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

In re Application of MOTOROLA SATELLITE COMMUNICATIONS, INC. For Authority to Modify Its License, For a Low Earth Orbit Satellite System in the 1616-1626.5 MHz Band	)	File No. ______________

APPLICATION FOR MINOR LICENSE MODIFICATION

MOTOROLA SATELLITE
COMMUNICATIONS, INC.

Michael D. Kennedy
Vice President and Director
Satellite Regulatory Relations
Barry Lambergman, Manager
Satellite Regulatory Affairs
MOTOROLA, INC.
1350 I Street, N.W., Suite 400
Washington, D.C. 20005
(202) 371-6900

Philip L. Malet
Alfred M. Mamlet
Brent H. Weingardt
STEPTOE & JOHNSON LLP
1330 Connecticut Avenue, N.W.
Washington, D.C. 20036
(202) 429-3000

Its Attorneys

December 4, 1996

FEDERAL COMMUNICATIONS COMMISSION

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(5) STREET ADDRESS LINE NO. 2: 1330 Connecticut Avenue, N.W.

(6) CITY: Washington,

(7) STATE: D.C.

(8) ZIP CODE: 20036

(9) DAYTIME TELEPHONE NUMBER (Include area code): (202) 429-6753

(10) COUNTRY CODE (if not U.S.A.)

ITEM #1 INFORMATION

(11A) NAME OF APPLICANT, LICENSEE, REGULATEE, OR DEBTOR: MOTOROLA SATELLITE COMMUNICATIONS, INC.

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Attn: Durrell H. Hillis	2501 South Price Road	Chandler, AZ

ITEM #2 INFORMATION

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TO THE ORDER OF Federal Communications Commission

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

In re Application of	)	
MOTOROLA SATELLITE COMMUNICATIONS, INC.	)	**File No. ________________**
For Authority to Modify Its License For a Low Earth Orbit Satellite System in the 1616-1626.5 MHz Band	)	

APPLICATION FOR MINOR LICENSE MODIFICATION

Pursuant to §§ 25.114 and 25.117 of the Commission's Rules, Motorola Satellite Communications, Inc. ("Motorola") hereby requests a minor modification to its license to construct, launch, and operate the IRIDIUM® System.[1/] Specifically, Motorola requests that the Commission authorize the IRIDIUM System to provide Aeronautical Mobile-Satellite Route Service ("AMS(R)S") in its authorized service band. In addition to providing a competitive alternative to existing AMS(R)S systems, the IRIDIUM System will offer a host of complementary advantages, collectively providing

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[1/] In Re Application of Motorola Satellite Communications, Inc. for Authority to Construct, Launch and Operate a Low Earth Orbit Satellite System in the 1616-1626.5 MHz Band, 10 FCC Rcd. 2268 (International Bureau 1995); reconsideration denied, Memorandum Opinion and Order, FCC 96-279 (rel. June 27, 1996); amendment granted, Order and Authorization, DA 96-1789 (rel. October 30, 1996). IRIDIUM® is a registered trademark and service mark of Iridium LLC.

improved system availability, performance and coverage to the aeronautical communications community. Given these advantages, and the need to begin developing performance and interference standards as soon as possible, Motorola urges the Commission to grant this request expeditiously.

I. REQUEST FOR AUTHORIZATION TO PROVIDE AMS(R)S SERVICES

From the outset, Motorola has intended to serve the aeronautical community with the IRIDIUM System's services.[2/] The IRIDIUM System offers a global voice/data service that will utilize small size, light weight terminal equipment to provide significant operational and economic benefits for all aircraft operators. Owing to these combined capabilities, a high penetration of all aviation market segments, from Wide Body Air Transport to General Aviation, is anticipated.

Motorola recognizes the complementary desire of the world's aviation authorities to extend Air Traffic Service ("ATS") coverage on a truly global basis and to all aircraft types. In recognition of this desire, Motorola has made an assessment of the feasibility of the IRIDIUM System to support AMS(R)S and has made the commitment to provide AMS(R)S as part of an enhanced service offering.

With this license modification, Motorola requests that the Commission authorize the IRIDIUM System to provide Aeronautical Mobile-Satellite Route Service in its authorized band.[3/] The 1610-1626.5 MHz band is currently allocated on a

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[2/] See, e.g., December 1990 Application of Motorola Satellite Communications, Inc. for the IRIDIUM System, File No. 9-DSS-P-91(87) at 14-15, 22-25, 28-30, 34.

[3/] AMS(R)S is defined in international RR 35A and the Commission's Rules, 47

(continued ...)

co-primary basis to AMS(R)S pursuant to international footnote 733, and the Commission's Domestic Table of Allocations.[4/]

In order to address the aviation market effectively, Iridium LLC has entered into an agreement with AlliedSignal Inc. that provides for AlliedSignal to develop, produce, market, install, and service aeronautical terminals for the IRIDIUM System. In addition, AlliedSignal will provide billing and other customer support functions for aeronautical safety and non-safety services.

Motorola recognizes that it will be necessary to develop performance standards for the operation of the IRIDIUM System as an aeronautical safety service, and that enhancements to the IRIDIUM System will be required in order to meet all of these standards as well as any priority and preemption obligations that may apply. These issues, and how Motorola intends to approach them, are addressed in detail in Appendix 1.0 attached hereto. Accordingly, the following paragraphs are limited to a brief summary of the unique contribution that the IRIDIUM System will bring to the field of aeronautical communications, and the nature and timing of the services that the IRIDIUM System will offer.

3/ (... continued)
C.F.R. § 2.1 as: "An *aeronautical mobile-satellite service* reserved for communications relating to safety and regularity of flights, primarily along national or international civil air routes" (emphasis in original). Aeronautical Mobile-Satellite Service is in turn defined as "[a] *Mobile-Satellite Service*, in which *Mobile Earth Stations* are located on board aircraft; *survival craft stations* and *emergency position-indicating radio-beacon stations* may also participate in this service." RR 35 (emphasis in original).

4/ International Footnote 733 states: "the band 1610-1626.5 MHz. . .[is] also allocated to the aeronautical mobile-satellite (R) service on a primary basis." See also 47 U.S.C. § 2.106.

The IRIDIUM System is capable of providing a robust aeronautical communication capability, which will serve as a major stepping stone toward achieving the International Civil Aviation Organization's ("ICAO") Future Air Navigation Systems Committee's ("FANS") vision. This vision entails a global, satellite-based communications, navigation and surveillance system that provides the full benefits of air traffic management. The IRIDIUM System will complement other AMS(R)S systems by offering the full range of AMSS/AMS(R)S Services, including air traffic service ("ATS"), aeronautical operational control ("AOC"), aeronautical administrative communications ("AAC"), and aeronautical public correspondence ("APC"). Other advantages of these services include the IRIDIUM System's:

- 100% global coverage because of its polar orbit constellation;
- Operation with all classes of aircraft because of its low cost, light weight, small size terminals;
- Compatibility with on board satellite navigation systems ("GNSS");
- Direct ("controller-to-pilot") communications where applicable;
- Integrated operation wholly within the MSS/AMS(R)S spectrum; and
- Intrinsic mobility management capabilities, allowing unambiguous addressing of discrete aircraft regardless of location.

The capability of the IRIDIUM System to meet the requirements of AMS(R)S will occur in two separate phases designated as Phase I and Phase II.

The IRIDIUM System begins full operational capability for commercial services to IRIDIUM handheld and paging terminals in 1998. Phase I of the IRIDIUM Aeronautical Services will commence in April 1999. These services will provide worldwide non-safety AAC and APC voice, fax and data communications to passengers and crew. AOC and ATS aeronautical safety voice and data services will also be offered at that time. The performance of the Phase I IRIDIUM Aeronautical Services is projected to exceed the current requirements for AMS(R)S usage in ATS (i.e., "FANS-1" operations).

In some parts of the world (e.g., higher latitudes including the polar regions), the IRIDIUM System will be the only AMS(R)S communication service capable of continuous, reliable operations. This service will enable the IRIDIUM System to provide a global voice and data communications capability between each equipped aircraft and designated ground network interface points. These interfaces will accommodate existing or new networks, Federal Aviation Administration ("FAA") or privately-operated, and will be able to support existing or future Aeronautical Telecommunications Network ("ATN") standards.

During Phase I, the IRIDIUM System's AMS(R)S requirements will be fully defined and integrated into the design of the Phase II enhanced system. In addition to the features provided during Phase I, the Phase II system will incorporate those features determined to be necessary through the standards development processes of ICAO and RTCA for ATS/AOC safety communications via Low Earth Orbiting Satellites. Motorola fully expects that the IRIDIUM System will comply with preemption, priority, and precedence requirements needed to meet aeronautical safety needs as well as with the Radio Regulations.

The IRIDIUM System will prove invaluable to the international aeronautical community in terms of system performance and coverage. Indeed, the IRIDIUM System is the only mobile satellite system, licensed or in development, that can provide a communications capability that is truly global, while using spectrum already allocated for AMS(R)S. Moreover, the inclusion of AMS(R)S during the initial IRIDIUM System implementation plan will make it possible to offer valuable AMS(R)S services starting as early as 1999. In addition, Phase I implementation will provide the aeronautical community with a basis for defining a future AMSS/AMS(R)S capability that can be incorporated into an economically viable and enhanced next-generation IRIDIUM System.

Motorola therefore urges the Commission to grant this request expeditiously. Motorola must begin the process of developing performance standards to ensure that the evolution of the IRIDIUM System matches the needs of the aeronautical community as closely as possible.

II. LEGAL QUALIFICATIONS

There have been no changes in Motorola's legal qualifications since the filing of its FCC Form 430 as part of its March 8, 1996 Minor License Modification Request (File No. 85-SAT-ML-96)

III. SECTION 304 WAIVER

In accordance with Section 304 of the Communications Act of 1934, as amended, 47 U.S.C. § 304, Motorola hereby 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.

IV. ANTI-DRUG ABUSE CERTIFICATION

Pursuant to Section 1.2002 of the Commission's Rules, 47 C.F.R. § 1.2002 (1995), Motorola certifies that neither the Applicant nor any of its shareholders, nor any of its officers or directors, nor any party to this Application is subject to a denial of Federal benefits pursuant to authority granted in Section 5301 of the Anti-Drug Abuse Act of 1988.

V. CONCLUSION

For the foregoing reasons, Motorola requests that the Commission promptly grant its request for modifications of its license to include the provision of AMS(R)S over the IRIDIUM® System.

The undersigned certifies individually and for Motorola, under penalty of perjury, that all of the statements made in this Amendment are true, complete and accurate to the best of its information, belief and knowledge , and are made in good faith.

Respectfully submitted,

MOTOROLA SATELLITE
COMMUNICATIONS, INC.

Bary R. Bertiger.
Vice President

Michael D. Kennedy,
Vice President and Director
Regulatory Relations
Barry Lambergman, Manager
Satellite Regulatory Affairs
Motorola, Inc.
1350 I Street, N.W.
Washington, D.C. 20005
(202) 371-6900

Philip L. Malet
Pantelis Michalopoulos
Colleen Sechrest
Brent Weingardt
Steptoe & Johnson LLP
1330 Connecticut Ave., N.W.
Washington, D.C. 20036
(202) 429-3000

Dated: December 4, 1996

ENGINEERING CERTIFICATE

I hereby certify under penalty of perjury that I am the technically qualified person responsible for preparation of the engineering information contained in the foregoing "Application for Minor License Amendment of Motorola Satellite Communications, Inc." I am familiar with the Commission's Rules concerning Part 25 and satellite space station matters. I have prepared or reviewed the engineering information contained in this application and the statements of fact made therein are true and correct to the best of my personal knowledge.

By: ______________________
Stephen J. Clark
Staff Engineer for Spectrum Licensing and
Standards Development
Motorola Satellite Communications, Inc.

Date: December 4, 1996

APPENDIX 1.0

PROVISION OF AERONAUTICAL COMMUNICATION SERVICES BY

THE IRIDIUM® SYSTEM

DECEMBER 4, 1996

APPENDIX 1.0
PROVISION OF AERONAUTICAL COMMUNICATION SERVICES BY THE IRIDIUM® SYSTEM

1.0 INTRODUCTION

Motorola Satellite Communications Inc. ("Motorola") desires that its license be modified to include AMS(R)S under the provisions of International Telecommunications Union Footnote 733 and the Commission's Domestic Table of Allocations.[1] This will allow the IRIDIUM System to provide global AMS(R)S.[2] No changes to system parameters or link budgets are required to provide AMS(R)S. ITU Radio Regulation Article 14 coordination procedures will be complied with as required by Footnote 733.

The IRIDIUM System can provide a unique combination of aeronautical communications capabilities:

- 100% global coverage because of its polar-orbit constellation;
- Operation with all classes of aircraft because of its low cost, light weight, and small size terminals;
- Compatibility with onboard Satellite Navigation Systems (GNSS);
- Complementary to other AMS(R)S systems;
- Direct ("controller to pilot") communications where applicable;
- Integrated operation wholly within the MSS/AMS(R)S spectrum
- Intrinsic mobility management capabilities, allowing unambiguous addressing of discrete aircraft regardless of location.

From the beginning, the business plan for the IRIDIUM System has included the provision of aeronautical communication services. Iridium LLC has taken action to define these

IRIDIUM® is a Trade Mark and Service Mark of Iridium LLC

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1 ITU Footnote 733, Radio Regulations, Vol. 1, 1994 Revised Edition states: "the bands 1610-1626.5 MHz.....are also allocated to the aeronautical mobile-satellite (R) service on a primary basis. Such use is subject to agreement obtained under the procedure set forth in Article 14" See also 47 U.S.C. § 2.106 (1995).

2 Motorola intends to provide a complete range of communication services to aviation, including AMSS and AMS(R)S. The term "AMSS" is generally considered to comprise ATS, AOC, AAC and APC (see Section 4.0 herein), while "AMS(R)S" is considered to be a subset comprising only communications associated with the ATS and AOC safety services (i.e., International RR, Article 51, priorities 1-6). Certain regulations and standards are focused exclusively on AMS(R)S; while others (e.g., U.S. Radio Regulations, Part 87; AMSS Minimum Operational Performance Standards) clearly apply to satellite network equipment irrespective of the type of aeronautical services. This application uses the combined term "AMSS/AMS(R)S" to address the full range of service and "AMS(R)S" where special safety requirements are addressed.

aeronautical services and to partner with AlliedSignal Inc., an established aeronautical equipment and service provider, to offer both AMSS and AMS(R)S.

The IRIDIUM System offers a low cost, global voice/data service which, coupled with the use of small, light weight, low cost terminal equipment, provides significant operational benefits for all aircraft operators. Owing to the IRIDIUM System's unique capabilities, a high penetration of all aviation market segments, from Wide Body Air Transport to General Aviation, is anticipated.

Motorola recognizes the complementary desire of the world's aviation authorities to extend Air Traffic Service (ATS) coverage on a truly global basis and to all aircraft types. In recognition of this desire, Motorola has made an assessment of the feasibility of supporting AMS(R)S and has made the commitment to provide AMS(R)S as part of an enhanced service offering.

Motorola recognizes that it will be necessary to develop standards for operation of the IRIDIUM System as an aeronautical safety service. Based on recent documentation of ICAO[3] and RTCA,[4] it is expected that the IRIDIUM System may require enhancements that are unique to the provision of AMS(R)S. It is also recognized that the standards process may take considerable time and, therefore, it should be initiated immediately to insure that necessary enhancements, if needed, are defined early so they can be incorporated into the system design as it evolves through satellite replacement.

The IRIDIUM System's unique communications capabilities, when coupled with AMS(R)S, will be a major stepping stone toward achieving the ICAO FANS[5] vision of a global, satellite-based communications, navigation and surveillance system providing the full benefits of global air traffic management. Notably, ICAO's Aeronautical Mobile Communications Panel has already initiated a study on an urgent basis to evaluate the feasibility of next generation satellite systems, including IRIDIUM, to provide AMS(R)S.

While the standards process is under way, the IRIDIUM System as currently designed can provide a needed interim service that will fulfill most of the objectives of AMSS/AMS(R)S. While this initial service may not provide all of the features ultimately desired, it will nonetheless meet current AMS(R)S requirements such as are stipulated for FANS-1 service.

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3 International Civil Aviation Organization, affiliated body of the United Nations.

4 RTCA, Inc. (formerly the Radio Technical Commission for Aeronautics), is a Federal Advisory Committee.

5 ICAO - Future Air Navigation Systems Committee.

2.0 ADVANTAGES OF THE IRIDIUM SYSTEM IN PROVIDING THE AERONAUTICAL MOBILE SATELLITE SERVICES

2.1 100% Global Coverage

The IRIDIUM System provides a truly global aeronautical communications capability. Its constellation of 66 polar-orbiting satellites provide 100% coverage of the surface of the Earth. This capability, using the L-band AMS(R)S allocated spectrum, is unique to the IRIDIUM System. No other planned or operational LEO MSS system provides full-period global service coverage, including polar coverage.

The IRIDIUM System's coverage is especially robust at higher latitudes where many intercontinental transatlantic and transpacific routes exist. At these latitudes, redundant multiple satellite beam coverage is available for selected use in the aeronautical service. This redundant beam coverage, in conjunction with beam activation control, provides a robust beam failure mitigation capability that ensures continuous single beam coverage.

Using the IRIDIUM System architecture, calls can be relayed between aircraft and the serving IRIDIUM Gateway or between aircraft using the IRIDIUM intersatellite crosslinks. Air-to-ground and air-to-air communications are possible without requiring a ground-based Gateway to be in the footprint of the satellite serving the aircraft. In fact, the IRIDIUM System's global coverage could be supported by a single Gateway, although availability considerations dictate the utilization of diverse Gateways.

2.2 Implementable In All Classes of Aircraft

IRIDIUM aeronautical terminals may be utilized by all classes of aircraft, from light single-engine general aviation to heavy commercial transport. The low cost, small size and light weight of both the antenna and the avionics equipment are unique to the IRIDIUM System.

Current AMSS aeronautical terminals are relatively expensive, heavy, and operate at high power levels. Such full-capability terminals supporting voice and high-speed data require a large steerable antenna. These factors limit the use of satellite communication to aircraft that are physically large enough to support such an installation, and that can justify the related costs. This effectively eliminates a majority of aircraft that could benefit from aeronautical satellite communications, including smaller commercial aircraft, most business aircraft, and general aviation aircraft, especially those aircraft that fly over land masses without terrestrial communications capabilities as well as those that fly over oceans.

The IRIDIUM aeronautical terminals will be inexpensive, small, lightweight, low power and will require only a small, non-steerable, low gain antenna for operation. This aeronautical equipment can be installed on all types of aircraft.

A unit installed in a light general aviation aircraft typically would have a single channel and would be smaller than a typical VHF panel-mount radio. It would utilize a small, light weight, non-steerable, low gain antenna. Installations on air transport aircraft would generally have multi-channels and would also utilize non-steerable low gain antennas.

Iridium LLC has contracted with AlliedSignal Inc., a major avionics manufacturer and service provider, to develop, produce, market, install, certificate and service IRIDIUM aeronautical terminals of several classes (ranging from large commercial air transport to light general aviation aircraft) and to provide services ranging from single-channel APC to multi-channel ATS/AOC/AAC/APC. Where applicable, the IRIDIUM aeronautical terminals will interface with aircraft communications equipment designed to aviation communication standards such as those for ATN[6] and ACARS[7].

2.3 Compatibility with Onboard Satellite Navigation Systems

An important consideration for operation of aeronautical satellite communications is the compatibility of the communication equipment with satellite navigation systems onboard the aircraft. Satellite navigation receivers using the GPS satellite constellation are becoming common in all classes of aircraft, including light single-engine general aviation aircraft. In the future, there is a possibility that GLONASS, a Russian satellite navigation system, may also be used.

Motorola recognizes the difficulties in controlling interference levels presented to Global Navigation Satellite Systems (GNSS) with the present class of AMSS transmitters. Mitigation techniques exist and will be implemented within the IRIDIUM aeronautical terminals that will allow them to co-exist with GNSS terminals onboard the same aircraft. These and any other necessary steps will be taken to insure that the onboard IRIDIUM aeronautical terminals will be GNSS compatible.

2.4 Complementary To Other Satellite AMSS/AMS(R)S Systems

The provision of aeronautical satellite communication services by the IRIDIUM System will complement existing aeronautical satellite communications services. Installed on an aircraft together with another AMS(R)S or radio communications system, the IRIDIUM System will provide a dual dissimilar communications path to and from the aircraft in support of AMS(R)S.

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6 Aeronautical Telecommunications Network.

7 ACARS - Aircraft Communications Addressing and Reporting System.

It is anticipated that having multiple sources in the aeronautical satellite communications service will provide advances in the quality of the offered equipment, the cost and the availability of the service.

2.5 Direct "Controller to Pilot" Communications

The unique design of the IRIDIUM System, through its use of intersatellite communication links, potentially enables Air Traffic Control authorities to communicate directly with aircraft on a global basis. This capability can complement the present aviation communications system.

In its simplest and most conventional form, ATC Controllers can communicate with all aircraft via the local/regional Gateway and a dedicated landline link. Alternatively, an ATC authority may establish its own System Access Terminal which supports direct L-band communications via the satellites and directly to/from the aircraft. In this latter case, no additional ground infrastructure is required and direct control is enabled on a local, regional or global basis.

2.6 Integrated Operation Wholly Within the AMS(R)S Spectrum

The IRIDIUM System is licensed for operation in a portion of the frequency band 1610 - 1626.5 MHz. That band is allocated by U.S. and international Radio Regulations to the Mobile-Satellite Service (MSS). By Footnote 733, applicable to the U.S. and all World Regions, this band is also allocated on a primary basis to AMS(R)S, subject to Article 14 coordination procedures. The AMS(R)S designation is necessary for conducting aeronautical safety radio communications, namely, Air Traffic Services (ATS) and Aeronautical Operational Control (AOC).

Of the several LEO and MEO satellite communications systems authorized or planned, only the IRIDIUM System utilizes the same band for communications in both directions. This is accomplished in the IRIDIUM System through the use of Time-Division Diplexing. The IRIDIUM System architecture employs a combination of Frequency-Division and Time-Division Multiple Access techniques. An IRIDIUM terminal utilizes the same frequency for transmitting and receiving high-speed bursts that are multiplexed in time. Therefore, all IRIDIUM MSS and AMS(R)S communications will take place within the band also allocated for both commercial MSS and aeronautical safety AMS(R)S, with the required priority and preemption mechanisms.

2.7 Intrinsic Mobility Management

The IRIDIUM System is designed to provide and maintain communication to and from highly mobile IRIDIUM subscriber terminals. Consequently, the system must be able to quickly locate and keep track of IRIDIUM terminals as they change location anywhere on the Earth, whether on sea, land or in the air. The IRIDIUM System mobility management is accomplished by extending native capabilities of the GSM (Global System for Mobile Communications) cellular system. The location of an IRIDIUM terminal, expressed in Earth-reference coordinates, is initially determined upon log-on, and is periodically re-determined and updated upon significant movement by each logged-on IRIDIUM terminal.

This intrinsic mobility management capability of the IRIDIUM System greatly simplifies the establishment and maintenance of communications with aircraft. This is in contrast to the procedures used by current AMSS/AMS(R)S architectures which require *a priori* knowledge of an aircraft's location by the caller and coordination with specific logged-on ground Earth stations, and/or specific satellites serving the aircraft.

3.0 APPLICATION OF THE IRIDIUM SYSTEM TO AMSS/AMS(R)S

Examination of the ICAO Standards and Recommended Practices (SARPs[8]) relevant to satellite communications for aviation reveals that the current standards are oriented specifically to geo-stationary orbit (GSO) AMSS systems. While performance and interface standards may be applicable to IRIDIUM AMSS/AMS(R)S, provision of these services by a non-GSO constellation of satellites will require supplementing these standards if operational details are necessary.

The Terms of Reference of the RTCA Special Committee 165 that prepared the DO-215A Document states, "Early attention should be given to standards for the space segment and other system elements that must be addressed in applications to the FCC for licenses to operate satellite systems in the frequency band(s) of interest to civil aviation."[9] The RTCA appears to be the most appropriate organization for undertaking system standards work in the U.S. relating to these services.

This standards process should begin immediately to insure that the evolution of the IRIDIUM System matches the needs of the aviation community. The scope of the IRIDIUM System is global, as is that of aviation. Clearly, it will be necessary to obtain approvals and certifications from national civil aviation authorities in order to employ the IRIDIUM System and its associated IRIDIUM aeronautical terminals for any type of aircraft communications. The use of the IRIDIUM System for AMS(R)S adds to the complexity of the task because more rigorous standards may be required, and cooperative international agreements will be necessary for the aviation community to fully realize the benefit of this service.

At first glance, the task of obtaining approvals and authorizations from the many aviation organizations appears lengthy. However, there are only a few key institutions in which to focus the process. The U.S. Federal Aviation Administration (FAA) is a world leader in the certification of equipment and systems used in aviation, and its decisions often are viewed as the model for other civil aviation authorities. RTCA Special Committees serve as forums for representatives of government, research organizations and the several segments of aviation industry to cooperate in the development of standards and related issues. The AEEC[10] establishes form, fit and function characteristics for equipment of interest to the

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8 ICAO, Aeronautical Communications, Annex 10, Vol. III, Part I -- Digital Data Communications Systems.

9 *Guidance on Aeronautical Mobile Satellite Service (AMSS) End-to-End System Performance,* RTCA/DO-215A, February 21, 1995, RTCA Inc.

10 Airlines Electronic Engineering Committee, including representatives of domestic and international airlines, and other aircraft operators.

commercial air carriers. Ultimately, international standards and recommended practices are developed in appropriate ICAO Panels, taking into account the work of other bodies.

The end point of the FAA process is an authorization for use of an equipment/system to perform a specified function in accordance with an approved installation onboard each specific aircraft, using approved operating procedures. The certification process verifies both that the intended function is accomplished and that it will not cause harm to other aviation systems and equipment.

The specific technical basis of the certification process for avionics equipment is generally dependent on a Minimum Operational Performance Standard (MOPS) for the equipment, which is prepared by a designated Special Committee of the RTCA. For larger-scale systems, such as the IRIDIUM System, RTCA has developed either a Minimum Aviation System Performance Standard (MASPS) or, as was done for GSO AMSS systems, a Guidance Document for system and service requirements.

The following standards documentation currently exists for the GSO AMSS/AMS(R)S:

ICAO:	AMSS SARPs and Guidance Material
RTCA:	DO-210C, AMSS MOPS
	DO-215A, Guidance on AMSS End-to-End System Performance
	DO-222, Guidelines on AMS(R)S Near-Term Voice
	DO-231, Guidelines & Recommended Standards for AMS(R)S Voice in a Data Link Environment
AEEC:	ARINC 741, Aviation Satellite Communication System

The task of modifying these documents, or creating similar documents, for the IRIDIUM System should not be as lengthy an undertaking as was developing the originals. Motorola notes that, in DO-215A, the fundamental performance parameters could be taken as starting points for the IRIDIUM AMSS/AMS(R)S; whereas, the signal-in-space details (e.g., link budgets) currently focused on GSO systems could be supplemented with similar content for the IRIDIUM System. The framework for relating the new medium of satellite communications to aeronautical safety applications has already been accomplished in these documents, providing the basis for developing standards that can be implemented within the IRIDIUM constellation.

These standards bodies have already begun preliminary work with regard to the IRIDIUM System and other next-generation systems. At the FAA's request, RTCA SC-165 is making an initial assessment of next-generation satellite communication systems, such as the IRIDIUM System, for provision of AMS(R)S. The AEEC has approved its Satellite Communications Subcommittee's undertaking the establishment of form, fit and interfaces for such next-generation systems.

The recent decision of the ICAO Aeronautical Mobile Communications Panel (AMCP) to undertake a study of the feasibility of the potential of non-GSO satellite systems for the provision of AMS(R)S denotes interest in such benefits. The AMCP observed that, "such a study is urgently needed in order to influence the designs of such systems for aeronautical purposes."[11] Included in the study's aspects are, "g) to recommend the development of SARPs, as deemed appropriate."[12] The AMCP also noted that, "...the availability of suitable AMS(R)S frequency allocations within the AMS(R)S spectrum requirements would need to be satisfied."[13] Motorola's instant application is intended to fulfill these requirements.

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11 ICAO, Report on the Fourth Meeting of the Aeronautical Mobile Communications Panel (AMCP) (1996), 25 March to 4 April 1996, Report on Agenda Item 7

12 _ID._

13 _ID._

4.0 SERVICES TO BE PROVIDED

Motorola intends for the IRIDIUM System to provide AMSS/AMS(R)S. The extent of the services ultimately provided will be based on the result of the standards processes as described in Section 3. The full capability of IRIDIUM AMSS/AMS(R)S will not occur with the initial commercial activation of the IRIDIUM System in late 1998, but will be phased in over time. Services that the IRIDIUM System will provide include:

- **SAFETY COMMUNICATIONS**
  - **Air Traffic Services (ATS)**

    Air Traffic Control, Weather, and Flight Information Services

  - **Aeronautical Operational Control (AOC)**

    Dispatch, Flight Planning, Weather, Maintenance Communications involving safety and regularity of flight, and independent Company Communications required by Federal Aviation Regulations

- **NON-SAFETY COMMUNICATIONS**
  - **Aeronautical Administrative Communications (AAC)**

    Cabin Provisioning, Passenger-related and other Company Communications not directly associated with safety and regularity of flight

  - **Aeronautical Public Correspondence (APC)**

    Public Correspondence, personal communications by/for passengers and crew.

5.0 PHASED IMPLEMENTATION OF THE IRIDIUM SERVICE

Motorola will implement AMSS/AMS(R)S in two phases of increased capability within the IRIDIUM System.

5.1 Phase I

Phase I will support circuit-mode and circuit-switched packet-mode data services beginning with the commercial activation of IRIDIUM data services in early 1999. Aeronautical packet data service will be implemented with packet-to-circuit conversion equipment in the gateways and in the IRIDIUM aeronautical terminals, permitting standard interfaces to existing aircraft and aviation ground networks. Phase I circuit-mode services will support AAC and APC Voice, Fax and Data communications for both the cabin and the cockpit. ATS and AOC will also be supported for near-term safety communications to the extent that the performance parameters are deemed to be satisfactory .

Phase I circuit-switched packet data service will support a global ATS/AOC packet data communications capability between each equipped aircraft and designated ground network interface points. These points can be designated for existing or new networks, FAA/CAA or privately operated, and can support existing or future FANS and/or ATN standards. Motorola believes that the performance parameters for both the circuit mode and circuit switched packet-mode services of the IRIDIUM System can meet the current requirements for AMS(R)S.

The services provided in Phase I will be:

- **AAC/APC - Non-Safety**
- **ATS/AOC - Safety (meeting current AMS(R)S requirements)**
- **Circuit-Mode Voice, Data and Fax**
- **Circuit-Switched Packet-Mode Data**

5.2 Phase II

The AMSS/AMS(R)S capabilities provided in Phase II will be those incorporated into the design of IRIDIUM enhanced satellites, gateways and system management facilities that become the second generation IRIDIUM System. The enhanced satellites are anticipated to be launched in approximately 2003. It is the intent of Motorola, Iridium LLC and AlliedSignal Inc. to participate in the aviation industry standards bodies (see Section 3.0) such that the Motorola design of the next generation of IRIDIUM satellites will be compliant with reasonable standards that may be developed for low earth orbit satellite systems to provide aeronautical safety services.

Dependent upon the outcome of the standards development process, the Phase II services are expected to include:

- **AAC/APC - Non-Safety**
- **ATS/AOC - Safety (meeting reasonable standards developed for LEO/MEO systems)**
- **Circuit-mode Voice, Data and Fax**
- **Circuit-Switched Packet-Mode Data**
- **Packet-Mode Data**

6.0 SYSTEM OVERVIEW

Motorola plans no additional changes to the satellite constellation design during Phase I of the AMSS/AMS(R)S implementation program.

Figure 6-1 shows the IRIDIUM AMS(R)S architecture for both the circuit-mode and packet-mode services. The Aeronautical Center represents ground user functionality; for example, an Air Traffic Control Center or an airline's Operations Center. Representative functionality's for the safety and non-safety services in an aircraft are depicted. For example, safety communications for air transport aircraft typically will be controlled through a Multi-Function Control/Display Unit (MCDU).

The kprimary differences between the IRIDIUM System and the architecture of the current GSO AMSS systems are listed below. Otherwise, the IRIDIUM AMSS/AMS(R)S system will be transparent to aeronautical voice and data communications as currently conducted. The IRIDIUM System interfaces will be compatible with other current and future aviation communications subsystems.

- Use of a Low Earth Orbit (LEO) satellite constellation that places approximately 2150 spot beams on the surface of the Earth

- Use of satellites with onboard processing

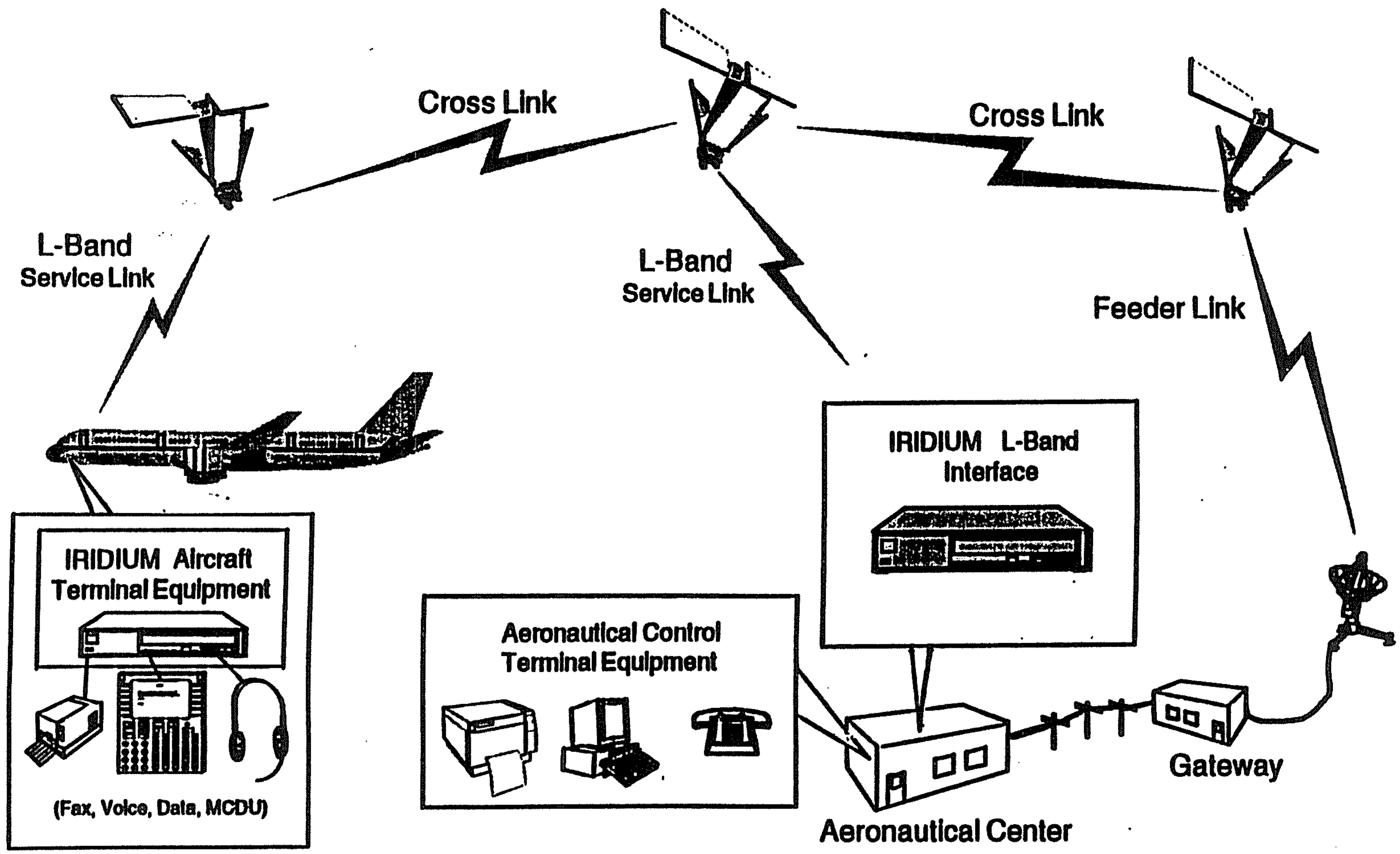
- Use of intersatellite links for relay between satellites (inter-satellite networking)

- Communications between airborne and ground users can be routed via the normal path through the inter-satellite network, feeder link, gateway and terrestrial distribution; or via direct service link to a dedicated IRIDIUM L-band Interface Unit in the Aeronautical Center for backup purposes

- Intrinsic mobility management capabilities, allowing unambiguous addressing of discrete aircraft regardless of location.

Figure 6 -1

IRIDIUM AMS(R)S Architecture



7.0 ASSESSMENT OF THE IRIDIUM SYSTEM FOR AMSS/AMS(R)S SERVICES

This section contains a review of certain features of the IRIDIUM System and its application to the aeronautical services.

7.1 Priority, Precedence and Preemption

Priority, precedence and preemption are three important features that have been associated with a system that shares resources among AMSS, AMS(R)S, and generic MSS services. The definitions of these attributes are as follows:

- Priority

  An attribute of a message used to determine the order of precedence of its transmission relative to messages of other types, and/or the determination of the need for preemption actions.

- Precedence

  The order of transmission, or access to system resources, of a message relative to other messages in accordance with defined circumstances. A common application is to order the transmission of messages queued at any given instant by their priority level and order of arrival, with the earliest and highest-priority messages receiving preference. At a particular priority level, the order of precedence is normally first-in, first-out.

- Preemption

  An action taken by the system protocols or management mechanisms to provide immediate access to system resources for certain uses. Intra-service preemption is required for certain individual messages within a given service (e.g., AMSS), in accordance with their respective priority levels as defined for that service's priority structure. Inter-service preemption may be required among services to assure that sufficient system resources are available for one or more particular services (e.g., AMS(R)S). Preemption may require interruption of a message or call of a lower priority.

In addition, aviation standards have established a rank-ordered priority structure for all aeronautical communications, both safety and non-safety, that is intended to satisfy the international and U.S. Radio Regulations as well as requirements peculiar to aviation.

7.1.1 Preemption, Priority and Precedence Requirements

The international Radio Regulations[14] and requirements particular to aviation[15] result in the following:

a) Provides for preemption of non-safety communications (including non-safety AMSS) for AMS(R)S communications, if necessary. This frees system resources as necessary for AMS(R)S traffic in a network that also transports other categories of communications.

b) Within the category of AMSS:

   i. distinguishes safety (AMS(R)S) and non-safety classes of AMSS communications,

   ii. establishes precedence of individual levels for both AMS(R)S and AMSS traffic, and

   iii. provides for preemption of lower classes of AMSS traffic in favor of AMS(R)S distress/urgency messages, if necessary.

These requiremens result in: (1) the establishment of an order of transmission precedence, favoring higher-priority messages; and (2) the making of more system resources available for messages of a higher class (i.e., shed load representing a lower class of traffic), if necessary, should there be contention for system resources.

7.1.2 Assessment of IRIDIUM Preemption, Priority and Precedence Capabilities

The focus of priority, precedence and preemption is with respect to the service links in the band 1610-1626.5 MHz. The precedence of transmissions in the Earth-to-space (from aircraft) direction is controlled by the IRIDIUM aeronautical terminals. Transmission in the space-to-Earth (to aircraft) direction is controlled by the satellites. In both directions, the controlling entity is acting on information sent by the System Control Centers regarding permitted priority levels. The following discusses the control features of each IRIDIUM entity.

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14 See e.g., RR Articles 50 and 51.

15 See e.g., AMSS SARP's, Sections 4.7, 4.8, and Tables 4.26 and 4.43.

IRIDIUM User Terminals (General) All user terminals operating in the band assigned to the IRIDIUM System are under ultimate control of the IRIDIUM ground segment (Gateways and Control Centers). As each terminal is authenticated upon registration (log-in), there can be no terminals operating in the IRIDIUM System that do not meet its control requirements. Each terminal also identifies the system priority level of each transmission.

IRIDIUM Aeronautical Terminals All IRIDIUM aeronautical terminals permitted to operate with the IRIDIUM System will be designed and qualified to operate in accordance with current AMS(R)S avionics priority/precedence/preemption criteria. These criteria embody the requirements as discussed above, and will be in operation commencing with the initial AMS(R)S service offerings.

IRIDIUM Gateways All aeronautical communications in the 'to-aircraft' direction will enter the IRIDIUM System's Gateways via Aeronautical Ground Interface Subsystems. This additional aeronautical service equipment, like the IRIDIUM aeronautical terminals, will be designed and qualified to current AMS(R)S priority/precedence/preemption criteria, thus assuring conforming operation with aeronautical terminals in the "from-aircraft" (space-to-Earth) direction.

IRIDIUM System Loading Control All IRIDIUM user terminals are under control of the IRIDIUM ground segment comprising the Gateways and the System Control elements. The IRIDIUM System assigns to each terminal, user, or service one of several Acquisition Classes, any or all of which can be inhibited as necessary for load management; attempts by terminals to request system resources may be permitted or inhibited selectively according to class.

The dynamic management of these Acquisition Classes by the System Control elements operates according to a precedence scheme. IRIDIUM non-AMS(R)S terminals, which constitute the bulk of system users, are assigned randomly among ten classes that comprise the lowest priority levels. If load limitations must be exercised, these classes (singly or in multiples) can be inhibited first.

Additional classes of higher priority exist. These are inhibited only under extreme conditions; e.g., as may be necessary to protect the health of the satellite(s). The higher priority levels in the IRIDIUM System include, in rank order, a class for distress calls from terminals normally using one of the ten lower-level classes; at least one class for terminals used by agencies providing emergency services; a number of classes used by the various priority levels within the AMS(R)S; and, at the highest priority level, a class reserved for system management purposes. These levels are arranged, and their corresponding Acquisition Classes will be managed, according to the Radio Regulations and the requirements particular to aviation.

These mechanisms allow, when necessary: (1) the selective shedding of non-AMS(R)S traffic loads for AMS(R)S traffic, and (2) the further shedding of lower-priority AMS(R)S traffic for higher-priority messages. This capability will be present at the start of service, assuring system capacity for AMS(R)S in accordance with its prioritization.

AMSS/AMS(R)S demands will develop gradually due to the time that will be required for the standards process, and due to the lead time necessary to develop, produce and install approved AMS(R)S equipment. Consequently, in the early years of IRIDIUM aeronautical service, relatively few aircraft will be equipped for IRIDIUM AMS(R)S. In this period, the AMS(R)S safety service demand, even allowing for a peak-to-average ratio of 5:1, would represent only a very small fraction of the system's capacity.

Accordingly, the availability of resources--at least during the early years of the IRIDIUM System--will be such that the need for preemption will not occur because the capacity of the system will not be exceeded even with peak safety service loads.

7.2 IRIDIUM AMSS/AMS(R)S Information Transfer Delay

An important performance parameter, particularly from a safety service point of view, are the delays experienced in the transmission of information through the system. These delays are made up of processing and queuing delays, link propagation delays and the actions of protocols. Propagation delays in the IRIDIUM System are quite low because of the low altitude of the satellites, and the sustainable rate of data transmission is relatively high (nominally 2400 bits per second of user data).

Call setup delay is the interval of time measured from the moment that the dialed number is sent to the time of the first ring. Data transfer delay is the interval of time from the moment the data is sent to the time its delivery is complete. Table 1 sets forth the expected performance capabilities for voice service and packet data service. These results compare favorably with those of RTCA DO-215A for current AMSS/AMS(R)S systems. The performance related to Phase II will be determined by the standards process.

Table 1 Projected Voice and Data Delays, IRIDIUM AMSS/AMS(R)S System

	Voice Call Setup Delay (sec)		Circuit-Switched Packet Delay (sec) (180 Octets)	
Direction	mean	95%	mean	95%
From Aircraft	16	17	18	19
To Aircraft	20	21	22	23

7.3 Availability Assessment

For safety services, such as AMS(R)S, it is important to evaluate the impact that communication outages cause due to potential failure modes. There are three basic failure modes at the system level: 1) Total Satellite Failure, 2) Single Beam Failure, and 3) Gateway Failure. Additionally, there are propagation effects that must be considered.

7.3.1 Satellite Failure

In the event of a single satellite failure, the impact of the failure will continue until an orbital spare has been positioned to take its place. During this replacement time, the impact of the loss on AMS(R)S communications is a function of the latitude of the aircraft involved. The loss of a satellite causes a communications "hole" the size of the satellite's footprint on the Earth. The worst-case condition occurs at the Equator. The size of the "hole" reduces as the latitude of the aircraft's position increases.

At the Equator, a failed satellite will cause a "hole" in communications for an interval ranging from 0 seconds to approximately 7 minutes. The variation in duration is due to the location of the aircraft relative to the footprint of the failed satellite, as the passes overhead. For a specific Equatorial location, the hole will occur twice in a 24 hour period. This is due to the rotation rate of the Earth and the North/South direction of the failed satellite in its orbital plane. Statistically, this condition represents a worst-case loss of service of about 1% over a 12 hour period. While this is not a significant amount of time in a relative sense, its seriousness would have to be evaluated in terms of the operational environment of this worst-case equatorial condition.

As the latitude of the aircraft's position increases, the outage time decreases. The "hole" size effectively goes to zero near 57 degrees North or South latitude. This reduction occurs because of the convergence of the orbital planes near the poles which in turn causes overlap of satellite coverage, thereby eliminating the hole. In other words, multiple satellite redundancy exists at higher latitudes.

7.3.2 Single Beam Failure

For similar reasons, the impact area of a single beam failure is greatest at the Equator. However, because of the IRIDIUM Satellite's multiple beams, the adjacent beams on the same satellite (or, if the failed beam is an edge beam, the edge beams of an adjacent satellite) are able to compensate for the hole. The gain of the individual adjacent beams is less than the primary beam due to beam gain roll off. This loss of gain is compensated for by using the available link margin of 16 dB that is not otherwise needed to communicate with the aircraft. As the latitude of the aircraft's location increases, the need for compensation is gradually reduced until overlapping beams effectively eliminate the need for beam gain compensation.

7.3.3 Gateway Failure

Because the IRIDIUM System relies on inter-satellite links, it is in effect a "network in the sky". Communications links can always be found between subscriber/airborne terminals and Gateways (Ground Earth Stations) in both directions, connecting with any one of the IRIDIUM System's multiple Gateways. This unique gateway interface redundancy enables the IRIDIUM System to provide continuous global AMS(R)S over all oceans and both poles.

7.3.4 RF Path

The IRIDIUM System has several design features that are particularly attractive to aviation in mitigating outages caused by propagation effects.

No changes to the IRIDIUM System parameters or link budgets are necessary to provide this additional service capability. The IRIDIUM L-band nominal link budget margin is 16 dB, which in MSS service is used to overcome attenuation due to expected path obstructions for the personal, handheld subscriber terminals. Because an aircraft is free from these obstructions, this relatively high margin is available to improve AMS(R)S performance with the aircraft. The result is essentially an insensitivity to aircraft attitude and maneuvers, aircraft antenna shadowing effects, multi-path and ionospheric scintillation fading. In addition, a portion of the margin can be utilized to simplify aircraft installations, and to mitigate the effect of a failed beam (see 7.3.2 above).

8.0 SUMMARY

Through the provision of AMSS/AMS(R)S, the IRIDIUM System will provide a significant benefit to the international aeronautical community on a global basis. The IRIDIUM System is the only MSS System, licensed or in development, that can provide an AMSS/AMS(R)S communications capability that is truly a global service. The IRIDIUM System's 66-satellite, polar-orbit constellation will provide functional coverage over 100% of the Earth's surface. Because of this unique coverage and performance capability, the IRIDIUM System provides a major advance in capability, performance and economy for the global aviation community.

IRIDIUM AMSS/AMS(R)S will provide significant capability in terms of global coverage, availability and performance. The inclusion of these services, as part of Phase I of the IRIDIUM AMSS/AMS(R)S implementation plan, will make it possible to have this capability in the immediate future -- a capability that might not otherwise be available or affordable. In addition, Phase I provides the FCC/FAA/RTCA/ICAO community with an opportunity to define a future AMSS/AMS(R)S capability that can be incorporated into a Phase II enhanced IRIDIUM System that will be economically viable for all types of aircraft.

CERTIFICATE OF SERVICE

I, Brent H. Weingardt, hereby certify that the foregoing "**Application For Minor License Modification**" was served by hand delivery or first-class mail, postage prepaid, this 4th day of December 1996 on the following persons:

* Thomas Tycz, Chief
Satellite and Radio Communications Division
International Bureau
Federal Communications Commission
2000 M Street, NW., Room 800
Washington, DC 20554

* Cecily C. Holiday
Deputy Chief, Satellite Division
International Bureau
Federal Communications Commission
2000 M Street, N.W., Room 520
Washington, D.C. 20554

* Harold Ng
Satellite Engineering Branch
International Bureau
Federal Communications Commission
2000 M Street, NW., Room 512
Washington, DC 20554

* Steve Sharkey
Chief, Satellite Engineering Branch
Federal Communications Commission
2000 M Street, N.W., Room 283
Washington, DC 20554

* Via Hand Delivery

* Frank Peace
Satellite Engineering Branch
International Bureau
Federal Communications Commission
2000 M Street, NW, Room 805
Washington, DC 20554

* Ron Repasi
Satellite Engineering Branch
International Bureau
Federal Communications Commission
2000 M Street, NW, Room 510
Washington, DC 20554

* Fern Jarmulnek
Chief, Satellite Policy Branch
International Bureau
Federal Communications Commission
2000 M Street, NW., Room 518
Washington, DC 20554

* Karl Kensinger
International Bureau
Federal Communications Commission
2000 M Street, NW., Room 521
Washington, DC 20554

Norman P. Leventhal
Raul R. Rodriguez
Stephen D. Baruch
Leventhal, Senter & Lerman
2000 K Street, N.W., Suite 600
Washington, D.C. 20006

Bruce D. Jacobs
Fisher Wayland Cooper Leader & Zaragoza, LLP
2001 Pennsylvania Avenue, N.W.
Suite 400
Washington, D.C. 20006-1851

* Via Hand Delivery