WILMERHALE

William T. Lake

+1 202 663 6725 (t)
+1 202 663 6363 (f)
william.lake@wilmerhale.com

March 9, 2007

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: Review of the Spectrum Sharing Plan among Non-Geostationary Orbit Mobile Satellite Service Systems in the 1.6/2.4 GHz Bands, IB Docket No. 02-364

Dear Ms. Dortch:

Globalstar, Inc. ("Globalstar") submits this further response to the January 22, 2007 *ex parte* submission by Iridium in the above-referenced proceeding.[1/] Globalstar cannot subscribe to the approach or principles embodied in Iridium's "Draft Coordination Agreement" purporting to establish a framework under which Globalstar's TDMA operations can share the spectrum between 1618.25 and 1621.35 with Iridium's TDMA operations.

Iridium's proposal is not technically feasible because CDMA and TDMA MSS operations cannot share the same spectrum in the same location, as Iridium itself recognized — indeed, argued — when the band plan for Big LEO MSS services was established. The validity of the Commission's 1994 decision establishing separate spectrum allocations for CDMA and TDMA systems has recently been independently confirmed by the conference of European regulators, which concluded after extensive study that there can be "no reasonable frequency band sharing between time division multiple access (TDMA) based systems like Iridium and code division multiple access (CDMA) systems like Globalstar."[2/]

1/ *See* Iridium *Ex Parte* filing of Jan. 22, 2007, attaching Iridium's "Draft Coordination Agreement."

2/ *See* Electronic Communications Committee within the European Conference of Postal and Telecommunications Administrations, "Draft ECC Report on Sharing Between MSS Systems Using TDMA and MSS Systems Using CDMA in the Band 1610-1626.5 MHz" (Sept. 2006) ("Draft ECC Report") at 2, submitted with Globalstar *Ex Parte* filing of September 21, 2006.

Globalstar reiterates that the only way in which Globalstar and Iridium can both operate in the spectrum between 1618.25 and 1621.35 without causing harmful interference to each other's operations is by *coordinating* their use of the spectrum on a channel-by-channel basis, taking into account each system's actual usage and realistic projections of future usage. Globalstar submitted months ago a proposed set of principles to guide that coordination.[3/] Iridium has not yet responded for the record in this proceeding to Globalstar's proposal. The Commission should adhere to its previous sound determination that co-channel, co-coverage sharing between CDMA and TDMA systems is infeasible, and should require the type of coordination proposed by Globalstar.

Iridium's "Draft Coordination Agreement" purports to invoke "traditional coordination principles"[4/] but rests at bottom on the previously rejected proposition that Globalstar's CDMA system and Iridium's TDMA system can operate in the same spectrum at the same time without harmful interference. Iridium's current position on that issue represents an about-face from the position Iridium took in the Commission's negotiated rulemaking proceeding to establish the Big LEO band plan. As those familiar with that proceeding recall, it was largely because of the insistence by Motorola (the developer of the Iridium system) that Iridium's TDMA system could *not* share the same spectrum on a co-frequency, co-coverage basis with any other TDMA or CDMA carrier that the Commission granted Iridium sole access to the most desirable portion of the L-band, whereas Globalstar and the other CDMA operators were allocated spectrum that they must share with other services.

For example, in 1993 Motorola insisted that complete segmentation of the 1610-1626.5 MHz band between CDMA and TDMA systems was necessary to avoid interference, stating:

> In most cases, the Iridium system's secondary downlinks will not be operating in the same frequency bands over the same coverage areas as the primary MSS uplinks of [CDMA and FDMA] systems. This is because the Iridium system downlinks and uplinks use the same frequencies and its uplinks *cannot share the spectrum with any of the proposed CDMA and FDMA systems on a co-frequency, co-coverage basis.*[5/]

3/ *See* Globalstar *Ex Parte* filing of September 21, 2006 (attaching proposed "Coordination Principles").

4/ *See* Iridium *Ex Parte* filing of Jan. 22, 2007 at 2.

5/ Attachment 2 to IWG1 Report (Annex 1), Report of Motorola on Band Segmentation Sharing to Working Group 1 of the Above 1 GHz Negotiated Rulemaking Committee, CC Docket No. 92-166 (April 6, 1993), Executive Summary at 5 (attached as Exhibit 1) (emphasis added).

Motorola adhered to that position throughout its participation in the Commission-sponsored working group that established the current Big LEO band plan. As the working group recognized in its Report:

> A TDMA bi-directional system [such as Iridium's] is inherently difficult to coordinate with other such systems and with CDMA systems. Motorola claims that its TDMA bi-directional system cannot share on a co-frequency, co-coverage basis with any other services. There are two basic consequences of this bi-directional design. First, bi-directional FDMA/TDMA systems must have exclusive use of frequency bands on a world-wide basis because they cannot share with each other. *Second, there are no practical means of to mitigate interference in co-frequency, co-coverage cases, and so it is difficult, if not impossible, to resolve interference problems.*[6/]

As noted, the Commission accepted this Motorola/Iridium position and, on that basis, gave Iridium exclusive access to 5.15 MHz of the prime, unencumbered portion of the Big LEO MSS band, the frequencies between 1621.35 and 1626.5 MHz.[7/]

Soon after the Commission adopted its Big LEO segmentation plan, Motorola advocated the adoption of band segmentation in Europe (and elsewhere), stating unequivocally that "*sharing on a co-frequency basis between TDMA and CDMA satellite systems is not feasible.*"[8/]

6/ Report of the MSS Above 1 GHz Rulemaking Committee (April 6, 1993), Report of Informal Working Group 1, Attachment 1 to Annex 1 at section 8.3.2 (excerpt attached as Exhibit 2) (emphasis added). "Bi-directional satellite systems cannot share on a co-coverage, co-frequency basis with other satellite systems or with other radio services in the band…." *Id.* at section 8.4.6.

7/ *See* Amendment of the Commission's Rules To Establish Rules and Policies Pertaining to a Mobile Satellite Service in the 1610-1626.5/2483.5-2500 MHz Frequency Bands, *Report and Order*, 9 FCC Rcd 5936, 5954-55 (1994) ("Motorola supports awarding a single TDMA/FDMA license in 5.15 MHz of bandwidth."); Amendment of the Commission's Rules To Establish Rules and Policies Pertaining to a Mobile Satellite Service in the 1610-1626.5/2483.5-2500 MHz Frequency Bands, *Memorandum Opinion and Order*, 11 FCC Rcd 12861, 12863 (1996) ("TDMA/FDMA systems do not allow frequency sharing with other systems…[i]nstead they require separate dedicated frequencies.").

8/ *See* Document SE28(96)41 (also known as SE40(05)(15) submitted by Motorola, "Sharing Analysis Between CDMA and TDMA Systems" (July 1, 1996) (attached as Exhibit 3) (emphasis added). Notwithstanding the Commission's decision to give Motorola exclusive

After considerable study and technical analysis, European regulators adopted a band plan substantially similar to this Commission's plan.[9/] Other regulatory administrations soon followed suit.

Iridium now argues that TDMA/CDMA sharing is feasible without even a nod to its consistent prior advocacy — on which the existing band plan was based. But Iridium was right on this issue before, and the Commission was right in accepting the findings of its Negotiated Rulemaking Committee. We respond in the attached Technical Analysis to some of the core shortcomings in Iridium's latest submission. That submission:

-- significantly understates the likely interference from Iridium handsets into Globalstar satellites;

-- ignores entirely the interference that Iridium's satellites would cause into Globalstar satellites; and

-- fails entirely to address the significant interference *from Globalstar's operations into Iridium's operations* that would occur in the event the two carriers attempt to operate on a co-frequency, co-coverage basis.

On the last point, as discussed above, Motorola and Iridium asserted throughout the Big LEO Negotiated Rulemaking Proceeding that such interference would be lethal; yet Iridium now ignores those prior showings without stating why they are no longer relevant or valid. Although Iridium's position may have changed, the engineering facts have not. The Commission should give no favorable consideration to Iridium's latest technical submission until Iridium explains why the technical arguments that Motorola advanced to obtain the current band plan are no longer valid.

---

access to 5.15 MHz, rather than one-half of the L-band, Motorola attempted to convince other regulatory administrations that it was entitled to one-half of the band. On October 4, 1996, Iridium, Globalstar, and Odyssey, another CDMA licensee, agreed not to protract the argument over spectrum allocations and to support the Commission's band plan worldwide. *See, e.g.*, Iridium LLC News Release, "Globalstar, Iridium, Odyssey Global Mobile Satellite Phone System Operators Sign Spectrum Agreement" (Oct. 16, 1996) (attached as Exhibit 4).

9/ *See, e.g.*, European Radiocommunications Committee, ERC Decision of 30 June, 1997 on the Harmonized Use of Spectrum For Satellite Personal Communications Services (S-PCS) Operating within the bands 1610-1626.5 MHz, 2485.5-2500 MHz, 1980-21010 MHz and 2170-2200 MHz.

The European report cited above also illustrates the fallacy in Iridium's assertion that it should be given access to the CDMA Big LEO spectrum because "only Globalstar remains" among the CDMA carriers that once planned to use the 1610-1621.35 MHz band.[10/] The Commission segregated the TDMA and CDMA spectrum blocks because sharing between TDMA and CDMA MSS systems is not feasible. By contrast, CDMA MSS carriers can share spectrum among themselves. Some of the earlier CDMA licensees have folded, but others can emerge and can successfully share the CDMA spectrum with Globalstar. Indeed, one has emerged — the German-based Courier system, which is slated to deploy in the spectrum that has been allocated worldwide for CDMA MSS operations. As the European report emphatically concludes, any requirement that the Courier system share spectrum co-frequency, co-coverage with Iridium's TDMA system would cause massive interference.[11/] As a result, the European regulators have refused Iridium's request for access to any of the spectrum allocated for CDMA MSS use.[12/]

In sum, Iridium's "Draft Coordination Agreement" is not implementable because it is based on the unsound — and previously rejected, including by Iridium — proposition that CDMA and TDMA MSS systems can share the same spectrum in the same location. To govern the use of the spectrum to which both Iridium and Globalstar currently have access, the

---

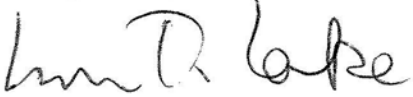
10/ *See, e.g.*, Iridium *Ex Parte* filing of Aug. 10, 2006 at 2 ("All of the Globalstar spectrum in solid or shaded red was to be shared among Globalstar, Odyssey, Ellipso and Constellation; however, only Globalstar remains.").

11/ Draft ECC Report at 2 ("The Courier system, operating on a co-polarization and co-frequency basis with the Iridium system will suffer from harmful interference from a deployment of [Iridium] TDMA terminals during 100% of the time."). Globalstar notes that, as required by the Big LEO rules and ITU regulations, it will coordinate its operations with the Courier system once that system is deployed. Such coordination should be possible since both the Globalstar and Courier systems use CDMA technology.

12/ *Id.* Globalstar will not reiterate here all the reasons why the Commission, having already given Iridium access to the spectrum between 1618.25 and 1621.35 MHz, should reject Iridium's pending request for access to still more CDMA MSS spectrum. *See, e.g.*, Comments of Globalstar LLC filed Sept. 8, 2004 in IB Docket No. 02-364; Reply Comments of Globalstar LLC filed Sept. 23, 2004 in IB Docket No. 02-364; Globalstar, Inc. *Ex Parte* filing of April 7, 2006; Globalstar *Ex Parte* filing of April 17, 2006.

Commission should implement coordination principles that recognize the oft-reaffirmed infeasibility of co-frequency, co-coverage sharing.[13/]

Respectfully Submitted,



William T. Lake
Counsel to Globalstar, Inc.

Attachments

cc (via email): Chairman Kevin J. Martin
Commissioner Michael J. Copps
Commissioner Jonathan S. Adelstein
Commissioner Deborah Taylor Tate
Commissioner Robert J. McDowell
Michelle Carey
Bruce Gottlieb
John Branscome
Barry Ohlson
Aaron Goldberger
Angela Giancarlo
Helen Domenici
John Giusti
James Ball
Howard Griboff
Jennifer Gorny
Paul Locke

13/ *See* Globalstar *Ex Parte* filing of September 21, 2006 (attaching proposed "Coordination Principles").

TECHNICAL ANALYSIS

Iridium's "Draft Coordination Agreement" contains serious technical errors and omissions and, as a result, fails to support and, in fact, is inconsistent with Iridium's conclusion that Iridium and Globalstar can operate in the same spectrum on a co-frequency, co-coverage basis without causing harmful interference to one another. When those errors and omissions are corrected, Iridium's submission confirms that such spectrum sharing would cause mutual, unacceptable interference.

(1) Iridium's proposal fails to address (or even acknowledge) the likelihood of interference to Iridium's operations from Globalstar's operations that would result if the two carriers were to operate co-frequency, co-coverage. The genesis of the divided band plan for Big LEO MSS providers was Motorola's firm insistence that such interference would result if TDMA and CDMA carriers shared spectrum. This interference was confirmed by SE28 in 1998, and more recently by CEPT in September 2006, which found that an Iridium satellite signal will suffer from harmful interference from Globalstar's operations during at least 45 percent of the time. The interference to an Iridium satellite will be even greater if the additional planned CDMA MSS system (Courier) is implemented. ECC Report 95, which we have previously submitted for the record in this proceeding, finds that interference to an Iridium satellite would measure at 100 percent when Iridium and Courier are operating on a co-polarization, co-coverage basis. Yet Iridium's "Draft Coordination Agreement" does not even mention interference from Globalstar into Iridium or show why Motorola's prior technical submissions on that subject are no longer valid.

(2) As to interference from Iridium into Globalstar (the only interference considered in Iridium's "Draft Coordination Agreement"), in Table A, and on page 3 of Iridium's draft agreement, Iridium uses a Time Average Over Frame factor of -10.4 dB predicated on its TDMA transmissions. While this factor may be reasonable for a lightly loaded system, it is *not* reasonable in calculating the total interference into Globalstar when Iridium is operating at or near capacity. In such a case, all time slots are occupied, and the more reasonable factor would be about -3 dB, which accounts for the fact that half the slots are occupied by uplink transmissions and the other half by downlink transmissions. Correction of the Time Average Over Frame factor to account for this error causes about 7.4 dB additional interference.

(3) On page 3 of the "Draft Coordination Agreement," Iridium underestimates the number of simultaneous Iridium transmitters that can be present in a Globalstar beam. If Iridium's frequency reuse factor is 6 (we note that in its previous filing with the Commission Iridium stated it to be 5), and the number of Iridium beams per Globalstar beam is 3, one must still account for the fact that multiple Iridium satellites overlap any given Globalstar beam. Accordingly, Iridium's suggested factor of 18 becomes at least 54 to 72 if three or four Iridium beams are in one Globalstar satellite beam. (This number is a function of latitude because the Iridium and Globalstar orbits are so dissimilar.)

(4) If the number of carriers is 54 or 72, then the impact on Iridium's Table B is to increase the interference by 10*log(54/18) = 4.7 dB or 10*log(72/18)= 6 dB respectively. This would lead to 3.35% and 4.46% degradation in self-interference plus noise, if all other factors

considered stayed the same in table B, which would already exceed the 3% criterion that Iridium proposes. Combining the effects of self-interference plus noise with correction of the Time Average factor discussed above, which as noted causes about 7.4 dB additional interference, we conclude that degradation will be 18.4% and 24.5%, respectively, with 54 and 72 carriers per beam.

(5) Iridium fails to take into account the fact that the secondary downlink from multiple Iridium satellites will interfere into a given Globalstar satellite, as shown in Figure 1, because of the sidelobes and backlobes of the Iridium satellite antenna. This fact was also significant in ECC Report 95. As that report correctly concludes, the Globalstar satellites will suffer from unacceptable interference from Iridium satellites (irrespective of the polarization that is used) when the Iridium system is fully loaded, as shown in Table 1. This is in addition to the interference levels caused by the handsets, which is the only thing addressed in Table B of Iridium's ex parte and the subject of the discussion in the above paragraphs, where the effect of incorrect Time Average factor and number of carriers is described.

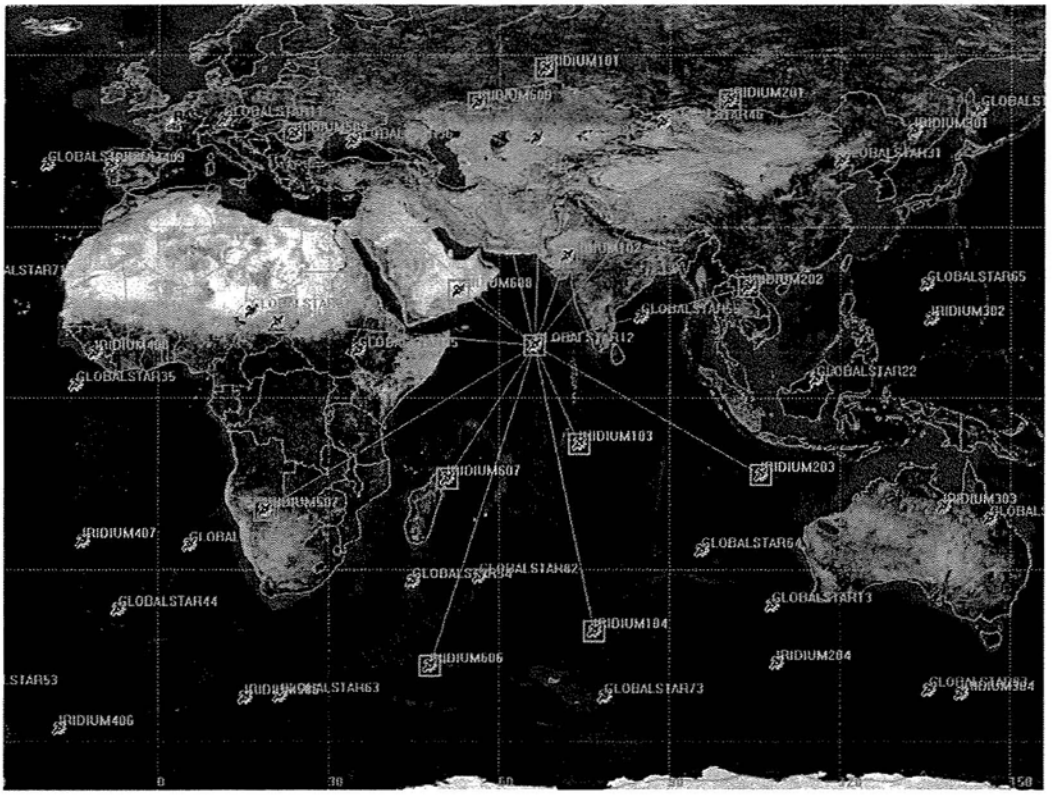


FIGURE 1: Iridium satellites in view of a Globalstar satellite

TABLE 1

Interference from IRIDIUM satellites to GLOBALSTAR satellites

IRIDIUM Activity	Frequency reuse factor	Maximum increase in noise + self interference *	% of time the 3% N+I criterion is exceeded
Voice	12	30 %	2.5 %
Voice	5	70 %	2.5 %
Data	12	1200 %	100 %
Data	5	3000 %	100 %

In sum, these errors and omissions in Iridium's submission preclude any reliance on it to demonstrate noninterference. When the errors and omissions are corrected, Iridium's submission actually confirms that co-frequency, co-coverage operation by TDMA and CDMA MSS systems would cause unacceptable interference to both types of systems.

EXHIBIT 1

(Excerpted)

Attachment 2 to
IWG1 Report (Annex 1)
MSSAC-41.7 (Final)
IWG1-85 (Final)

REPORT OF

MOTOROLA

ON
BAND SEGMENTATION
SHARING

TO
WORKING GROUP 1
OF THE
ABOVE 1 GHz
NEGOTIATED RULEMAKING COMMITTEE

APRIL 6, 1993

EXECUTIVE SUMMARY

BACKGROUND

This report by Motorola Satellite Communications, Inc. ("Motorola") on band segmentation sharing in the 1610-1626.5 MHz and 2483.5-2500 MHz bands is presented to Informal Working Group 1 ("IWG1") for its consideration in preparing a summary report to the full Committee. At the IWG1 meeting on April 1, 1993, final agreement was reached on text for several sections of this report (Sections 1, 2, 3, 6 and 7). With respect to the remaining sections (Sections 4, 5, 8, and 9), this report reflects the views of Motorola. As a proponent of FDMA/TDMA modulation and band segmentation, Motorola's views on the issues addressed in these sections of the report differ significantly from the views of proponents of full band interference sharing. Motorola does not concur with parallel sections of the report submitted by the proponents of that alternative sharing approach.

The principal conclusions of this report are as follows:

(1) Motorola's band segmentation plan is far superior to the CDMA applicants' full band interference sharing plan because:

(i) It allows the two access technologies proposed by the applicants to proceed and compete in the marketplace for customers and financing, whereas the CDMA full band sharing proposal would not allow the Iridium™ system to operate using FDMA/TDMA on a bidirectional basis;

(ii) It allows the two fundamentally different visions of the MSS marketplace to develop. Motorola intends to serve primarily handheld portable terminals located anywhere in the world and under most shadowed and fading conditions, whereas the CDMA applicants cannot provide the same level of service because of the interference sharing rule and their lack of coverage/diversity of many

regions of the world including several states and U.S. territories;

(iii) It is easy to administer and would not require the FCC to micro-manage the coordination process;

(iv) It does not mandate a worldwide standard for LEO MSS systems and would result in greater flexibility in the international coordination process. A full band sharing plan can only accommodate foreign non-CDMA systems by segmenting the band;

(2) There are serious risks and limitations associated with a CDMA full band interference sharing approach which will have a significant impact on CDMA system capacity and performance. These risks and limitations include:

(i) Substantial ambient noise levels in the S-band from ISM devices (primarily microwave ovens) exceeding the thermal noise of the receivers which will prevent MSS operations in many urban and other populated areas;

(ii) Limitations on the dynamic range of handsets which will cause serious degradation of service or substantially reduced system capacities;

(iii) A requirement to use path satellite diversity which would approximately double the number of satellites required for worldwide coverage;

(iv) As additional systems share the spectrum, fade margin will be reduced resulting in either significant loss in capacity if service quality is maintained or a reduction in service quality (e.g., higher dropped call rates);

(v) Difficulties in international coordination with other CDMA, FDMA, and FDMA/TDMA systems proposed by foreign countries. A full band interference sharing plan

effectively would require the rest of the world to conform to the U.S. approach, whereas a band segmentation sharing plan has much greater flexibility for purposes of international coordination.

(3) The Commission should adopt the secondary allocation for MSS downlinks in the 1613.8-1626.5 MHz band. The only applicant that proposes to use the secondary allocation for its downlinks is Motorola. Secondary MSS downlinks from the Iridium™ system will not cause harmful interference to the primary uplinks of any of the proposed MSS systems. To the extent such interference might occur, Motorola can use different techniques, such as frequency and beam avoidance, to reduce interference to a non-harmful level;

(4) FDMA technology provides a peak traffic demand capability in both time and geographic areas because of the ability to redirect power from idle to high traffic density beams. CDMA systems under the interference sharing rule cannot serve peak demand loads;

(5) The lack of adequate spectrum to meet the service requirements of all of the applicants, particularly with all of the 16.5 MHz of S-band and up to 6 MHz of the 16.5 MHz of L-band spectrum severely restricted by existing services and applications.

DESCRIPTION OF MOTOROLA'S BAND SEGMENTATION PLAN

Under Motorola's band segmentation plan, all qualified applicants would receive a permit to construct their proposed systems over both bands in their entirety or as much thereof as they have requested in their applications. Thereafter, each licensee would remain subject to stringent construction, launch and operation milestones, whereby its license would be subject to revocation for failing to meet the conditions in its license.

The first system to operate would have access to the entire band (or to the 1616-1626.5 MHz band in the case of Motorola). If systems with

both access technologies become operational, then the 16.5 MHz uplink band would be partitioned into two equal segments based upon access technology (FDMA/TDMA vs. CDMA). If only one access technology ultimately develops, then systems using that technology would be authorized in the entire band.

The CDMA operators would share their entire uplink spectrum on an interference sharing basis. Interference sharing refers to the technical sharing criteria proposed by the CDMA applicants. FDMA/TDMA operators would share their band on a dynamic sharing basis, whereby they would periodically adjust their subband partitions based upon originating and terminating billed minutes of use in accordance with a set formula established in advance by the FCC.

When required, the FDMA/TDMA subband would occupy the upper half of the uplink band (1618.25-1626.5 MHz) and the CDMA subband would occupy the lower half of the band. When subsequent systems become operational, they would occupy the subband devoted to their particular access technology.

NEED FOR OUT-OF-BAND EMISSIONS AND ATTENUATION LIMITATIONS

Motorola, as well as most of the other applicants, have recognized a need to update and clarify the Commission's existing rules regarding out-of-band emissions and attenuation limits for MSS stations. All of the applicants have proposed that Section 25.202 of the Rules be amended to specify a power spectral density mask measured relative to the average in-band PSD at the maximum design power setting.

The proposed MSS systems have varying bandwidth and modulation types. An adequate PSD mask will protect other services and MSS systems from the sum of the out-of-band emissions from many overlapping CDMA carriers or multiple side-by-side FDMA carriers. The current rule, which specifies out-of-band PSD relative to the transmitter carrier power, does not adequately account for multiple carriers. In addition, a PSD mask can more adequately be applied to systems with varying bandwidths. The proposed rules specify emission limits in terms of out-of-band PSD

across each band segment which will control interference between dissimilar system types.

Motorola further recommends that the Commission consider changing its reference bandwidth for these rules from 4 kHz to 3 kHz. A 3 kHz integration bandwidth, unlike the current 4 kHz reference bandwidth, is available on standard test equipment which will simplify measurements.

LACK OF HARMFUL INTERFERENCE FROM SECONDARY DOWNLINKS INTO PRIMARY UPLINKS

The Commission should authorize MSS secondary downlinks in the 1613.8-1626.5 MHz band in accordance with the decisions reached at WARC-92. No special operating conditions or criteria need be applied to these secondary downlinks. The Commission's rules and regulations already provide adequate protection to primary MSS uplinks from harmful interference by any secondary service. In this regard, it should be noted that "harmful interference" is defined in the Commission's Rules as follows:

> Interference which endangers the functioning of a radionavigation service or of other safety services or <u>seriously</u> degrades, obstructs or repeatedly interrupts a radiocommunications service operating in accordance with these Radio Regulations.

47 C.F.R. 2.1 (Emphasis added).

In most cases, the Iridium™ system's secondary downlinks will not be operating in the same frequency bands over the same coverage areas as the primary MSS uplinks of other systems. This is because the Iridium™ system downlinks and uplinks use the same frequencies and its uplinks cannot share spectrum with any of the proposed CDMA and FDMA systems on a co-frequency, co-coverage basis. There does not appear to be any dispute that the out-of-band emissions of the Iridium™ system downlinks will be sufficiently attenuated to avoid harmful interference to the MSS uplinks of other systems in adjacent bands.

Under some circumstances, Iridium™ system downlinks could operate co-coverage, co-frequency with other systems. For example, the Iridium™ system might operate in other regions of the world on different frequencies than it does in the United States. Motorola's analysis of this potential interference situation, however, confirms that such occurrences will be occasional and not continuous, and that the amount of any interference (in terms of power) into a victim satellite will be extremely small. Moreover, such interference is not likely to be harmful to the uplinks of other systems since it will be dwarfed by the interference received from Iridium's primary uplinks plus the interference from any other MSS systems operating in these bands. More importantly, the Iridium™ system will be able to avoid causing harmful interference by various mitigation techniques, such as frequency and beam management.

Motorola requires use of secondary downlinks in the L-band because the MSS downlink band (2483.5-2500 MHz) is not suitable for FDMA downlink transmissions. Motorola's business plan calls for highly reliable, ubiquitous service to handheld units anywhere in the world. The IRIDIUM™ system has therefore been designed with high link margins to overcome shadowed and fading conditions expected in real operating environments. There are at least three fundamental obstacles to meeting these objectives with S-band downlinks. First, the regulatory trigger on power flux density in that band simply will not permit sufficient downlink power to meet Motorola's service objectives. Second, coordination of the S-band downlink with all of the fixed services in the band would be virtually impossible. Third, the ambient noise in most metropolitan areas due to Industrial, Scientific and Medical (ISM) applications -- primarily microwave ovens -- is substantially above the noise floor of the MSS receivers that would operate in this band.

REALIZABLE CAPACITY AND PERFORMANCE OF PROPOSED SYSTEMS

FDMA/TDMA and CDMA systems are proposed to operate under band segmentation rules. The overall channel capacities and spectral efficiencies available from FDMA/TDMA systems are superior to the collective realizable capacities of CDMA systems sharing spectrum on an interference sharing basis.

Band segmentation also allows each applicant to operate in the manner proposed in their respective applications, and to proceed with their business plans and access technologies. This is because interference between systems under these rules are controlled by frequency and geographical separation. This allows FDMA systems to increase beam power to satisfy peak traffic demand conditions without affecting traffic in other beams of the same system or in other systems. In fact, FDMA/TDMA systems are designed with peak to average demand factors on the order of ten.

Band segmentation also allows system operators to serve different MSS markets. For example, the Iridium™ system primarily will serve handheld terminals in virtually all propagation conditions anywhere in the world. On the other hand, CDMA systems will not be able to serve all of these customers in an interference sharing environment.

Motorola's analysis of CDMA capacity and performance levels varies significantly from those obtained by the proponents of CDMA technology. In Motorola's view, the CDMA applicants have made unrealistic assumptions concerning the operation of their systems in an interference sharing environment, and have ignored or failed to adequately consider various effects which will degrade their performance and/or decrease their capacity estimates. For example, even with dual diversity operation, dynamic range limitations were found to be significant for all of the proposed CDMA systems. Even at an assumed lowest power sharing level, only two of the five systems could share spectrum on a co-frequency, co-coverage basis. Moreover, those systems that will be unable to close their links for a fixed fade criterion will have to lower their service quality in order to continue to serve customers as more systems are introduced. Similarly, operation at lower power sharing levels in order to meet fade objectives will result in a loss of capacity.

ANALYSIS OF SHARING OPTIONS

Motorola's band segmentation sharing plan will meet all of the Commission's policy objectives for MSS, and is far superior to the CDMA applicants' full band sharing plan.

First, band segmentation will maximize multiple entry by permitting multiple technological approaches to be implemented, and by facilitating multiple system operations. The FDMA/TDMA, FDMA and CDMA applicants have proposed fundamentally different system designs based upon their respective "visions" of the marketplace and service objectives. Motorola primarily expects to serve handheld terminals with low dropped-call rates and high quality service virtually anywhere in the world. Motorola describes its vision as "Global PCS" because it believes that customers will demand an MSS service that can provide highly reliable service to small, lightweight terminals while they are travelling anywhere in the world. Several of the CDMA applicants have repeatedly asserted this same vision, however, their system designs clearly will not be able to accommodate the same users with the same service objectives. At least for their first generation systems, they will not be able to provide high quality MSS service to handheld users in many urban areas and during difficult propagation conditions. They also believe that their market objectives can be met with less than complete and continuous coverage, and without providing peak traffic demand service in any geographic area or during certain periods of time.

Some form of band segmentation is necessary to accommodate both types of technological approaches. All of the members of this working group admit that the IRIDIUM™ system and the proposed CDMA systems cannot operate on the same frequencies under the full band sharing rules proposed by the CDMA proponents. Motorola has further indicated that it will not be able to meet its business plan objectives if it had to change its system design radically, as suggested by the CDMA applicants. In any event, such fundamental modifications to the Iridium™ system still would not permit viable co-frequency sharing. Motorola simply cannot proceed with a system design that fails to meet the service requirements that it believes the market will demand.

On the other hand, Motorola's band segmentation sharing plan does afford both the CDMA and the FDMA proponents with a means of sharing the available spectrum. Under this plan, the marketplace, rather than regulatory fiat, will make the ultimate determination as to whether one or both of these technological approaches will succeed.

Second, there is no merit to the criticism that Motorola's plan improperly gives equal treatment to access technologies rather than to the number of applicants. Under this plan, the first operational system would use the entire uplink band. It is only when the next system with a different access technique becomes operational that the uplink band is split in half. Thus, if one of the proposed access technologies never results in an operational system, the entire uplink band would be devoted to a single modulation technique. Moreover, an equal division of spectrum by access technology, when and if it becomes necessary, gives proponents of each vision of the marketplace sufficient bandwidth to start providing service, and does not prejudge market and technology developments. Any other approach would reward spectrally inefficient systems and penalize high-capacity systems. For example, any division of the spectrum based upon the number of applicants would be inappropriate because the current number of applicants proposing a particular access technology is not a reliable indicator of the amount of spectrum that will be needed to accommodate real operations systems.

Third, Motorola's plan would accommodate some system growth and potentially new MSS systems. In the short term, both FDMA/TDMA and CDMA systems would be able to grow incrementally into the band allocated to its respective access technology as customer demand increases. Depending upon the number of the current group of applicants that ultimately become operational, there may also be room in the band for future applicants. In the long term, however, the limited amount of spectrum under consideration in this proceeding may only be sufficient to satisfy the first generation requirements of two or three high-capacity systems. This would be true whether the bands are devoted entirely to CDMA systems or band segmented by technology. It is for this reason that Motorola proposed at the beginning of this process that the Committee consider additional MSS spectrum in order to accommodate future applicants, as well as to allow for growth of licensed systems.

Fourth, Motorola's plan permits the award of construction permits to all qualified applicants, thereby avoiding any mutual exclusivity concerns. While there may not be adequate spectrum to accommodate all of the proposed systems, it is reasonable to expect that only a few of them will

ever become operational. Under Motorola's plan, if a permittee fails to become operational within a fixed period of time, it will be because the applicant did not succeed in the marketplace, and not because the Commission denied it the opportunity to go forward. On the other hand, the CDMA applicants' full band sharing plan would require the Commission to dismiss at least one of the applicants based upon its choice of technology.

Fifth, under Motorola's plan domestic coordination could be administered as readily as under a full band sharing approach. From an administrative standpoint, Motorola's band segmentation plan is self-implementing; i.e., once a system is authorized and becomes operational, the specific frequencies are predetermined. In addition, adjustments to the FDMA/TDMA subband, if more than one such system became operational, could be easily accomplished without Commission involvement based upon a predetermined formula using actual billed minutes. Such adjustments ensure that spectrum will not be warehoused by any operator and encourage all operators to use the spectrum in an efficient manner by rewarding performance in the marketplace.

Sixth, international coordination should be much easier to accomplish under a band segmentation plan than under an interference sharing plan. International coordination would be accomplished in accordance with the procedures developed at WARC-92. Historically, such coordination of satellite systems has involved FDMA and FDMA/TDMA geostationary satellite systems and the process of coordinating systems employing such modulation techniques is well understood. FDMA/TDMA LEO systems, such as the Iridium™ system, are frequency, bandwidth and beam agile, which should help facilitate international coordination with foreign systems. In addition, Motorola's band segmentation plan does not dictate a particular access technology to the rest of the world. Foreign CDMA systems could be accommodated in the lower portion of the band, while foreign FDMA systems could be coordinated in the upper portion of the band.

In this regard, the CDMA applicants fail to recognize that their plan not only fails to allow for any domestic FDMA/TDMA system, but also does not consider possible international coordination with a foreign

FDMA/TDMA system. In the latter case, band segmentation would be required in order to accommodate these foreign systems.

EXHIBIT 2

(Excerpted)

DOCKET FILE COPY ORIGINAL

CC Docket No. 92-166

RECEIVED

MAY 21 1993

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Report

of the

MSS Above 1 GHz Negotiated Rulemaking Committee

April 6, 1993

No. of Copies rec'd 2 Copies
List A B C D E

(c) Facilitating new entrants, international and domestic.

The following section conducts an evaluation of the sharing approaches based upon these three criteria.

8.2. Evaluation of Sharing Approaches.

8.2.0. As shown in earlier sections of this Report, several approaches have been identified as a means of permitting access to the limited spectrum. This section evaluates the various approaches in terms of system viability and the three fundamental criteria enumerated above. The cases considered include:

- Full Band Interference Sharing
- Band Segmentation by Access Technology (8.25/8.25)
- Band Segmentation by Number of Applicants (1/n)
- Band Segmentation by Channelization (1.25 MHz)
- Full Band/Polarization Segmentation Sharing

8.2.1. The following Table 8.1 compares each of the band sharing approaches discussed in this Report under the three critical criteria described in Section 8.1 above.

TABLE 8.1

CRITICAL CRITERIA	APPROACH				
	Full Band Interference Sharing	Band Segment. By Access Technology[2/]	Band Segmentation 1/N[2/]	Band Segmentation Channelization[2/]	Full Band/ Polarization Segmentation[2/]
Number of Economically Viable Applicants[1/]	5	1-3(?)	5	Unknown (?)	6
Aggregate Capacity[3/]	11,436	CDMA: 5,718[4/] TDMA: 3,852[5/] Total: 9,570	9,530[4/]	Unknown (?)	CDMA: 12,500 TDMA: 3,600 Total: 16,100
Facilitation of new entrants	Greatest	Least	Moderate	Moderate	Good

1/ Assumes maximum number is the current number of pending applicants, i.e., six (6).

2/ Assumes CMDA applicants aggregate band assignments and share on full-band interference basis.

3/ Capacity (given in duplex voice channels) is based upon data in Section 5.1.5.2 (Case 4) and Section 5.5; it assumes 16.5 MHz L-Band and 6 dB cross polar isolation. The data assumes for CDMA applicants an average of 20 beams. If 60 beams were used (as Motorola proposes), the capacity shown here for CDMA would triple.

4/ Some of this capacity is unrealizable due to non-viability of some of the respective systems.

5/ The Iridium capacity used in this analysis (as provided by Motorola) is overstated. As Annex 5.5 shows, the capacity is only 1,292 channels.

8.2.2. From Table 8.1 IWG1 concludes that both the Band Segmentation by Access Technology and Band Segmentation by Channelization approaches are unacceptable as means for licensing MSS systems, albeit for differing reasons.

8.2.2.1. An approach based upon Band Segmentation by Access Technology is inequitable, leads to the fewest potential number of viable operators, has the lowest total voice channel capacity

serving CONUS, and is the most difficult to coordinate internationally.

The Band Segmentation by Access Technology approach, whereby a single FDMA or FDMA/TDMA applicant is assigned 8.25 MHz in the upper portion of the L-band, and the remaining five CDMA applicants the lower 8.25 MHz, would appear to support viable operation by the FDMA/TDMA applicant, which would achieve some 3,800 circuits over CONUS. The remaining five applicants would have to share spectrum (most of which is subject to inter-service sharing restrictions (see Sections 1.3 and 7) which, at best, would yield an average of only 6,000 circuits. This level of capacity is insufficient to enable two of the CDMA applicant systems to operate viably as currently proposed and is of questionable utility to the other three applicants, although it is possible that two applicants proposing smaller initial systems could commence viable operation under this approach. (Given this fact, total CDMA capacity will likely be reduced.) Under this approach, if two FDMA systems were to share the upper 8.25 MHz, the existing TDMA applicant's system (employing bi-directionality) would not be viable.

One significant difficulty with this approach is that CDMA systems are assigned that part of the L-band which requires accommodation of either the Radio Astronomy (1610.2-1613.8 MHz) and/or Aeronautical Radionavigation Services (1610-1616 or 1621 MHz). Thus, those systems will face the possible loss of capacity and/or greater system operational complexity and expense. (It has been suggested that one way to militate against this inequitable result is to assign each licensee its proportional allotment of spectrum from both the lower and higher portions of the L-band. It is difficult to assess at this time whether such an approach can be implemented and what practical complexities may arise from such a procedure.)

This band segmentation approach (supported only by Motorola) also raises the following difficulties:

(a) Initial assignment. Motorola's plan provides that the upper 8.25 Mhz should be assigned for TDMA operation in order to fit the needs of the characteristics of the Iridium system (i.e., desired use of secondary downlinks, desired power levels preclude use of S-band). A decision which accommodates the needs of only one applicant would be inequitable and not necessarily consistent with the public interest.

(b) Subsequent re-assignment. Because Motorola's band segmentation plan fixes the boundaries within which systems must operate, it has proposed to re-evaluate spectrum usage on a periodic basis, and re-assign spectrum based on demand and/or

usage. A formula would have to be devised in order to equitably re-assign to one system spectrum which had been previously assigned to another system. Considerable debate would be required in order to determine what formula would fairly characterize the conditions under which each system operates and how spectrum should be reallocated (potentially monthly) in the public interest. Also to be decided would be how frequently readjustments would be made and how an operating system would be required to curtail usage of segments which have been assigned to a newly operational system.

(c) Competition. Another problem with Motorola's band segmentation plan is that it would not promote competition. Only one applicant -- Motorola -- currently proposes to use TDMA operation, and so, once operational, would obtain a monopoly in the upper 8.25 MHz band, while potentially five licensees would be relegated to 8.25 in the lower half of the L-band. As demonstrated above, this plan would restrict to one or two the number of economically viable systems in each segment of the band, thereby reducing the total number of operating systems and thereby restrict competition.

(d) Equity. Given the issue raised in IWG2 with respect to the feasibility of using the 1610-1616 MHz band for MSS, due to the question of coordination with GLONASS, the Motorola band segmentation scheme is also inequitable. According to Motorola, CDMA operations would be restricted to operation in the 1610-1618.25 MHz band, which may potentially provide only 2.25 MHz for CDMA use.

(e) Public Interest. Based upon the capacity figures provided in Section 5, as summarized in Section 8.1, band segmentation would result in an inefficient use of the spectrum and therefore would be contrary to the public interest. Moreover, the advantage of CDMA sharing -- which allows more users per MHz due to multiple system sharing than a single system such as Motorola has proposed -- will be lost. Since the uplink spectrum will be limited for CDMA operation, the potential sharing of the "CDMA segment" would be truncated.

8.2.2.2. The Band Segmentation by Channelization approach is undesirable for other reasons. First, since the single FDMA/TDMA applicant cannot aggregate its channel assignment with others, and thus share a larger pool of spectrum resource, it will be able to obtain less than 590 circuits over CONUS. This would not permit an economically viable operation for this applicant.

One of the major difficulties with the channelization approach to band segmentation is that no applicant can be assured how much capacity will be available for growth since each is only assigned

a small segment of capacity when licensed (e.g., one or two channels). This may make it very difficult for some systems to meet their business plans and/or secure necessary financing to construct their systems.

In addition, it is likely the initial operating spectrum for the applicants will be in the upper portion of the band until the Glonass system can be reconfigured to operate below 1610 MHz. A band segmentation by channelization approach will disadvantage applicants that have designed their systems to operate over larger spread bandwidths. The smaller the amount of operational spectrum the less likely it is to develop a channelization plan which accommodates all applicants. No channelization plan gives the Iridium system sufficient spectrum for their operation.

8.2.3. On the other hand, this Report shows that Full Band Interference sharing is achievable based on a relatively simple set of "coordination interface" parameters related to spectral PFD and areal EIRP spectral density (see Sections 2 and 3), and that high capacities are possible, using realistic assessments of other factors. For example, Table 8.1 shows that under the Full Band Interference Sharing approach five applicants can readily enter the market sharing 12,200 circuits over CONUS. This is sufficient capacity to permit all five of the CDMA applicants to meet their business plans. (Section 6.2 of this Report shows that further capacity improvements are probable.)

Full band interference sharing also meets a number of other important criteria. Because each licensee would be authorized to operate in the entire L-band and S-band allocation, no evaluation of system designs would be required. Moreover, each licensee would bear any burden associated with the issue of how to accommodate existing services in the lower portion of the L-band and the S-band.

As is apparent from the presentations on its continuing development, CDMA technology represents the most flexible access technology available and adopting its use for the MSS/RDSS bands would allow future technical innovations to be utilized by all applicants. Moreover, because each applicant is allocated the entire 16.5 MHz of each band, full band interference sharing inherently avoids warehousing and more easily accommodates growth of individual systems.

Coordination procedures would be straightforward for both domestic and international environments. The CDMA proponents have already been able to agree on a approach to coordination which could be the foundation of interservice coordination once the systems are licensed. This approach also has the advantage of permitting expansion into other parts of the band (e.g., after

resolution of the Glonass sharing issue) without requiring any changes to the technical rules developed to facilitate sharing.

It should be noted that the Commission has already once adopted a full band sharing approach through CDMA for the bands at issue here. See Radio-Determination Satellite Service, 60 RR 2d 298 (1986). The advantages which made CDMA the technology of choice at that time are no less applicable now.

Based upon the foregoing, IWG1 believes that this approach presents the best means of meeting the Commission's goals.

8.2.4. Band Segmentation by Number of Applicants (1/n) -- if accompanied by a requirement that CDMA proponents aggregate their assigned band segments and share it on a Full Band Interference basis -- would appear to provide sufficient capacity to allow the CDMA applicants to operate viably, but would not permit the single FDMA/TDMA applicant to do so, as long as it operates in a bi-directional manner. For example, under a 1/n approach, the FDMA/TDMA applicant would receive an assignment of 2.75 MHz, which would yield it a capacity of only 1,284 circuits over CONUS, an amount which it has stated is insufficient to meet the costs of its system. Thus, as compared to Full Band Interference Sharing, this approach will yield the same number of operators (5), but sharing a lesser amount of total capacity.

8.2.5. Another option -- a hybrid full band/polarization segmentation approach -- would allow the maximum number of entrants. Because it uses polarization isolation to divide the spectrum, the single FDMA/TDMA applicant must remove bi-directional operation from its system architecture, a step the applicant has indicated it is not prepared to do. Nevertheless, if this applicant would alter its system design in this manner, over 10-15,000 channels over CONUS can be obtained, more than any other band sharing approach. Accordingly, IWG1 urges the Commission to adopt this approach if the Full Band Interference Sharing option is not adopted for regulatory or other non-sharing reasons.

8.2.6. IWGi wishes to note that of particular concern in all of these cases where the full band is broken down into segments is how future growth and new entrants (domestic or international) can be accommodated. In general, however, IWG1 concludes that the band segmentation approaches may result in the following disadvantages for the proposed systems: (1) increased complexity (and cost) of satellite systems wedged into smaller bandwidths; (2) lower overall capacity from increased interference as systems are made more complex to make up for less usable spectrum; (3) loss of capacity gain from multiple CDMA systems using the entire bandwidth; (4) spectrum warehousing in one segment because

multiple systems cannot reuse the entire bandwidth; and (5) reduced competition.

Also, band segmentation requires the use of guard bands which necessarily is wasteful of the spectrum dedicated to that purpose. In addition, a portion or all of the unmatched S-band may lie follow as a result of bi-directional operation by one applicant.

8.3. International Coordination Issues.

8.3.0. Resolution 46 adopted by the 1992 WARC specifies the international coordination process for non-geostationary MSS/RDSS satellite systems with other satellite systems and with other radio services in the 1610-1626.6 MHz and 2483.5-2500 MHz bands. The procedures are an extension of the current advance publication, coordination and notification procedures of Articles 11 and 13. The major difference in the application of Resolution 46 will be in the technical issues that will be raised in the coordination of non-geostationary satellite systems.

8.3.1. IWG1 concludes that it will be easier to effect the introduction of MSS systems by other countries and conclude international coordinations with U.S. systems if the FCC authorizes spread spectrum systems operating on a Full Band Interference sharing basis. This Full Band Interference sharing approach draws on the method for multiple RDSS systems operating in these bands on a co-coverage, co-frequency basis described in CCIR Report 1050. The Lower PFD and EIRP density bands of CDMA systems make coordination with other services in the band practical on a co-coverage and co-frequency basis. Moreover, coordination of CDMA systems with other satellite systems on the basis of a few generalized parameters would be much easier than coordination on the basis of complex schedules of frequency and beam activation and deactivation which would be required for the TDMA bidirectional system discussed below.

8.3.2. A TDMA bidirectional system is inherently difficult to coordinate with other such systems and with CDMA systems. Motorola claims that its TDMA bidirectional system can not share on a co-frequency, co-coverage basis with any other systems or services. There are two basic consequences of this bidirectional design. First, bidirectional FDMA/TDMA systems must have exclusive use of frequency bands on a world-wide basis because they cannot share with each other. Second, there are no practical means to mitigate interference in co-frequency, co-coverage cases, and so it is difficult, if not impossible, to resolve interference problems. Also, the effect of the secondary downlink on the primary MSS uplinks operating in a co-frequency,

non co-coverage basis needs to be quantified on a system-by-system basis.

The practical effects of these technical consequences is that significant operational difficulties, with attendant administrative burden on the FCC, will arise if the TDMA bidirectional system is licensed where an adjacent country authorizes any other MSS system. In such cases, gaps in service near the borders of a country in which the TDMA bidirectional system is authorized to operate are likely because of interference caused by the primary uplinks in the adjacent country to the secondary downlinks and because each secondary downlink beam must be shut down as soon as it touches the territory of a country where it is not authorized to operate. Also, the FCC will be required to protect primary uplinks operating in the U.S. from the effects of secondary downlinks licensed to operate in other areas of the world.

Thus, unless the TDMA bidirectional system has exclusive access to a band on a world-wide basis, the FCC will be involved in the development of coordination agreements based on specific beam and frequency activation and deactivation schedules for each pair of adjacent countries where this system and another dissimilar U.S. or foreign system provides service. Additional coordination complications will arise through interference caused by the secondary downlink to the satellite system of another country, particularly if the orbital altitude of another system is close to that of the system employing bi-directional operation.

8.3.3. The full band interference approach greatly simplifies international coordination, particularly where there are significant differences in system design parameters among U.S. and foreign systems. In large part, this is due to the lower power densities at which these systems are designed to operate and to the averaging effects of spread spectrum which mitigate the adverse impact of any individual instance of interference and allow gradual adjustment of parameters to balance the interference caused by varying traffic loads of different systems.

As discussed in Sections 2 and 3, coordination among CDMA systems is based on reaching agreement on a few basic technical operating constraints, analogous to the use of "generalized parameters" in the fixed satellite allotment plan. This would reduce coordination complexity and eliminate the need to negotiate coordination agreements on the basis of an extensive list of technical parameters. For Full Band Interference sharing, coordination can be focused on the negotiation of only an aggregate downlink PFD and an aggregate uplink areal EIRP density for all U.S. systems, which can then be allocated further among

U.S. system operators through a coordination process identical to the domestic coordination process. This approach to coordination is self-enforcing and less complex to regulate since the allocation of interference noise between systems, in terms of downlink PFD and uplink areal EIRP density, can be related to the traffic being carried over each system within each country. Moreover, there is no need to shut down beams as a satellite passes over a country it is not authorized to serve; the only requirement is to ensure that the PFD does not exceed the RR 2566 limits if coordination agreement is not reached on the slightly higher levels anticipated for current spread spectrum systems.

FCC involvement in coordination of systems operating on a Full Band Interference approach will therefore be much less than that for bi-directional FDMA/TDMA. The administrative burden of coordination can be even further reduced, and probably eliminated, if a future WARC adopts a modest increase in the PFD limit at 2483.5-2500 MHz to eliminate the need for any coordination of planned systems in the band.

8.3.4. In the case where the U.S. must coordinate with narrowband FDMA or FDMA/TDMA systems, some type of band segmentation may be required to accommodate incompatible systems from other administrations. If any band segmentation is required to accommodate a system from another administration, the band segments should be at one end of the spectrum or the other so that the U.S. systems are able to operate over a contiguous amount of spectrum. This will prevent any one U.S. MSS system from being severely disadvantaged and allow the U.S. systems to maximize the available channel capacity over the remaining portion of the spectrum.

8.4. General Conclusions and Recommendations.

IWG1 reaches the following conclusions and recommendations:

8.4.1. There is sufficient spectrum to accommodate all of the pending applicants with some adjustments to all currently proposed system designs and Celsat.

8.4.2. A resource allocation plan, whether allocating frequency segments, time slots, or interference power, should be based upon sound principles and avoid arbitrariness. A fundamentally important principle for resource allocation is the equitable treatment of licensees. Since MSS/RDSS is a new service, equity requires that each applicant receive equal access to the spectrum resource.

8.4.3. The best means of assigning the available spectrum resource among multiple systems is Full Band Interference

sharing. Such an approach is the most flexible and spectrum efficient, provides the greatest aggregate capacity, facilitates international coordination, promotes competition, and avoids inequitable assignment of different portions of the band with greater sharing constraints. This is the only approach that allows the pending applicants to share on a co-frequency, co-coverage basis with each other and with systems operated by other countries using CDMA and still permit entrance by Celsat. This approach also minimizes sharing problems with other services in the bands.

8.4.4. In principle, both geostationary and non-geostationary satellite systems can operate in the MSS bands on an interference sharing basis provided that system parameters are chosen appropriately. No restriction on the selection of orbit needs to be placed on applicants.

8.4.5. The Full Band Interference sharing approach can be extended to accommodate non-spread spectrum systems since FDMA/TDMA systems can be configured to operate in a manner that causes no more equivalent interference than a spread spectrum system, provided that it does not operate bi-directionally.

8.4.6. The FCC should not authorize the use of the secondary MSS downlink at 1613.8-1626.5 MHz because of potential interference to other U.S. satellite systems. Bi-directional satellite systems cannot share on a co-coverage, co-frequency basis with other satellite systems or with other radio services in the band, and no coordination should be required between secondary and primary services. The analysis has shown that the secondary downlink cannot operate on a non co-coverage, co-frequency basis with U.S. MSS uplinks using an interference sharing approach since it will cause a reduction in capacity for these systems.

8.4.7. The FCC should adopt rules that grant all pending applicants satisfying these recommendations authorizations to construct, launch and operate their proposed systems, subject to coordination among the immediate and future operators and the use of default values for certain critical parameters such as downlink PFD and uplink areal EIRP density.

8.4.8. The Report and Order adopting the rules recommended in Section 9 below shall specify the Default Values described in Section 2.1. above and provide as follows: "In order to insure compliance with the agreed upon, or default (as the case may be), values discussed above, all MSS licensees will cooperate with each other in good faith to resolve questions concerning alleged violations of the coordination agreement reached between them. Each licensee shall (1) make available to any other coordinating licensee raising such question, subject to an appropriate

confidentiality agreement, all pertinent technical data in the possession of such alleged offending licensee necessary to resolve such question, and (2) promptly undertake to alter its system operations as required to correct such violations as may have occurred."

8.4.9. In recognition of the substantial net increase in U.S. MSS capacity to be realized through the addition of yet another CDMA applicant such as Celsat and the incremental public benefit which would flow therefrom, and subject to the limitations and rights of current applicants under the cutoff rules, the IWG1 recommends that the Celsat system receive the fair consideration to which it is entitled as a new entrant when and if it chooses to formalize the work which it has done with respect to bandsharing in an FCC application.

EXHIBIT 3

SE28 SE28 [96] 4

London, 1-3 July 1996

Source: Motorola

Re: Sharing Analysis between CDMA and TDMA

Abstract:

In this paper it will be shown that sharing on a co-frequency basis between TDMA and CDMA satellite systems is not feasible. This is shown based on an Iridium (for TDMA) and Globalstar (for CDMA) example.

Criterion for co-frequency sharing

Co-frequency sharing has been proposed for CDMA systems. This idea is motivated by the fact that CDMA is based on interference sharing, with seperation done by code. When it comes to TDMA and FDMA the situation is different as, in these cases, orthogonality in time and frequency is used for separation. The proper operation of a TDMA system requires that the noise floor does not increase substantially by interference. It has been accepted in the satellite communication industry that a total increase of 25% of the noise floor represents the maximum acceptable interference level to a TDMA/FDMA satellite system from all other systems. In the numerical example below, which is based on Iridium and Globalstar, respectively representing TDMA and CDMA systems, it is shown that a single CDMA co-channel user introduces interference to Iridium significantly above this threshold.

Interference calculation

Iridium noise floor is -201.6 dBW/Hz. Beam boresight distance is between 960 km (inner beam) to 2461 km (outer beam). This translates to path loss from 156.3 to 164.5 dB.

Antenna gain varies from 17 (inner beam) to 24 dB (outer beam).

A single Globalstar handheld is -2 dBW in power, which, by its 1.25 MHz spreading, translates to -63 dBW/Hz. Taking into account path loss and antenna gain we have that a single Globalstar co-channel handheld will cause an interference level at the Iridium receiver of -202.3 dBW/Hz to -202.5 dBW/Hz.

This demonstrates that even a single co-channel Globalstar unit raises the noise floor at the Iridium receiver by 80%, which is significantly above the interference threshold level mentioned above, hence unacceptable.

Conclusion:

TDMA/CDMA sharing on a co-frequency basis is not feasible.

EXHIBIT 4

FOR IMMEDIATE RELEASE

Jeanette Clonan +1 212.338.5658
Globalstar™

John Windolph +1 202.326.5626
IRIDIUM®

Jack Prichett +1 310.812.5227
Odyssey™

Globalstar, Iridium, Odyssey Global Mobile Satellite Phone System Operators Sign Spectrum Agreement

October 16, 1996 -- The operators of "Big LEO" systems Globalstar™, IRIDIUM®, and Odyssey™ have agreed to cooperate in an effort to secure global authorizations for the portions of the radio frequency spectrum to be used by their mobile phones.

The three systems are the only U.S.-licensed Big LEOs.

"This agreement provides us with a unified, cooperative approach to our spectrum-use and segmentation as we seek frequency authorizations and operating licenses around the world," said William F. Adler, vice president and division counsel for Globalstar L.P., in announcing the pact.

Globalstar™ and Odyssey™, which employ CDMA, or code division multiple access, share a segment of spectrum for their mobile links. That spectrum segment can accommodate other global systems employing compatible technologies. IRIDIUM®, a TDMA, or time division multiple access, system uses a separate segment for its mobile links.

"Our agreement conforms with the International Telecommunication Union's frequency authorizations for global mobile systems. We think it provides a workable framework for countries around the world to adopt," added Francis Latapie, Iridium LLC executive director for government affairs.

The frequency-use plan to which the three companies agreed is premised upon the same spectrum-sharing and segmentation plan adopted by the U.S. Federal Communications Commission (FCC) in its "Big LEO Order" (as adopted in October 1994, and modified by the FCC in February 1996), which authorized the three systems to operate in the U.S. The band plan was adopted by the FCC after years of discussions, negotiations, and formal and informal FCC rule-making proceedings, according to John T. Feneley, director for international development and regulatory affairs for Odyssey Telecommunications International Inc.

- more -

The three companies reached the pact less than two weeks before the International Telecommunication Union's World Telecommunication Policy Forum, which opens in Geneva, Switzerland, on October 21. At the Forum, more than 100 countries will consider the regulatory issues raised by the introduction of global mobile personal communications by satellite.

Globalstar, Iridium, Odyssey, and other proposed mobile satellite system operators are seeking recognition at the conference for the benefits that mobile satellite services will offer to countries around the world. The companies are advocating a set of voluntary principles to guide countries in developing regulatory policies for mobile satellite systems.

"The fact that we have agreed to pursue a common spectrum sharing and segmentation plan for our mobile links should simplify the regulatory process in countries where we seek to operate," said Feneley.

Globalstar L.P., based in San Jose, Calif., is a partnership of 12 international telecommunications service providers and equipment manufacturers who are building a global mobile satellite telephone system that will be operational in 1998. Globalstar's dual-mode (cellular-satellite) handsets will be compatible with the world's existing cellular and wireline networks. Globalstar™ will sell access to the Globalstar™ system to a worldwide network of regional and local telecommunications service providers, including its strategic partners.

Iridium LLC is an international consortium of leading telecommunications and industrial companies funding the development of the IRIDIUM® system. The IRIDIUM® system is a 66-satellite telecommunications network designed to provide global wireless services to handheld telephones and pagers virtually anywhere in the world, starting in late 1998. The first satellite will be launched this year.

Odyssey Telecommunications International Inc. (OTI), which has TRW Inc. and Teleglobe Inc. as founding shareholders, is developing the patented Odyssey™ system to provide global, satellite-based personal communications services. A constellation of 12 Odyssey™ satellites in medium-Earth orbit, about 10,300 kilometers above the globe, will permit subscribers equipped with Odyssey dual-mode pocket telephones to call any phone on Earth, from anywhere on Earth. OTI will operate as a wholesale provider of personal communications services to national service operators, who in turn will provide Odyssey™ services to retail consumers.

###