kg)
Mission Ascent	114
Orbit Maintenance	17
End Of Life De-orbit Maneuver	114
Performance Reserve	20
Residual and Pressurant	6
Total Propellant Mass	**271**

a) Electrical Power Subsystem

The electrical power subsystem provides the power to the satellite electrical loads over the expected lifetime of the satellite. The bus voltage varies from 22 to 36 volts and is converted to the required equipment voltages by power converters located at the loads. This subsystem is configured as a series regulated solar array system. The batteries are always on line. The equipment includes the following major elements:

- a high-output GaAs/Ge on graphite epoxy photovoltaic solar array;
- long-life 22-cell nickel hydrogen secondary batteries; and
- software-configurable battery charging controls.

The solar array consists of two Sun-oriented planar wings, or panels. During liftoff, the panels are folded against the satellite body. Following separation of the satellite from the launch vehicle, the array is deployed and full power will be available.

The power subsystem is capable of supplying a payload peak demand of more than 7300 watts. Beginning of life power requirements are nominally the same, with the power sources capable of supplying an additional 10% margin. The design of the power source components includes a 10% margin to account for End of Life (EOL) degradation effects of ionizing and ultraviolet radiation, temperature, and micrometeroids. Table 9 sets forth the electrical power budget and indicates EOL power requirements.

Table 9. 24-Hour Average Power Budget

SUBSYSTEM	EOL watts (8.5 years, 24 hour average, Beta=0 degrees)
Communications Payload	780
Main Mission Antenna (Phased Array)	325
Satellite Housekeeping	200
TOTAL LOAD	**1305**

b) Space Vehicle Structure

The vehicle structure is a high-strength graphite epoxy composite. The integrated structure supports the various subsystem hardware, which make up each satellite. This structure provides the integrity necessary to survive all phases of the satellites' mission lifecycle, including the launch loads. The structure also provides the mounting surfaces and attachment interface for hardware mechanisms and for attachment to the launch vehicles. Table 10 shows the mass budget for a satellite.

Table 10. Satellite Mass Budget

Item	Mass (kg)
Main Mission Antenna	173
Bus (Power, AOCS, Structure, Propulsion, Reserve)	599
Communications Electronics	670
Propellant, Pressurant, Residuals	271
TOTAL Wet Liftoff Mass per Satellite	**1713**

c) Space Vehicle Operational Lifetime

The operational life and reliability of each satellite is determined by a number of factors, including solar array degradation, stationkeeping fuel consumption, and random parts failures. Table 11 indicates the estimated lifetime of the satellites for each of these factors:

Table 11. Satellite Operational Lifetime

Item	Lifetime
Solar array degradation	8.5 years
Stationkeeping fuel	8.5 years (3 sigma orbital insertion)
Random failure	Redundancy will be provided on critical hardware as determined for a 7.5 year mission

Each individual satellite will be de-orbited at the end of its useful mission lifetime, and all TT&C radio link functions will be discontinued.

D. EARTH SEGMENT

1. System Control Segment

The domestic System Control Segment (SCS) provides control of the entire

satellite constellation and the MACROCELL system space network connectivity. The SCS manages and controls all MACROCELL system elements, thus insuring continual service to the subscribers. Functions performed by the SCS fall into two general areas: a) constellation operations and b) network operations. These tasks are performed by separate, co-located subsystems.

a) Constellation Operations

The primary functions of the constellation operations subsystem include:

- Managing each individual satellite state-of-health
- Supporting satellite launch and early-orbit checkout
- Responding to satellite emergencies
- Managing End-Of-Life operations

b) Network Operations

The network operations subsystem of the SCS provides management of the communications network. Under normal conditions the functioning of the satellites in terms of communication to the subscriber units, gateways, and to each other is autonomous. In case of abnormal conditions, such as very heavy traffic loading or node failure, the network operations subsystem will provide instructions to the network nodes on what steps to take to maintain service quality to the users.

c) Location of SCS Subsystems

The network operations and constellation operations subsystems will be replicated at separate sites to provide a continuous capability in case of a catastrophic loss of function at one site. The control facilities themselves may be located separate from the earth station antennas. The earth stations may be located in higher latitudes, allowing observation of multiple planes of the constellation from one location.

d) SCS Earth Terminals

The SCS shares a common earth terminal design with the Gateway Segment.

2. Gateway Segment

The MACROCELL system constellation will be supported by a number of terrestrial facilities around the world. This terrestrial infrastructure, comprised of Gateways, provides services to users on a call-by-call basis and otherwise supports the network. An essential function of these Gateways is to support and manage the mobile, roaming subscriber units and the interconnection of the MACROCELL system network to other networks.

A Gateway comprises several subsystems. The core subsystems are the Earth Terminals (ETs), Earth Terminal Controller (ETC), and Gateway Management Subsystem (GMS). Depending on the subscriber service mix at a particular Gateway, there can also be a Switching Subsystem (SSS) for circuit services, a Packet Services Subsystem (PSS), and a Messaging Subsystem (MS). Together these subsystems allow the Gateway to perform the following general functions with the MACROCELL system network:

- Interface to other networks, such as the PSTN (Public Switched Telephone Network), ISDN (Integrated Digital Services Network), PDN (Public Digital Network), and PLMN (Public Land Mobile Network);

- Provide the earth terminal (ET) physical data links between a gateway and the satellites;

- Maintain constellation connectivity -- the Gateway provides functions to maintain continuous communication between the Gateway and the other nodes of the MACROCELL system network;

- Provide call and service processing and related functions, including

subscriber mobility management.

3. Subscriber Units

The MACROCELL system's subscriber units for the satellite portion of the system will provide service for a variety of applications. The types of subscriber units that will be made available may comprise a variety of portable (to include handheld units) and mobile terminals.

Section 2. INTERFERENCE AND SHARING ANALYSIS

A. 2 GHz SERVICE LINKS

The FCC faces a significant challenge in accommodating the needs of MSS applicants and incumbent users of the 2 GHz band and related feeder link frequency bands. Iridium notes that the service rules for these 2 GHz MSS and feeder links are yet to be finalized. However, Iridium believes that the MACROCELL system can coexist with other MSS applicants in this frequency band. It has intentionally designed flexibility into the MACROCELL system and will work with other Applicants and the Commission to accommodate the maximum number of qualified systems in the 2 GHz band. Additionally, and to the extent necessary, Iridium will provide any additional technical information regarding the MACROCELL system's sharing and interference characteristics as requested by the Commission. Iridium will modify or amend this application to meet new service rules as they are adopted.

1. Inter-service

Iridium will comply with FCC rules regarding sharing and coordination in the 2 GHz band for the MACROCELL system. Iridium is actively participating and will continue to participate in studies currently underway within the Telecommunication Industry Association in the U.S. and within the International Telecommunication Union (ITU) Joint Rapporteur's Group 8D/9D to determine how inter-service sharing is possible with other services (e.g., FS, BAS) currently allocated in these bands.

2. Intra-service

Studies conducted within the ITU have reached certain conclusions regarding MSS intra-service sharing. The results of these sharing studies are summarized in the report of ITU CPM 97 in Section 4.2.1.2. The conclusion reached is that co-directional, co-frequency, co-coverage spectrum sharing between presently proposed FDMA/TDMA and CDMA global non-GSO MSS systems in the 1-3 GHz band is not practicable.

Furthermore, such sharing among FDMA/TDMA non-GSO MSS systems is also not practicable.

For CDMA, co-frequency sharing between satellite systems has been claimed to be feasible, depending on the parameters chosen. However, this results in a reduction in capacity for each CDMA system sharing the band.

3. Intra-system

Within the MACROCELL system, self-interference between the TDMA and CDMA payloads will be mitigated by the use of non-overlapping frequency bands.

B. Ka-BAND FEEDER LINKS (29.1-29.5/19.3-19.7 GHz)

Iridium will operate the MACROCELL system across the Ka-band 400 MHz bandwidth range that is already allocated for this service in the ITU international Table of Frequency Allocations.

1. Inter-service

Iridium will ensure the MACROCELL system will comply with FCC rules regarding sharing and coordination in these frequency bands. This includes following established coordination procedures for antenna site locations and for frequency usage. Iridium acknowledges that this will require coordination of the MACROCELL system with the current IRIDIUM and Odyssey systems.

The MACROCELL system feeder link transmissions will employ Gateway earth stations at fixed locations around the world and therefore are considered part of the Fixed-Satellite Service (FSS). In all of the band segments planned for these feeder links, there are international Fixed Service (FS) and Mobile Service (MS) allocations. However, not all countries or all regions will have authorized, existing or planned FS and MS networks in these frequency bands. The MACROCELL system will be built to operate over a 400 MHz bandwidth range and will use this entire bandwidth in all countries authorizing MACROCELL system operations across this band. Within the

U.S., Iridium requests operations across the entire band for the MACROCELL system.

Section V of Article S21 and FCC Part 25.208 specify the downlink power flux density (PFD) limits for the 17.7 - 19.7 GHz band. The PFD of the MACROCELL system space station feeder links will comply with these limits under all normal operational conditions.

a) United States

The U.S. does not authorize MS networks in these frequency bands.

Conventional FS point-to-point fixed stations currently are being licensed over the entire requested downlink band, but each station typically occupies only a 40 MHz bandwidth. Experience with the existing IRIDIUM feeder-link stations has shown that coordination with FS in these bands is only necessary for those FS stations that are within line-of-sight of the feeder-link station. Terrain shielding and possibly site shielding will protect the Gateway earth station for the rare case where the FS is within line-of-sight and pointing directly at the gateway. In rarer cases, frequency avoidance may be required.

b) International

No planned or existing MS networks have been identified in these band segments.

Worldwide coordination with FS for the multiple Gateways planned should not be difficult, provided ITU Radio Regulation (RR) Appendix S7 (as improved by Recommendation IS.849) is complied with and that a full 400 MHz of bandwidth is available for coordination.

2. Intra-service

The requested Gateway feeder link bands are allocated for use by two types of FSS: geostationary (GSO) networks and feeder links for MSS networks. Currently, the bands 29.1 - 29.4 GHz and 19.3 - 19.6 GHz are designated for joint use in accordance

with the coordination provisions of ITU RR Resolution 46. In addition, the frequency bands 29.4 - 29.5 GHz and 19.6 - 19.7 GHz are listed as co-primary for GSO FSS and NGSO FSS, but RR Number (No.) S22.2 applies. Radio Regulation No. S22.2 is an operational constraint upon NGSO networks that is designed to give preferential protection to GSO networks. The removal of RR No. S22.2 from this 100 MHz of spectrum is on the agenda at WRC-97 and is supported by the U.S. Delegation proposals.

At present, the U.S.-licensed "Odyssey" network is the only planned NGSO system proposing feeder links in the 20/30 GHz bands (other than the IRIDIUM system) that has reached the coordination stage. In addition, only Japan and Italy have operational GSO networks in these bands. One U.S. government network is operational, and coordination with this network will be conducted in accordance with FCC Table of Allocations, U.S. footnote 334.

a) United States

The U.S. prohibits domestic operation by GSO FSS in the 29.1 - 29.25 GHz and 19.3 - 19.7 GHz bands. Therefore, coordination with GSO networks is only required for 250 MHz of the uplink band. Sharing studies within the ITU-R have concluded that sharing between NGSO feeder links and GSO networks is feasible with appropriate mitigation. The three most effective mitigation techniques as cited in the Conference Preparatory Meeting-97 (CPM-97) report are:

- Geographic separation of the earth stations
- Adaptive uplink power control
- Large antennas (with high directivity)

As previously stated, in the U.S. the mitigation techniques need only be applied to 250 MHz of the uplink band. The mutual interference problem in the uplink is manifested primarily by potentially large interference levels into the MACROCELL system network, and no significant interference is caused into the GSO network due to

the approximate 30 dB differential range loss. To mitigate interference into the Gateway uplink from a typical GSO network, the GSO network must restrict its uplink power to the minimum necessary to close the link in accordance with Part 25.204(d) of the FCC Rules. That is, the use of adaptive power control is quite important in the 20/30 GHz bands because propagation losses in the uplink are quite high. If the GSO transmitting station is at maximum power to overcome a rain cell, the signal to the MACROCELL system satellite receiver during the in-line crossing will be attenuated by a like amount. Therefore, if the GSO network implements adaptive power control for weather, the peak interference into the MACROCELL system network is the same in clear air as when the GSO network is seriously propagation-impaired.

The frequency and duration of the uplink interference from the GSO network is also a function of the GSO earth station antenna size. As no U.S. commercial GSO systems are currently operating in these bands, it is difficult to estimate the typical antenna size and therefore, the severity of the uplink interference. GSO networks have several sharing constraints that drive their antenna size up in these band segments. For example, the U.S. GSO band plan calls for spacing every two degrees of the orbital arc. Draft New Recommendation ITU-R 4/67 (Rev. 1) estimated that the GSO earth station size must be at least 0.7 meters in order to achieve this spacing in the 20/30 GHz bands.

Coordination with FS in the downlink is also quite difficult for the GSO networks in the U.S., especially if the GSO systems plan to deploy ubiquitous small-aperture VSATs in urban areas. However, the GSO networks propose using these uplink bands for low-quantity, large aperture point-to-point backbone satellite links. Also, the GSO VSATs will likely be deployed in the 29.5 - 30.0 GHz band, where no FS is allowed on either the uplinks or downlinks.

Given these drivers toward a few large co-frequency GSO earth terminals in these bands, it is reasonable to conclude that successful coordination is possible even with multiple GSO satellites spaced along the orbital arc. Coordination of these GSO

networks with NGSO feeder links seems to be achievable, particularly if 400 MHz of bandwidth is available to the NGSO MSS gateway, of which 150 MHz is exclusive to NGSO networks.

Both the IRIDIUM system and MACROCELL system networks use large earth terminal antennas and adaptive power control on both the up and down links. In addition, the operating bandwidth required by the IRIDIUM network is much less than the MACROCELL system network. It is therefore feasible to coordinate between the two networks.

b) International

Italy and Japan have pre-WRC-95 operational GSO networks that carry large static up and down link margins. It is yet to be determined whether these countries will be willing to coordinate under Resolution 46 (as adopted at WRC-95) or will attempt to invoke RR S22.2 that was in effect when they finished their coordination. NGSO and GSO networks can suffer harmful interference even when their earth terminals are in non-overlapping service areas. The MACROCELL system employs adaptive power control; an effective method for mitigation of harmful interference into the GSO uplink and, by using earth terminals separated by no more than 500 miles, the downlink interference into the GSO earth station will be within acceptable limits.

The sharing difficulty is in protecting the NGSO feeder link. Clearly, the burden of mitigation of interference from these existing systems will be the responsibility of the NGSO feeder link network. If the gateway has access to a full 400 MHz of bandwidth in each direction, then a combination of frequency avoidance and in-line event avoidance can be utilized. In general, a GSO earth terminal will not have an assigned bandwidth of more than 120 MHz per carrier at a time. Therefore, the feeder link station has the option to switch to another frequency not utilized by any particular GSO.

Again, few countries have operational 20/30 GHz GSO networks. At present, the

majority of ITU filings can be considered uncertain as to implementation. The existing IRIDIUM network and the proposed MACROCELL system network can readily share with new GSO networks with the implementation of appropriate mutual mitigation procedures. The sharing possibilities are much improved if the GSO networks use large antennas and adaptive power control on both the up and down links.

C. Ka-BAND INTERSATELLITE LINKS (23.18-23.38/24.45-24.75)

1. Inter-service

The 23.18 - 23.38 GHz band is also allocated to the FS and MS on a primary basis. Internationally, the limits for space station emissions in Article S21 of the simplified Radio Regulations apply. For the 24.45 - 24.75 GHz band, there are several other services co-allocated, depending on the ITU-R Region. These services include fixed, mobile, radionavigation, and radiolocation satellite (Earth-to-space). Relevant Radio Regulations, such as Article S21, would also apply to the protection of such services.

2. Intra-service

Prior studies have indicated that intersatellite links of NGSO systems can operate on a co-frequency basis with intersatellite links of GSO systems. As for co-frequency operation with intersatellite links of other NGSO networks, coordination can be used to avoid harmful interference.

Section 3. TRANSMISSION CHARACTERISTICS

Tables 12 through 19 include link budgets describing the transmission characteristics of the four communications link types: (1) service links at 2 GHz described with voice or data and in clear or shadowed paths; (2) Ka-band Gateway feeder links; (3) intersatellite links; and (4) primary and secondary TT&C.

The service links have different characteristics as the user direction changes from nadir out to the outer beams. The budgets define values for using these beams, titled: "Nadir" for an exemplary central beam near nadir, Type 1; and "Outer" for an exemplary Type 8 edge beam.

Table 12. FDMA/CDMA Data Service Links with Shadowing.

	Nadir Beam		Outer Beam	
	Uplink	Downlink	Uplink	Downlink
Frequency (MHz)	2007.5	2182.5	2007.5	2182.5
Elevation (deg)	90.0	90.0	15.0	15.0
Transmit Antenna Directivity (dBi)	0.0	19.8	0.0	27.8
EIRP (dBW)	-1.0	14.1	-1.0	22.1
Free Space Loss (dB)	157.1	157.8	165.1	165.8
Atmos/Pol. Loss (dB)	0.8	0.8	0.8	0.8
Shadowing Loss (dB)	15.0	15.0	15.0	15.0
Total Path Loss (dB)	172.9	173.6	180.9	181.6
Receive Antenna Directivity (dBi)	19.8	0.0	27.8	0.0
Tsys (dBK)	27.7	24.8	27.7	24.8
G/T (dB/K)	-7.9	-24.8	0.1	-24.8
Data Rate (kbps)	9.6	9.6	9.6	9.6
Eb/No Thermal (dB)	7.0	4.4	7.0	4.4
Eb/Io (dB)	7.2	15.8	7.2	15.8
Eb/(No+Io) (dB)	4.1	4.1	4.1	4.2
Rqd Eb/(No+Io) (dB) (1)	4.1	4.1	4.1	4.1
Margin (dB)	0.0	0.0	0.0	0.1
Spreading Rate (Mbps)	1.229	1.229	1.229	1.229
Carrier PFD (dBW/m^2/4 kHz)	NA	-140.4	NA	-140.4
(1) includes modem implementation loss				

Table 13. FDMA/CDMA Data Service Links with No Shadowing.

	Nadir Beam		Outer Beam	
	Uplink	Downlink	Uplink	Downlink
Frequency (MHz)	2007.5	2182.5	2007.5	2182.5
Elevation (deg)	90.0	90.0	15.0	15.0
Nadir Angle (deg)	0.0	0.0	58.4	58.4
Transmit Antenna Directivity (dBi)	0.0	19.8	0.0	27.8
EIRP (dBW)	-14.5	5.9	-14.5	13.9
Free Space Loss (dB)	157.1	157.8	165.1	165.8
Atmos/Pol. Loss (dB)	0.8	0.8	0.8	0.8
Shadowing Loss (dB)	0.0	0.0	0.0	0.0
Total Path Loss (dB)	157.9	158.6	165.9	166.6
Receive Antenna Directivity (dBi)	19.8	0.0	27.8	0.0
Tsys (dBK)	27.7	24.8	27.7	24.8
G/T (dB/K)	-7.9	-24.8	0.1	-24.8
Data Rate (kbps)	9.6	9.6	9.6	9.6
Eb/No Thermal (dB)	8.5	11.2	8.5	11.3
Eb/Io (dB)	10.2	7.0	10.2	7.0
Eb/(No+Io) (dB)	6.2	5.6	6.3	5.6
Rqd Eb/(No+Io) (dB) (1)	4.1	4.1	4.1	4.1
Margin (dB)	2.1	1.5	2.2	1.5
Spreading Rate (Mbps)	1.229	1.229	1.229	1.229
Carrier PFD (dBW/m^2/4 kHz)	NA	-148.6	NA	-148.6

(1) includes modem implementation loss

Table 14. FDMA/TDMA Service Voice Links with Shadowing

	Nadir Beam		Outer Beam	
	Uplink	Downlink	Uplink	Downlink
Frequency (MHz)	2007.5	2182.5	2007.5	2182.5
Elevation (deg)	90.0	90.0	15.0	15.0
Transmit Antenna Directivity (dBi)	0.0	19.8	0.0	27.8
EIRP (dBW)	4.0	21.6	4.0	29.6
Free Space Loss (dB)	157.1	157.8	165.1	165.8
Atmos/Pol. Loss (dB)	0.8	0.8	0.8	0.8
Shadowing Loss (dB)	15.0	15.0	15.0	15.0
Total Path Loss (dB)	172.9	173.6	180.9	181.6
Receive Antenna Directivity (dBi)	19.8	0.0	27.8	0.0
Tsys (dBK)	27.7	24.8	27.7	24.8
G/T (dB/K)	-7.9	-24.8	0.1	-24.8
Data Rate (kbps)	34.5	34.5	34.5	34.5
Eb/No Thermal (dB)	6.4	6.4	6.4	6.4
Eb/Io (dB)	18.0	18.0	18.0	18.0
Eb/(No+Io) (dB)	6.1	6.1	6.1	6.1
Rqd Eb/(No+Io) (dB) (1)	6.1	6.1	6.1	6.1
Margin (dB)	0.0	0.0	0.0	0.0
Maximum PFD (dBW/m^2/4 kHz)	NA	-114.4	NA	-114.3
(1) includes modem implementation loss				

Table 15. FDMA/TDMA Service Voice Links with No Shadowing

	Nadir Beam		Outer Beam	
	Uplink	Downlink	Uplink	Downlink
Frequency (MHz)	2007.5	2182.5	2007.5	2182.5
Elevation (deg)	90.0	90.0	15.0	15.0
Transmit Antenna Directivity (dBi)	0.0	19.8	0.0	27.8
EIRP (dBW)	-2.0	15.6	-2.0	23.6
Free Space Loss (dB)	157.1	157.8	165.1	165.8
Atmos/Pol. Loss (dB)	0.8	0.8	0.8	0.8
Shadowing Loss (dB)	0.0	0.0	0.0	0.0
Total Path Loss (dB)	157.9	158.6	165.9	166.6
Receive Antenna Directivity (dBi)	19.8	0.0	27.8	0.0
Tsys (dBK)	27.7	24.8	27.7	24.8
G/T (dB/K)	-7.9	-24.8	0.1	-24.8
Data Rate (kbps)	34.5	34.5	34.5	34.5
Eb/No Thermal (dB)	15.4	15.4	15.4	15.4
Eb/Io (dB)	12.0	12.0	12.0	12.0
Eb/(No+Io) (dB)	10.4	10.4	10.4	10.4
Rqd Eb/(No+Io) (dB) (1)	6.1	6.1	6.1	6.1
Margin (dB)	4.3	4.3	4.3	4.3
Maximum PFD (dBW/m^2/4 kHz)	NA	-120.4	NA	-120.3
(1) includes modem implementation loss				

Table 16. Feeder Links

	Rain		Clear w/pwr control (1)	
	Uplink	Downlink	Uplink	Downlink
Frequency (MHz)	29200.0	19500.0	29200.0	19500.0
Elevation (deg)	15.0	15.0	15.0	15.0
Transmit Antenna Directivity (dBi)	57.1	27.1	57.1	27.1
EIRP (dBW)	74.4	27.8	49.6	17.5
Free Space Loss (dB)	188.3	184.8	188.3	184.8
Interference/Pol. Loss (dB)	0.6	0.6	0.6	0.6
Propagation Loss (dB)	30.0	14.2	2.2	2.0
Total Path Loss (dB)	218.9	199.6	191.1	187.4
System Implem. Losses (2) (dB)	3.5	3.5	3.5	3.5
Receive Antenna Directivity (dBi)	30.1	53.6	30.1	53.6
Tsys (dBK)	31.6	27.8	31.6	26.7
G/T (dB/K)	-1.6	25.8	-1.6	26.9
Burst Rate (kbps)	12500.0	12500.0	12500.0	12500.0
Eb/No Thermal (dB)	8.0	8.0	11.0	11.0
Eb/Io (dB)	20.0	20.0	20.0	20.0
Eb/(No+Io) (dB)	7.8	7.8	10.5	10.5
Rqd Eb/(No+Io) (dB) (3)	7.7	7.7	7.7	7.7
Margin (dB)	0.1	0.1	2.8	2.8
PFD (dBW/m^2/MHz)	NA	-120.8	NA	-131.1
(1) includes 3 dB for power control				
(2) includes pointing, implementation and radome losses				
(3) includes modem implementation loss				

Table 17. Intersatellite Links

	In-Plane		Cross-Plane	
	Band 1	Band 2	Band 1	Band 2
Frequency (MHz)	23280.0	24600.0	23280.0	24600.0
Transmit Power at Aperture (dBW)	1.4	1.4	-0.7	-0.7
Transmit Antenna Directivity (dBi)	37.0	37.5	37.5	38.0
EIRP (dBW)	38.4	38.9	36.8	37.3
Range (km)	3743.0	3743.0	3385.0	3385.0
Free Space Loss (dB)	191.3	191.7	190.4	190.9
Total Path Loss (dB)	191.3	191.7	190.4	190.9
System Implem. Losses [2] (dB)	2.0	2.0	2.0	2.0
Receive Antenna Directivity (dBi)	37.0	37.5	37.5	38.0
Tsys (dBK)	29.8	29.8	29.8	29.8
G/T (dB/K)	7.2	7.7	7.7	8.2
Burst Rate (kbps)	12500.0	12500.0	12500.0	12500.0
Eb/No Thermal (dB)	10.0	10.5	9.7	10.3
Eb/Io (dB)	27.0	27.0	27.0	27.0
Eb/(No+Io) (dB)	9.9	10.4	9.7	10.2
Rqd Eb/(No+Io) (dB) [1]	7.7	7.7	7.7	7.7
Margin[3]	2.2	2.7	2.0	2.5
(1) includes modem implementation loss				
(2) includes pointing and implementation losses				
(3) does not include 2.0 dB required to operate through solar conjunction				

Table 18. Primary TT&C Links

	Rain		Clear w/pwr control (1)	
	Uplink	Downlink	Uplink	Downlink
Frequency (MHz)	29200.0	19500.0	29200.0	19500.0
Elevation (deg)	90.0	90.0	15.0	15.0
Transmit Antenna Directivity (dBi)	57.1	27.1	57.1	27.1
EIRP (dBW)	74.4	27.8	43.6	11.5
Free Space Loss (dB)	180.4	176.9	188.3	184.8
Interference/Pol. Loss (dB)	0.6	0.6	0.6	0.6
Propagation Loss (dB)	44.0	28.3	2.2	2.0
Total Path Loss (dB)	225.0	205.8	191.1	187.4
System Implem. Losses (2) (dB)	3.5	3.5	3.5	3.5
Receive Antenna Directivity (dBi)	30.1	53.6	30.1	53.6
Tsys (dBK)	31.6	27.8	31.6	26.7
G/T (dB/K)	-1.6	25.8	-1.6	26.9
Burst Rate (kbps)	3125.0	3125.0	3125.0	3125.0
Eb/No Thermal (dB)	8.0	7.9	11.1	11.1
Eb/Io (dB)	20.0	20.0	20.0	20.0
Eb/(No+Io) (dB)	7.7	7.7	10.5	10.5
Rqd Eb/(No+Io) (dB) (3)	7.7	7.7	7.7	7.7
Margin (dB)	0.0	0.0	2.8	2.8
PFD (dBW/m^2/MHz)		-106.8		-131.1
(1) includes 3 dB for power control				
(2) includes pointing, implementation and radome losses				
(3) includes modem implementation loss				

Table 19. Secondary TT&C Links

	Rain		Clear	
	Uplink	Downlink	Uplink	Downlink
Frequency (MHz)	29200.0	19500.0	29200.0	19500.0
Elevation (deg)	15.0	15.0	15.0	15.0
Transmit Antenna Directivity (dBi)	57.1	5.5	57.1	5.5
EIRP (dBW)	72.6	3.2	72.6	3.2
Free Space Loss (dB)	188.3	184.8	188.3	184.8
Interference/Pol. Loss (dB)	0.6	0.6	0.6	0.6
Propagation Loss (dB)	25.6	11.3	2.2	2.0
Total Path Loss (dB)	214.5	196.7	191.1	187.4
System Implem. Losses (1) (dB)	13.4	13.8	13.4	13.8
Receive Antenna Directivity (dBi)	5.5	53.6	5.5	53.6
Tsys (dBK)	31.6	27.8	31.6	26.7
G/T (dB/K)	-26.1	25.8	-26.1	26.9
Burst Rate (kbps)	1.0	1.0	1.0	1.0
Eb/No Thermal (dB)	17.1	17.1	40.6	27.5
Eb/Io (dB)	20.0	20.0	20.0	20.0
Eb/(No+Io)	15.3	15.3	20.0	19.3
Rqd Eb/(No+Io) (dB) (2)	15.3	15.3	15.3	15.3
Margin (dB)	0.0	0.0	4.7	4.0
PFD (dBW/m^2/MHz)		-134.4		-134.4
(1) includes worst case pointing losses from omni antenna, radome losses, and implementation margins				
(2) includes modem implementation loss				

Section 4. ADVANCE PUBLICATION AND COORDINATION

Iridium's MACROCELL system is associated with and corresponds to the Appendix 4 for MSSLEO-2 filed by the FCC at the ITU. Iridium will, pursuant to Section 25.111(b) of the Rules, provide any additional information required or requested by the FCC.

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION CONTAINED IN THIS APPLICATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this Application and the exhibits attached hereto; that I am familiar with Part 25 of the Commission's Rules; that I have either prepared or reviewed the engineering information contained in this application and the exhibits attached hereto; and that it is complete and accurate to the best of my knowledge.

By:

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