Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of Application of	)	
	)	
Iridium LLC	)	File No. 187-SAT-P/LA-97(96)
	)	
Concerning Use of the 1990-2025/2165-2200 MHz and Associated Frequency Bands for a Mobile-Satellite System	)	IBFS Nos. SAT-LOA-19970926-00147 SAT-AMD-20001103-00156

ORDER AND AUTHORIZATION

Adopted: July 17, 2001 **Released:** July 17, 2001

By the Chief, International Bureau:

I. INTRODUCTION

1. By this *Order*, we authorize Iridium LLC (Iridium) to use spectrum in the 2 GHz band to provide Mobile-Satellite Service (MSS).[1] We also authorize Iridium to operate feeder uplinks in the 29.1-29.25 GHz band, feeder downlinks in the 19.3-19.7 GHz band, and inter-satellite links in the 23.18-23.38 GHz and 24.45-24.75 GHz bands. This action is a significant step in assigning this spectrum for MSS use and facilitates implementation of Iridium's proposed system's technology and service offerings in the marketplace.

II. BACKGROUND

2. Iridium proposes to construct and launch a mobile-satellite system comprised of ninety-six non-geostationary satellite orbit (NGSO) satellites in eight orbital planes with twelve satellites equally spaced in each orbital plane.[2] Iridium proposes to use service links[3] in the 2 GHz MSS band, feeder links[4] in the Ka-

[1] The term "2 GHz MSS Band" is used in this *Order* to refer to the 1990-2025 MHz (uplink) and 2165-2200 MHz (downlink) frequencies. These frequencies are allocated to the Mobile-Satellite Service (MSS) in the United States. *See Amendment of Section 2.106 of the Commission's Rules to Allocate Spectrum at 2 GHz for Use by the Mobile-Satellite Service*, ET Docket No. 95-18, First Report and Order and Further Notice of Proposed Rule Making, 12 FCC Rcd 7388 (1997), *aff'd on recon.*, Memorandum Opinion and Order and Third Notice of Proposed Rule Making and Order, 13 FCC Rcd 23949 (1998), *further proceedings*, Second Report And Order and Second Memorandum Opinion and Order, 15 FCC Rcd 12315 (2000) (*2 GHz Allocation & Relocation Proceeding*).

[2] Application of Iridium LLC, File No. 187-SAT-P/LA-97(96); IBFS File No. SAT-LOA-19970926-00147 at 1, A-7 (Iridium Application).

[3] "Service links" are the radio links that transmit a user's messages in both directions between a user's earth terminal and the system's satellite(s).

band,[5] and inter-satellite service (ISS) links in the 23.18-23.38 GHz and 24.45-24.75 GHz bands.[6] Iridium proposes to use the 1990-2025 MHz and 2165-2200 MHz bands to serve the United States and, where feasible, to use the 1980-2025 MHz and 2160-2200 MHz bands to serve areas outside the United States.[7] The proposed satellites would operate at an altitude of approximately 850 kilometers in circular orbits.[8] Each orbital plane in Iridium's system is inclined at 98.8 degrees to the equatorial plane with an orbital period of 102 minutes.[9]

3. Iridium submitted its 2 GHz MSS application on September 26, 1997.[10] On March 19, 1998, we sought comment on Iridium's application and other 2 GHz MSS applications that we accepted for filing.[11] Several parties commented on Iridium's proposal and The Boeing Company petitioned to defer consideration of this proposal.[12] Iridium responded. The Commission subsequently adopted service rules for 2 GHz MSS systems.[13] Iridium amended its application to address the requirements adopted in the *2 GHz MSS Order*.[14]

---

[4] "Feeder links" are the radio links that transmit a user's messages in both directions between the system's satellite(s) and its gateway earth station(s), connecting the MSS network with the public switched telephone network.

[5] The "Ka-band" refers to the Earth-to-space (uplink) frequencies at 27.5-30.0 GHz and the corresponding space-to-Earth (downlink) frequencies at 17.7-20.2 GHz. The sub-bands 29.1-29.5 GHz and 19.3-19.7 GHz are allocated on a primary basis to MSS feeder uplinks.

[6] ISS links are communication links between in-orbit satellites.

[7] Iridium Application at A-4 & A-5. The Members of the International Telecommunication Union (ITU) have divided the world into three Regions. Generally, Region 1 includes Africa, Europe, Northern and Western portions of Asia; Region 2 includes the Americas and Greenland; and Region 3 includes Southern portions of Asia, Australia and the South Pacific. *See* ITU Radio Regulations Article S5, Section I. In accordance with ITU Regulations, the 1980-2010 MHz and 2170-2200 MHz bands are allocated to MSS worldwide. *Id.* Article S5, Section IV. Region 2 allocations, however, vary slightly from those of the other regions. In Region 2, the 1980-1990 MHz band does not become available for MSS until January 1, 2005. *Id.* S5.389A. In addition, the 2010-2025 MHz and the 2165-2170 MHz bands, which the ITU already has made available for MSS use in Canada and the United States, will become available for MSS in the rest of Region 2 on January 1, 2002. *Id.* S5.389C & S5.389D.

[8] Iridium Application at A-7.

[9] *Id.*

[10] In this document, the terms "applicant" and "application" refer to all parties and their respective submissions that seek to operate 2 GHz MSS systems, whether the party is an applicant for U.S.-licensed systems or a filer of a letter of intent from non-U.S. licensed systems seeking to serve the U.S. market using 2 GHz MSS spectrum.

[11] *See* Public Notice, Report No. SPB-119 (rel., March 19, 1998).

[12] For a list of pleadings submitted in response to Iridium's application, *see* Appendix A.

[13] *The Establishment of Policies and Service Rules for the Mobile Satellite Service in the 2 GHz Band*, IB Docket No. 99-81, Report and Order, 15 FCC Rcd 16127 (2000) (*2 GHz MSS Order*).

[14] Amendment to Pending Application of Iridium LLC, SAT-AMD-20001103-00156 (November 3, 2000) (Iridium Amendment); *see also* Public Notice, Report No. SAT-00061 (rel. November 29, 2000) (*2 GHz MSS Amendment PN*).

III. DISCUSSION

4. Under rules adopted in the Commission's *2 GHz MSS Order*, Iridium must demonstrate that its system meets certain technical requirements. We address these requirements first. We then turn to Iridium's request for service links in the 2 GHz MSS band, Iridium's request for feeder links and inter-satellite links, Iridium's orbital debris mitigation strategy, implementation milestones, and other licensing issues.

A. Threshold Technical Requirements

1. Frequency Agility

5. Under the Commission's service rules and policies, 2 GHz MSS systems must be capable of operating across at least seventy percent of the United States' 2 GHz MSS allocation in the 1990-2025 MHz and 2165-2200 MHz bands.[15] The Commission also requires that 2 GHz MSS systems be capable of operating without fixed frequency translations between the uplink and downlink frequencies.[16] Iridium's proposed system meets these requirements.[17]

2. NGSO Coverage Requirements

6. Section 25.143(b)(2) of the Commission's rules requires NGSO 2 GHz MSS systems to provide continuous coverage throughout all fifty states, Puerto Rico and the U.S. Virgin Islands, i.e., that at least one satellite is visible at an elevation angle of at least five degrees at all times within this geographic area.[18] In addition, at locations as far north as 70 degrees North Latitude and as far south as 55 degrees South Latitude, NGSO MSS systems must operate such that at least one satellite is visible at an elevation angle of at least five degrees for eighteen hours of every day.[19] Iridium's proposed system meets these requirements.[20]

B. Service-Link Spectrum

7. The *2 GHz MSS Order* adopted a hybrid band arrangement that divided the 2 GHz MSS uplink (1990-2025 MHz) and downlink (2165-2200 MHz) bands into segments of equal bandwidth based on the number of systems seeking assignments.[21] The Commission determined that providing 3.5 megahertz in each direction for the nine then-pending system proponents would be sufficient to commence operations.[22] The Commission provided that, in the event not all system proponents proceed toward authorization, the remaining system proponents would receive more than 3.5 megahertz of spectrum in each direction upon

[15] *2 GHz MSS Order*, 15 FCC Rcd at 16152 ¶ 52.

[16] *Id.* at 16152 ¶ 53.

[17] Iridium Application at A-4.

[18] 47 C.F.R. § 25.143(b)(2)(iii).

[19] 47 C.F.R. § 25.143(b)(2)(ii).

[20] Iridium Application at 27.

[21] *2 GHz MSS Order*, 15 FCC Rcd at 16138 ¶ 16.

[22] *Id.* at 16139 ¶ 17.

authorization.[23] In addition, the Commission reserved one additional spectrum segment in each direction for expansion of system(s) by operator(s) meeting certain criteria for service to unserved areas.[24] The following formula expresses the amount of spectrum available for each system in each direction of transmission:

35 megahertz ÷ (Number of System Proponents + One) = Size of Each Spectrum Segment[25]

There are currently eight 2 GHz MSS system proponents participating in this processing round.[26] We will not at this time, however, implement that portion of the Commission's *2 GHz MSS Order* that would give each system proponent access to more than 3.5 megahertz of spectrum in each direction on a primary basis. Subsequent to release of the *2 GHz MSS Order*, the Commission has received new proposals for use of the 2 GHz MSS bands.[27] Delaying the designation of additional spectrum will give the Commission the opportunity to consider these proposals. Therefore, in this *Order*, Iridium will receive access to a spectrum segment of 3.5 megahertz, in each direction of transmission, on a primary basis, *i.e.*, a "Selected Assignment."[28] Iridium will choose its Selected Assignment such that the band edge of the assignment is an integer multiple of 3.88 megahertz from the band edge of the 2 GHz MSS band, which will allow the Commission to address the proposals before it.

8. Iridium must identify the specific frequencies of its Selected Assignment when the first satellite in its system reaches its intended orbit and notify the Commission in writing of its selection.[29] Consistent with the *2 GHz MSS Order*, Iridium also may elect to operate outside its Selected Assignment on a secondary basis with respect to other 2 GHz MSS operators, subject to certain conditions.[30]

C. Other Requests for Spectrum Assignments

1. Feeder Links

9. Iridium proposes feeder link operations in portions of the Ka-band spectrum designated for NGSO MSS feeder links. Specifically, Iridium proposes to use the 29.1-29.5 GHz (Earth-to-space) and the 19.3-19.7 GHz (space-to-Earth) bands. The Commission established a co-primary allocation for NGSO MSS

[23] *Id.*

[24] *Id.* at 16146-47 ¶¶ 35-39.

[25] *Id.* at 16138 ¶ 16.

[26] *See 2 GHz MSS Amendment PN*, Report No. SAT-00061.

[27] *See Ex parte* Letter of New ICO Global Communications (Holdings) Ltd., IB Docket No. 99-81 (dated March 8, 2001) (ICO *Ex Parte* Letter); Petition for Rulemaking of the Cellular Telecommunications & Internet Association (filed May 18, 2001) (CTIA Petition).

[28] Systems must be implemented consistent with the plans for incumbent relocation adopted in the *2 GHz Allocation & Relocation Proceeding*, Second Report And Order and Second Memorandum Opinion and Order, 15 FCC Rcd 12315, including the phased plan for relocation in the 1990-2025 MHz band.

[29] *2 GHz MSS Order*, 15 FCC Rcd at 16138 ¶ 16. A satellite's intended orbit is the final orbit it will occupy to provide commercial service. *Id.* n.75.

[30] *Id.* at 16139-40 ¶ 19. The 1990-2025 MHz (Earth-to-space) and 2165-2200 MHz (space-to-Earth) bands are immediately adjacent to the 2025-2110 MHz (Earth-to-space, space-to-space) and 2200-2290 MHz (space-to-Earth, space-to-space) bands, respectively, where the Federal Government has extensive satellite network operations. To avoid the possibility of adjacent band interference, this potential interference situation needs to be considered by both non-Government and Government satellite operators when implementing their respective satellite systems near the band edges.

feeder uplinks in the 29.1-29.5 GHz band that is shared with the Local Multipoint Distribution Service (LMDS) at 29.1-29.25 GHz, and geostationary satellite orbit (GSO) fixed-satellite service (FSS) systems at 29.25-29.5 GHz,[31] subject to the special sharing requirements set forth in Sections 25.257 and 25.258 of the Commission's rules.[32] In addition, the Commission designated the 19.3-19.7 GHz band for NGSO MSS feeder downlinks on a co-primary basis with the terrestrial fixed service (FS), subject to site and frequency coordination.[33] We note that Iridium is authorized to use the 29.1-29.25 GHz (Earth-to-space) and the 19.4-19.6 GHz band (space-to-Earth) for its currently operational system and we are unaware of any interference problems with the co-primary services.[34]

10. In its application, Iridium asks us to waive Section 25.258(c) of the Commission's rules, which at the time Iridium filed its application,[35] required NGSO MSS feeder link operations in the 29.25-29.5 GHz band to provide repeating sub-satellite ground tracks on the surface of the Earth.[36] Iridium's waiver request was placed on Public Notice on October 15, 1997, along with its request to operate feeder links in the Ka-band.[37] In response to this Public Notice, Hughes Communications Galaxy, Inc. (Hughes) filed a Petition to Deny Iridium's waiver request.[38] The Commission recently eliminated the repeating ground tracks requirement.[39] Therefore, we dismiss Iridium's waiver request and Hughes' Petition to Deny as moot. Other commenters on Iridium's feeder link request raised concerns regarding the Iridium system's ability to share frequencies in the Ka-band with FS operators in the 19.3-19.7 GHz band,[40] GSO FSS systems in the 29.25-29.5 GHz band,[41] and LMDS facilities in the 29.1-29.25 GHz band.[42] According to Iridium, it is "committed to complying with the Commission's rules and policies, [and] to coordinating with all services and systems with which it is required to coordinate . . . ."[43] Indeed, Iridium has shown its

---

[31] *See Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, to Reallocate the 29.5-30.0 GHz Frequency Band, to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services*, First Report and Order and Fourth Notice of Proposed Rulemaking, 11 FCC Rcd 19005, 19023-38 ¶¶ 41-81 (1996), *modified on recon.*, Memorandum Opinion and Order, CC Docket No. 92-297, FCC 01-164 (rel., May 25, 2001) (*Ka-band Reconsideration Order*).

[32] 47 C.F.R. § 25.257; *id.* § 25.258, as modified by *Ka-band Reconsideration Order*, FCC 01-164.

[33] *See Redesignation of the 17.7-19.7 GHz Frequency Band, Blanket Licensing of Satellite Earth Stations in the 17.7-20.2 GHz and 27.5-30.0 GHz Frequency Bands, and the Allocation of Additional Spectrum in the 17.3-17.8 GHz and 24.75-25.25 GHz Frequency Bands for Broadcast Satellite-Service Use*, IB Docket No. 98-172, Report and Order, 15 FCC Rcd 13430, 13456 ¶¶ 53-54 (2000) (*18 GHz Report and Order*), *petition for review pending, Teledesic LLC v. FCC*, D.C. Cir. No. 00-1466 (filed November 6, 2000).

[34] *See U.S. Leo Services, Inc.*, Order and Authorization, 11 FCC Rcd 13962 (Int'l Bur. 1996).

[35] 47 C.F.R. § 25.258(c) (1997).

[36] Iridium Application, Exhibit D at 1-2.

[37] *See* Public Notice, Report No. SPB-106, 13 FCC Rcd 8020, 8021-22 (1997).

[38] *See* Petition to Deny of Hughes Communications Galaxy, Inc. (filed December 22, 1997) (Hughes Petition).

[39] *Ka-band Reconsideration Order*, FCC 01-164, at ¶ 7.

[40] *See* Comments of the Fixed Point-to-Point Communications Section, Wireless Communications Division of the Telecommunications Industry Association (filed December 22, 1997)

[41] *See* Comments of KaStar Satellite Communications Corp. (filed December 22, 1997); Comments of Lockheed Martin Corporation (filed December 22, 1997). *See also* Hughes Petition, Exhibit A.

[42] *See* Comments of CellularVision USA, Inc. (filed December 22, 1997).

[43] Consolidated Opposition and Response of Iridium LLC at 2 (filed February 2, 1998).

ability to do so through its feeder link operations in the 19.4-19.6 GHz and 29.1-29.25 GHz bands. We will grant Iridium's requests for feeder link spectrum, as circumscribed below.

11. We grant Iridium authority to configure its space stations to receive feeder link transmissions from earth stations in the 29.1-29.5 GHz band; however, this authorization should not be construed as a license for Earth-to-space transmission. Instead, Iridium must request authority for Earth-to-space transmissions in an earth-station application.[44] At that time, Iridium will need to demonstrate that its system can share the spectrum with other authorized services in the band, and specifically demonstrating that coordination with authorized GSO FSS operations in the band is feasible.[45] Iridium also must comply with the provisions pertaining to coordination in Subsections 25.203(h) and 25.203(k) of the Commission's rules.[46]

12. In the 19.3-19.7 GHz band, Iridium has met the requirements set forth in Section 25.208(c) of our rules.[47] Therefore, we grant Iridium's request to transmit from its authorized space stations to earth stations in the 19.3-19.7 GHz band. Prior to using this band, Iridium must coordinate with the U.S. Government systems operating in the 19.3-19.7 GHz frequency band, in accordance with footnote US334 to the Table of Frequency Allocations.[48] This footnote requires coordination of commercial systems with U.S. Government systems in the 17.8-20.2 GHz frequency band. We note that Government GSO and NGSO FSS networks are presently operating in the frequency band 17.8-20.2 GHz, and plan to operate in accordance with the power flux-density (PFD) limits contained in the current International Telecommunication Union (ITU) Radio Regulations.[49]

2. Inter-Satellite Links

13. Iridium proposes to operate inter-satellite links at 23.18-23.38 GHz and 24.45-24.75 GHz bands.[50] Iridium states that emissions limits and other protections will permit inter-service sharing and coordination will permit co-frequency operation with inter-satellite links of other NGSO networks.[51] Iridium plans to use the inter-satellite links to communicate between satellites in the constellation and to improve efficiency

[44] *See* 47 C.F.R. § 25.130.

[45] *See, e.g.*, 47 C.F.R. § 25.257; *id.* § 25.258, as modified by *Ka-band Reconsideration Order*, FCC 01-164.

[46] Subsection 25.203(h) requires any applicant for an earth-station license authorizing operation in a frequency band allocated on a co-primary basis for NGSO and GSO uplinks to select a site, or sites, where mainlobe-to-mainlobe coupling will not occur with respect to satellites of other systems and to pre-coordinate the proposed site and spectrum use with existing earth-station licensees and applicants. 47 C.F.R. § 25.203(h). Subsection 25.203(k) requires an applicant for an earth-station license in a band designated for sharing by GSO and NGSO systems to show that the proposed operation will not cause unacceptable interference to any satellite system licensed for operation in the same band or else certify that the proposed operation would comport with established coordination agreements with the licensees of the affected satellite systems. 47 C.F.R. § 25.203(k).

[47] *See* 47 C.F.R. § 25.208(c) (establishing power flux density limits to observe in certain bands, including the 19.3-19.7 GHz band).

[48] *See* 47 C.F.R. § 2.106 US334.

[49] *See 18 GHz Report and Order*, 15 FCC Rcd at 13473 ¶ 90. The PFD limits in the 18.3-18.6 GHz band are -115/-105 dB (W/m^2) in any one megahertz, depending upon the angle of arrival. There are currently no PFD limits in the 19.7-20.2 GHz band. *See* Letter from William T. Hatch, National Telecommunications and Information Administration, to Dale Hatfield, Chief, Office of Engineering and Technology, Federal Communications Commission (March 29, 2000).

[50] Iridium Application at A-5, A-41.

[51] *Id.* at A-41.

and transmission quality. We grant Iridium's request to operate inter-satellite links in the 23.18-23.38 GHz band on a secondary basis to geostationary inter-satellite operations.[52] We also grant Iridium's request to operate inter-satellite links in the 24.45-24.75 GHz band, subject to coordination among the other authorized users in the band.[53] Under Footnote S5.533 of Section 2.106 of our rules, however, Iridium cannot claim protection against harmful interference from airport surface-detection-equipment stations of the radionavigation service in the 24.45-24.65 GHz band.[54]

14. The National Telecommunication and Information Administration (NTIA) has informed the Commission of sharing issues in the 22.55-23.55 GHz and 24.45-24.75 GHz bands.[55] These sharing issues include coordination that will be required with Government operations and the requirement to meet specified PFD limits.[56] Therefore, Iridium's inter-satellite service operations must be coordinated through the NTIA's Frequency Assignment Subcommittee of the Interdepartment Radio Advisory Committee.

D. Pre-operational Authority

15. Under Commission rules, the fifteen-year license term for a 2 GHz MSS system begins upon a certification by the system operator that the first satellite in its system has begun operations consistent with the terms and conditions specified in its authorization.[57] The Commission indicated in the *2 GHz MSS Order* that it would "authorize system operators to conduct pre-operational testing in the license grant, to the extent that applicants include such information in their applications."[58] Iridium did not request such authority. Accordingly, this authorization does not include authority for operations except at the orbits and on the frequencies specified in the application. Authority for any other radio transmissions on any frequency or satellite orbit will need to be obtained by filing a request for a license modification or special temporary authorization, as appropriate.

E. Regulatory Classification

16. Iridium requests that the satellite operations being authorized herein not be regulated as a common carrier.[59] Under the Communications Act, Commission Rules, and consistent with our *2 GHz MSS Order*, we grant Iridium's request and treat its space station operations as non-common carrier.[60] We will address

[52] 47 C.F.R. § 2.106 n.US278.

[53] 47 C.F.R. § 2.106.

[54] 47 C.F.R. § 2.106 n.S5.533.

[55] *See* Letter from the Acting Associate Administrator, Office of Spectrum Management, NTIA to Chief, Office of Engineering and Technology, FCC (May 18, 1998).

[56] *See* 47 C.F.R. § 25.208(c).

[57] *2 GHz MSS Order*, 15 FCC Rcd at 16175-76 ¶ 103; 47 C.F.R. § 25.121(a) ("Licenses for facilities governed by this part will be issued for a period of 10 years, except that licenses and authorizations in the 2 GHz Mobile-Satellite Service will be issued for a period of 15 years").

[58] *2 GHz MSS Order*, 15 FCC Rcd at 16176 ¶ 103.

[59] Iridium Application at 9.

[60] 47 U.S.C. §§ 153(44), 332(c)(5); 47 C.F.R. § 20.9(a)(10); *2 GHz MSS Order*, 15 FCC Rcd at 16173 ¶ 95.

the regulatory classification of earth stations operating as part of Iridium's system in connection with earth-station licensing.[61]

F. Implementation Milestones

17. The *2 GHz MSS Order* adopted milestones for implementation that apply to 2 GHz MSS systems.[62] Consistent with the *2 GHz MSS Order*, Iridium must observe the following milestone requirements:

Milestone	Deadline
Enter Non-contingent Satellite Manufacturing Contract	12 months after authorization
Complete Critical Design Review (CDR)	24 months after authorization
Begin Physical Construction of All Satellites	30 months after authorization
Complete Construction and Launch First Two Satellites in System	42 months after authorization
Certify Entire System Operational	72 months after authorization

18. Iridium must describe the status of system construction and operation in its annual reports, and file a certification with the Commission within ten days following each of the milestones specified above.[63]

G. Orbital Debris Mitigation

19. Currently, the FCC addresses issues regarding orbital debris and satellite systems on a case-by-case basis, under the general "public interest, convenience and necessity" standard in the Communications Act.[64] To facilitate our orbital debris analysis, under Section 25.143(b)(1) of our rules, 2 GHz MSS system proponents are required to "describe the design and operational strategies that they will use, if any, to mitigate orbital debris."[65] This rule also requires 2 GHz MSS system proponents to "submit a casualty risk assessment if planned post-mission disposal involves atmospheric re-entry of the spacecraft."[66]

---

[61] We also note that the Commission will address issues concerning protection for aeronautical radionavigation in the 1559-1610 MHz band from the out-of-band emissions of 2 GHz MSS mobile earth terminals (METs) in the pending Global Mobile Personal Communications by Satellite (GMPCS) rulemaking, and the 2 GHz MSS METs will be subject to applicable rules and policies the Commission will adopt in that proceeding. *2 GHz MSS Order*, 15 FCC Rcd at 16196-97 ¶ 163 (citing *Amendment of Parts 2 and 25 to Implement the Global Mobile Personal Communications by Satellite (GMPCS) Memorandum of Understanding and Arrangements*, IB Docket No. 99-67, Notice of Proposed Rule Making, 14 FCC Rcd 5871 (1999)).

[62] *2 GHz MSS Order*, 15 FCC Rcd at 16177-78 ¶ 106.

[63] *See* 47 C.F.R. §§ 25.143(e)(1) (requiring satellite space-station operators to file annual reports with the Commission every October 15), 25.143(e)(3) (requiring satellite space-station operators to file a certification with the Commission within 10 days of a system implementation milestone).

[64] 47 U.S.C. § 303.

[65] 47 C.F.R. § 25.143(b)(1), as amended by the *2 GHz MSS Order*, 15 FCC Rcd at 16205. The Commission also stated that it intends to commence a rulemaking proceeding proposing to explore orbital debris mitigation issues. *2 GHz MSS Order*, 15 FCC Rcd at 16188 ¶ 138.

[66] 47 C.F.R. § 25.143(b)(1), as amended by the *2 GHz MSS Order*, 15 FCC Rcd at 16205.

20. In adopting this requirement, the Commission indicated that applicants may wish to consult the National Aeronautics & Space Administration (NASA)/Department of Defense (DoD) Guidelines on Debris Mitigation, as well as the ITU Recommendation on disposal of geostationary satellites.[67] The NASA/DoD Guidelines identify four main objectives: 1) controlling debris released during normal operations; 2) minimizing debris generated by accidental explosions; 3) selecting safe flight profiles and operational configurations; and 4) providing for post-mission disposal of space structures.

21. Under the NASA/DoD Guidelines, these objectives are accomplished by a number of means.[68] The first objective – controlling debris released during normal operations – is addressed by minimizing the amount of debris released in a planned manner during normal operations. The second objective – minimizing debris generated by accidental explosions – is addressed by limiting the risk to other space systems from accidental explosions both during mission operations and after completion of mission operations. For mission operations, this is accomplished through analysis of credible failure modes and development of methods to limit the probability they will occur. Post-mission, this is accomplished through depletion of all sources of stored energy on board the spacecraft when they are no longer required for mission operations or post-mission disposal. The third objective – selecting a safe flight profile and operational configuration – is addressed through estimating and limiting the probability of collision with large objects during orbital lifetime, and the probability of disabling collisions with small debris during mission operations.

22. The fourth objective in the NASA/DoD Guidelines – providing for post-mission disposal of space structures – is met by planning for disposal of a spacecraft at the end of mission life to minimize impact on future space operations. This is accomplished through one of two options relevant here. The first option is atmospheric reentry, *i.e.*, leaving the structure in an orbit in which it will remain in orbit for no longer than 25 years after mission completion. Under this option, it is also necessary to address the casualty risk from any portions of the spacecraft that may survive atmospheric reentry. The second option is maneuvering to a storage orbit. There are three suggested storage orbits. The first is between low and middle Earth orbit, *i.e.*, satellite perigee altitude above 2,000 kilometers and apogee altitude below 19,700 kilometers. The second is between middle and geosynchronous Earth orbit, *i.e.*, perigee altitude above 20,700 kilometers and apogee altitude below 35,300 kilometers. The third is above geosynchronous Earth orbit, *i.e.*, perigee altitude above 36,100 kilometers (or approximately 300 kilometers above geosynchronous altitude). In addition to the NASA/DoD guidelines, and as the Commission observed in the *2 GHz MSS Order*,[69] the ITU has developed a recommendation concerning operations in the GSO.[70]

23. Each of the 2 GHz MSS systems submitted a narrative statement concerning orbital debris mitigation. We note that, to the extent that the statements address debris mitigation issues involving launch

[67] *See 2 GHz MSS Order*, 15 FCC Rcd at 16118 ¶ 138.

[68] *See The Establishment of Policies and Service Rules for the Mobile Satellite Service in the 2 GHz Band*, IB Docket No. 99-81, 14 FCC Rcd 4843, 4901-03 (1999) (Appendix C).

[69] *2 GHz MSS Order*, 15 FCC Rcd at 16118 ¶ 138.

[70] Recommendation ITU-R S.1003. The recommendation suggests, in pertinent part, that a geostationary satellite at the end of its life should be transferred before complete exhaustion of its propellant, to a "supersynchronous graveyard orbit that does not intersect the GSO," with GSO defined as the mean earth radius of 42,164 kilometers plus or minus 300 kilometers. The recommendation also notes that what constitutes "an effective graveyard orbit" requires further studies. In this regard, we note that orbital perturbations due to solar and lunar gravitation, solar pressure, or other sources, may, over time, result in an inactive satellite's orbit intersecting the GSO, as defined by the ITU recommendation, even if the initial disposal altitude does not intersect the GSO.

vehicle operations, we have neither reviewed nor concluded the plans disclosed are appropriate.[71] We also note that, to the extent debris mitigation plans for MSS systems change, the system proponents should evaluate those changes to determine whether disclosure and/or prior approval is required.[72]

24. In its application amendment, Iridium presented a detailed and comprehensive plan for mitigating orbital debris addressing all phases of system operation.[73] Specifically, Iridium indicated that it will minimize the risk of accidental explosions during mission operations as follows: "Failure mode and effects or equivalent analyses will be used to assure either that there are no credible failure modes which can lead to an accidental explosion on orbit or that design or operational procedures will be in place to limit the probability of such an event."[74]

25. Iridium adequately addressed minimizing the potential for collision with large, known objects by stating that "[i]f an appropriate information or service is available, consideration will be given to maintaining an ongoing situational awareness capability designed to provide a warning of the collision risk posed by tracked objects" and "[i]deally, satellite station keeping maneuvers will be used to minimize the possibility of collision . . . ."[75] Iridium also indicated that it will maintain "close working relationships with NASA, US Space Command, and other US Government agencies to ensure the risk of collision with US Government manned and unmanned assets" is minimized during all phases of system deployment, operations, and decommissioning.[76] At this time, Iridium's plans and procedures are an appropriate response to this issue.

26. Iridium also addressed end-of-mission orbital debris mitigation issues, including defining a system disposal strategy and depletion of stored energy sources.[77] As part of this plan, each Iridium satellite will be lowered to a disposal orbit at the end of its operational life. In the disposal orbit, the satellite will experience drag from the upper reaches of the Earth's atmosphere, causing its orbit to decay, until it reenters the Earth's atmosphere. Iridium indicates that this should occur within twenty-five years. Iridium estimates the reentry casualty expectation for each spacecraft to be "on the order of 1 in 10,000 to 1 in 1,000 (a more accurate estimate will be computed once the satellite configuration is better defined)."[78] Iridium indicates that satellites will be designed "[t]o the maximum extent possible" so that the casualty expectation is less than 1 in 10,000 per reentry.[79] Iridium indicates that when its constellation is fully deployed and operational for several years, approximately twelve satellites per year will be decommissioned and deorbited.[80]

---

[71] The United States licensing authority for commercial launches is the Federal Aviation Administration. *See* 14 C.F.R. § 400 *et seq*.

[72] *See* 47 C.F.R. §§ 1.65, 25.117(a). *See also 2 GHz MSS Order*, 15 FCC Rcd at 16179 ¶ 108 (system modifications requiring prior FCC approval should be identified well in advance of the CDR milestone).

[73] Iridium Amendment, Exhibit 1.

[74] *Id.* at 1.

[75] *Id.* at 2.

[76] *Id.*

[77] *Id.* at 3-4.

[78] *Id.* at 4.

[79] *Id.*

[80] *Id.*

27. Iridium's estimated casualty risk for each spacecraft reentry is unacceptably high. That risk is of particular concern given that Iridium intends to dispose of multiple spacecraft. Nevertheless, Iridium indicates that the design of its satellites has not been finalized and that a satellite design involving a lower casualty risk is readily achievable. Therefore, we condition grant of this *Order* on the filing of an application for modification of Iridium's license to address end-of-life disposal, not later than six months prior to the CDR milestone.[81] That application should also address the justification for choosing uncontrolled atmospheric reentry as a disposal option. We also note that this *Order* does not authorize the relocation of operational satellites to storage orbits at end-of-life.

H. Other Issues

1. Coding Techniques

28. Iridium indicates that it intends to use both code-division multiple access (CDMA) and time-division multiple access (TDMA) technologies.[82] In its Petition, Boeing questions how Iridium will use these incompatible technologies and requests that we require Iridium to "disclose the amount or percentage of the proposed capacity" that it will use for each access technique.[83] Constellation and ICO raise similar objections.[84]

29. Iridium recognizes the technical incompatibility of CDMA and TDMA technologies and does not propose to use the two protocols simultaneously within the same frequency band.[85] Iridium states that it will use each protocol "within discrete sub-bands to support specific types of services: TDMA to support Iridium's voice communications services and CDMA to support a variety of variable rate data transmissions."[86]

30. In the *2 GHz MSS Order*, the Commission adopted a hybrid band arrangement that balanced the needs of operators capable of using overlapping frequencies with those of systems that may not be designed to share co-frequency by providing incentives for shared-technology proponents to cooperate during system implementation.[87] While the Commission allowed operators to choose their exclusive Selected Assignments, the Commission elected to permit operators to aggregate their respective spectrum assignments by reaching sharing agreements among themselves.[88] The *2 GHz MSS Order* not only

[81] *See* 47 C.F.R. § 1.65 (requiring prompt filing of material additional information); *2 GHz MSS Order*, 15 FCC Rcd at 16179, ¶ 108 (noting that prospective 2 GHz MSS operators must "identify any system modifications needing prior FCC approval well in advance of the CDR [Critical Design Review] milestone").

[82] Iridium Application at 7.

[83] Boeing Petition at 10; Boeing Response at 24.

[84] *See, e.g.*, Constellation Comments at 24-25 (noting that the "technical and operating conditions under which both TDMA and CDMA access techniques are used in the same system requires careful consideration to insure [sic] that such operations do not complicate the inter-system coordination process"); Constellation Response at 4 (contending that without additional detail about how systems plan to use CDMA and TDMA technologies "it will be difficult to make any determinations on how the various systems can be accommodated in the bands); ICO Response at 8 (operating two different access technologies would force operators to divide the 2 GHz MSS band into several sub-bands and "present . . . an intricate spectrum assignment and coordination challenge").

[85] Iridium Reply Comments at 11.

[86] *Id.*

[87] *2 GHz MSS Order*, 15 FCC Rcd at 16141 ¶ 22.

[88] *Id.*

provides sufficient incentives for the 2 GHz MSS licensees to develop a sharing arrangement among satellite operators using different access technologies, but also offers sufficient protection in the event complete sharing cannot be accomplished.

2. GMDSS and AMS(R)S

31. Iridium states that its proposed system will "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)."[89] GMDSS is primarily a ship-to-shore system that consists of several distinct communications systems to provide communications for domestic and international maritime traffic.[90] AMS(R)S is a type of MSS that uses mobile earth stations aboard aircraft to provide communications for domestic and international air traffic and air traffic control.[91] Constellation criticizes Iridium's proposal as inappropriate for the 2 GHz MSS band.[92] ARINC asserts that we should require priority and real-time preemption for AMS(R)S in the 2 GHz MSS band.[93] Iridium responds by stating that it does not seek to obtain rights superior to other 2 GHz MSS licensees and by recognizing "the present limitations on AMS(R)S in the 2 GHz band."[94]

32. The *2 GHz MSS Order* held that, to the extent 2 GHz MSS licensees wish to provide GMDSS, AMS(R)S or other, similar services in the 2 GHz MSS band, licensees must meet certain statutory obligations and coordinate with the appropriate safety and rescue organizations.[95] Consistent with the *2 GHz MSS Order*, therefore, Iridium may equip its space stations with GMDSS and AMS(R)S capabilities. Before offering these services, however, Iridium must comply with relevant Commission rules, meet its statutory obligations and fulfill its coordination responsibilities.[96]

3. Timing of Licensing

33. AT&T Wireless Services, Inc., Cingular Wireless LLC, Sprint PCS, and Verizon Wireless (Wireless Carriers) in a recent joint letter requested the Commission to defer grant of the pending 2 GHz MSS applications until (1) public comment is sought and received on the implications of New ICO Global Communications (Holdings) Ltd.'s March 8, 2001 *ex parte* letter proposing amendment of the 2 GHz MSS service rules to permit licensees to incorporate an "ancillary terrestrial component" into their 2 GHz MSS networks; and (2) the Commission considers a petition for rule making submitted by the Cellular

[89] Iridium Application at 13.

[90] *See* 47 C.F.R. §§ 80.1065-80.1135.

[91] *See* 47 C.F.R. § 2.1 (defining AMS(R)S).

[92] Constellation Comments at 24 (asserting that Iridium should only provide safety-of-life services in the 1.5/1.6 GHz bands); *see also* Constellation Response at 5 (expressing concern about Iridium's possible need for higher priority access to 2 GHz MSS spectrum).

[93] ARINC Comments at 1 n.1, 3 (asserting that Iridium's proposal to provide AMS(R)S in the 2 GHz band should be subject to the same requirements of priority and real-time preemption now required of L-band mobile satellites).

[94] Iridium Reply Comments at 10; *see also* Constellation Response at 7 (noting that "to the extent Iridium does not … seek priorities vis-à-vis other 2 GHz MSS licensees, [Constellation's] concerns regarding Iridium's operations would be minimized").

[95] *See 2 GHz MSS Order*, 15 FCC Rcd at 16181-16182 ¶¶ 117-119.

[96] *See, e.g.,* 47 C.F.R. § 25.143(f)(1) (citing 47 U.S.C. §§ 321(b) (addressing operator responsibilities with respect to distress signals), 359 (describing lawful operations under applicable international safety conventions)).

Telecommunications & Internet Association (CTIA) requesting that the 2 GHz MSS bands be reallocated for other uses, such as terrestrial wireless services.[97] For the reasons set forth in the ICO *Order* issued contemporaneously with this *Order and Authorization*, we deny the Wireless Carriers' request to defer action on the 2 GHz MSS applications.[98]

IV. ORDERING CLAUSES

34. Accordingly, IT IS ORDERED that the Application File No. 187-SAT-P/LA-97(96); IBFS File Nos. SAT-LOA-19970926-00147 and SAT-AMD-20001103-00156 IS GRANTED and Iridium LLC IS AUTHORIZED to construct, launch and operate ninety-six satellites capable of operating in the 1990-2025/2165-2200 MHz frequency bands in the United States, in accordance with the technical specifications set forth in its application, as amended, and the conditions set forth in the preceding paragraphs and consistent with our rules, unless specifically waived herein, and subject to the following conditions:

a. Iridium LLC must choose a Selected Assignment in the 1990-2025 MHz and 2165-2200 MHz frequency bands upon launch of one satellite into its authorized satellite orbit and commencement of operations by that satellite;

b. The Selected Assignment shall give Iridium LLC access to 3.5 megahertz in each direction of transmission on a primary basis;

c. The Selected Assignment shall be chosen such that the band edge of the assignment is an integer multiple of 3.88 megahertz from the band edge of the 2 GHz MSS band;

d. Operations in frequencies in these bands outside the Selected Assignment shall be on a secondary basis to operations of other 2 GHz MSS systems; and

e. No later than six month prior to the Critical Design Review milestone, Iridium LLC must file an application to modify this license to address end-of-life disposal of its satellites, in accordance with the orbital debris discussion in this *Order and Authorization*.

35. IT IS FURTHER ORDERED that Iridium LLC IS AUTHORIZED to operate its proposed mobile-satellite system in the 1980-2025 MHz and 2160-2200 MHz frequency bands outside the United States subject to the following conditions:

a. In International Telecommunication Union (ITU) Regions 1 and 3, operations shall be limited to the 1980-2010 MHz and 2170-2200 MHz bands and shall comply with footnote S5.389F of the ITU Radio Regulations;[99]

---

[97] Letter to Michael K. Powell, Chairman, Federal Communications Commission from Douglas Brandon, AT&T Wireless Services, Inc., Brian F. Fontes, Cingular Wireless, LLC, Luisa L. Lancetti, Sprint Corporation, and John T. Scott, III, Verizon Wireless, IB Docket No. 99-81 (dated June 13, 2001) (citing the ICO E*x Parte* Letter and CTIA Petition). *Accord Ex parte* Letter of CTIA, IB Docket No. 99-81 (dated July 12, 2001). *But see Ex parte* Letter of Globalstar, L.P., IB Docket No. 99-81 (dated July 2, 2001) (objecting to the Wireless Carriers' request); *Ex parte* Letter of Celsat America, Inc., IB Docket No. 99-81 (dated June 25, 2001) (same).

[98] *See ICO Services Limited, Letter of Intent to Provide Mobile-Satellite Service in the 2 GHz Bands*, Order, DA 01-1635, at ¶¶ 29-31 (Int'l Bur./OET, rel. July 17, 2001).

[99] *See* ITU Radio Regulations n. S5.389F (placing limitations on MSS use of the 1980-2010 MHz and 2170-2200 MHz bands in Algeria, Benin, Cape Verde, Egypt, Mali, Syria and Tunisia).

b. In ITU Region 2, operations shall comply with footnotes S5.389A, S5.389B, S5.389C, S5.389D, S5.389E, and S5.390 of the ITU Radio Regulations;[100] and

c. Iridium LLC is obligated to comply with the applicable laws, regulations, rules, and licensing procedures for those countries it proposes to serve.

36. IT IS FURTHER ORDERED that Iridium LLC IS ASSIGNED the 29.1-29.5 GHz band (Earth-to-space) and 19.3-19.7 GHz band (space-to-Earth) for feeder link operations in accordance with the technical specifications set forth in its application and consistent with our rules unless specifically waived herein.

37. IT IS FURTHER ORDERED that Iridium LLC must coordinate its Ka-band feeder downlink operations with the U.S. Government systems, in accordance with footnote US334 to the Table of Frequency Allocations, 47 C.F.R. § 2.106.

38. IT IS FURTHER ORDERED that Iridium LLC IS ASSIGNED the 23.18-23.38 GHz and 24.45-24.75 GHz bands for inter-satellite link operations in accordance with the technical specifications set forth in its application and consistent with our rules unless specifically waived herein.

39. IT IS FURTHER ORDERED that Iridium LLC cannot claim protection against harmful interference from airport surface-protection-equipment stations of the radionavigation service in the 24.45-24.65 GHz band, 47 C.F.R. § 2.106 n. S5.533.

40. IT IS FURTHER ORDERED that Iridium LLC shall coordinate its use of the 23.18-23.38 GHz and 24.45-24.75 GHz bands for inter-satellite link operations through the Frequency Assignment Subcommittee of the Interdepartment Radio Advisory Committee of the National Telecommunication and Information Administration.

41. IT IS FURTHER ORDERED that the Petition to Hold in Abeyance of the Boeing Company (filed May 4, 1998) IS DENIED.

42. IT IS FURTHER ORDERED that the Petition to Deny of Hughes Communications Galaxy, Inc. (filed December 22, 1997) IS DISMISSED as moot.

43. IT IS FURTHER ORDERED that this authorization shall be become NULL and VOID with no further action required on the Commission's part in the event the space station is not constructed, launched and placed into operation in accordance with the technical parameters and terms and conditions of the authorization by the following dates:

Milestone	**Deadline**
Enter Non-contingent Satellite Manufacturing Contract	July 17, 2002

[100] *See* ITU Radio Regulations nn.S5.389A (allocating the 1980-2010 MHz and 2170-2200 MHz bands to MSS, subject to coordination, effective January 1, 2000, except for the use of the 1980-1990 MHz band in Region 2, which is effective January 1, 2005), S5.389B (placing limitations on MSS use of the 1980-1990 MHz band in Argentina, Brazil, Canada, Chile, Ecuador, the United States, Honduras, Jamaica, Mexico, Peru, Suriname, Trinidad & Tabago, Uruguay and Venezuela), S5.389C (allocating the 2010-2025 MHz and 2160-2170 MHz bands to MSS in Region 2, subject to coordination, effective January 1, 2002), S5.389D (permitting MSS use of the 2010-2025 MHz and 2160-2170 MHz bands in the United States and Canada, effective January 1, 2000), S5.389E (placing limitations on MSS use of the 2010-2025 MHz and 2160-2170 MHz bands in Region 2 with respect to other services' operations in these bands in Regions 1 and 3), S5.390 (placing limitations on MSS use of the 2010-2025 MHz and 2160-2170 MHz bands in Argentina, Brazil, Chile, Columbia, Cuba, Ecuador and Suriname).

Complete Critical Design Review	July 17, 2003
Begin Physical Construction of All Satellites	January 17, 2004
Complete Construction and Launch First Two Satellites in System	January 17, 2005
Certify Entire System Operational	July 17, 2007

44. IT IS FURTHER ORDERED that Iridium LLC shall prepare the necessary information, as may be required, for submission to the ITU to initiate and complete the advance publication, international coordination, and notification process of this space station in accordance with the ITU Radio Regulations. No protection from interference caused by radio stations authorized by other administrations is guaranteed unless coordination procedures are timely completed or, with respect to individual administrations, coordination agreements are negotiated. Any radio station authorization for which coordination has not been completed may be subject to additional terms and conditions as required to effect coordination of the frequency assignments with other administrations. *See* 47 C.F.R. § 25.111(b).

45. IT IS FURTHER ORDERED that this *Order and Authorization* is subject to change by summary order of the Commission on 30 days' notice and does not confer any permanent right to use the orbit and spectrum.

46. IT IS FURTHER ORDERED that Iridium LLC may decline this authorization as conditioned within 30 days of the date of the release of this *Order and Authorization*. Failure to respond within this period will constitute formal acceptance of the authorization as conditioned.

47. This *Order and Authorization* is issued pursuant to Section 0.261 of the Commission's rules on delegations of authority, 47 C.F.R. § 0.261, and is effective upon release.

FEDERAL COMMUNICATIONS COMMISSION

Donald Abelson
Chief, International Bureau

Appendix A

LIST OF PLEADINGS ADDRESSING IRIDIUM'S APPLICATION AND AMENDMENT

Filed May 4, 1998

Petition to Hold in Abeyance of the Boeing Company (Boeing Petition)
Comments of Constellation Communications, Inc. (Constellation Comments)
Consolidated Comments of ICO Services Limited (ICO Comments)
Comments of Bell Atlantic (BA Comments)
Comments of Aeronautical Radio, Inc. (ARINC Comments)
Comments of the Wireless Cable Association International, Inc. (WCA Comments)

Filed June 3, 1998

Consolidated Response and Opposition to Petition to Hold in Abeyance (Iridium Reply)

Filed June 18, 1998

Consolidated Reply of Iridium LLC (Iridium Response)
Consolidated Reply of the Boeing Company (Boeing Response)
Reply of Constellation Communications, Inc. (Constellation Response)
ICO's Consolidated Response to Reply Comments (ICO Response)
Response of the Wireless Communications Association International, Inc. (WCA Response)