

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

In the Matter of)
)
Review of the Spectrum Sharing Plan Among) IB Docket No. 02-364
Non-Geostationary Satellite Orbit Mobile Satellite)
Service Systems in the 1.6/2.4 GHz Bands)

**COMMENTS OF CORNELL UNIVERSITY
and MOTION FOR LEAVE TO FILE**

Cornell University, by its attorney, hereby submits comments in response to the February 10, 2003 Notice of Proposed Rulemaking (the “*NPRM*”) in the above-captioned proceeding.¹ Herein, Cornell expresses its concern about the possibility of additional harmful interference from operations of Iridium Constellation LLC and Iridium US LP (“Iridium”) in the frequencies proposed for reassignment to TDMA systems. Cornell notes that there has been little opportunity to evaluate the impact of Iridium’s use of expanded frequencies at full load, at least in the satellite footprint that covers Arecibo, Puerto Rico. Accordingly, Cornell suggests if the Commission concludes that the public interest requires assignment of additional spectrum to Iridium, then the Commission should grant to Iridium use of only part of the 5.85 megahertz of the

¹ Comments in this proceeding were due to be filed on July 11, 2003. Accordingly, Cornell hereby moves for leave to file these Comments late. Good cause exists for accepting these Comments because they contains responses to issues raised in the *NPRM* which impact on the Radio Astronomy Service, and thus on the public interest. Indeed, these Comments are likely to be one of the only pleadings responding to the issues discussed herein from the perspective of radio astronomers, parties whose interests are directly affected by the issues raised in the *NPRM*. Thus, consideration of these Comments is important if the Commission is to have a full record upon which to act. Furthermore, these Comments are being filed only one business day after the filing deadline, so there is sufficient time for other parties to review and address in reply comments, the matters raised herein. In order to facilitate that process, Cornell is directly serving a copy of these Comments on the parties that have participated in related recent proceedings, and any other parties who filed comments in this proceeding on July 11th.

spectrum it seeks, specifically the frequencies farthest away from the 1610.6-1613.8 MHz Radio Astronomy Service (“RAS”) band. Any assignment of the spectrum closest to the RAS band should be conditioned on the results of investigation of the impact of the use of those frequencies when the Iridium transmissions are more fully loaded, and thus testing can produce a more realistic prediction of potential harm.

I. Background

Cornell has a substantial interest in this proceeding, as it operates the Arecibo Observatory (“Arecibo”) in Arecibo, Puerto Rico. Arecibo is part of the National Astronomy and Ionosphere Center (“NAIC”), a national research center operated under a cooperative agreement with and funded by the National Science Foundation (“NSF”). The NSF is an independent federal agency whose aim is to promote scientific and engineering progress in the U.S.

As the site of the world’s largest single-dish radio telescope, Arecibo is recognized as one of the most important centers in the world for research in radio astronomy and planetary radar.² Arecibo has been operating since 1963, and in 1997 work was completed on a multi-million dollar upgrade of the facilities, which significantly expanded the range and sensitivity of the observations that could be made, while increasing the shielding around the telescope in an attempt to reduce interference from ground radiation.

² Arecibo has a long history of being the site where very significant accomplishments in astronomy have occurred, including: the first discovery of planets outside of our own Solar System; discovery of the first pulsar in a binary system, leading to important confirmation of Einstein’s theory of gravitational waves and a Nobel Prize for two radio astronomers who performed their research at Arecibo (the third Nobel Prize for radio astronomy in its short 50 year history); and discovery of the correct rotation rate of the planet Mercury, as well as the discovery of ice in craters on Mercury’s polar regions (and similar investigation of the polar regions of the Earth’s Moon).

The emissions that radio astronomers review are extremely weak -- a typical radio telescope receives less than one-trillionth of a watt from even the strongest cosmic source. Because radio astronomy receivers are designed to pick up such remarkably weak signals, observations by radio astronomers are particularly vulnerable to interference from spurious and out-of-band emissions from licensed and unlicensed users of neighboring bands, and those that produce harmonic emissions that fall into the RAS bands.

Of particular concern to Cornell in this proceeding is interference to radio astronomy observations in the 1610.6-1613.8 MHz band. This band is allocated on a co-primary basis to the RAS. There is a reason for this primary allocation: observations in and around these frequencies are among the most important for the science of radio astronomy, for spectral line observations of the hydroxyl (OH) molecule. Such observations are of great importance to scientists studying stellar expansion velocities. Indeed, Recommendation ITU-R RA.314-8 includes observations of the Hydroxyl molecule at the rest frequency of 1612.231MHz as being among the spectral lines of greatest importance to radio astronomy. Due to Doppler shifting of such cosmic emissions, that Recommendation suggests that the minimum preferred band for such observations includes the band 1606.8-1613.8 MHz.

It is for the above reasons that the Commission has established certain inter-service coordination requirements for satellite systems operating in the 1610-1626.5 MHz band. These requirements are contained in Section 25.213 of the FCC's Rules and Regulations, and Section 25.213(a)(4) states:

“Mobile Satellite Service space stations transmitting in the 1613.8-1626.5 MHz band shall take whatever steps necessary to avoid causing harmful interference to [list of observatories, including Arecibo] during periods of observation.”

At the encouragement of the Commission, and in order to facilitate coordination of Iridium’s responsibility to avoid interfering with observations at Arecibo along with Arecibo’s obligation to avoid scheduling radio astronomy observations during peak MSS traffic periods to the greatest extent practicable, the previous Iridium licensees and Cornell negotiated and signed a Coordination Agreement in March of 1998.³ In granting MSS licenses to Iridium, the FCC made Iridium’s fulfillment of the terms of that Agreement an express condition of the MSS licenses.

II. Attempts to Evaluate Current and Future Harmful Interference Have Been Problematic.

In this proceeding, Iridium seeks reassignment of 5.85 megahertz of spectrum in the 1615.5-1621.35 MHz portion of the Big LEO band (hereinafter, “Expanded Band”). Cornell has serious concerns about the increased potential for harmful interference to RAS observations that could result from Iridium’s use of the frequencies in the Expanded Band. The incidence of out-of-band emissions from Iridium operations into the 1610.6-1613.8 MHz RAS band depends on (i) the proximity of frequencies used by Iridium to the RAS band, (ii) the number of separate channels on which Iridium simultaneously transmits, and hence (iii) on the density of Iridium’s traffic. Cornell expects that most harmful out-of-band emissions would come from intermodulation products between the different channels transmitted by Iridium. Moreover the frequency range covered by such products increases as the number of channels increase, which

³ That Agreement was updated to reflect the Commission’s grant of the licenses to the current Iridium licensees. A copy of the current Agreement is attached.

implies that the size of the guard band at the edge of any additional frequency assigned to Iridium should depend on the number of channels used.

Cornell has been investigating whether Iridium's recent temporary use of some of this spectrum has created harmful interference. However, there are difficulties in doing so. Recent observations at Arecibo have shown a change in the incidence of low intensity emission features within the 1610-1613 MHz RAS band, over the time-frame in which Iridium has been using Channels 8 and 9 of the Expanded Band. Indeed, the worst of these features disappeared when Iridium discontinued use of Channel 8, though that result might of course be coincidental.

One method for investigating whether these unwanted emission features were generated by Iridium has involved adapting the output from existing new pulsar instrumentation to provide independent spectra once every millisecond. These can then be processed with offline software to lock onto the Iridium clock cycle, and appropriately summed to provide the sensitivity needed to determine the status of the weak spurious emission features in the RAS band. Cornell expects to have this work completed in approximately one to two months.⁴

Similarly, Cornell is trying to evaluate the potential for harmful interference from Iridium's permanent use of the Expanded Band, if so assigned. However, there are problems that prevent obtaining a definitive answer at this time. Specifically, it is difficult to evaluate the likelihood of harmful interference that could result from Iridium's future

⁴ An alternative method attempted by Cornell would have used an air interface blanker supplied to it by Iridium six years ago to provide a blanking pulse to [note continued next page] Arecibo's correlator, so as to synchronize its response to the Iridium clock cycle. However, this approach has not been helpful, because the blanker does not appear to work.

full commercial use of the Expanded Band, when the footprint covering the Arecibo Observatory currently exhibits low-density traffic.

In sum, through no fault of its own, Cornell has not yet been able to evaluate whether the increased emission features recently observed in the RAS band are the result of Iridium's recent use of Channels 8 and 9. Cornell hopes to have a better answer to that issue shortly. In any case, however, it appears to be difficult or impossible to predict at this time what the impact would be of Iridium's full use of the entire Expanded Band.

III. Any Additional Assignment to Iridium, if Granted, Should Be For the Frequencies Farthest From the RAS Band.

While Iridium seeks reassignment of 5.85 megahertz of spectrum in this proceeding, the *NPRM* notably suggests at para. 266 that "it is now appropriate to consider making at least 3.1 megahertz of additional spectrum available to Iridium." (emphasis added). Cornell does not have the technical expertise to evaluate whether Iridium has a demonstrable commercial or technical need for the additional spectrum it has requested.⁵ However, as discussed above, Cornell has serious concerns about the increased potential for harmful interference in the RAS 1610.6-1613.8 MHz band that could result from Iridium's use of frequencies closer to the RAS band than those currently used by Iridium. Accordingly, consistent with the implications of the above-cited statement in para. 266, if the Commission concludes that the public interest

⁵ It should be noted, however, that while Iridium seeks 5.85 megahertz of additional spectrum in this proceeding, and the *NPRM* contemplates assigning at least 3.1 megahertz to Iridium, originally 2.5 megahertz, and now only 1.25 megahertz, of additional spectrum appeared to be sufficient to meet Iridium's temporary needs to serve troops in the Middle East, which generated "extraordinarily high demand" for Iridium service, according to counsel for Iridium. See July 9, 2003 Letter from Peter Shields to Thomas Tycz, at page 3. If the Commission concludes that more spectrum should be assigned to Iridium, then perhaps the 1.25 megahertz of additional spectrum temporarily being used by Iridium at this time (Channel 9) would be the appropriate amount and frequency for such assignment.

requires grant of additional spectrum to Iridium, then Cornell urges the Commission to grant only part of the 5.85 MHz Expanded Band, specifically the frequencies farthest away from the RAS band. Any grant of the portion closest to the RAS band should be conditioned on the results of investigation of the impact of the use of those frequencies when the Iridium transmissions are more fully loaded.

Cornell's analysis of the legal issues herein begins with Iridium's obligations under Section 25.213(a)(2) of the Commission's Rules, to "take whatever steps necessary to avoid causing harmful interference" to Arecibo during periods of observation in the 1610.6-1613.8 MHz band. As a result of Iridium's obligations under that rule section, and as further defined in the NAIC/Iridium Coordination Agreement, any use by Iridium of the Expanded Band that causes harmful interference to RAS observations at Arecibo would be a violation of the Commission's Rules and of the Coordination Agreement. Cornell could at that time seek a remedy for such violations from the Commission.

Nevertheless, Cornell fears the future use of the "*fait accompli*" argument that has been raised in similar circumstances in past satellite matters: that once a satellite is launched, it is allegedly "too difficult" or "too expensive" to make the changes to the satellite's transmission characteristics necessary to eliminate or reduce interference caused by that satellite. A similar future situation involving Iridium interference with RAS observations at 1610.6-1613.8 MHz would be disastrous.

Cornell strongly believes that the closer Iridium transmissions are to 1610.6-1613.8 MHz, the more difficult it will be for Iridium to comply with its obligation to avoid creating harmful interference in that band. Accordingly, if the Commission concludes

that the public interest requires assignment of additional spectrum to Iridium, then Cornell urges the Commission to assign it use of only part of the 5.85 MHz Expanded Band, specifically the frequencies farthest away from the RAS band. Any assignment of the portion closest to the RAS band should be conditioned on the results of investigation of the impact of the use of those frequencies when the Iridium transmissions are more fully loaded, and thus testing can produce a more realistic prediction of potential harm.

Respectfully submitted,

CORNELL UNIVERSITY

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July 14, 2003

Coordination Agreement Regarding the Operation of the IRIDIUM[®] System and the Arecibo Radio Astronomy Observatory

1. Introduction

This Coordination Agreement arose out of discussions between representatives of Space System License, Inc., a wholly owned subsidiary of Motorola, Inc. under contract to Iridium LLC; and Cornell University, operator of the National Astronomy and Ionosphere Center (“NAIC”).¹ Those discussions led to a Framework Agreement dated March 19, 1997, and then to a Coordination Agreement dated March 1, 1998. In light of the pending assignment of the Mobile Satellite Service License that is the subject of the Coordination Agreement, from Space System License, Inc. to Iridium Constellation LLC (“ICL”), a wholly owned subsidiary of Iridium Satellite LLC (“ISL”) (ICL and ISL shall hereinafter be referred to collectively as “New Iridium”), NAIC and New Iridium have entered into this new Coordination Agreement which is intended to ensure that the mutual obligations set forth in the March 1, 1998 Coordination Agreement in connection with coordination between the IRIDIUM System and the Arecibo Radio Astronomy Observatory are fulfilled by New Iridium and NAIC.

2. FCC Regulations

The FCC has established certain inter-service coordination requirements for satellite systems operating in the 1610-1626.5 MHz band. These requirements are contained in Section 25.213 of the FCC’s Rules and Regulations. They include:

47 CFR 25.213(a)(2):

“Mobile Satellite Service space stations transmitting in the 1613.8-1626.5 MHz band shall take whatever steps necessary to avoid causing harmful interference to [list of observatories, including Arecibo Radio Observatory] during periods of observation.”

47 CFR 25.213(a)(4):

“The Radio Astronomy Service shall avoid scheduling radio astronomy observations during peak MSS/RDSS traffic periods to the greatest extent practicable.”

⁶ The National Astronomy and Ionosphere Center is operated by Cornell University under a Cooperative Agreement with the National Science Foundation.

3. Principles of Coordination

The following basic principles have been agreed upon regarding the coordination of the IRIDIUM[®] System⁷ with the Arecibo Radio Astronomy Observatory (“Arecibo”):

- a) New Iridium will operate the IRIDIUM System in a spectrum efficient and economic manner, without causing harmful interference to Arecibo. It is recognized that the main area of concern is potential interference to the radio astronomy observations scheduled at Arecibo in the 1610.6-1613.8 MHz band from the IRIDIUM System downlinks, covered by international RR S5.372.
- b) Arecibo is to be protected from harmful interference during those periods that radio astronomy observations are conducted in the 1610.6-1613.8 MHz band. The scheduling of these periods will, to the greatest extent practicable, be done in such a way as to coincide with the minimum traffic periods for the IRIDIUM System. It is anticipated that observations at Arecibo will not unnecessarily inhibit the ability of New Iridium to operate the IRIDIUM System in a spectrum efficient and economic manner.
- c) The IRIDIUM System mobile earth terminals will be capable of terminating operations after the first position fix of the terminals.
- d) The NAIC will provide New Iridium with scheduling information, either directly or through the Electromagnetic Spectrum Management Unit of the National Science Foundation (“ESMU”), regarding the periods when radio astronomy observations in the 1610.6-1613.8 MHz band are expected to be conducted at Arecibo.
- e) Motorola/Iridium has provided to the NAIC, at no charge, an air interface to the IRIDIUM System that provides a signal with a blanking period during approximately 50% of each 90 millisecond time frame. This signal will indicate when the transmitters on board the IRIDIUM System space vehicles are active. It is understood that the use of the air interface reduces the sensitivity of the Arecibo telescope, and that it allows carrying out only some types of radio astronomy observations. Nevertheless, it will enable NAIC, at its option, to conduct certain observations at Arecibo at any time, by “seeing through” the IRIDIUM System transmissions.
- f) The parties recognize that the provisions of this Coordination Agreement are based on the unique conditions and facilities of Arecibo, and may not apply to New Iridium’s coordination with any other radio astronomy observatory in the U.S. or elsewhere.

⁷ IRIDIUM is a registered trademark and service mark of Iridium Satellite LLC.

4. Coordination

Arecibo is a unique national facility that accepts observing proposals from scientists all over the world. Observing time on the instrument is granted to projects reviewed favorably by external referees, solely on the basis of scientific merit. Therefore, prior to the proposal deadline, Arecibo can neither predict nor modify the total number of observing hours in any band during a particular scheduling period; this is set by proposal pressure and the reviewers. Nothing in this Coordination Agreement shall be construed as restricting or limiting Arecibo's ability to accept and review proposals, and to grant observing time solely on the basis of scientific merit.

Except when lightly loaded, it is anticipated that the IRIDIUM System will produce an average SPFD not exceeding $-223 \text{ dBW m}^{-2} \text{ Hz}^{-1}$ in the 1610.6-1613.8 MHz band at the surface of the Earth at Arecibo. This figure reflects the fact that IRIDIUM space vehicle antennas will transmit in one polarization only, that the transmissions are averaged over a 2000 second interval, and that the satellite is in the 0 dBi sidelobe of the Arecibo antenna.

Recommendation ITU-R RA.769, Table 2, provides detrimental interference threshold levels for spectral line radio astronomy observations in the 1610.6-1613.8 MHz band as $-238 \text{ dBW m}^{-2} \text{ Hz}^{-1}$ assuming, inter alia:

- 2000 second integration time and 20 kHz bandwidth for the radio astronomy observations;
- interference is received through 0 dBi sidelobes of the radio telescope.

Coordination between the parties to this Coordination Agreement is based upon the following provisions:

- a) Starting in 2001, New Iridium will provide quarterly to the NAIC the best available information about the expected IRIDIUM System traffic patterns in the vicinity of Arecibo, in the form of an hourly ranking for a typical week. NAIC will provide New Iridium with the best available information about the scheduled observations in the 1610.6-1613.8 MHz band, a month in advance of the observations. The parties will establish mutually convenient dates for the exchange of this information.
- b) New Iridium agrees to protect Arecibo to the SPFD level $-238 \text{ dBW m}^{-2} \text{ Hz}^{-1}$ or better from 10 p.m. to 6 a.m. (Miami local time) seven days a week during periods when observations which have been notified to New Iridium in accordance with the procedure set forth in 4(a), above, are being taken. These levels will be adjusted to reflect actual sidelobe performance of the Arecibo antenna as determined by Arecibo and evaluated and jointly agreed upon by the parties.

- c) A few observations of special celestial objects (comets, supernovae, and other celestial objects of heretofore unknown type) may need to be accommodated outside the agreed 10 p.m.-6 a.m. scheduling window. To the greatest extent practicable, these observations will be carried out using the blanker described in 3(e), above. Special observations that cannot be done using the blanker will be protected to the $-238 \text{ dBW m}^{-2} \text{ Hz}^{-1}$ level as set forth in 4(b), above. Such observations shall not exceed 8 passes per calendar year.
- d) New Iridium will comply with Section 25.213(a)(2) of the FCC's Rules as currently formulated (see Section 2 herein) as applied to the Arecibo Observatory.
- e) New Iridium will attempt to reduce emissions of any future generation satellites in the IRIDIUM System into the 1610.6-1613.8 MHz band. The NAIC will continue to attempt to decrease the Arecibo telescope's susceptibility to interference from spaceborne systems (e.g., by reducing sidelobe levels, effects on the antenna pattern due to screen illumination, and by incorporating blanking or other signal processing techniques into the observations).

5. Disclosure

The terms and provisions of this coordination agreement will not be held as confidential. Certain information, to be exchanged under the terms of this agreement, and information that was exchanged in the course of negotiations leading to the March 1, 1998 Coordination Agreement, and was or is marked as "Confidential Proprietary," will remain confidential.

6. Modification

This Coordination Agreement may be modified only by mutual agreement, in writing. In the event the parties reach an impasse on changes to this Coordination Agreement, they agree to submit the issue to the FCC and NTIA for mediation and resolution.

7. Review

The parties agree to work on the items listed in the Annex and to meet annually beginning in February 1999 to review this Coordination Agreement.

8. Benefit

This Agreement shall inure to the benefit of and be binding upon the parties hereto and their respective successors or assigns.

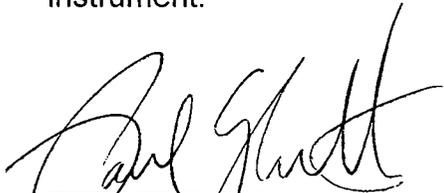
9. Assignment.

ICL agrees to notify NAIC prior to or the day of the filing with the FCC of an application to assign or transfer control of its Mobile Satellite Service License to a third party. ICL also agrees to obtain from such third party and deliver to NAIC prior to any assignment or transfer of the Mobile Satellite Service License, a written assumption of this Coordination Agreement, with such assumption being effective upon the consummation of the assignment.

ACCEPTED AND AGREED UPON:

It is understood that the undersigned have the actual authority necessary to bind their respective companies and organizations to this Coordination Agreement.

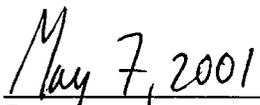
This agreement may be executed by counterparts, each of which shall be deemed to be an original but all of which together shall constitute one and the same instrument.



Dr. Paul F. Goldsmith
Professor
Cornell University
Director, NAIC

[officer]
Iridium Constellation, LLC

[officer]
Iridium Satellite, LLC



Date

Date

Date

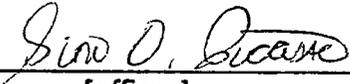
9. Assignment.

ICL agrees to notify NAIC prior to or the day of the filing with the FCC of an application to assign or transfer control of its Mobile Satellite Service License to a third party. ICL also agrees to obtain from such third party and deliver to NAIC prior to any assignment or transfer of the Mobile Satellite Service License, a written assumption of this Coordination Agreement, with such assumption being effective upon the consummation of the assignment.

ACCEPTED AND AGREED UPON:

It is understood that the undersigned have the actual authority necessary to bind their respective companies and organizations to this Coordination Agreement.

This agreement may be executed by counterparts, each of which shall be deemed to be an original but all of which together shall constitute one and the same instrument.

_____ Dr. Paul F. Goldsmith Professor Cornell University Director, NAIC [officer]	 _____ [officer] Iridium Constellation, LLC President and CEO	 _____ [officer] Iridium Satellite, LLC President and CEO
_____ Date	4/30/01 _____ Date	4/30/01 _____ Date

ANNEX

1. Areas of Investigation by Motorola

In accordance with the “Areas for Further Investigation” in the Framework Agreement dated 19 March 1997, and the associated Work Plan, Motorola has:

- a) Provided preliminary information on expected 24-hour IRIDIUM System traffic patterns, ranked hourly. No weekday/weekend data is currently available, but it is expected that such data will become available as the system becomes operational.
- b) Provided estimates of SPFD of a single IRIDIUM System burst transmission in the band 1610.6 - 1613.8 MHz, and the spectral signal characteristics of the IRIDIUM System within the same band, as a function of loading.
- c) Investigated the grouping of carriers to higher frequencies and local channel crowding, and found that this approach will not reduce emissions into the band of interest to radio astronomy under the current constraints on the IRIDIUM System. Channel crowding will be further investigated in future generation IRIDIUM System satellites.
- d) Conducted a study on the IRIDIUM System satellite elevation angle statistics at Arecibo. The study shows that, in relation to the Arecibo telescope, all IRIDIUM satellites are at off-axis angles of:
 - i) More than 48° about 80% of the time;
 - ii) More than 30° about 95% of the time;
 - iii) More than 19° about 98% of the time.
- e) Provided information on filters used during testing of the IRIDIUM System with National Radio Astronomy Observatory, which reduce emissions from the IRIDIUM space vehicles in the 1621.35-1626.5 MHz band.

2. Areas of Investigation by NAIC

In accordance with the “Areas of Further Investigation” in the aforementioned Framework Agreement, and the associated Work Plan, NAIC has:

- a) Determined, based on 1988 data, that:
 - i) Most Arecibo observations in the 1610.6 - 1613.8 MHz band could be scheduled between 8 p.m. and 6 a.m. local time every day of the week and one full day per week, e.g., Saturdays or Sundays;

- ii) A small number of observations (approximately 36 hours during the year) could not be fit into such a schedule and require additional time.
- b) Provided a study of bandwidth and integration time distribution, based on 1988 data, to show that, relative to the $-238 \text{ dBW m}^{-2} \text{ Hz}^{-1}$ detrimental interference level specified in ITU-R RA.769:
 - i) 5% of the observations required 3-6 dB less sensitive measurements;
 - ii) 13% of the observations require 0-3 dB less sensitive measurements;
 - iii) 18% of the observations require 0-3 dB more sensitive measurements;
 - iv) 52% of the observations require 3-6 dB more sensitive measurements;
 - v) 12% of the observations require 6-9 dB more sensitive measurements.
 - c) Provided information on the current estimate of the Arecibo telescope's sidelobe structure.
 - d) Provided information showing that using simulations of dual beam switching techniques of the Arecibo receivers reduced the effect of GLONASS interference to an acceptable level approximately 70% of the time.

3. Future and Ongoing Work

- a) The NAIC will, as soon as practicable, measure the actual Arecibo antenna sidelobe characteristics. NAIC will promptly provide a copy of the results to New Iridium.
- b) New Iridium/NAIC will evaluate the effect of interference from the IRIDIUM System using techniques similar to those employed in 2(d) of this Annex.
- c) The parties agree to jointly evaluate new data and techniques which may affect this Agreement. This evaluation includes, but is not limited to, data regarding actual traffic loads and actual demand for observing time; test results of the levels of interference generated by the IRIDIUM System; averaging techniques that would ameliorate interference from the IRIDIUM System; and improvements to the Arecibo antenna's sidelobes.

CERTIFICATE OF SERVICE

I, Joan P. George, a secretary in the law firm of Fletcher, Heald & Hildreth, do hereby certify that a true copy of the *Comments of Cornell University and Motion for Leave to File* was sent this 14th day of July, 2003 by e-mail where indicated and via United States First Class Mail, postage prepaid, to the following:

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*** By e-mail**