A

APPENDIX A

Appendix A

Technical Information on the Adaptation of Terrestrial 3G Technology to MSS Applications

Introduction

Considering that MSS systems are complementary to terrestrial cellular systems and should provide the same services, an economically viable next generation MSS system should offer ubiquitous coverage with globally roaming terminals that support leading terrestrial 3G and 2G services with multi-mode terminals. In addition to basic voice and messaging services, the next generation MSS systems will be required to offer enhanced services such as high-speed data, e-mail, internet access file transfer, and interactive multimedia such as videophone and teleconferencing.

The key to the success of a next generation MSS system is a high-quality and low cost system design, which implies affordability. A low-cost next generation system design requires: 1) leveraging already existing terrestrial wireless infrastructure investments; 2) keeping a high degree of commonality in design with the leading terrestrial wireless technologies to insure low cost manufacturing of multi-mode user terminals; 3) flexibility to address future service needs (yet to be known) due to the prohibitive cost of upgrading the space segment; and, 4) multiple potential suppliers for the system components and increased competition.

Recently Approved Third Generation Radio Transmission Technologies

Among the terrestrial wireless technologies that have emerged from ITU Task Group 8/1, the cdma2000 and WCDMA proposals are currently the leading ones.

The WCDMA technology, supported by Ericsson, Nokia, Motorola and NTT Docomo , has been advocated by the ITU as the recommended method of implementation of Direct Spread CDMA (IMT-DS). The WCDMA technology is backwards compatible with the GSM standard widely deployed around the globe. A recommended deployment method of WCDMA is using a building block, 5MHz, channel bandwidth segment. A successful adaptation of WCDMA to next

generation MSS would utilize these 5 MHz building blocks to supply a full range of viable and low cost services over a bandwidth utilization of 5-15 MHz.

The cdma2000 technology, proposed by Qualcomm, Lucent, Motorola and Nortel, has been advocated by the ITU as the recommended method of implementation of Multi-Carrier CDMA (IMT-MC). The cdma2000 technology is backwards compatible with the IS-95A and B standards widely deployed in the United States. A recommended deployment method of cdma2000 is a graceful evolution from IS-95 by initially using three IS-95 channels of 1.25 MHz each, hence resulting in a 3.75 MHz channel. An adaptation of cdma2000 to MSS systems would require a minimum bandwidth of 3.75 MHz (3x) with limited types of services that exclude multimedia services due to the need for large antennas with an extremely large number of beams and the associated handoff problems. A successful adaptation of cdma2000 to next generation MSS for a full range of viable and low cost services requires a bandwidth of 11.25 MHz (9x) while medium speed data applications would require a bandwidth of 7.5 MHz (6x).

The proposed allocation of 3.88 MHz (35 MHz/N) per operator rules out the adaptation of the WCDMA technique that requires a building block spectrum segment of 5 MHz, and it forces next generation MSS operators into using only cdma2000 in the US. Both cdma2000 and WCDMA have been approved by the ITU for 3G usage and have their own virtues. It is, therefore, in the best interest of the consumer to let the competition determine the usefulness of both technologies rather than restricting operators to the one advocated only in the USA.

Required Spectrum Segment Width

The proposed allocation of 35 MHz/N in the US is insufficient for the next generation MSS systems. A minimum bandwidth of 15 MHz is required to offer all enhanced 3G services to US consumers. Table 1 below shows the types of services and their availability to US consumers with 35/N, 5, 10 and 15 MHz spectrum segmentation plans for the next generation MSS systems. The reasons for the requirement for a 10 –15 MHz bandwidth are as follows:

1) Deployment of high speed internet and multimedia services in 3.88 MHz bandwidth yields insufficient aggregate Kbps/MHz/beam information capacity and requires spreading to

bandwidths of 10 - 15 MHz to reduce system self interference. Table 2 below shows the static circuit capacity per beam of an example satellite system using cdma2000 and WCDMA for the different types of services explained in Table 1 with various spectrum segmentations. The circuit capacity for 3.75 MHz is realized with cdma2000, while the capacity for bandwidths 5, 10 and 15 MHz is realized with WCDMA. The table shows that it is not possible to support even one high speed multimedia user with the 3.75 MHz and 5 MHz segmentations.

2) The proposed allocation requires complex and costly satellite antennas and will force an unreasonably high number of beams to achieve the desired capacity and services. The greater number of beams causes an increased handoff rate that results in a lower quality of service. In addition, stringent code and frequency planning is required.
3) One type of enhanced service is a non-real-time and delay tolerant application such as internet web-browsing that takes better advantage of user inactivity periods in wider bandwidths. A wide bandwidth offers a larger capacity pool for mixing delay tolerant and delay sensitive applications in the same band and hence makes better use of the spectrum during periods of user inactivity. More bandwidth allows different users to share resources within a larger capacity pool. By so doing the varying data rates of multimedia traffic are smoothed out by using a wideband signal. Mixing applications within the capacity pool results in less variance in the composite data rate. This overall lower data rate allows the maintenance of a reasonably large spreading gain which results in a smaller demand for transmit power. The power amplifiers on satellites can thus operate closer to their saturation point. This increases the efficiency and reduces the cost of the satellite power system. Considering the large number of non-GEO satellites in an MSS system, this reduces the overall system cost substantially.
4) Since wider band signals have better tolerance to frequency selective fading , they are more easily received when going through deeply-faded propagation channels. More multipath components can be recovered in suburban areas where surrounding buildings tend to bounce signals around. To the customer, this means higher quality of service.

As a result of the above considerations, the minimum spectrum segments for CDMA systems must be 5 MHz wide and systems that support sharing must be allocated 10-15 MHz of

contiguous spectrum that is required to provide multimedia services to consumers in rural areas. Segments of 10 - 15 MHz of contiguous spectrum must be allocated only to operators that support sharing due to scarcity of the spectrum. Non-contiguous segmentation will not allow the direct spreading mode and will restrict the availability of high speed multimedia services to consumers.

	Availability of Services to a Handheld User Terminal with Various Spectrum Assignments			
Service Type	3.88 MHz	5 MHz	10 MHz	15 MHz
Voice and Messaging Voice Paging and SMS	Yes	Yes	Yes	Yes
Low Speed Data E-mail w/o attachment Low speed data transfer Data Transactions	Yes	Yes	Yes	Yes
Medium Speed Data E-mail w/ attachments Internet Access File and image transfer Database/LAN access	Yes	Yes	Yes	Yes
High Speed Data & Low Speed Multimedia Higher speed internet access Videophone Compressed video Data Services Remote Medicine	**No**	**No**	Yes	Yes
Medium Speed Multimedia Video conferencing Distance learning	**No**	**No**	Yes	Yes
High Speed Multimedia Interactive multimedia Interactive Video	**No**	**No**	**No**	Yes

Table 1. Availability of various enhanced services in U.S. with different spectrum segmentation plans

		Bandwidth (MHz)				
Service Type	Source bit rate (kbps)	3.75 (cdma2000)	5 (WCDMA)	10 (WCDMA)	15 (WCDMA)	20 (WCDMA)
Voice and Messaging	8	115	76	153	230	307
Low Speed Data	64	14	17	35	53	71
Medium Speed Data	144	5	7	15	23	31
Low Speed Multimedia	384	0	2	5	8	11
Medium Speed Multimedia	1024	0	1	2	3	4
High Speed Multimedia	2048	0	0	0	1	2

Table 2. Static circuit capacity per beam of an example Mobile Satellite system for various services and spectrum segmentations

Engineering Certification

I hereby certify under penalty of perjury that I am the technically qualified person responsible for the preparation of the technical information contained in the foregoing "Supplement Comments"; that I am familiar with the information contained therein; that such information is true and correct to the best of my knowledge and belief; and that I am familiar with Part 25 of the Commission's Rules and Regulations.

Signed this 17th day of February 2000.

David E. Weinreich
Spectrum Manager
Globalstar, L.P.

B

APPENDIX B

ITU-R FACT SHEET

Working Party: 8D Document: USWP-8D/
Date: 5 March 1998
Document Title: Working Document Leading towards a Draft Revision of ITU-R Recommendation M.1186 TECHNICAL CONSIDERATIONS FOR COORDINATION BETWEEN MOBILE SATELLITE SERVICE (MSS) NETWORKS UTILIZING CODE DIVISION MULTIPLE ACCESS (CDMA) AND OTHER SPREAD SPECTRUM TECHNIQUES IN THE 1-3 GHZ BAND

	Phone	Fax
Authors: Egemen Gonen	408-933-4458	408-933-4956
David Weinreich	301-607-4165	301-607-4178

Organization: Globalstar, L. P.

Purpose/Objective: To modify the existing Recommendation M.1186 to include sharing considerations for systems that use access techniques other than CDMA.

Abstract: The proliferation of NGSO MSS systems calls for the efficient use of the allocated spectrum and the rigorous coordination of the sharing of these bands among systems. ITU-R Recommendation M.1186 is currently being used to coordinate the sharing of frequencies among systems using Code Division Multiple Access or other spread spectrum techniques. The purpose of this contribution is to extend the concept of using power flux density and e.i.r.p. density as the basis for coordination among MSS networks using all types of multiple access methods including TDMA and CDMA in the 1-3 GHz bands.

Documents
Radiocommunications Study Groups
Working Party 8D

USWP8D/
16 March 1998
Original: English

UNITED STATES OF AMERICA

WORKING DOCUMENT TOWARDS A DRAFT REVISION TO ITU-R RECOMMENDATION M.1186

TECHNICAL CONSIDERATIONS FOR COORDINATION BETWEEN MOBILE SATELLITE SERVICE (MSS) NETWORKS UTILIZING CODE DIVISION MULTIPLE ACCESS (CDMA) AND OTHER SPREAD SPECTRUM TECHNIQUES IN THE 1-3 GHZ BAND

I. Introduction

With the proliferation of Non-Geostationary Orbit Mobile Satellite Service (NGSO MSS) Networks, the spectrum allocated to these systems in the 1-3 GHz band will soon become congested using traditional band splitting methods. Geosynchronous techniques such as orbit slot spacing and control do not work for NGSO systems. Without sharing considerations which employ techniques that allow operators to choose various modulation techniques the spectrum for MSS systems will be inadequate and will soon be exhausted. The continued growth of these systems calls for the efficient use of the allocated spectrum and the rigorous coordination of sharing of these bands among systems.

ITU-R Recommendation M.1186 is currently being used to coordinate the sharing of frequencies among systems utilizing Code Division Multiple Access (CDMA) or other spread spectrum techniques. The purpose of this contribution is to extend the concept of using power flux density and e.i.r.p. density as the basis for coordination among MSS networks using all types of multiple access methods including TDMA and CDMA in the 1-3 GHz bands.

II. Background

The purpose of this document is to show the technical feasibility of coexistence between properly designed TDMA-based NGSO-MSS systems and properly designed CDMA-based NGSO-MSS systems using the same frequencies within a band. In Section III, recommendations for CDMA/TDMA sharing are presented and an example of sharing is given. In Section IV, proposed revisions to ITU-R Recommendation M.1186 are presented, and, conclusions are provided in Section V.

III. Recommendations for CDMA/TDMA Sharing

NGSO-MSS Systems sharing the same service links to and from the satellites and the user within the same frequency band and within a region of overlapping beams in the up and down service links will create interference into the other.

In the service downlink, the interference parameter for sharing is the total intersystem interference presented to a user terminal of one system due to other systems

operating over an overlapping service area and in an overlapping frequency band. It is recommended that this interference be defined in terms of an appropriate and agreed-upon *spectral pfd mask* over all elevation angles. Due to constantly changing geometry of non-geostationary systems and the number of satellites visible at any particular moment at a point in the service area being coordinated, the value of maximum spectral pfd should be specified as the maximum spectral pfd that is permitted at any point in the service area from the aggregate of all satellites in the interfering system. For all systems, the maximum permissible spectral pfd should be averaged over an appropriate and agreed-upon period of time to account for various factors. A common factor for all systems is that the number of satellites in view change continuously. Additional characterizations for properly designed TDMA systems applied to system sharing include: 1) In TDMA systems all time-frequency traffic channels may not be occupied continuously due to time-frequency channel allocation plan and/or due to the possible use of frequency hopping; 2) Control channels for TDMA are periodic transmissions and therefore do not occupy the channel on a continuous basis; 3) Voice activity ratio, 4) Power control transients. The agreed-to maximum spectral pfd per network should be determined on the basis of achieving coordination between multiple satellite networks subject to other spectral pfd constraints on a per satellite basis that is established in the radio regulations during coordination of MSS downlinks with terrestrial services under Resolution No. 46.

In the uplink direction, the interference parameter of interest is the total intersystem interference presented at the satellite receiver input of one system due to emissions of the user terminals of other systems operating over an overlapping service area and in an overlapping frequency band. It is recommended that this interference be defined in terms of an appropriate and agreed-upon maximum *aggregate e.i.r.p. spectral density* simultaneously radiated by all mobile earth stations for a single interfering system that are located within an appropriately sized reference area within the service area being coordinated. Since different beam sizes are used in different systems, such aggregate e.i.r.p. spectral density levels should be specified for a set of reference averaging areas that approximate the range of beam sizes being coordinated. For all systems, the maximum aggregate e.i.r.p. spectral density should be averaged over an appropriate and agreed-upon period of time to account for various factors as explained in the above paragraph. It should be noted that these agreed-to aggregate e.i.r.p. spectral density limits must be within applicable e.i.r.p. spectral density limits imposed on mobile earth stations as a result of sharing with other services in the band.

Recommended CDMA/TDMA Sharing Interference Analysis

The interference presented by a NGSO-MSS system to another NGSO-MSS system will be referred to as *inter-system interference* in the following. Since signals in both systems are not correlated, the inter–system interference appears as thermal noise of each system and is added on a power basis. The following analysis method is recommended for calculating the interference among the TDMA and CDMA system service links. This method applies to both up and down servicelink interference analyses.

Let the channel bandwidths of the TDMA and CDMA systems be B_t and B_c, respectively, and that there are K TDMA channels operating in one CDMA channel. This scenario is shown in Figure 1.

Let the number of CDMA users in a CDMA frequency channel in the overlap frequency band and within the area of overlap be N_c with uplink CDMA power per user equal to P_c and voice activity factor equal to V_c. Both CDMA and TDMA systems are power controlled. Let the voice activity factor and the number of time slots in a frame for the TDMA system be V_t and S_{tdma}, respectively.

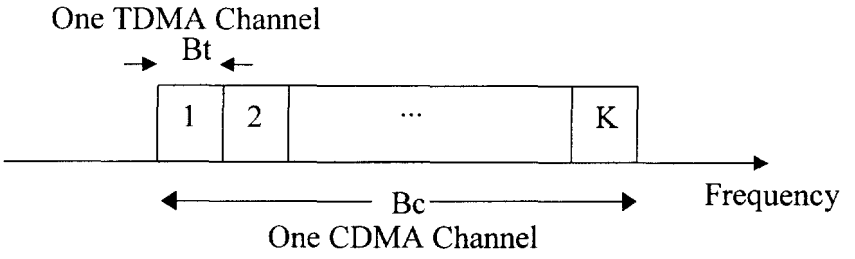


Figure 1. Overlapping CDMA and TDMA systems channels.

The inter-system interference density within a single CDMA channel bandwidth, $I_{inter,ct}$ created by the CDMA system which interferes with the co-frequency channels of TDMA system is given by

$$I_{inter,ct} = I_c \cdot V_c \cdot N_c \tag{1}$$

where $I_c = P_c / B_c$ is the uplink power spectral density per CDMA user, and V_c accounts for the fact that, on the average, V_c of all CDMA users will be active at a given time instant.

The total interference density into the TDMA system is equal to

$$I_{tdma} = I_{inter,ct} + I_{intra,td} + N_o \tag{2}$$

where $I_{intra,td}$ is the total intra-system (self) interference plus noise density for the TDMA system, and N_o is the thermal noise density. The intra-system interference for the TDMA system is the self interference of the TDMA system due to various factors such as beam overlap, partial time overlap of successive TDMA slots, residual doppler frequency shift, etc. which depend on the TDMA system under consideration. Consequently, total interference power within the bandwidth of a single TDMA channel is given by

$$I_{tdma,pwr} = I_{tdma} \cdot B_t \tag{3}$$

The above total interference power within the bandwidth of a TDMA channel, $I_{tdma,pwr}$ should be used in the overall carrier-to-interference power ratio calculation in the TDMA system up and down service link budgets to account for the CDMA interference.

The inter-system interference density within a CDMA channel, $I_{inter,tc}$ caused by the TDMA system is given by

$$I_{inter,tc} = K \cdot I_t \cdot V_t \cdot B_t / B_c \tag{4}$$

where K is the number of TDMA channels within the CDMA channel bandwidth, $I_t = P_t / B_t$ is the power spectral density per TDMA user in a TDMA channel, and V_t accounts for the fact that, on the average, V_t of all TDMA users in the channel will be active at a given time instant. In (4), the TDMA signal power density is reduced

by B_t/B_c because the uncorrelated TDMA signal is spread by a CDMA receiver. The total interference density into the CDMA system is equal to

$$I_{cdma} = I_{inter,tc} + I_{intra,cd} + N_o \quad (5)$$

where I_c is the total intra-system interference plus noise density for the CDMA system. Consequently, total interference power within the bandwidth of a TDMA channel is given by

$$I_{cdma,pwr} = I_{cdma} \cdot B_c \,. \quad (6)$$

The above total interference power within the bandwidth of a CDMA channel, $I_{cdma,pwr}$ should be used in the overall carrier-to-interference power ratio calculation in the CDMA system up and down service link budgets to account for the TDMA interference.

Recommended Power Flux Density Analysis Method for TDMA/CDMA Sharing

The downlink pfd for a specific system depends on design parameters such as the frequencies, antenna gains and line losses, and also depends on some time varying and geographic area dependent parameters for example the number of users per channel. The pfd calculations are performed different in a CDMA and TDMA system, as a in hybrid system.

Now a method of calculating pfd is presented, and the CDMA and TDMA schemes are discussed separately.

The instantaneous downlink pfd in the system channel bandwidth for a single user at a specific elevation angle is calculated as follows:

$$pfd_{inst} = C/N_o + I_o + L_a - G_a + M + 10\log(4\pi/\lambda^2) \quad (7)$$

where C/N_o is the required carrier-to-noise power ratio at the user terminal receiver, I_o is the total interference density plus thermal noise density at the user terminal receiver input, L_a is the receiver antenna loss, G_a is the user terminal antenna gain for the elevation angle under consideration, M is the link margin, and λ is the wavelength of the signal.

For a CDMA system: In general the CDMA system has FDM channels with a number of users per FDM channel, and there is no time-sharing between the users. As the number of users per FDM channel varies with time a term is added to equation (7) which compensates for average loading of the channel. For P CDMA users in the FDM channel on the average, the downlink pfd for the CDMA system is:

$$pfd_{cdma} = pfd_{inst} + 10\log(P) \quad (8)$$

For a TDMA system: In a TDMA system each user is dedicated a timeslot within a certain FDM channel. Averaging over time when calculating the pfd will account for voice activity and compensate for the fact that all time-frequency channels will not be occupied all the time. When the TDMA system uses frequency hopping, all time-frequency traffic channels are not occupied continuously, which means reduced pfd averaged over a period of time.

For a TDMA system that uses a voice data rate of R_{max} when the user is active, and uses a data rate of R_{min} when the user is not active with a voice activity factor of x, the average data rate is

$$R_{avg} = R_{\max} \cdot x + R_{\min}(1-x),$$

and the reduction in the pfd (in dB) is given by

$$10\log(R_{\max} R_{avg}).$$

For a frequency hopping TDMA system, the pfd is further reduced by an amount F_h (in dB) which depends on various factors including the available bandwidth for hopping, the number of frequencies in the hopping-sequence and the spacing between the hop-frequencies.

Consequently, the average pfd the TDMA the system is given by

$$pfd_{tdma} = pfd_{inst} - 10\log(R_{\max} / R_{avg}) - F_h$$

A Sharing Example: In this example, two NGSO-MSS systems, a CDMA and a TDMA system, having 1.23 MHz and 25 KHz channel bandwidths, respectively operate over overlapping service areas in overlapping frequencies, and interfere with each other. The constellation altitudes are 1450 km and 1350 km for the CDMA and TDMA systems, respectively. In this example, the return link is interference limited in both systems, and therefore the results of sharing for the return link are presented. The service link beams of the CDMA system are much larger than those of the TDMA system, and cover several TDMA beam service areas. On the average, two of the TDMA beams overlapping with a CDMA beam are allocated the same set of frequencies. Each CDMA channel of 1.23 MHz bandwidth is fully reused by 92 TDMA channels of 25 KHz bandwidth in the two overlapping TDMA beams. An appropriate area for sharing coordination is chosen as the size of a CDMA beam, and a maximum user e.i.r.p. is calculated for each system such that both systems can share the same frequency band over overlapping service areas. Both systems have a C/I equal to 10dB due to intra-system adjacent beam overlap. The CDMA system requires an Eb/No=6.3 dB, and the TDMA system requires a C/No=49 dBHz. In Table 1, we present the return link budget when both systems share the same frequency. It is assumed that all of the available TDMA channels in the CDMA channel bandwidth are fully occupied, i.e. 6 users / TDMA channel. Table 2 presents the CDMA capacity as a function of CDMA and TDMA user EIRP. This example demonstrates that a properly designed CDMA system and a properly designed TDMA system can share a common service link spectrum with overlapping beams over a common service area.

IV. Proposed Revisions

The proposed revisions to ITU-R Recommendation M.1186 are shown in ANNEX 1.

V. Conclusions

ITU-R Recommendation M.1186 is currently being used to coordinate the sharing of frequencies among systems utilizing Code Division Multiple Access (CDMA) or other spread spectrum techniques. This contribution has demonstrated that this concept can be extended to using power flux density and e.i.r.p. density as the basis for coordination among MSS networks using all types of access methods including TDMA and CDMA in the 1-3 GHz bands.

Table 1. A sample link budget

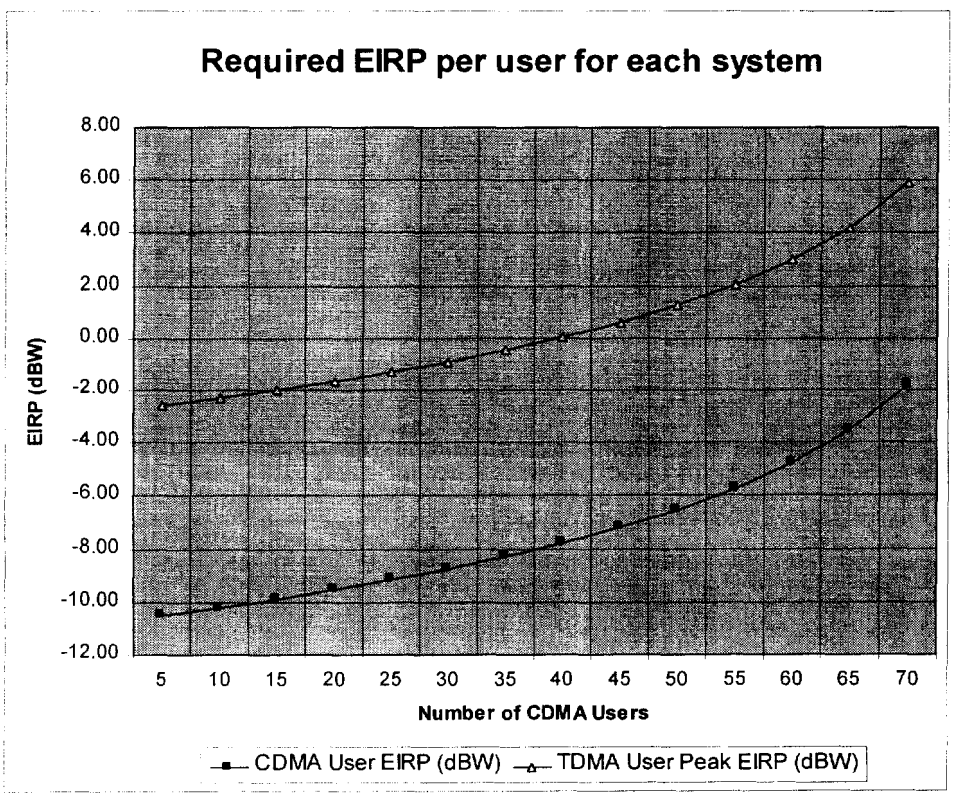
CDMA RETURN LINK BUDGET

Link Parameters	Uplink	Downlink	Units
Carrier Frequency	2000.00	6950.00	MHz
UT Signal EIRP Per User	-1.84	-17.71	dBW
Satellite Altitude	1450.00	1450.00	
User Elevation Angle	70.00	40.00	deg
Range	1524.56	2016.37	km
Free Space Loss	-162.13	-175.38	dB
Polarization Loss	-0.32	-0.28	dB
Power Flux Density (pfd)	-136.49	-154.79	dBW/m2
G/T	-14.35	28.42	dB/K
System Noise Temperature	509.64	140.67	deg K
Receive C/No			
Data Rate	2400.00	2400.00	bps
Receive Eb/No	16.48	29.93	dB
No of CDMA users/CDMA Chann	70		
CDMA Intra-System Interference	-132.34	-136.50	dBW
Channel Bandwidth	1.23	1.23	MHz
CDMA Intra-System Int'f Density	-193.24	-197.40	dBW/Hz
TDMA Intersystem Int'f Density	-198.10	-1000.00	dBW/Hz
Total Int'f Density, Io	-192.01	-197.40	dBW/Hz
Thermal Noise Density, No	-201.53	-207.12	dBW/Hz
Receive Eb/Io	6.96	20.21	dB
Receive Io/No	8.29	9.72	dB
Receive Eb/(No+Io)	6.50	19.77	dB
Equiv. Transp. Gain		125.00	dB
Total Eb/(No+Io)		6.50	dB

TDMA RETURN LINK BUDGET

Link Parameters	Uplink	Downlink	Units
Carrier Frequency	2000.00	6980.00	MHz
UT Signal EIRP Per User	5.92	-9.34	dBW
Satellite Altitude	1350.00	1350.00	
User Elevation Angle	70.00	40.00	deg
Range	1420.38	1887.84	km
Free Space Loss	-161.52	-174.85	dB
Polarization Loss	-0.32	-0.28	dB
Power Flux Density (pfd)	-128.12	-145.85	dBW/m2
G/T	-14.35	28.46	dB/K
System Noise Temperature	509.64	140.67	deg K
Receive C/No	58.65	72.68	dBHz
Burst Data Rate	36.00	36.00	kbps
Receive Eb/No	13.09	27.11	dB
No. of TDMA users/TDMA Ch.	6		
TDMA Intra-System Interference	-157.11	-153.79	dBW
Channel Bandwidth	0.03	0.03	MHz
TDMA Intra-System Int'f Density	-201.09	-197.76	dBW/Hz
CDMA Intersystem Int'f Density	-193.24	-1000.00	dBW/Hz
Total Int'f Density, Io	-192.58	-197.76	dBW/Hz
Thermal Noise Density, No	-201.53	-207.12	dBW/Hz
Receive C/Io	49.70	63.32	dBHz
Receive Io/No	8.95	9.35	dB
Receive C/(Io+No)	49.18	62.85	dBHz
Received C/(I+N)	5.20	18.87	dB
Equiv. Transp. Gain		125.00	dB
Total C/(No+Io)		49.00	dBHz

Table 2. Required user e.i.r.p. per system



ANNEX 1

TECHNICAL CONSIDERATIONS FOR THE COORDINATION BETWEEN MOBILE SATELLITE SERVICE (MSS) NETWORKS ~~UTILIZING CODE DIVISION MULTIPLE ACCESS (CDMA) AND OTHER SPREAD SPECTRUM TECHNIQUES~~ IN THE 1-3 GHz BAND

Summary

This Recommendation provides the technical parameters to be considered for the coordination of ~~CDMA~~ MSS systems, and recommends the administrations implementing such systems to coordinate based on agreed values for the pfd or e.i.r.p. density, in space-to-Earth or Earth-to-space direction, respectively.

The ITU Radiocommunication Assembly,

considering

a) that non-geostationary satellite systems in the mobile-satellite service (MSS) using ~~CDMA or other spread spectrum techniques~~ using frequency division multiple access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA) or other multiple access techniques have been proposed for operation in the 1-3 GHz band;

~~b) that MSS systems using other modulation methods frequency division multiple access (FDMA)/time division multiple access (TDMA) have also been proposed for operation in the 1-3 GHz band;~~

~~c)~~ b) that the World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (Malaga-Torremolinos, 1992) (WARC-92) adopted Resolution No. 46 to provide interim procedures for coordination and notification of frequency assignments of non-geostationary satellite networks in certain frequency bands and for certain space services;

~~d)~~ c) that multiple MSS systems using ~~CDMA or other spread spectrum transmission techniques~~ FDMA, TDMA, CDMA or any other multiple access technique can in some cases operate on a co-channel and co-coverage basis;

~~e)~~ d) that the application of Resolution No. 46 requires the development of new technical criteria and calculation methods for the technical coordination of MSS systems when such systems operate in the same band;

~~f)~~ e) that the most recent technical information developed by the Radiocommunication Study Groups should be made available to administrations for their use in the coordination of these systems,

recommends

1 that administrations implementing MSS networks using ~~CDMA or other spread spectrum transmission techniques~~ FDMA, TDMA, CDMA or any other multiple access technique exchange detailed information on the following system parameters, to facilitate the coordination process (see Note 1):

- downlink spectral power flux-density (pfd),
- aggregate uplink e.i.r.p. spectral density over a specified geographical area,
- polarization,
- TDMA burst and frame structures
- ~~frequency use~~ time and frequency channel use approaches,
- code structures and associated cross-correlation properties
- frequency hopping method and rate (if applicable)
- antenna beam patterns,
- signal burst structures (if applicable);

2 that administrations implementing MSS networks using ~~CDMA or other spread spectrum transmission techniques~~ FDMA, TDMA, CDMA or any other multiple access technique may undertake coordination in the space-to-Earth direction based on agreed values for the spectral power flux-density on Earth resulting from those MSS space stations (see Note 2);

3 that administrations implementing MSS networks using ~~CDMA or other spread spectrum transmission techniques~~ FDMA, TDMA, CDMA or any other multiple access technique may undertake coordination in the Earth-to-space direction based on agreed values of e.i.r.p. density from the mobile earth stations within a given geographical area (see Note 3).

NOTE 1 – Additional parameters can be utilized to facilitate the coordination process among MSS ~~spread spectrum~~ networks. Administrations should exchange information on and may wish to coordinate additional technical parameters. These additional technical parameters are:

Polarization – The sense of polarization used should be specified, although only circular polarization is assumed for the user terminal antennas. While the amount of intersystem isolation due to use of different sense of circular polarization in the service link that can be assumed in coordination may be small, any amount of isolation can provide a usable increase in system capacity under interference sharing conditions.

TDMA burst and frame structures – The duration and structure of traffic and control channel time slots and the structure of the TDMA frames of a TDMA system are required in calculating interference into other systems.

~~*Frequency*~~ *Time and frequency channel use approaches* – System operators would be required to specify their satellite ~~frequency~~ time and frequency channel use in terms of frame structures and ~~the~~ individual radio-frequency channels (slot and frame durations, centre frequency and bandwidth) in their systems. Time and frequency channel ~~frequency~~ use approaches may indicate a degree of isolation between systems, and constraints on time and frequency channel ~~frequency~~ use approaches may be needed to achieve compatibility (i.e. avoidance of simultaneous co-channel operation).

Code structures and associated cross-correlation properties – There are numerous pseudo-random noise codes of adequate length and acceptable properties that can be selected by a CDMA system operator to ensure satisfactory system operation. However, there is a small probability that system operators can independently select codes that have cross-correlation artifacts that produce more interference than would be in the case of the white gaussian noise usually assumed in the intersystem interference calculations. For this reason, coordination between system operators would include identification of their code structures to ensure that the codes selected have sufficiently good cross-correlation properties that the effects of intersystem interference are no worse than white gaussian noise.

Antenna beam patterns – Antenna beam patterns (number of beams, pointing angle of maximum gain, side-lobe gain patterns and beam array layout) together with frequency plans, can be used to represent the distribution of spectral pfd/e.i.r.p. spectral density across a specified geographic area and the assigned frequency band. Satellite beam patterns are especially important in cases where geographic operating constraints are needed (e.g. where co-channel sharing is not possible between global-coverage systems and regional-coverage systems).

Frequency hopping method and rate - If a system uses frequency hopping technique, the method and rate of frequency hopping should be described. Cordination between system operators on their frequency hopping and allocating hop frequencies can decrease the level of intersystem interference and increase the capacity under sharing conditions.

Signal burst structures – If a system uses a form of transmission that does not radiate a continuous signal, the time dependent characteristics of the transmission should be described in such terms as peak/average power levels, duty cycle, framing and guard time structure, burst synchronization characteristics, etc.

NOTE 2 – In the downlink direction, the key interference parameter is the total amount of interfering power presented to the receiving mobile earth station, and this interference level can most readily be defined in terms of a spectral pfd value. Because of the constantly changing geometry of non-geostationary systems and the number of satellites visible at any particular moment at a point in the service area being coordinated, the value of maximum spectral pfd should be specified as the maximum spectral pfd that is permitted at any point in the service area from the aggregate of all satellites in the interfering network. It may be desirable to average the maximum permissible spectral pfd limit over an appropriate and agreed-upon period of time to account for various factors. These factors include short-term peak situations due to power control transients, differing number of satellites in view, and other time-varying system characteristics. Other factors for TDMA systems are: 1) In TDMA systems all time-frequency traffic channels may not be occupied continuously due to time-frequency channel allocation plan and/or due to the possible use of frequency hopping; 2) Control channels for TDMA are periodic burst transmissions and therefore do not occupy the channel on a continuous basis; 3) Voice activity ratio. Polarization effects shall also be considered during coordination. This agreed-to maximum spectral pfd per network is determined on the basis of achieving coordination between multiple ~~spread spectrum~~ satellite networks subject to other spectral pfd constraints on a per satellite basis that are established during coordination of MSS downlinks with terrestrial services under Resolution No. 46.

NOTE 3 – In the uplink direction, the key interference parameter is the total interference power presented at the satellite receiver input, and this parameter can be most conveniently addressed in the coordination process for ~~spread spectrum~~ satellite networks by agreeing on a limit on the aggregate e.i.r.p. spectral density simultaneously radiated by all mobile earth stations for a single interfering system that are located within an appropriately sized reference area within the service area being coordinated. Because of different beam sizes used in ~~spread spectrum~~ MSS systems such aggregate e.i.r.p. spectral density levels may have to be specified for a set of reference averaging areas that approximate the range of beam sizes being coordinated. ~~Some time averaging also may be desirable to account for short-term peak situations due to random access channels, power control system transients, and other time-varying system characteristics~~ For all systems, the maximum aggregate e.i.r.p. spectral density should be averaged over an appropriate and agreed-upon period of time to account for various factors as explained in the above paragraph. It should be noted that these agreed-to aggregate e.i.r.p. spectral density limits must be within applicable e.i.r.p. spectral density limits imposed on mobile earth stations as a result of sharing with other services in the band and in some bands if the e.i.r.p. spectral density limits are exceeded.

CERTIFICATE OF SERVICE

I, William D. Wallace, hereby certify that I have on this 17th day of February, 2000, caused to be served true and correct copies of the foregoing "Supplemental Comments of Globalstar, L.P." upon the following parties via hand delivery (marked with an asterisk (*)), or by first-class United States mail, postage prepaid:

The Honorable William Kennard *
Chairman
Federal Communications Commission
445 12th Street, S.W., Room 8-B201
Washington, D.C. 20554

The Honorable Susan Ness *
Commissioner
Federal Communications Commission
445 12th Street, S.W., Room 8-B115
Washington, D.C. 20554

The Honorable Gloria Tristani *
Commissioner
Federal Communications Commission
445 12th Street, S.W., Room 8-C302
Washington, D.C. 20554

Howard Griboff *
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room 6-C467
Washington, D.C. 20554

Fern J. Jarmulnek *
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room 6-A523
Washington, D.C. 20554

The Honorable Harold Furchtgott-Roth *
Commissioner
Federal Communications Commission
445 12th Street, S.W., Room 8-A302
Washington, D.C. 20554

The Honorable Michael Powell *
Commissioner
Federal Communications Commission
445 12th Street, S.W., Room 8-A204
Washington, D.C. 20554

Donald Abelson, Chief *
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room 6-C734
Washington, D.C. 20554

Karl Kensinger *
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room 6-A663
Washington, D.C. 20554

Harold Ng *
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room 6-A668
Washington, D.C. 20554

Cassandra Thomas *
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room 6-A666
Washington, D.C. 20554

Alex Roytblat *
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room 6-A623
Washington, D.C. 20554

Cecily C. Holiday *
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room 6-A760
Washington, D.C. 20554

Antoinette Cook Bush
John C. Quale
Skadden, Arps, Slate, Meagher
& Flom, L.L.P.
1440 New York Avenue, N.W.
Washington, D.C. 20005-2111

Thomas J. Keller
Julian L. Shepard
Verner, Liipfert, Benrhard, McPherson,
and Hand, Chartered
901 15th Street, N.W., Suite 700
Washington, D.C. 20005-2301

Jill Abeshouse Stern
Gerald B. Helman
Mobile Communications Holdings, Inc.
Two Lafayette Center
1133 21st Street, N.W.
Washington, D.C. 20036

Thomas S. Tycz *
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room 6-A665
Washington, D.C. 20554

Linda L. Haller *
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room 6-C747
Washington, D.C. 20554

Christopher J. Murphy *
International Bureau
Federal Communications Commission
445 12th Street, S.W., Room 6-C437
Washington, D.C. 20554

Gregory C. Staple
Peter M. Connolly
Koteen & Naftalin, L.L.P.
1150 Connecticut Avenue, N.W.
Washington, D.C. 20036

Cheryl A. Tritt
Charles H. Kennedy
Morrison & Foerster, L.L.P.
2000 Pennsylvania Avenue, N.W.
Suite 5500
Washington, D.C. 20006-1888

Joseph P. Markoski
Herbert E. Marks
Bruce A. Olcott
Squire, Sanders & Dempsey, L.L.P.
1201 Pennsylvania Avenue, N.W.
P.O. Box 407
Washington, D.C. 20044-0407

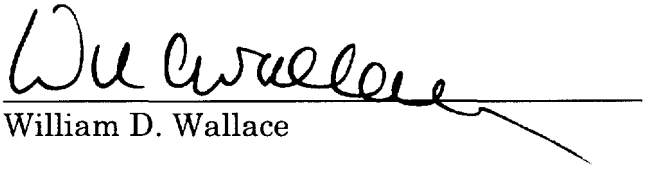
Kelly Cameron
Powell, Goldstein, Frazer & Murphy LLP
1001 Pennsylvania Avenue, N.W.
Sixth Floor
Washington, D.C. 20004

Robert A. Mazer
Albert Shuldiner
Vinson & Elkins, L.L.P.
1455 Pennsylvania Avenue, N.W.
Washington, D.C. 20004-1008

F. Thomas Tuttle
Patricia A. Mahoney
Iridium LLC
1575 I Street, N.W., 8th Floor
Washington, D.C. 20005

Tom Davidson
Phil Marchesiello
Akin, Gump, Strauss, Hauer & Feld, LLP
1333 New Hampshire Avenue, N.W.
Suite 400
Washington, D.C. 20036

Warren Grace
Director General
Inmarsat
99 City Road
London EC1Y 1AX England
United Kingdom



William D. Wallace