APPENDICES

FOR

SECTION 1

APPENDIX 1.1

PLAN TO SELECT SPECTRUM FOR THIRD GENERATION (3G) WIRELESS SYSTEMS in the UNITED STATES October 20, 2000

I. PRESIDENTIAL MEMORANDUM (PM)

President Clinton signed a memorandum dated October 13, 2000, (Attachment 1) that states the need and urgency for the United States to select radio frequency spectrum to satisfy the future needs of the citizens and businesses for mobile voice, high speed data, and Internet accessible wireless capability; the guiding principles to be used for the development of 3G wireless systems; and the direction to the Federal agencies to carry out the selection of spectrum.

In summary, the President directed

- the Secretary of Commerce in cooperation with the Federal Communications Commission (FCC) to:

  - develop a plan by October 20, 2000, for the identification and analysis of possible spectrum bands for 3G services that would enable the FCC to select specific frequencies by July 2001 for 3G and complete the auction for licensing 3G wireless providers by September 30, 2002.
  - issue an interim report by November 15, 2000, on the current spectrum uses, and the potential for the sharing or segmenting, of two of the bands identified at the World Radiocommunication Conference (WRC-2000) for 3G wireless use, 1755-1850 MHz and 2500-2690 MHz, about which the United States does not have sufficient knowledge at present to make a considered decision about allocation.
  - work with government and industry representatives through a series of public meetings to develop recommendations and plans for identifying spectrum for 3G wireless systems.

- the Secretary of Defense, Secretary of the Treasury, Secretary of Transportation, Department of State and heads of any other executive department or agency that currently use any of the spectrum identified at the WRC-2000 for 3G systems to participate and cooperate with the government-industry group as established above by the Secretary of the Commerce.

- the Department of State to coordinate and present the evolving views of the United States to foreign governments and international bodies.

All of the above work is expected to lead to the issuance of a final report by March 1, 2001, that describes the potential use of all identified bands for 3G wireless applications.

The President encouraged the FCC to participate in the government-industry program being led by the Secretary of Commerce and complete rulemaking for spectrum allocation in full coordination with the Assistant Secretary of Commerce for Communications and Information (Administrator, National Telecommunications and Information Administration (NTIA)) by July 2001.

II. BACKGROUND

Over the past decade, there has been enormous worldwide growth in the use of mobile radios. Studies in the International Telecommunication Union (ITU) and elsewhere indicate that this growth in personal communications is likely to continue. First and second generations of personal communications service (PCS) are operating now. The 3G PCS will provide mobile and satellite-based broadband capabilities, and represent a path for the evolution of existing cellular and PCS. A summary of various administrations' spectrum usage (cellular and PCS) and planned 3G wireless is shown in Attachment 2.

The ITU Radiocommunication Sector has addressed the characteristics of a 3G system and has termed it International Mobile Telecommunications-2000 (IMT-2000). Key features of IMT-2000 include: a high degree of commonality of design worldwide; compatibility of services within IMT-2000; and high-quality worldwide use and roaming capability for multi-media applications (e.g. video-teleconferencing and high-speed Internet access). The following was considered by the ITU's 2000 WRC-2000: "review of spectrum and regulatory issues for advanced mobile applications in the context of IMT-2000, noting that there is an urgent need to provide more spectrum for the terrestrial component of such applications and that priority should be given to terrestrial mobile needs, and adjustments to the Table of Frequency Allocations as necessary"(1).

The 698-960 MHz, 1710-1885 MHz, 2500-2690 MHz and the 2700-2900 MHz bands were some of the bands that WRC-2000 considered for IMT-2000 terrestrial systems. The United States position for this conference was established among U.S. industry and government representatives, resulting in a proposal that the United States believed could be the basis for a compromise at the conference, given the conflicting positions of many of the other administrations. The United States and many ITU Region II administrations proposed no change to the allocations in the 2700-2900 MHz band. The United States also suggested three possible bands for terrestrial IMT-2000, including the 1710-1885 MHz band (favored by the Americas), the 2500-2690 MHz band (favored by Europe), and the 698-960 MHz band. At the conference, the United States stated that it would study the 1755-1850 MHz and 2500-2690 MHz bands domestically to (1) see if there are alternate bands to relocate the existing systems, (2) determine the costs of any required relocation, (3) identify who would pay for relocation, and (4) assess how long the transition would take. The United States proposed, and the WRC-2000 adopted, full regulatory flexibility, giving each administration the right to determine which band it may want to identify for IMT-2000, if it wants to do so at all. Administrations can identify these bands at any time. Also, the United States proposed to keep bands identified for IMT-2000 open to any technology that fits in the mobile service rather than specifying a technology or standard for use in the spectrum.

WRC-2000 identified the 806-960, 1710-1885, and 2500-2690 MHz bands for terrestrial IMT-2000. The 1525-1559, 1610-1660.5, 2483.5-2500, 2500-2520 and 2670-2690 MHz bands were identified for the satellite portion of IMT-2000. These bands are shown in Attachment 2. The conference also adopted a resolution pointing out that some countries may implement IMT-2000 in the 698-806 and 2300-2400 MHz bands. The WRC-2000 agreed that the identification of these bands does not preclude the use of these bands by any application of services to which they are allocated, and does not establish priority in the Radio Regulations. Administrations can implement any bands in any timeframe, for any service or technology, and may use any portion of the bands that they deem appropriate, based on national requirements. All of these bands are used at present. For those who may be required to relocate, additional spectrum may have to be found or other accommodations will have to be made to continue their operations.

The United States recognizes that discussions relative to spectrum for advancing mobile telecommunications systems are vital for administrations to plan their spectrum use, and for industry to plan how it will meet the marketplace needs of the future. The United States supports the development and implementation of advancing mobile telecommunications systems, such as IMT-2000, as critical components of the communications and information infrastructure of the future.

In addition to the three WRC-2000 bands, other bands that could be considered in the United States are: 698-746, 746-764, 776-794, 806-960 (includes the present U.S. cellular), 1710-1850, 1850-1990 (present PCS bands), 2110-2150, 2160-2165 and 2500-2690 MHz. A brief description of these bands is contained in Attachment 3. All these bands will be given full consideration in the formulation of the final allocation order. For some of these bands, no extensive studies are required to provide decision-makers with a factual basis for a decision. However, in order to achieve a full understanding of all the options available, the FCC and NTIA need to undertake studies of the frequency ranges of 1755-1850 MHz and 2500-2690 MHz. The studies' purpose is to determine whether, and under what conditions, these bands could be made available for 3G wireless systems and the costs and operating impacts to the incumbent users. These analyses are the subject of the study plan described below.

III. <u>STUDIES</u>

A. Overview

The NTIA will study the 1755-1850 MHz band, and the FCC will study the 2500-2690 MHz band. It is important that the studies be based on the same assumptions where applicable and address common spectrum options. The two studies will proceed along the same timelines and use similar assumptions to assure equal treatment for both.

The results of the two studies, relevant information regarding the other bands identified in Section II, above, (806-960, 1710-1755, 2110-2150, 2160-2165 MHz) and public comment generated either during the Secretary of Commerce's government-industry dialogue (*see* Section IV, "Outreach," below) or in response to the FCC's Notice of Proposed Rulemaking will be taken into consideration when reviewing the overall spectrum requirements and future plans for 3G. Among other things, there will be an evaluation of private sector plans to migrate their 1G and 2G systems to 3G in the existing bands they already have. National security and public safety will also be taken in account. In addition, among other factors, the U.S. will also have to consider the ramifications of the deployment of 3G elsewhere in the world with regard to possible spectrum harmonization that could lead to global roaming.

The analysis will also have to take into account the provisions of the FY 00 National Defense Authorization Act, which requires that before there can be any reallocation of spectrum where the Department of Defense is a primary user, which includes 1755-1850 MHz, certain conditions must be met: (1) NTIA, in consultation with the FCC, must identify and make available to the Department of Defense an alternative band or bands of frequencies as a replacement; and (2) the Secretary of Commerce, the Secretary of Defense, and the Chairman of the Joint Chiefs of Staff have jointly certified to specified committees of the Congress that the replacement band or bands of frequencies provides comparable technical characteristics to restore essential military capability that will be lost as a result of this reallocation. The same analysis will apply if the DoD is a primary user of a band selected as an alternate band in which to place incumbent users of the candidate bands.

B. Study Information Basic Requirements

1. **3G System Description.** The study will describe 3G system requirements and include: (1) nature of proposed use; (2) system technical characteristic description (as a minimum, the necessary information to perform sharing studies with candidate band systems); (3) spectrum required including channeling bandwidths and overall spectrum plans (includes segmentation of candidate bands) to cover regions or nationwide; (4) timing requirements for identification of spectrum; (5) planned geographical deployments; (6) interference thresholds (ITU based if available); (7) potential relationship with other countries' deployment of 3G and global roaming; (8) potential alternate spectrum band plans including any band segmentation; and (9) any operational considerations that will have a bearing on the evaluation of the sharing/relocation options below. FCC will provide this description.

2. **Candidate Band Incumbent System Description.** The studies will describe incumbent systems in the candidate bands including: (1) nature of use (what it is used for); (2) system technical characteristics description (as a minimum, the necessary information to perform sharing studies with 3G systems); (3) spectrum currently used, including channeling bandwidths and overall spectrum to cover regions or nationwide; (4) current geographical deployments; (5) planned geographical deployments; (6) system life expectancy; (7) planned replacement systems; (8) interference thresholds (ITU based if available); (9) unique operational features (e.g., it has to be located in a specific location, area or elevation; or it has a special relationship with other frequency bands such as a set separation between uplinks and downlinks); and (10) any operational considerations including national security and public safety that will have a bearing on the evaluation of the sharing or relocation options above. If any of the above information is classified or non-releaseable under the Freedom of Information Act or any other legislation, it will not be released to the public or contained in any unrestricted report. This information and subsequent use will be contained in a separate report accessible only to those having the necessary security clearances and/or need-to-know. FCC will provide the report on the 2500-2690 MHz band and the NTIA will provide the report on the 1755-1850 MHz band.

3. **Potential Alternate Bands.** When selecting alternate bands for incumbent users of candidate bands, consideration should first be given to those bands in which no, or minimum, disruption would occur to the incumbents in those bands. Also, the potential alternate bands should afford candidate band incumbent systems that may require replacement spectrum the capability to function without loss of functionality or necessary interoperability in the alternate band(s). The study will describe the alternate bands as to: (1) existing rules and regulations that govern the use of the bands; (2) the changes in allocation rules and regulations that would be necessary to make them acceptable to the candidate band incumbent users; (3) the relocation of alternate band incumbents if necessary; (4) the operational constraints on the alternate band incumbents or on the candidate band systems; and (5) any other considerations, including national security and public safety, in the use of the alternate bands that would have a negative effect on candidate band incumbent users.

C. Spectrum Sharing/Relocation Options

Using the information above, the study will include a technical evaluation of the following sharing/relocation options:

1. **System Sharing.** An evaluation of the current and planned systems in the candidate bands to share with 3G systems.

2. **Band/Channel Segmentation.**

The studies will assess the feasibility of dividing the candidate bands into segments and/or channels and evaluating how the incumbent and 3G systems would share these segments and/or channels to meet their respective radiocommunication requirements. The FCC will propose possible segmentation plans for both 1755-1850 and 2500-2690 MHz bands to evaluate as part of the interim band studies. These options may also consider use of the 1710-1755 and 2110-2160 MHz segments. Additional segmentation possibilities may be evaluated later in the process. 3G alternate plans and 1G/2G migration could have a bearing on this option.

Studies for both sharing and segmentation will use generally-accepted interference protection criteria, where available, for determining unacceptable levels of interference. Studies will also consider possible operational methods to mitigate potential interference while retaining the capability to perform the same mission or service in light of current requirements.

3. **Band/Channel Segmentation & Alternate Band Combination.** If the candidate bands could not support all requirements of the incumbents and 3G simultaneously, identification of alternate bands to satisfy requirements would be required.

4. **Alternate Bands Only.** Relocate incumbents to other bands if necessary.

5. **Other Options**. Potential combination of the above.

For each of options above, the evaluation will consider implementation of the option by the end of 2003, 2006, 2010 or any other variant that is costed out above.

D. Cost and Benefits

1. **Option Implementation Cost Estimates.** For each of the options in C. above, a cost estimate will be provided to include a description of the costs to implement the option or any iterations thereof and any associated assumptions. The estimates will include implementing the option by the end of 2003, 2006, 2010, or at times where there is a potential cost advantage to do so (an example might be that an incumbent system is scheduled to relocate to a different band in the future and there would be no new cost to relocate the incumbent; or by stopping any further build-outs of systems thereby reducing the costs to relocate future incumbents).

2. **Benefits.** An estimate will be made of the benefits, if any, including potential auction receipts that could be potentially realized as a result of the auction of the spectrum selected for 3G as well as the economic benefits. The assumptions made in the estimates will also be described. There may be a number of band options to be estimated.

3. **Cost and Benefits Analysis.** Based on 1 and 2 above, OMB/FCC/NTIA will perform a cost and benefits analysis for each option and implementation timeframe. An independent audit may be appropriate to evaluate the cost estimates.

4. **Costing Rules.** Both the FCC and NTIA will use consistent cost standards. OMB may have to delineate the portions of the cost estimates that may be disallowed.

E. Schedule

1. **3G Description.** FCC will provide the 3G description to NTIA so the options can be evaluated and reports completed as scheduled below.

2. **Reports and Content.**

a. **Interim Report - Nov 15, 2000**

(1) 3G description
(2) candidate band incumbent system description
(3) evaluation of system sharing and band segmentation options

b. **Final Report - Mar 01, 2001**

(1) information from Interim Report
(2) information on other bands
(3) description of alternate bands/relocation studies
(4) evaluation including costing and migration schedule for three time periods (2003, 2006, & 2010) for the two options in the interim report and the other options (segmentation & alternate band combination, alternate bands only, and other sharing/ segmentation/alternate band mixes)

c. Other Information - As required

IV. OUTREACH

The President's Memorandum instructs the Secretary of Commerce to work with government and industry representatives through a series of regular public meetings to develop recommendations and plans for identifying spectrum for 3G wireless systems. Additionally, it directs the Federal agencies that use the spectrum, and urges the FCC, to participate and cooperate with the government-industry group. NTIA, on behalf of the Secretary of Commerce, will act as the primary facilitator in the Department's outreach program. Each Federal agency will designate a person to represent the agency to attend these public meetings. The following activities are planned to carry out the President's direction:

A. Initial Ideas and Positions. NTIA will invite industry representatives to articulate their ideas and positions for selection of spectrum for 3G and to suggest industry initiatives to supplement this plan. Areas of discussion could include anticipated 3G spectrum requirements, band segmentation, 1G/2G/2.5G migration, alternate bands for incumbents, short and long range plans, and global roaming considerations. Representatives will be asked to submit their ideas and positions in writing. NTIA, on behalf of the Secretary of Commerce, will schedule an opportunity for industry representatives to explain their ideas and positions. Based on this initial information, subsequent meetings may be held.

B. Interim Reports. The FCC and NTIA will release their interim reports to the public on November 15. NTIA will ask industry for comments. Subsequent meetings may be held depending on the nature of the comments.

C. FCC Notice of Proposed Rulemaking (NPRM). The FCC plans to release a NPRM on 3G in December which will include information from the interim reports. The FCC will receive comments on the NPRM. The FCC and NTIA will hold joint information exchange meetings with industry representatives relative to the comments.

D. Final Report. The FCC and NTIA will release their final reports on March 1, 2001, describing all identified bands for 3G wireless use. Industry will be asked to comment on these reports.

V. <u>FCC PROCESS DESCRIPTION AND PLAN</u>

The FCC is responsible for allocating spectrum for non-government uses. The Commission allocates spectrum through the rule making process in accordance with the Administrative Procedures Act. The process generally begins when an organization or member of the public submits a petition for rule making requesting a change in the United States Table of Frequency Allocations contained in Section 2.806 of the FCC rules. The Commission issues a public notice inviting comment on such petitions. If the Commission finds that the petition has merit, it issues a Notice of Proposed Rule Making (NPRM). The public is afforded an opportunity to file comments which the Commission must consider before arriving at a final decision. The Commission then adopts a Report and Order that makes changes to the Table of Frequency Allocations as appropriate.

The Commission recently received two petitions for rule making requesting spectrum allocations for 3G mobile services. The Cellular Telecommunications Industry Association (CTIA) submitted a petition (RM-9920) asking the Commission to allocate spectrum for 3G terrestrial mobile services, and in particular to conduct studies to consider use of the 1755-1850 MHz and 2500-2690 MHz bands identified at WRC-2000. The Satellite Industry Association (SIA) submitted a petition (RM-9911) asking the Commission to allocate the 2500-2520 MHz and 2670-2690 MHz bands for the mobile satellite service for the mobile component of 3G services. Comments were filed on both petitions on September 12, 2000.

The Commission plans to initiate a Notice of Proposed Rule Making by the end of this year proposing spectrum allocations for fixed and mobile services that would be available for 3G terrestrial mobile services. It is anticipated that the Notice of Proposed Rule Making will consider the frequency bands identified in attachment 1. Further, the NPRM is expected to consider the future role of the cellular and PCS services in providing 3G services. The NPRM may consider other relevant frequency bands that may be used to serve the demand for 3G terrestrial services. A number of factors will be considered in developing proposed allocations, including the studies of 1755-1850 MHz and 2500 - 2690 MHz bands.

A Report and Order (R&O) is planned to be completed by July 2001 allocating spectrum for fixed and mobile services that will be available for 3G services. The allocation decisions will be based on the comments filed on the Notice of Proposed Rule Making and studies of the 1755 -1850 MHz and 2500 - 2690 MHz bands, and any other relevant information.

The Commission routinely coordinates frequency allocations that may affect government use of the spectrum with the NTIA. Because certain of the frequency bands of interest are allocated to the Federal Government, the Commission will closely coordinate both the NPRM and R&O with NTIA.

The spectrum allocation proceeding will be followed by another rule making proceeding to establish service rules. The service rule proceeding will be completed in time to complete auctions of the licenses by September 30, 2002.

VI. <u>OVERALL SCHEDULE</u>.

A.	Oct 13, 2000	President signs Memorandum to set the major milestones and guidance to the Federal Agencies and FCC
B.	**Oct 20, 2000**	Secretary of Commerce releases a plan to select spectrum for 3G to the public
C.	Oct 20-Nov15, 2000	Industry shares its ideas, positions, & supplemental plans on 3G spectrum selection.
D.	**Nov 15, 2000**	Secretary of Commerce and the FCC release their Interim band studies
E.	**Nov 15-30, 2000**	Industry provides comments on Interim Reports.
F.	Dec 31, 2000	FCC releases Notice of Proposed Rule Making (NPRM) to address 3G allocation issues.
G.	Mar 1, 2001	Final FCC/NTIA band studies completed and final reports describing all identified bands for 3G wireless use made available for public comment
H.	Mar 1 - Jun 15, 2001	NTIA/FCC will have information exchange meetings with industry.
I.	Mar 1 - Jun 15, 2001	NTIA/FCC will meet regularly during the formulation of the allocation order, and final draft will be coordinated between them.
J.	**Jul 30, 2001**	FCC issues an allocation order (specifies the bands selected for 3G) and a FNPRM on service & auction rules for allocated bands
K.	Dec 15, 2001	FCC issues Service & Auction rules for allocated bands
L.	Jun 15, 2002	FCC conducts the auction of 3G spectrum
M.	**Sep 30, 2002**	Assignment of licenses for 3G spectrum is completed.

Those items in "bold" are the major milestones that are contained in the President's Memorandum.

ATTACHMENT 1 TO APPENDIX 1.1

THE WHITE HOUSE

Office of the Press Secretary

For Immediate Release October 13, 2000

October 13, 2000

MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

SUBJECT: Advanced Mobile Communications/Third Generation Wireless Systems

The United States and the rest of the world are on the verge of a new generation of personal mobile communications, as wireless phones become portable high-speed Internet connections. The United States Government must move quickly and purposefully so that consumers, industry, and Government agencies all reap the benefits of this third generation of wireless products and services.

In less than 20 years, the U.S. wireless industry has blossomed from virtually nothing to one with 100 million subscribers, and it continues to grow at a rate of 25 to 30 percent annually. Globally, there are over 470 million wireless subscribers, a number expected to grow to approximately 1.3 billion within the next 5 years. It is an industry in which U.S. companies have developed the leading technologies for current and future systems. It is an industry whose products help people throughout the world communicate better and in more places, saving time, money, and lives.

Many saw the first generation of wireless -- cell phones -- as an extravagant way to make telephone calls. Yet as with all communications systems, the value of wireless communications increased as the number of users and types of use increased. Today's second generation wireless technology increased services and information offered to users and increased competition among providers. Digital "personal communications services" provide added messaging and data features, including such services as voice mail, call waiting, text messaging, and, increasingly, access to the World Wide Web. These first and second generation services increased productivity and reduced costs for thousands of businesses as well as Government agencies.

The next generation of wireless technology holds even greater promise. Neither the first nor the second generation of wireless technologies were designed for multi-media services, such as the Internet. Third generation wireless technologies will bring broadband to hand-held devices. Higher speeds and increased capability will lead to new audio, video, and other applications, which may create what many are calling "mobile-commerce" (m-commerce) that people will use in ways that are unimaginable today. Moreover, an international effort is underway to make it possible for the next generation of wireless phones to work anywhere in the world.

The Federal Government has always played a crucial role in the development of wireless services. To foster the development of cellular telephone service, the Federal Government made available radio frequency spectrum that had previously been used by other commercial and Government services. For the second generation -- digital PCS -- the Federal Government allocated spectrum in bands occupied by private sector users, and ensured competition by awarding numerous licenses, while maintaining technology neutrality.

The United States has also placed a high value on promoting Internet access. Government support for the development of third generation wireless systems will help combine the wireless revolution with the Internet revolution. As part of these efforts, radio spectrum must be made available for this new use. The United States has already been active by, among other things, participating at the World Radiocommunication Conference 2000 (WRC-2000) earlier this year. WRC-2000 adopted the basic principles of the U.S. position, which was negotiated by Government and industry stakeholders: (1) governments may choose spectrum from any one or all of the bands identified for third generation mobile wireless; (2) governments have the flexibility to identify spectrum if and when they choose; and (3) no specific technology will be identified for third generation services. This result will allow deployment of the best technologies and permit the United States to move forward with rapid deployment of third generation services in a way that advances all U.S. interests.

The spectrum identified by international agreement at WRC-2000, however, is already being used in the United States by commercial telecommunications, television, national defense, law enforcement, air traffic control, and other services. Similar difficulties in making spectrum available for third generation mobile wireless systems are evident in other parts of the world. Because different regions have already selected different bands, there almost certainly will be a few preferred bands rather than a single band for third generation services. In the United States, Federal Government agencies and the private sector must work together to determine what spectrum could be made available for third generation wireless systems.

Accordingly, I am hereby directing you, and strongly encouraging independent agencies, to be guided by the following principles in any future actions they take related to development of third generation wireless systems:

-- Third generation wireless systems need radio frequency spectrum on which to operate. Executive departments and agencies and the Federal Communications Commission (FCC) must cooperate with industry to identify spectrum that can be used by third generation wireless systems, whether by reallocation, sharing, or evolution of existing systems, by July 2001;

-- Incumbent users of spectrum identified for reallocation or sharing must be treated equitably, taking national security and public safety into account;

-- The Federal Government must remain technology-neutral, not favoring one technology or system over another, in its spectrum allocation and licensing decisions;

-- The Federal Government must support policies that encourage competition in services and that provide flexibility in spectrum allocations to encourage competition; and

-- The Federal Government must support industry efforts as far as practicable and based on market demand and national considerations, including national security and international treaty obligations, to harmonize spectrum allocations regionally and internationally.

I also direct the relevant agencies as follows:

1. I direct the Secretary of Commerce to work cooperatively with the FCC, as the agencies within the Federal Government with shared responsibility and jurisdiction for management of the radio frequency spectrum, to develop, by October 20, 2000, a plan to select spectrum for third generation wireless systems,

and to issue, by November 15, 2000, an interim report on the current spectrum uses and potential for reallocation or sharing of the bands identified at WRC-2000 that could be used for third generation wireless systems, in order that the FCC can identify, in coordination with the National Telecommunications and Information Administration, spectrum by July 2001, and auction licenses to competing applicants by September 30, 2002.

2. I also direct the Secretary of Commerce to work cooperatively with the FCC to lead a government-industry effort, through a series of regular public meetings or workshops, to work cooperatively with government and industry representatives, and others in the private sector, to develop recommendations and plans for identifying spectrum for third generation wireless systems consistent with the WRC-2000 agreements, which may be implemented by the Federal Government.

3. I direct the Secretaries of Defense, the Treasury, Transportation, and the heads of any other executive department or agency that is currently authorized to use spectrum identified at WRC-2000 for third generation wireless services, to participate and cooperate in the activities of the government-industry group.

4. I direct the Secretary of State to participate and cooperate in the activities of the government-industry group, and to coordinate and present the evolving views of the United States Government to foreign governments and international bodies.

Furthermore, I strongly encourage the FCC to participate in the government-industry outreach efforts and to initiate a rule-making proceeding to identify spectrum for third generation wireless services that will be coordinated with the Assistant Secretary of Commerce for Communications and Information during the formulation and decision making process with the goal of completing that process by July 2001, so that such spectrum can be auctioned to competing applicants for licenses by September 30, 2002.

WILLIAM J. CLINTON

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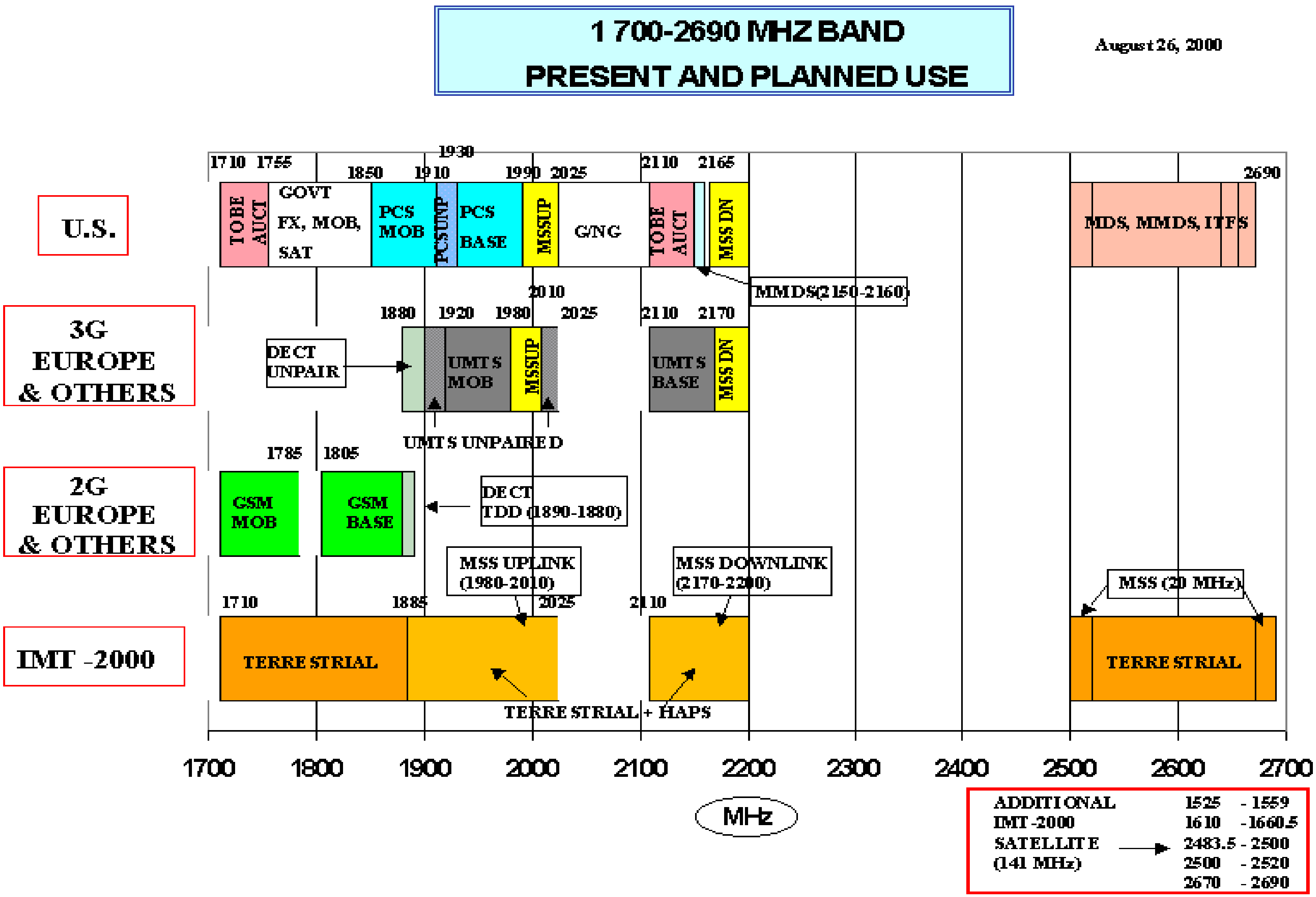
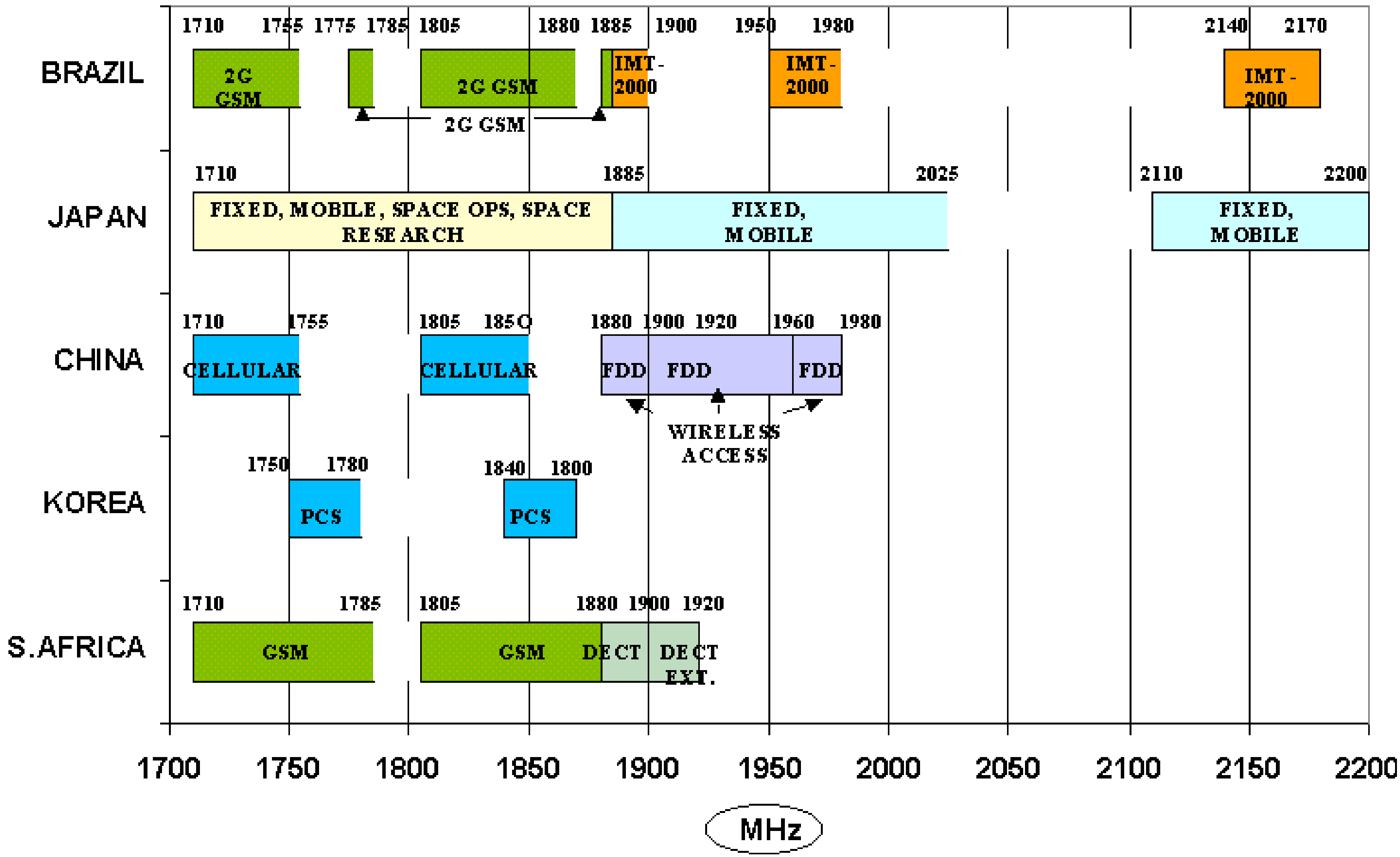
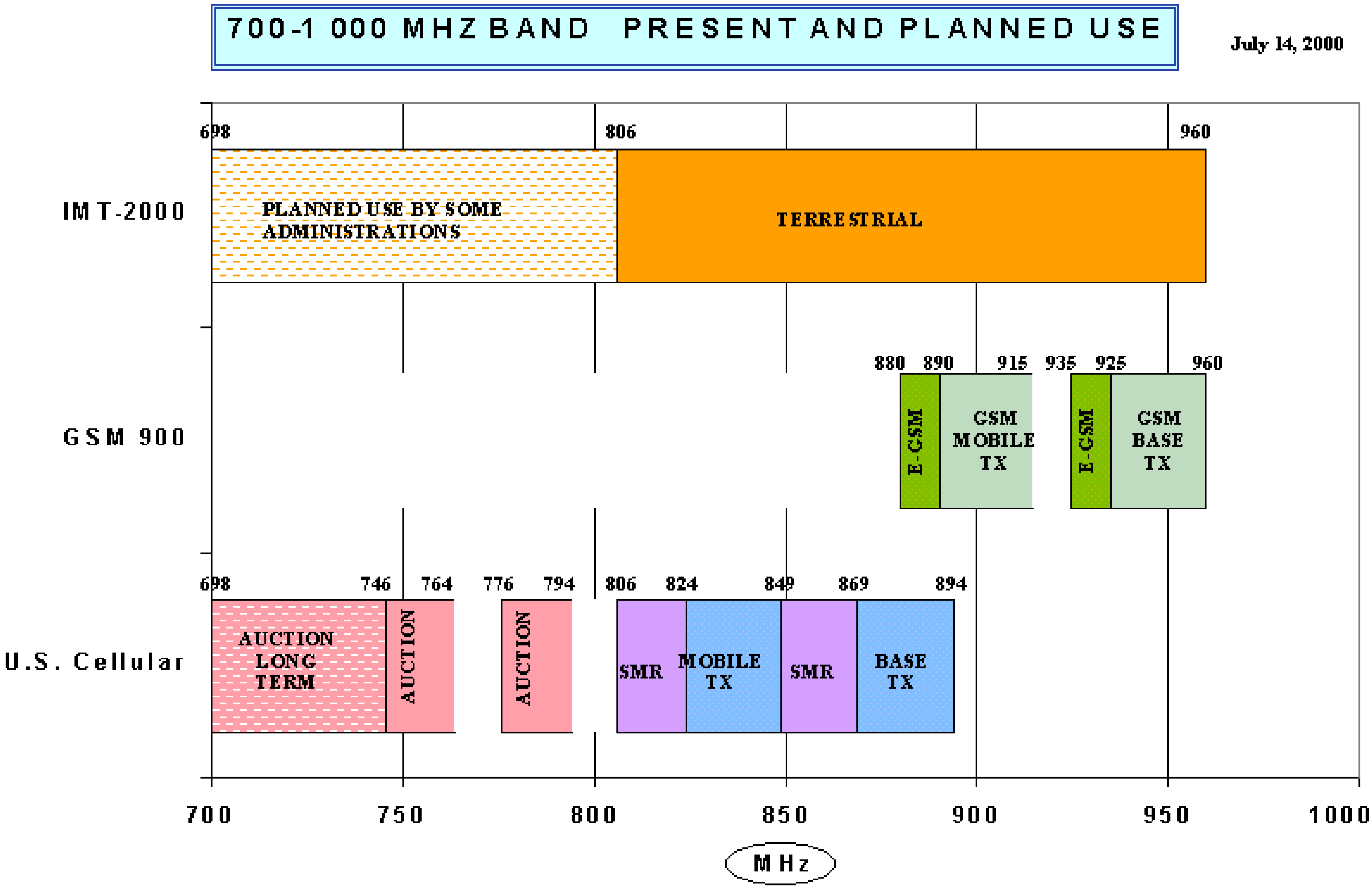
ATTACHMENT 2 TO APPENDIX 1.1
SPECTRUM CHARTS



1 700-2 200 MHZ BAND PRESENT AND PLANNED USE

July 14, 2000




700-1 000 MHZ BAND PRESENT AND PLANNED USE
July 14, 2000
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PLANNED USE BY SOME ADMINISTRATIONS
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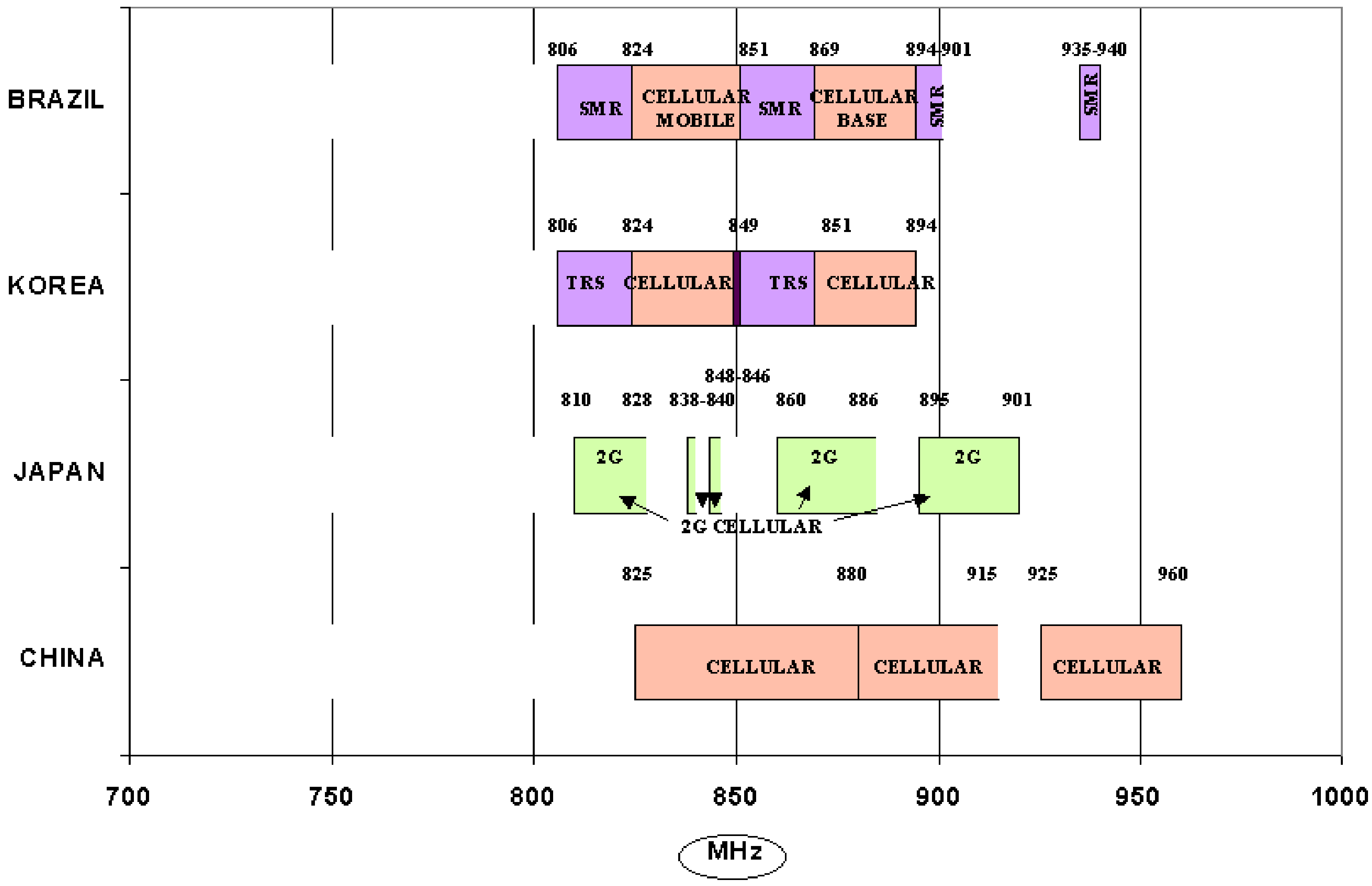
700-1 000 MHZ BAND PRESENT AND PLANNED USE

August 2, 2000



ATTACHMENT 3 TO APPENDIX 1.1
Spectrum Use Summary in the United States
(October 18, 2000)

1. **698-746 MHz (TV channels 52 - 59) Band.** This spectrum is allocated in Region 2, which includes the United States, on a primary basis to the Broadcasting and on a secondary basis to the Fixed and Mobile Services. In addition, within the 698-746 MHz band segment, assignments may be made to television stations using frequency modulation in the Broadcasting-satellite Service subject to agreement between administrations concerned and those having services that might be affected. This spectrum is currently designated as TV channels 52-59 and is used by existing analog full service stations, Low Power TV stations, TV translator and booster stations, and new DTV television stations. In the United States, this band is allocated on a primary basis to the Broadcasting Service. This band is also allocated to the Fixed Service to permit subscription television operations. Further, TV broadcast licensees are permitted to use subcarriers on a secondary basis for both broadcast and non-broadcast purposes. The Balanced Budget Act of 1997 requires this spectrum to be reallocated and auctioned by September 30, 2002. Existing TV service and the service of new digital television (DTV) stations will continue on channel allotments in this band until at least December 31, 2006, when the transition to DTV service is scheduled to end and all television stations are to be located on channels in the DTV core spectrum (Channels 2-51). Television stations will cease operations on these channels at the end of the DTV transition, or possibly later on a market-by-market and channel-by-channel basis, depending on the availability of DTV television service and receivers. The rules for any new services on 698-746 MHz frequencies provide for the protection of those stations during the DTV transition. The WRC results recognize that some administrations may choose to provide for 3G services in this spectrum.

2. **746-806 MHz (TV Channels 60-69) Band**. The Federal Communications Commission (FCC) has reallocated this spectrum in accordance with the 1997 Balanced Budget Act. Specifically, the 36 megahertz of spectrum at 746-764 MHz and 776-794 MHz (TV channels 60-62 and 64-66) was reallocated for fixed, mobile and new broadcast services for commercial uses. The 24 megahertz of spectrum at 764-776 MHz and 794-806 MHz (TV channels 63-64 and 68 - 69) were reallocated to the fixed and mobile services for use by public safety. Segments of the 746-764 MHz and 776-794 MHz bands, totaling 6 megahertz and referred to as the public safety guard bands, were recently auctioned. Cellular-type systems are prohibited in the guard bands in order to protect public safety operations against adjacent channel interference, and therefore this spectrum is not suitable for 3G systems. However, the remaining 30 megahertz of spectrum may be used for 3G services. This spectrum is planned for auction by March 6, 2001. The WRC results recognize that some administrations may choose to provide for 3G services in this spectrum.

3. **806-960 MHz Band.** WRC 2000 adopted a footnote S5.XXX to the international table of frequency allocation stating that Administrations wishing to implement International Mobile Telecommunications-2000 (IMT-2000) may use those parts of the band 806-960 MHz which are allocated to the mobile service on a primary basis and are used or planned to be used for mobile systems (see Resolution 224 (WRC-2000)). The footnote also states that this identification does not preclude the use of these bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. In keeping with its principle that existing mobile operators should be free to evolve to IMT-2000 and beyond as the market demands, any band available for 1st or 2nd generation systems is also available in the United States for IMT-2000 or other advanced communications applications. In the United States, these bands include 806-821 / 851-866 MHz for the Specialized Mobile Radio Services (SMRs) and 824-849 / 869-894 for the cellular radio service. The Commission's planned Notice of Proposed Rule Making is expected to consider the extent to which the existing SMR and cellular radio

services may meet the demand for 3G services. The Notice may also consider parts of the 806 - 960 MHz band that are used by other radio services.

4. **1710-1755 MHz Band.** This band is currently allocated on a primary basis for Federal Government Fixed and Mobile Services. In addition, radio astronomy services may use the 1718.8-1722.2 MHz band segment on an unprotected basis. This band is currently used for Government point-to-point microwave communications, military tactical radio relay, and airborne telemetry systems. NTIA identified this spectrum for transfer to the FCC for non-government use, effective in 2004, to satisfy the requirements of the Omnibus Budget Reconciliation Act of 1993 (OBRA 93). NTIA indicates that, as required under OBRA 93, all microwave communication facilities in the 1710-1755 MHz band that are operated by Federal power agencies will continue to operate in the band and must be protected from interference. A list of exempted Federal power agency microwave systems, as well as 17 Department of Defense sites, is presented in Appendix E of the 1995 NTIA Spectrum Report. The Balanced Budget Act of 1997 (BBA 97) requires this spectrum to be assigned for commercial use by competitive bidding, with the auction to commence after January 1, 2001 and to be completed by September 30, 2002.

5. **1755-1850 MHz Band.** The 1755-1850 MHz band supports four main Federal functions; space telecommand, tracking and control (TT&C, or space operations), medium capacity fixed microwave, tactical radio relay training, and aeronautical mobile applications such as telemetry, video and target scoring systems. This band is allocated on an exclusive basis to the Federal Government for fixed and mobile services, and in the 1761-1842 MHz portion, used for space operations. Fixed links are operated by federal agencies for voice, data, and/or video communications where commercial service is unavailable, excessively expensive, or unable to meet required reliability. Applications include law enforcement, emergency preparedness, supporting the National air space system, military command and control networks, and control links for various power, land, water, and electric-power management systems. Other specified fixed links include video relay, data relay, and timing distribution signals

Probably the most critical system in the band is the USAF Space Ground Link Subsystem (SGLS). This system, via Earth-to-space uplinks in the 1761-1842 MHz band, controls the U.S. military satellites, including telecommunications satellites, intelligence gathering satellites, the Global Positioning System (GPS) satellite constellation, and satellites of other Government agencies and U.S. allies. These satellites provide space-based capabilities that are critical to the execution of all US military operations. The satellites already in use that are associated with SGLS are not capable of being modified to operate to accommodate another frequency and would have to be replaced by new satellites. SGLS operations must continue to control these on-orbit assets for the duration of their life spans; which for some may extend beyond 2017.

Air Combat Training (ACT) systems are also used extensively in this band segment. ACT systems are more complex by the nature of their operations, as both fixed and aeronautical mobile equipment are used. Air Force and Navy operate ACT systems. The DoD has stressed that training support systems such as these are key elements in the military's effort to provide realistic simulation and combat preparedness for pilot training in a peacetime environment.

Fixed links are operated by federal agencies for voice, data, and/or video communications where commercial service is unusable. Applications include law enforcement, emergency preparedness, support for the National air space system, military command and control networks, and control links for various power, land, water, and electric-power management systems. Other specified fixed links include video relay, data relay, and timing distribution signals.

The Mobile Subscriber Equipment is a multi-band, tactical line-of-sight microwave radio system, more accurately described as a "system-of-systems", because it is composed of several components which are fully operational systems. The individual components that make up the Mobile Subscriber Equipment are dependent upon several portions of the radio frequency spectrum (e.g., 30-88 MHz, 225-400 MHz, 1350-1850 MHz, and 14.5-15.35 GHz). The inability of any of these components to operate successfully would result in the failure of the overall Mobile Subscriber Equipment "system". One critical component of Mobile Subscriber Equipment, the AN/GRC-226(V)2 Radio, is dependent on the 1755-1850 MHz band. It is used to connect Radio Access Units (RAU) in the AN/TRC-190 series, to the Node Center Switch (AN/TTC-47) of the network. Operational use plans call for 465 units per Army Corps, giving a total of 2,325 units for 5 Corps.

6. **1850-1990 MHz Band (present PCS bands).** RR S5.388, which was adopted at WRC-92, states that the band 1885-2025 MHz is intended for use, on a worldwide basis, by administrations wishing to implement IMT-2000, and that such use does not preclude the use of the band by other services to which it is allocated. In the United States the band 1850 - 1990 MHz is allocated for the Personal Communications Service (PCS). The Commission's planned Notice of Proposed Rule Making is expected to consider the extent to which the PCS may meet the demand for 3G services. The 1990 - 2025 MHz band was recently reallocated for mobile satellite services that are expected to partly satisfy the satellite component of 3G services.

7. **2110-2150 MHz Band.** RR S5.388, which was adopted at WRC-92, states that the band 2110-2200 MHz is intended for use, on a worldwide basis, by administrations wishing to implement IMT-2000, and that such use does not preclude the use of the band by other services to which it is allocated. Domestically, the FCC has identified the 2110-2200 MHz band for reallocation from the fixed service for new emerging technologies. The 2165-2200 MHz segment of this band was recently reallocated for the mobile satellite service. BBA-97 requires reallocation of the 2110-2150 MHz band and assignment by competitive bidding by September 30, 2002.

8. **2500-2690 MHz Band.** The two major services in the 2500-2690 MHz band are the Multichannel Multipoint Distribution System (MDS), and the Instructional Television Fixed Service (ITFS)**.** There are currently thirty-three 6 MHz channels, or 198 MHz of spectrum, allocated to MDS and ITFS. MDS utilizes two channels in the 2150 to 2160 MHz band. MDS and ITFS share spectrum in the 2500 to 2686 MHz band.

MDS licensees transmit programming from one or more fixed stations, which is received by multiple receivers at various locations. Nation-wide, there are over 2500 licenses for MDS in the band. Licenses are granted on an area-wide basis, utilizing Basic Trading Areas. Formerly, MDS licensees used their channels to provide a multichannel video programming service, so-called "wireless cable." Approximately one million homes currently receive multichannel video programming service from MDS/ITFS-based wireless cable systems. However, the MDS frequencies, located in the 2.1 and 2.5-2.7 GHz bands, also are suited for the high-speed, high-capacity delivery of broadband access to data, voice and Internet service. The primary current and future uses of MDS will be to deliver this access. Rather than being hardwired like the local telephone companies and local cable systems, MDS uses microwave frequencies. Like broadcast television, MDS is transmitted from a broadcast tower, usually located on a mountain or tall building, to special antennas on residences or businesses throughout a local market. In the two-way environment, system configurations will be based on a "cellularized" plan, using series of hub and booster stations to link various main stations to individual subscribers and to relay transmissions throughout the system.

The other major service in the band is the ITFS, which is regulated under Part 74, Subpart I of the Commission's Rules. ITFS channels are from 2500 to 2596 MHz, and interleaved with MDS channels above 2644 MHz. Of the 31, six-megahertz channels in the MDS/ITFS spectrum band, the FCC licenses twenty of these channels to non-profit educational entities. ITFS stations are currently utilized for a wide variety of educational services by schools, hospitals and other educational facilities. In addition, ITFS unused channels can be used for the same kind of broadband services discussed above and excess capacity on those channels may be leased to MDS operators. Partnerships have developed between ITFS spectrum holders and MDS companies that provide expertise, revenue, and access to hardware and software to ITFS partners, to better enable them to build their distance learning programs.

In the last two years, the spectrum has undergone significant changes. In September 1998, the FCC amended its rules to facilitate the provision of two-way communication services by MDS and ITFS licensees. When MDS is used for two-way service, it becomes a viable broadband service delivery option. Implemented two-way systems can provide advanced, ultra-high speed, high-capacity broadband data and Internet services to households and business subscribers, as well as voice service to households in competition with local exchange carriers. The new rules still contemplate fixed service, even for two-way operations. The initial filing window for two-way service occurred from August 14, 2000 until August 18, 2000 and approximately 3,000 applications were received.

APPENDICES

FOR

SECTION 2

APPENDIX 2.1

Industry Working Group
on 3G Characteristics

Report

Characteristics of International Mobile Telecommunications (IMT) 2000 Technology

Chair: Gerry Flynn
20 February 2001

Executive Summary

The goal of this industry group is to review/update the 3G system characteristics in order to ensure that the characteristics utilized for the analysis of sharing between IMT-2000 and other systems represent the most accurate information of 3G systems. Attached below is the table of characteristics that represent the current systems, much of this information is the same as found in ITU-R Recommendation 1457 “Detailed specifications of the radio interfaces of international mobile telecommunications-2000 (IMT-2000)”. This recommendation in turn points to the approved standards that have been developed by the appropriate standards bodies.

TABLE 1. CHARACTERISTICS OF IMT-2000 MOBILE STATIONS

Parameter	CDMA-2000 1X	CDMA-2000 3X	UWC-136 (TDMA)[l**]		TD-CDMA [21,22,23,24]	W-CDMA [23]
Carrier Spacing	1.25 MHz	3.75 MHz	30 kHz [14]	200 kHz [7]	5 MHz (nominal)	5 MHz +/- n*0.2MHz [6]
Duplex Method	FDD	FDD	FDD	FDD	TDD	FDD
Transmitter Power, (typical)	100 mW	100 mW	100 mW	100 mW	100 mW	100mW
Transmitter Power, (maximum)	250mW	250mW	1 W [15]	1 W [8]	250 mW	250 mW or 125mW [1]
Antenna Gain	0 dBi	0 dBi	0 dBi	0 dBi	0 dBi	0 dBi
Antenna Height	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m
Access Techniques	CDMA	CDMA	TDMA [15]	TDMA[m]	TDMA/CDMA	CDMA[j]
Data Rates Supported	153.6 kbps (standard supports up to 625.35 kbps on forward link and up to 433.35 on reverse link)kbps	460.8 kbps (standard supports up to 2084.55. kbps on forward link and up to 1354.95 on reverse link)kbps	13.0 kbps (π/4 DQPSK) 19.95 kbps (8-PSK downlink) 18.6 kbps (8-PSK uplink)	144 kbps [9] 384 kbps	Pedestrian: 144 kbps Vehicular: 384 kbps Indoors: 2 Mbps	Pedestrian: 144 kbps Vehicular: 384 kbps Indoors: 2 Mbps
Modulation Type	QPSK/BPSK	QPSK/BPSK	π/4-DQPSK 8-PSK	GMSK 8-PSK	QPSK	HPSK[o]

** UWC-136 consists of three components: enhancements to the 30 kHz channels (designated as 136+) for advanced voice and data capabilities, a 200 kHz carrier component for high speed data (384 kbit/s) accommodating high mobility (designated as 136HS Outdoor), and a 1.6 MHz carrier component for very high speed data (2 Mbit/s) in low mobility applications (designated as 136HS Indoor). The combined result constitutes the IMT-2000 Radio Interface referred to as UWC-136.

Emission Bandwidth	1250 < |f – fc| < 1980 kHz, -42 dBc in 30 kHz; 1980 < |f – fc|, -50 dBc in 30 kHz;	2,5 MHz < |f – fc| < 2.7 MHz, -14 dBm in 30 kHz; 2,7 MHz < |f – fc| < 3.5 MHz, -(14+15(f-fc-2.7 MHz)) dBm in 30 kHz; 3.5 MHz < |f – fc| < 7.5 MHz, -(13+(f-fc-3.5 MHz)) dBm in 1 MHz; 7.5 MHz < |f – fc| < 8.5 MHz, -(13+10(f-fc-7.5 MHz)) dBm in 1 MHz; 8.5 MHz < |f – fc| -27 dBm in 1 MHz	See [17]		cf. Section 6.6 of [21]	See [4]
-3 dB				0.12 MHz [10], 0.12 MHz [11]		
-20 dB				0.18 MHz [10], 0.18 MHz [11]		
-60 dB				0.40 MHz [10], 0.60 MHz [11]		
Receiver Noise Figure, (worst case)	9 dB	9 dB	9 dB	9 dB	9 dB	9 dB
Antenna Temperature, (kTb)[g]			-128 dBm [b]	-121 dBm [b]	-108 dBm in 3.84 MHz	-108 dBm[i]
Receiver Thermal Noise Level	125. dBm[a] -113 dBm -104 dBm[b]	-125 dBm[a] -108 dBm -99 dBm[b]	-119 dBm	-112 dBm	-99 dBm/3.84 MHz	-99 dBm
Receiver Bandwidth			See [18]	See [12]	Unavailable, < 5 MHz	See [5]
-3 dB						
-20 dB						
-60 dB						
E_b/N_o for $P_e = 10^{-3}$	4 dB for 1% FER for 9600 bps speech services 1.9 dB for 1%FER in AWGN 3.9 dB for 5% FER in slow fading channel (nominal supported rate)	performance not available	7.8 dB	8.4 dB	3 dB (single antenna, equivalent rate ½ code)	3.1 dB*

Receiver Sensitivity[c]	-104 dBm Total received power in fully loaded system. Single 9600 bps traffic channel is at –119.6 dBm in AWGN for 1% FER	-99 dBm Total received power in fully loaded system Single 9600 bps traffic channel is at –119.6 dBm in AWGN for 1% FER	-113 dBm [19]	-102 dBm [9]	-105 dBm (cf. Table 7.2, [21])	-106 dBm See [3] [k]
Interference Threshold 1[d]	-110 dBm in 1.25 MHz	-105 dBm in 3.75 MHz	No equivalent	See [13]	-111 dBm in 3.84 MHz	-105dBm [f]
Interference Threshold 2[e]	-94 dBm in 1.25 MHz	-90 dBm in 3.75 MHz	No equivalent	See [13]	-92 dBm in 3.84 MHz	-89 dBm [f]

[a]in bandwidth equal to data rate : for 1x and 3x CDMA2000, values are given for 9600 bps speech services and nominal supported rate (153.6 kbps) for data services.

[b]in receiver bandwidth
[c]For a 10^{-3} raw bit error rate, theoretical E_b/N_o
[d]Desired signal at sensitivity, I/N = -6 dB for a 10 percent loss in range
[e]Desired signal 10 dB above sensitivity, S/(I+N) for a 10^{-3} BER
[f] Let N = receiver thermal noise = -99 dBm for WCDMA. Let S = receiver sensitivity = -106 dBm for WCDMA. See also explanatory note [f] in Table 2

[g] ^{10}Log(kTb) + 30 (dBm), where k = Boltzman's constant = 1.38e-23, T = reference temperature = average Earth temperature = 277 K, b = noise equivalent bandwidth (Hz).

[h] The above antenna temperature plus the worst-case receiver noise figure.

[i] b = chip rate = 3.84e6 chips/sec.

[j] Chip rate = 3.84e6 chips/sec.

[k] Reference sensitivity for bit error ratio (BER) not to exceed 10e-3 for specified values of energy per chip (Ec) = -117 dBm and received power spectral density (Ior) = -107 dBm measured at mobile station antenna connector.

[l] A nominal operational frequency band of 1900 MHz is assumed.

[m] TDMA, comprising 8 timeslots (577 us) per single TDMA frame (4.615 ms). For user packet data service, 1-4 timeslots per frame may be used by mobile stations having multi-slot classes that do not require simultaneous transmission and reception, i.e. classes for which a duplexer is not required.

[n] Data rate on a per-timeslot basis.

[o] Hybrid Phase Shift Keying: a method peculiar to UMTS WCDMA in which the peak to average ratio is reduced in comparison to a QPSK signal by mixing the orthogonal variable spreading factor (OSVF) with both information sources as real signals, i.e. those destined for I and Q modulation components, and then shifting one component by 90 degrees to produce an equivalent imaginary signal and then utilizing gain control on the Q channel to preserve orthogonality.

* Assumes Eb/No for Pe = 10E-6 without diversity

Table 2. Characteristics of IMT-2000 Base Stations

<table>
<tr><th>Parameter</th><th>CDMA-2000
1X</th><th>CDMA-2000
3X</th><th colspan="2">UWC-136
(TDMA)**
EDGE</th><th>TD-CDMA
[21,22,23,24]</th><th>W-CDMA
[23]</th></tr>
<tr><td>Operating Bandwidth</td><td>1.25 MHz</td><td>3.75 MHz</td><td>30 kHz</td><td>200 kHz</td><td>5 MHz (nominal)</td><td>5 MHz +/- n*0.2MHz</td></tr>
<tr><td>Duplex Method</td><td>FDD</td><td>FDD</td><td>FDD</td><td>FDD</td><td>TDD</td><td>FDD</td></tr>
<tr><td>Transmitter Power</td><td>10 W</td><td>10 W</td><td>10 W</td><td>10 W</td><td>10 W</td><td>10 W</td></tr>
<tr><td>Antenna Gain</td><td>17 dBi per 120 deg. sector</td><td>17 dBi per 120 deg. sector</td><td>17 dBi per 120 deg. sector</td><td>17 dBi per 120 deg. sector</td><td>17 dBi per 120 deg. sector</td><td>17 dBi per 120 deg. sector</td></tr>
<tr><td>Antenna Height</td><td>40 m</td><td>40 m</td><td>40 m</td><td>40 m</td><td>40 m</td><td>40 m</td></tr>
<tr><td>Tilt of Antenna</td><td>2.5 degs down</td><td>2.5 degs down</td><td>2.5 degs down</td><td>2.5 degs down</td><td>2.5 degs down</td><td>2.5 degs down</td></tr>
<tr><td>Access Techniques</td><td>CDMA</td><td>CDMA</td><td>TDMA</td><td>TDMA</td><td>TDMA/CDMA</td><td>CDMA</td></tr>
<tr><td>Data Rates Supported</td><td>153.6 kbps (standard supports up to 625.35 kbps on forward link and up to 433.35 on reverse link)</td><td>460.8 kbps (standard supports up to 2084.55. kbps on forward link and up to 1354.95 on reverse link)</td><td>30 kbps
44 kbps</td><td>384 kbps</td><td>Pedestrian: 144 kbps
Vehicular: 384 kbps
Indoors: 2 Mbps</td><td>Pedestrian: 144 kbps
Vehicular: 384 kbps
Indoors: 2 Mbps</td></tr>
<tr><td>Modulation Type</td><td>QPSK/BPSK</td><td>QPSK/BPSK</td><td>π/4-DQPSK
8-PSK</td><td>GMSK
8-PSK</td><td>QPSK</td><td>QPSK</td></tr>
<tr><td>Emission Bandwidth</td><td>885 < |f – fc| < 1250 kHz, -45 dBc in 30 kHz; 1250 < |f – fc| < 1980 kHz, min (-45 dBc in 30 kHz, -9dBm in 30 kHz); 1980 < |f – fc| < 2250 kHz, -55 dBc in 30 kHz; 2250 < |f – fc, -13 dBm in 1 MHz</td><td></td><td></td><td></td><td>cf. Section 6.6.2 of [22]</td><td></td></tr>
<tr><td>-3 dB</td><td></td><td></td><td>0.03 MHz</td><td>0.18 MHz</td><td></td><td>3 GPP</td></tr>
<tr><td>-20 dB</td><td></td><td></td><td>0.03 MHz</td><td>0.22 MHz</td><td></td><td>TS25.104</td></tr>
<tr><td>-60 dB</td><td></td><td></td><td>0.04 MHz</td><td>0.24 MHz</td><td></td><td></td></tr>
<tr><td>Receiver Noise Figure, (worst case)</td><td>5 dB</td><td>5 dB</td><td>5 dB</td><td>5 dB</td><td>5 dB</td><td>5 dB</td></tr>
</table>

** UWC-136 consists of three components: enhancements to the 30 kHz channels (designated as 136+) for advanced voice and data capabilities, a 200 kHz carrier component for high speed data (384 kbit/s) accommodating high mobility (designated as 136HS Outdoor), and a 1.6 MHz carrier component for very high speed data (2 Mbit/s) in low mobility applications (designated as 136HS Indoor). The combined result constitutes the IMT-2000 Radio Interface referred to as UWC-136.

Receiver Thermal Noise Level	-129 dBm -117dBm[a] -108 dBm[b]	-129 dBm -112 dBm[a] -103 dBm[b]	-125 dBm[a]	-117 dBm[a]	-113 dBm at 384 kbps	-113 dBm in 384 kbps
Receiver Bandwidth					Unavailable, < 5 MHz	
-3 dB			0.03 MHz	0.18 MHz		
-20 dB			0.04 MHz	0.25 MHz		Reference
-60 dB			0.09 MHz	0.58 MHz		Reference
E_b/N_o for $P_e = 10^{-3}$	6.0 dB for 0.3% FER for 9600 bps speech services in AWGN. 4.9 dB for 2.4% FER in AWGN, 4.3 dB for 2.5% FER in slow fading for nominal supported rate	performance not available	7.8 dB	8.4 dB	3 dB (single antenna, equivalent ½ rate code)	3.4 dB*
Receiver Sensitivity[c]	-119 dBm for Fundamental channel in AWGN	-119 dBm for Fundamental channel in AWGN	-117 dBm	-108.Bm	-109 dBm (cf. Table 7.1 of [22])	-110 dBm
Interference Threshold 1[d]	-114 dBm in 1.25 MHz	-109 dBm in 3.75 MHz	-131 dBm	-123 dBm	-115 dBm in 3.84 MHz	See note[f]
Interference Threshold 2[e]	-98 dBm in 1.25 MHz	-93 dBm in 1.25 MHz	-115 dBm	-107dBm	-96 dBm in 3.84 MHz	See note[f]

[a]in bandwidth equal to data rate : for 1x and 3x CDMA2000, values are given for 9600 bps speech services and nominal supported rate for data services.
[b]in receiver bandwidth
[c]For a 10^{-3} raw bit error rate, theoretical E_b/N_o
[d]Desired signal at sensitivity, I/N = -6 dB for a 10 percent loss in range
[e]Desired signal 10 dB above sensitivity, S/(I+N) for a 10^{-3} BER
[f] The thermal noise figure for a W-CDMA receiver is –108dBm based on kTf where k is Boltzman's constant (1.38E-23), T is the temperature in Kelvin and f is the bandwidth in Hertz. For a noise figure of 4dB (typical value for a base station receiver), the thermal noise becomes –104dBm. However receiver sensitivity depends on the service (voice, packet etc.). For example, the voice (DTCH 32) sensitivity for the base station receiver is –121 dBm for BER < 0.001

* Assumes Eb/No for Pe = 10E-6 without diversity

Table 3. IMT-2000 Traffic Model Characteristics[a]

Parameter	Value
Traffic Environments	Rural Vehicular Pedestrian In-building (Central business district)
Maximum Data Rates	Rural - 9.6 kbps Vehicular - 144 kbps Pedestrian - 384 kbps In-building - 2 Mbps
Cell Size	Rural - 10 km radius Vehicular - 1000 m radius Pedestrian - 315 m radius In-building - 40 m radius
Users per cell during busy hour	Rural - not significant Vehicular - 4700 Pedestrian - 42300 In-building - 1275
Percent of total uplink traffic >64 kbps during busy hour	Rural - not significant Vehicular - 34% Pedestrian - 30% In-building - 28%
Percent of total downlink traffic >64 kbps during busy hour	Rural - not significant Vehicular - 78% Pedestrian - 74% In-building - 73%
Average number of users per cell per MHz during busy hour assuming frequency duplex operation	Rural - not significant Vehicular < 64 kbps - 16 > 64 kbps - 4 Pedestrian < 64 kbps - 150 > 64 kbps - 64 In-building < 64 kbps - 4 > 64 kbps - 2

[a] Values in the table are for a mature network.

Table 4. Rate of IMT-2000 Network Development[a]

	Calendar Year		
Local Environment	2003	2006	2010
Urban	10%	50%	90%
Suburban	5%	30%	60%
Rural	0%	5%	10%

[a] For some interactions the potential for interference will be influenced by the degree to which IMT-2000 networks are built out. Table 4 identifies assumptions that will be used in the assessments with respect to the degree to which US IMT-2000 networks are developed following the granting of licenses. The levels of aggregate emissions for a fully mature IMT-2000 environment will be taken from ITU-R 687.2 or other reference material as appropriate.

II. REFERENCES:

[1] "3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; UE Radio Transmission and Reception", (3G Technical Specification 25.101), clause 6.2.1. User equipment (UE) power specified for power class II and III.

[2] "3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; UE Radio Transmission and Reception", (3G Technical Specification 25.101), clause 8.3.1.

[3] "3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; UE Radio Transmission and Reception", (3G Technical Specification 25.101), clause 7.3.1.

[4] "3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; UE Radio Transmission and Reception", (3G Technical Specification 25.101), clause 6.6.2.1.1:

The power of any UE emission shall not exceed the levels specified in Table 6.10

Table 6.10: Spectrum Emission Mask Requirement

Frequency offset from carrier Δf	Minimum requirement	Measurement bandwidth
2.5 - 3.5 MHz	-35 -15*(Δf – 2.5) dBc	30 kHz *
3.5 - 7.5 MHz	-35- 1*(Δf-3.5) dBc	1 MHz *
7.5 - 8.5 MHz	-39 - 10*(Δf – 7.5) dBc	1 MHz *
8.5 - 12.5 MHz	-49 dBc	1 MHz *

[5] "3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; UE Radio Transmission and Reception", (3G Technical Specification 25.101), clause 7.6.1:

The BER shall not exceed 0.001 for the parameters specified in Table 7.6 and Table 7.7. For Table 7.7 up to (24) exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a 1 MHz step size.

Table 7.6: In-band blocking

Parameter	Unit	Offset	Offset
DPCH_Ec	dBm/3.84 MHz	-114	-114
$\hat{I}_{or}$	dBm/3.84 MHz	-103.7	-103.7
$I_{blocking}$ (modulated)	dBm/3.84 MHz	-56	-44
F_{uw} (offset)	MHz	+10 or –10	+15 or –15

NOTE definitions:

$DPCH\_E_c$	Average energy per PN chip for DPCH.
$\hat{I}_{or}$	The received power spectral density of the down link as measured at the UE antenna connector.

[6] "3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; UE Radio Transmission and Reception", (3G Technical Specification 25.101), clause 5.4.1.

[7] "RF Minimum performance requirements 136HS Outdoor and 136HS Indoor Bearers", (TR45 technical specification, TIA/EIA-136-290), clause 2.

[8] "RF Minimum performance requirements 136HS Outdoor and 136HS Indoor Bearers", (TR45 technical specification, TIA/EIA-136-290), clause 4.1.1.2. Refers to Power Class II mobile station.

[9] "RF Minimum performance requirements 136HS Outdoor and 136HS Indoor Bearers", (TR45 technical specification, TIA/EIA-136-290), clause 6.2. Specifies data rates and reference sensitivity. Reference sensitivity listed for 144 kb/s at a 10% block erasure rate (BLER).

[10] "RF Minimum performance requirements 136HS Outdoor and 136HS Indoor Bearers", (TR45 technical specification, TIA/EIA-136-290), Table A3a: Modulation and noise spectrum mask due to GMSK modulation. Measurement bandwidth is 30 kHz.

[11] "RF Minimum performance requirements 136HS Outdoor and 136HS Indoor Bearers", (TR45 technical specification, TIA/EIA-136-290), Table A3b: Modulation and noise spectrum mask due to 8-PSK modulation. Measurement bandwidth is 30 kHz.

[12] "RF Minimum performance requirements 136HS Outdoor and 136HS Indoor Bearers", (TR45 technical specification, TIA/EIA-136-290), clause 5.1:

The mobile station shall meet the requirements set forth in clause 6.2 in the presence of an unmodulated carrier at the following frequencies and amplitudes:

Frequency of blocking signal	Amplitude of blocking signal
600 kHz <= $\|f - f_0\|$ < 800 kHz	-43 dBm
800 kHz <= $\|f - f_0\|$ < 1.6 MHz	-43 dBm
1.6 MHz <= $\|f - f_0\|$ < 3 MHz	-33 dBm
3 MHz = $\|f - f_0\|$	-26 dBm

[13] "RF Minimum performance requirements 136HS Outdoor and 136HS Indoor Bearers", (TR45 technical specification, TIA/EIA-136-290), clause 6.3:

In the following table the reference co-channel interference (C/Ic), Block Error Rate (BLER) performance is defined for each of the channel conditions. The actual interference ratio is defined as the interference ratio for which this performance is met. The actual interference ratio shall be less than a specified limit, called the reference interference ratio. For 200 kHz bearers the reference interference ratio shall be, for BTS and all types of MS:

Table 1a: Input signal level and interference ratio for Outdoor BTS at reference performance

Bearer	Environment	Speed km/hr	Coding Scheme	Error Rate	C/I (dB)
136HS Outdoor	Pedestrian A	3	GCS-1	10% BLER	7
136HS Outdoor	Pedestrian A	3	GCS-2	10% BLER	8.5
136HS Outdoor	Pedestrian A	3	GCS-3	10% BLER	9.5
136HS Outdoor	Pedestrian A	3	GCS-4	10% BLER	13.5
136HS Outdoor	Pedestrian A	3	PCS-1	10% BLER	13
136HS Outdoor	Pedestrian A	3	PCS-2	10% BLER	16
136HS Outdoor	Pedestrian A	3	PCS-3	10% BLER	18
136HS Outdoor	Pedestrian A	3	PCS-4	10% BLER	19.5
136HS Outdoor	Pedestrian A	3	PCS-5	10% BLER	21
136HS Outdoor	Pedestrian A	3	PCS-6	10% BLER	24.5
136HS Outdoor	Vehicular A	50	GCS-1	10% BLER	3.5
136HS Outdoor	Vehicular A	50	GCS-2	10% BLER	7
136HS Outdoor	Vehicular A	50	GCS-3	10% BLER	8.5
136HS Outdoor	Vehicular A	50	GCS-4	10% BLER	17
136HS Outdoor	Vehicular A	50	PCS-1	10% BLER	9
136HS Outdoor	Vehicular A	50	PCS-2	10% BLER	13
136HS Outdoor	Vehicular A	50	PCS-3	10% BLER	14.5
136HS Outdoor	Vehicular A	50	PCS-4	10% BLER	18
136HS Outdoor	Vehicular A	50	PCS-5	10% BLER	21
136HS Outdoor	Vehicular A	50	PCS-6	10% BLER	-(see note)
136HS Outdoor	Vehicular A	120	GCS-1	10% BLER	7
136HS Outdoor	Vehicular A	120	GCS-2	10% BLER	8.5
136HS Outdoor	Vehicular A	120	GCS-3	10% BLER	9.5
136HS Outdoor	Vehicular A	120	GCS-4	10% BLER	13.5
136HS Outdoor	Vehicular A	120	PCS-1	10% BLER	13
136HS Outdoor	Vehicular A	120	PCS-2	10% BLER	16
136HS Outdoor	Vehicular A	120	PCS-3	10% BLER	18
136HS Outdoor	Vehicular A	120	PCS-4	10% BLER	19.5
136HS Outdoor	Vehicular A	120	PCS-5	10% BLER	21
136HS Outdoor	Vehicular A	120	PCS-6	10% BLER	24.5

Note: This is the GMSK interfering channel. The channel models in the above table are taken directly from ITU-M1225.

[14] "Mobile Station Minimum Performance", (Technical Specification TR45, SP-4027-270b), clause 2.3.1.3.1.

[15] "Mobile Station Minimum Performance", (Technical Specification TR45, SP-4027-270b), clause 1.4

and clause 3.2.2. Refers to Power Class II mobile station.

[16] "Digital Traffic Channel Layer 1", (Technical Specification, TR45, TIA/EIA 136-131), clause 1.3.

[17] "Mobile Station Minimum Performance", (Technical Specification TR45, SP-4027-270b), clause 3.4.1.1.3.

[18] "Mobile Station Minimum Performance", (Technical Specification TR45, SP-4027-270b), clause 2.3.2.4.3:

Table 2.3.2.4.3-1 Blocking and Spurious Response Rejection [4]

Frequency Band	Desired Signal (frequency f_c)	Blocking Signal (frequency fo)	Spurious Response Limit (frequency fo)	Error Rate (%)
|fc-fo| > 3MHz /4 DQPSK)	-102	-30	-45	3
3MHz>|fc-fo|>90KHz /4 DQPSK)	-102	-45	-45	3
|fc-fo| > 3MHz (8-PSK)	-99	-30	-45	3
3MHz>|fc-fo|>90kHz (8-PSK)	-99	-45	-45	3

[19] "Mobile Station Minimum Performance", (Technical Specification TR45, SP-4027-270b), clause 2.3.1.1.3.

[20] Body Loss Expectation is that values are similar for all technologies. Footnote retained for information purposes"3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; RF System Scenarios", (3G Technical Specification 25.942), clause 4.1.1.2.

[21] "3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; UTRA (UE) TDD; Radio Transmission and Reception (Release 1999)", (Technical Specification 3GPP TS 25.102 v3.4.0 (2000-10)

[22] "3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; UTRA (BS) TDD; Radio Transmission and Reception (Release 1999)", (Technical Specification 3GPP TS 25.105 v3.4.0 (2000-10)

[23] The "TD-CDMA" and "W-CDMA" air interfaces referred to in this document are standards developed by the 3G Partnership Project (3GPP). 3GPP's official designations for these air interfaces are UTRA-TDD and UTRA-FDD, respectively. Complete specifications for UTRA-TDD and UTRA-FDD are available through the 3GPP website at http://www.3gpp.org/3G_Specs/3G_Specs.htm. Series 25 of the specifications describes the UTRA-TDD and UTRA-FDD radio subsystems. A specification index is available at http://www.3gpp.org/ftp/Information/Databases/Change_Request/.

[24] TD-CDMA differs from the other air interfaces in the table in that it uses time division duplexing — uplink and downlink transmissions occur in the same spectrum, alternating in time — rather than frequency division duplexing in which uplink and downlink transmissions occur in distinct frequency blocks. In other

respects, such as in-band and out-of-band emissions levels, modulation formats, etc., it is substantially similar to the other air interfaces and essentially identical to W-CDMA. TD-CDMA's coexistence behavior with a given incumbent government system (or class of systems) can therefore be assessed through the uplink and downlink coexistence behavior of W-CDMA with those system(s). It can be well approximated for coexistence calculations by treating it as a system which has the combined (worst case from a coexistence perspective) uplink and downlink coexistence behavior of W-CDMA in a single spectrum block (i.e. by combining the uplink coexistence behavior of W-CDMA in frequency block "A" with an incumbent system in block "B", and the downlink coexistence behavior of W-CDMA in frequency block "A" with an incumbent system in block "B"). At such time as the FCC may choose to make some or all of the spectrum under consideration available for commercial use, additional analyses will be required to develop a sound band plan incorporating allocations for both FDD and TDD systems. These analyses are already underway in various segments of the industry including 3GPP [20].

APPENDIX 2.2
INTERNATIONAL USE OF 1710-1885 AND 2500 – 2690 MHZ BANDS

[Charts Reproduced from Report ITU-R M.2024][1]

Current and Planned Utilization Terrestrial Component Bands	
1 710-1 785/1 805-1 885 MHz	
CEPT*	**1 710-1 785/1 805-1 880 MHz:** This band is also used in Europe for second generation mobile (GSM 1800). Availability of this band for IMT-2000 can only be made progressively in the longer term as current usage of the band decreases. The timetable availability of this band for IMT-2000 may differ on national basis. On this basis, this band as a whole is also considered by CEPT to be a candidate for IMT-2000 expansion. **1 880-1 885 MHz:** This band in Europe currently forms the lower part of the DECT band. The upper part of the DECT band (1 885–1 900 MHz) is already identified for IMT-2000. The band 1 880–1 885 MHz is considered by CEPT as a candidate for IMT2000 expansion. The whole of the [Digital Enhanced Cordless Telecommunications] DECT band (1 880–1 900 MHz) can only be made available for IMT-2000 in the longer term however as DECT usage decreases.
U.S.A	**1 710-1 755 MHz** – reallocated for mixed (government/non-government use after Jan. 1999) available for commercial use Jan. 2004. This band may be suitable for IMT-2000. **1 805-1 850 MHz** – Satellite Ground Link System (SGLS). Exclusive government allocation. Not suitable or available for IMT-2000 **1 755-1 805 MHz** – Exclusive government allocations to FIXED, MOBILE and in parts of the band SPACE OPERATIONS. Not suitable or available for IMT-2000. **1 850-1 910/1 930-1 990 MHz:** US PCS Band. Suitable for IMT-2000 as pre-IMT-2000 services evolve to IMT-2000. **1 910-1 930 MHz:** Unlicensed Low-Power PCS. May be suitable for low power IMT-2000 applications as pre-IMT-2000 services evolve to IMT-2000.
Malaysia	DCS 1800 **1 880-1 900 MHz** DECT (FOR INDOOR USE ONLY)
Korea	These bands were assigned for land mobile service(using CDMA system)
China	**1 710-1 755/1 805-1 850 MHz**: cellular system **1 880-1 900/1 960-1 980 MHz**: Wireless access system of FDD mode **1 900-1 920 MHz**: Wireless access systems of TDD mode

[1] "Summary of Spectrum Usage Survey Results," Report ITU-R M.2024 (2000), International Telecommunication Union.

* Agreed and developed within European Radiocommunications Committee Task Group 1 of the Conférence Européenne des Administrations des Postes et des Télécommunications (CEPT ERC TG1).

Japan	These bands were assigned for FIXED, MOBILE, SPACE RESERCH, and SPACE OPERATION service	
Canada	**1 710-1 850 MHz**: In Canada, this band is used for low capacity fixed systems Canada's view is that fixed systems can be phased out at an appropriate time and this band has been identified by Canada as a candidate for IMT-2000. 1 850-1 885 MHz: This band forms part of the frequency range referred to as the PCS Band Plan and has also been identified as a candidate for ITM-2000.	
Australia	Fixed/mobile: in extensive use	
South Africa	**1 710-1785/1 805-1 880 MHz**	DCS 1800
	1 880-1 900 MHz	DECT
	1 900-1 920 MHz	Extended DECT
	1 885-2 025/2 110-2 200 MHz	(WARC-92) reserved for FPLMTS/UMTS
	1 980-2 010/2 170-2 200 MHz	reserved for satellite component of FPLMTS/UMTS
Brazil	**1 710–1 850 MHz**	In Brazil, this band is used for low capacity fixed systems. Parts of this band might be suitable for IMT-2000.
	1 850–1 885 MHz	In Brazil, this band is used for low capacity fixed systems. It forms part of the frequency range referred to as the PCS Band Plan, although Brazil has not implemented it. The bands 1 850-1 870/1 930-1 950 MHz are planned for introduction of Fixed Wireless Access systems. Parts of this band might be suitable for IMT-2000.
New Zealand	**1 706.5-1 880/ MHz**	FS, Potentially suitable and available for IMT-2000 extension
	1 880-1 920 MHz	FS, PHS, DECT Potentially suitable but unavailable for IMT-2000 extension; clearance may be difficult

Current and Planned Utilization Terrestrial Component Bands		
2 500-2 690 MHz		
CEPT*	This band is considered by CEPT as a prime candidate band for IMT-2000 expansion after phasing out of existing usage (fixed and ENG/OB). Geographical sharing (urban/rural) is one solution to facilitate the transition, or where sharing between services in the longer term is required.	
U.S.A	Multipoint Distribution Service/Instructional Television Fixed Service, point to multipoint video links to homes, schools and businesses. Two way response use as well. This band is also assigned to the Broadcast Satellite Service. Coordination of the BSS service with additional satellite and terrestrial systems would be difficult. This band is currently not available for IMT-2000, however some licensees may choose to evolve to technologies and services, such as IMT-2000.	
Malaysia	MMDS Application	
Korea		
Japan	This band is used for mobile satellite system and was assigned Broadcasting Satellite service.	
China	**2 535-2 599 MHz :** Multiple Microwave Distribute System (MMDS) of cable TV transmission system Broadcasting-satellite service (audio).	
Canada	This band has been identified for use for multipoint communications service (2 500-2 596 MHz) and multipoint distribution service (Broadcasting) (2 596-2 686 MHz. Canada has extensive licensing activity for MCS and MDS underway in this band. No other types of radio systems are currently being licensed in this range.	
Australia	2450 – 2690 MHz Electronic News Gathering (ENG)	
South Africa	**2 690-2 700 MHz** **2 520-2 593/2 597-2 670 MHz**	MMDS / FS Radio Astronomy FS
Brazil	**2 500-2 690 MHz**	This band is used for multichannel multipoint distribution service. At this time Brazil is concluding an extensive licensing activity for MMDS in this band. No other types of radio systems are currently being licensed in this range. Not suitable for IMT-2000.
New Zealand	**2 498.5-2 690 MHz**	FS, used extensively for ENG/OB**.** Suitable for IMT-2000 extension, but currently unavailable due to extensive ENG/OB applications.

Current and Planned Utilization Satellite component	
2 500-2 520/2 670-2 690 MHz	
CEPT*	This frequency band could be made available for IMT-2000 in Europe, pending market demand.
U.S.A	Multipoint Distribution Service/Instructional Television Fixed Service, point to multipoint video links to homes, schools and businesses. Two way response use as well. Not suitable for IMT-2000. Not allocated to MSS on a worldwide basis until 2005.
Malaysia	Frequencies have been filed by MEASAT for LEO/MEO use.
Korea	These bands were allocated for mobile satellite service at WARC-92. Any assignment for these bands is reserved until specific plans in Korea
China	Space Service
Japan	These bands are extensively used for Mobile-Satellite systems.
Canada	These bands have been identified for terrestrial services.
Australia	Current Australian usage of these bands would make usage by MSS in Australia difficult.
South Africa	
Brazil	These bands are used for multichannel multipoint distribution service. At this time Brazil is concluding an extensive licensing activity for MMDS in these bands. No other types of radio systems are currently being licensed in this range. Not suitable for IMT-2000.
New Zealand	

Current and Planned Utilization Satellite component	
2 520-2 535/2 655-2 670 MHz	
CEPT[*]	These bands have been identified as possible candidate bands for the terrestrial component of IMT-2000, and are therefore not identified as suitable for satellite component. However, it is envisaged that these bands may be used for MSS in some areas, where the demand for satellite services is high.
U.S.A	2 520-2 655 MHz: Multipoint Distribution Service/Instructional Television Fixed Service, point to multipoint video links to homes, schools and businesses. Two way response use as well. This band is currently not available for IMT-2000, however some licensees may choose to evolve to technologies and services, such as IMT-2000. 2 655-2 670 MHz: Multipoint Distribution Service/Instructional Television Fixed Service, point to multipoint video links to homes, schools and businesses. Two way response use as well. Also used for Radio Astronomy. This band is currently not available for IMT-2000, however some licensees may choose to evolve to technologies and services, such as IMT-2000.
Malaysia	Available
Korea	These bands were allocated for mobile satellite service at WARC-92. Any assignment for these bands is reserved until specific plans in Korea.
China	Space service
Japan	These bands are extensively used for Mobile-Satellite systems.
Canada	Currently identified for terrestrial services.
Australia	Current Australian usage of these bands would make usage by MSS in Australia difficult.
South Africa	
Brazil	These bands are used for multichannel multipoint distribution service. At this time Brazil is concluding an extensive licensing activity for MMDS in these bands. No other types of radio systems are currently being licensed in this range. Not suitable for IMT-2000.

[*] Agreed and developed within European Radiocommunications Committee Task Group 1 of the Conférence Européenne des Administrations des Postes et des Télécommunications (CEPT ERC TG1).

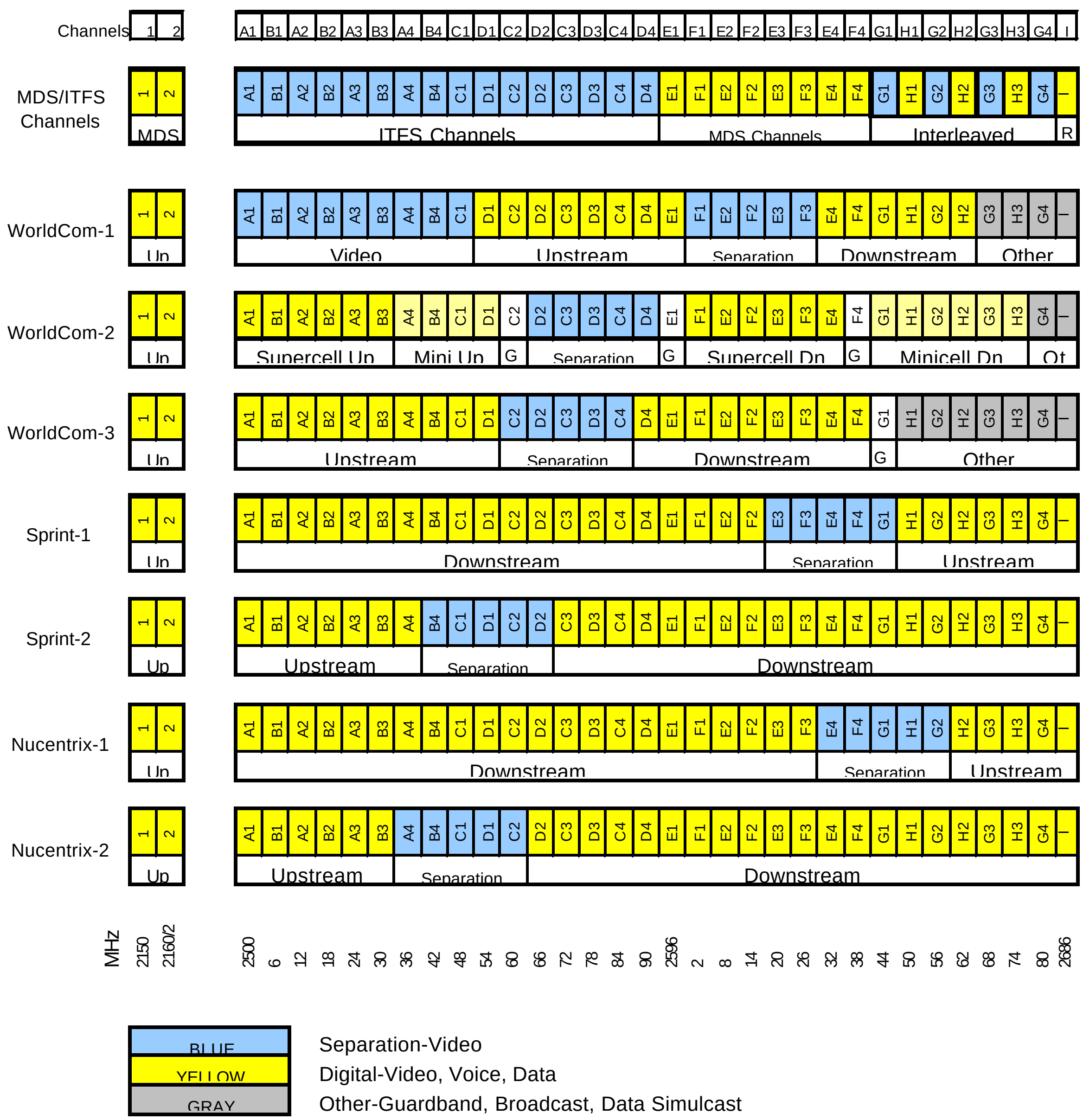
APPENDICES

FOR

SECTION 3

APPENDIX 3.1

Generic Band Plans for 2500-2690 MHz (Planned Use)



APPENDIX 3.2

TECHNICAL CHARACTERISTICS OF MDS/ITFS STATIONS

The technical characteristics of the MDS and ITFS stations can be summarized as follows. Tables 3-A and 3-B list the characteristics of stations used for traditional 'one-way' point-to-multipoint ITFS and MDS (also called MMDS) systems. These systems are used primarily for the distribution to educational institutions (ITFS systems) of instructional video programming and for the distribution to paying customers (MDS systems) of entertainment video programming.

Table 3-A Stations		**Table 3-B Stations**	**Signal**
Main Station Transmitter	>>>>>>>	Customer Receivers	Downstream NTSC (6 MHz channels)
Main Station Receiver	<<<<<<<<<	Customer Narrowband Response Transmitters	Upstream Audio (125 kHz channels)

Tables 3-C and 3-D list the characteristics of stations used for two-way 'cellularized' digital MDS and ITFS systems. These systems are used primarily for wireless internet access and other two-way wireless communications between fixed points by educational institutions (ITFS systems) and by paying customers (MDS systems).

Table 3-C Stations		**Table 3-D Stations**	**Signal**
Main/Booster Station Transmitter	>>>>>>>>>>	Customer Response Station Receivers	Downstream Digital 1-30 Mbps typical
Hub Station Receiver	<<<<<<<<<<	Customer Response Station Transmitters	Upstream Digital 250K-1 Mbps typical

TABLE 3-A
ITFS/MDS Point-to-Multipoint One-Way System Base Station Characteristics
(Main Station Transmitter; Main Station Receiver)

Parameter	Specification	Notes
Main Station Transmitter		
Spectrum Available	2150-2162 & 2500-2686 MHz	
Signal Bandwidth	6 MHz nominal	1
Power Output	Not specified	2
Antenna Gain	Not specified	3
Antenna Beam Tilt	Permitted	4
EIRP	≤ 2000 Watts (33 dBW)	5
Modulation Type	NTSC Composite Video/Audio	7
Emission Bandwidth	@ -38 dB 6 MHz @ -60 dB 7.5 MHz	
Path Length	Up to 35 Miles	
Free Space Path Loss	135.5 dB @ 35 Miles	
Main Station Receiver		
Signal Spectrum	2686-2690 MHz	8
Signal Bandwidth	125 kHz nominal	
Emission Bandwidth	@ -35 dB 125 kHz @ -60 dB 375 kHz	
Modulation Type	AM or FM	9
Antenna Gain	Not specified	10
Signal Level (from individually-licensed narrowband Response Stations)	Various	11
Noise Figure	5 dB	
Noise Level	-107 dBm ≥ N ≥ -127 dBm (typical)	
SNR	60 ≥ SNR ≥ 40 dB (typical)	
Interference Protection	None	

Notes

1. Licensees are authorized one or more 6 MHz channels per station.
2. The rules do not restrict transmitter output, however the peak aural power must not exceed 10% of the peak visual power for standard NTSC composite video/audio signals.
3. The rules do not specify maximum or minimum permissible antenna gain. Licensees may use omnidirectional antennas and/or directional antennas as needed to achieve desired area coverage.
4. The rules do not restrict beam tilt, either mechanical or electrical, although the details of the tilted beam pattern must be specified on the station application form.
5. The maximum permissible EIRP per 6 MHz channel is 2000 watts (33 dBW) for MDS/ITFS Main stations in one-way systems utilizing an omnidirectional antenna (i.e. no azimuthal-plane directivity). For stations using directional (i.e. azimuthal-plane directivity) and sectorized antenna systems, the maximum EIRP per 6 MHz channel is given by the formula 33 dBW + 10 log (360/beamwidth), with an upper limit of 39 dBW permissible. *See* Rule Sections 21.904 (MDS) and 74.935 (ITFS).
6. Digital modulation for the transmission of one or more visual and composite aural signals, and/or for the transmission of data, is also permitted pursuant to the provisions of the Commissions *Digital Declaratory Ruling*, 11 FCC Rcd at 18840.
7. *See* Rule Sections 21.905 (MDS) and 74.936 (ITFS).
8. The 2686-2690 MHz spectrum available for individually-licensed Response Stations transmitting to Main Station receivers in one-way systems is subdivided into 31 channels of 125 kHz bandwidth each, with the center of

the 1st channel at 2686.0625 MHz and the center of the 31st channel at 2689.8125 MHz. All 31 channels are available to ITFS licensees and 4 channels are available to MDS licensees on a shared basis with ITFS licensees. *See* Rule Sections 21.901(b) (MDS) and 74.939 (ITFS).

9. Digital emissions are also permissible pursuant to the to the provisions of the Commission's *Digital Declaratory Ruling*, 11 FCC Rcd at 18840.

10. The Main Station receiving antennas in a one-way system are used for reception of signals transmitted by individually-licensed narrowband (125 kHz) Response Stations. Directional and/or omnidirectional Main Station receiving antennas, or a combination of both, are permissible.

11. This is dependant on path lengths from the individually-licensed narrowband response station transmitters to the Main Station, as well as the power level and the antennas in use.

TABLE 3-B
ITFS/MDS Customer Receive Stations and Individually-Licensed Customer Narrowband Response Station Transmitters in One-Way Systems (Customer Receiver; Customer Narrowband Response Transmitter, if used)

Parameter	Specification	Notes
Narrowband Response Station Transmitter		
Spectrum Available	2686-2690 MHz	1
Signal Bandwidth	125 kHz	1
Power Output	2 Watts (3 dBW) Maximum	2
Antenna Gain	Gain Antenna Required	3
Transmitted EIRP	≤ 40 Watts (16 dBW) Maximum	4
Modulation Types	AM, FM	5
Emission Bandwidth	@ 35dB 125 kHz @ 60 dB 375 kHz	6
Path Length	Up to 35 Miles	
Free Space Path Loss	135.5 dB @ 35 Miles	
Customer Receiver		
Signal Spectrum	2150-2162 & 2500-2686 MHz	
Signal Bandwidth	6 MHz nominal	
Emission Bandwidth	@ -38 dB 6 MHz @ -60 dB 7.5 MHz	
Modulation Type (Rx)	NTSC Composite Video/Audio	7
Antenna Gain	Directional Antenna Required	8
Received Signal Level	-52.5 dBm	9
Noise Figure	5 dB	
Noise Level	-100.2 dBm	10
SNR	47.7 dB	11
Interference Protection	Service Area Protection; Registered Receive Site Protection	12

Notes

1. *See* Rule Sections 21.901(b)(5) (MDS) and 74.949 (ITFS).
2. *See* Rule Sections 21.909(g)(2) (MDS) and 74.949(c)(2) (ITFS).
3. *See* Rule Section 21.949(e) (MDS) and 74.937(b) (ITFS).
4. *See* Rule Sections 21.904(a) (MDS) and 74.949(c)(3) (ITFS).
5. *See* Rule Sections 21.905 (MDS) and 74.936 (ITFS). Digital emissions are also permitted pursuant to the provisions of the Commission's *Digital Declaratory Ruling*, 11 FCC Rcd at 18840.
6. *See* 21.909(j) (MDS) and 74.949(k) (ITFS).
7. The modulation type received at the customer receiver (from the Main Station transmitter in a one-way system) may also be digital, pursuant to the provisions of the Commission's *Digital Declaratory Ruling*, 11 FCC Rcd at 18840.
8. *See* Rule Sections 21.906(d) (MDS) and 74.937(a) (ITFS).
9. + 63 dBm (Main/Booster Transmitter EIRP) – 135.5 dB (35 mi. PL) + 20 dBi (gain of assumed Rx antenna) = -52.5 dBm.
10. For thermal noise only, excluding interference; -106.2 dBm (kTB for 6 MHz) + 5 dB (NF) + 1 dB (cable loss) = -100.2 dBm.
11. –52.5 + 100.2 = 47.7.
12. Protection for Customer Receivers in most MDS one-way systems licensed in 1997 and later is primarily in the

form of protection of the service area in which they are located. Specifically, at the service area boundary, all geographically adjacent licensees must engineer their systems to limit the calculated free space power flux density at any shared border with the protected system to a maximum value of –73 dBW/m^2 (per 6 MHz bandwidth) as measured with an FCC reference antenna at a height of 10 meters. For pre-1997 MDS one-way systems and for all ITFS one-way systems, additional requirements for protection inside the service area are imposed in the form of permissible D/U ratios of 45 dB for co-channel interference and 0 dB for adjacent channel interference. *See* Rule Sections 21.902 (MDS), 21.909 (MDS), 21.913 (MDS), 74.903 (ITFS), 74.939 (ITFS) and 74.985 (ITFS).

TABLE 3-C
MDS/ITFS Point-to-Multipoint 2-Way System Base Station Characteristics
(Main/High Power Booster Transmitter; Hub Station Receiver)

Parameter	Specification	Notes
Main/Booster Station Transmitter		
Spectrum Available	2150-2162 & 2500-2690 MHz	
Signal Bandwidth	6 MHz nominal	1
Power Output	Not specified	2
Antenna Gain	Not specified	3
Antenna Beam Tilt	Permitted	4
EIRP	≤ 2000 Watts (33 dBW)	5
Access Techniques	TDMA/CDMA	6
Modulation Types	QAM, VSB, COFDM	7
Emission Bandwidth	@ -25 dB 6 MHz @ -40 dB 6.5 MHz @ -60 dB 12 MHz	8
Path Length (Main/Booster Station to Response Station Receiver)	Up to 35 Miles	9
Free Space Path Loss	135.5 dB @ 35 Miles	
Hub Station Receiver		
Signal Spectrum	2500-2690 MHz	10
Signal Bandwidth	6 MHz nominal	11
Emission Bandwidth	@ -25 dB 6 MHz @ -40 dB 6.5 MHz @ -60 dB 12 MHz	
Modulation Types	QAM, VSB, COFDM	7
Antenna Gain	10 dBi typical	12
Signal Level (at Hub Station receiver from Response Station transmitter)	-62.5 dBm	13
Noise Figure	2.5 dB	
Noise Level	-102.7 dBm	14
SNR	40.2 dB	15
Interference Protection	≤ 1 dB Rx Noise Floor Degradation	16

Notes

1. A licensee may be authorized one or more 6 MHz channels per station and may subdivide a 6 MHz channel into multiple smaller channels (subchannelization) and may itself, or in combination with one or more other licensees, aggregate multiple contiguous 6 MHz channels into larger channels (superchannelization). *See* Rule Sections 21.905 (MDS) and 74.936 (ITFS).

2. The rules do not restrict Main/Booster transmitter power output.

3. The rules do not specify maximum or minimum permissible antenna gain. Licensees may use omnidirectional antennas and/or directional antennas as needed to achieve desired area coverage. Main and Booster Stations utilize multiple directional antennas to achieve sectorized coverage of the service area as a means of achieving frequency reuse. *See* Rule Sections 21.906(a) (MDS), 74.931(b)(3) (ITFS) and 74.937(b) (ITFS).

4. The rules do not restrict beam tilt, either mechanical or electrical, although the details of the tilted beam pattern must be specified on the station application form.

5. The maximum permissible EIRP per 6 MHz channel is 2000 watts (33 dBW) for stations utilizing an omnidirectional antenna (i.e. no azimuthal-plane directivity). For stations using directional (i.e. azimuthal-

plane directivity) and sectorized antenna systems, the maximum EIRP per 6 MHz channel is given by the formula 33 dBW + 10 log (360/beamwidth), with an upper limit of 39 dBW permissible. Rule Sections 21.904 (MDS) and 74.935 (ITFS).

6. *See* Rule Sections 21.905 (MDS) and 74.936 (ITFS).

7. In addition, other forms of digital modulation are permitted if the applicant provides a showing that interference will not result from their use. *See* Rule Sections 21.905 (MDS) and 74.936 (ITFS).

8. Emission measurements are to be made in accordance with the formulas set out at Rule Section 21.908 (MDS and ITFS). Attenuation applies only at edges of 6 MHz channels, not to subchannels within a 6 MHz channel. For superchannels, attenuation applies only at the upper and lower edges of the superchannel, not to channels within the superchannel.

9. Path length from Main/Booster transmitter to Response Station receiver will depend on size of service area to be covered and the amount of 'cellularization' used, *i.e.* if a service area is served by multiple cells, the path lengths in each cell will be significantly shorter than if a single cell is used to cover the entire 35 mile radius of a typical service area.

10. The 6 MHz channels listed in Note 1, above, for point-to-multipoint use in the MDS and ITFS Services may also be used at Response (customer) stations for transmissions which are received by the Base Station receiver ("Hub Station"). MDS and ITFS licensees are permitted to allocate the channels assigned to their systems on a real-time basis for both downstream (point-to-multipoint) and upstream (multipoint-to-point) use without regard to which channels are used for which purpose so long as all interference protection criteria are met with respect to neighboring systems. Upstream and downstream bandwidths may be symmetrical or asymmetrical, with some or most systems utilizing greater bandwidth downstream than upstream. Downstream bit rates in a range of 1-30 Mbps are likely, with upstream bit rates likely in a range of 250 kbps- 1 Mbps.

11. The bandwidths of the signals transmitted from 2-Way System Response Stations which are received at the base station receiver ("Hub Station") are determined by the licensee of the system on a real-time basis. (See Note 2, above.) The bandwidth may be 6 MHz, or a fraction thereof, or a multiple thereof.

12. Gain of a parabolic antenna with a half-power beamwidth of approximately 30 degrees. Twelve such sector antennas would be necessary to provide omnidirectional coverage at the Hub receiving Station.

13. + 63 dBm (EIRP) – 135.5 dB (35 mi. PL) + 10 dBi (Rx Ant Gain) = -62.5 dBm

14. For thermal noise only, excluding interference; –106.2 dBm (kTB for 6 MHz) + 2.5 dB (NF) + 1 dB (Cable Losses) = -102.7 dBm

15. –62.5 + 102.7 = 40.2

16. *See* Rule Sections 21.909(i) (MDS) and 74.939(i) (ITFS). *See* also Appendix D to the *Report and Order* in MM Docket 97-217, 13 FCC Rcd 19,112 (1998), at paragraphs 40-49.

TABLE 3-D
MDS/ITFS Response (Customer) Stations in 2-Way Systems
(Response Station Transmitter & Receiver)

Parameter	Specification	Notes
Response Station Transmitter		
Spectrum Available	2150-2162 & 2500-2690 MHz	
Signal Bandwidth	6 MHz nominal	1
Power Output	2 Watts (3 dBW)	2
Antenna Gain	≥ 0	3
EIRP	≤ 2000 Watts (33 dBW)	4
Access Techniques	TDMA/CDMA	5
Modulation Types	QAM, VSB, COFDM	6
Emission Bandwidth	@ -25 dB 6 MHz @ -40 dB 6.25 MHz @ -60 dB 12 MHz	7
Path Length (Response Station Transmitter to Hub Station Receiver)	Up to 35 Miles	
Free Space Path Loss	135.5 dB @ 35 Miles	
Response Station Receiver (from Main/Booster Station)		
Signal Spectrum	2500-2690 MHz	9
Signal Bandwidth	6 MHz nominal	10
Emission Bandwidth	@ -25 dB 6 MHz @ -40 dB 6.25 MHz @ -60 dB 12 MHz	7
Modulation Types	QAM, VSB, COFDM	6
Antenna Gain	Directional Antenna Required	11
Signal Level	-52.5 dBm	12
Noise Figure	5 dB	
Noise Level	-100.2 dBm	13
SNR	47.7 dB	14
Interference Protection	System Service Area Protected	15

Notes

1. Response Station transmitters in 2-Way systems are not individually licensed. MDS/ITFS 2-Way system licensees are authorized one or more 6 MHz channels per system and may allocate the licensed bandwidth between and among Main, Booster and Response Station transmitters as needed on a real-time basis. A licensee may subdivide a 6 MHz channel into multiple smaller channels (subchannelization) and may, itself, or in combination with one or more other licensees, aggregate multiple contiguous 6 MHz channels into larger channels (superchannelization). *See* Rule Sections 21.905 (MDS) and 74.936 (ITFS).

2. *See* Rule Sections 21.909(g)(2) (MDS) and 74.939(g)(2) (ITFS)

3. *See* Rule Sections 21.909(g)(4) (MDS) and 74.939(g)(4) (ITFS)

4. *See* Rule Sections 21.909(g)(3) (MDS) and 74.939(g)(3) (ITFS)

5.*See* Rule Sections 21.905 (MDS) and 74.936 (ITFS)

6. In addition, other forms of digital modulation will be permitted if the applicant provides a showing that interference will not result from their use. *See* Rule Sections 21.905 (MDS) and 74.936 (ITFS).

7.Emission measurements are to be made in accordance with the formulas set out at Rule Section 21.908 (MDS and ITFS). Attenuation applies only at the edges of 6 MHz channels, not to subchannels within a 6 MHz channel. For superchannels, attenuation applies only at upper and lower edges of the superchannel, not to channels within the superchannel.

8. Path length from response station transmitter to Base Station receiver (Hub Station) will depend on size of service area to be covered and the amount of ‘cellularization’ used, *i.e.* if a service area is served by multiple cells, the path lengths in each cell will be significantly shorter than if a single cell is used to cover the entire 35 mile radius of a typical service area.

9. The 6 MHz channels listed in Note 1, above, for ‘upstream’ use for 2-Way systems in the MDS and ITFS Services are identical to those available for ‘downstream’ (Main/Booster transmitters to Response Station receivers) use in these services and such channels may be subchannelized and superchannelized to form channels or less or greater width, respectively.

10. The signal received by the Response Station receiver (transmitted from an MDS or ITFS Main or Booster Station) may be 6 MHz in bandwidth, or less than 6 MHz (if the 6 MHz channel has been divided into subchannels) or greater than 6 MHz (if 2 or more 6 MHz channels have been combined to form a superchannel). This bandwidth may vary dynamically, on a real-time basis, as needed by the system operator to adapt to system information transmission requirements.

11. There are no requirements for receiver antenna directivity; however, for interference calculations, it is assumed that the receiver antenna has, at a minimum, a directive pattern meeting the requirements of the FCC reference receiving antenna. *See* Rule Sections 21.906(d) (MDS), 21.909(g)(4) (MDS) and 74.937(a) (ITFS).

12. +63 dBm (Main/Booster Station EIRP) – 135.5 dB (35 mi. PL) + 20 dB (assumed gain of typical receiving antenna at Response Station) = -52.5 dBm

13. For thermal noise only, excluding interference; -106.2 dBm (kTB for 6 MHz) + 5 dB (NF) + 1 dB (Cable Loss) = -100.2 dBm

14. –52.5 + 100.2 = 47.7

15. Response Stations are not licensed individually, nor are their locations known in advance of installation and operation. Protection for response station receivers in most 2-way MDS systems is primarily in the form of protection of the service area in which they are located. Specifically, at the service area outer boundary, all geographically adjacent licensees must engineer their systems to limit the calculated free space power flux density at any shared border with the protected system to a maximum value of –73 dBW/m^2 (per 6 MHz bandwidth) as measured with an FCC reference antenna at a height of 10 meters. For pre-1997 MDS systems and for all ITFS systems, additional requirements for protection inside the service area are imposed in the form of permissible D/U ratios of 45 dB for co-channel interference and 0 dB for adjacent channel interference. *See* Rule Sections 21.902 (MDS), 21.909 (MDS), 21.913 (MDS), 74.903 (ITFS), 74.939 (ITFS) and 74.985 (ITFS).

APPENDICES

FOR

SECTION 4

APPENDIX 4.1

TABLE 4-A: Planning Factors for Interference Protection of MDS/ITFS Response Stations

Quantity	Value	Comment
Mid-frequency of 2500-2690 Band	2595 MHz	Arithmetic mean for estimation of antenna aperture areas
Gain of Receiving Antennas of Response Stations	Factor of 100, or 20 dBi	*See* 47 C.F.R. §§ 21.939 and 74.937(a).
Antenna Aperture of Receiving Systems	0.162 m^2	$(\text{wavelength})^2$ * (gain) / (4π)
Desired Signal Strength for Response Stations on Periphery of Protected Service Area	-83 dBW for 6 MHz channels	*See* 47 C.F.R. § 21.902(f)(6)(iii).
Desired Power Flux Density for Response Station on Periphery of Protected Service Area	-75 dBW/m^2 for 6 MHz channels	Value calculated from that given in 47 C.F.R. § 21.902(f)(6)(iii) and antenna aperture of 0.162 m^2.
Desired-to-undesired Signal Ratio for Co-channel Interference	45 dB	*See* 47 C.F.R. §§ 21.902(f)(6)(iv) and 74.739(d)(3)(iv).
Power Flux Density of Co-channel Undesired Signals Causing Harmful Interference	-120 dBW/m^2 for 6 MHz channels	Calculated from D/U ratio, 45 dB.

TABLE 4-B: Planning Factors for Interference Protection of MDS/ITFS Hubs

Quantity	Value	Comment
Transmitter Power of Response Stations (source of MDS/ITFS desired signals)	Maximum 18 dBW EIRP for 125 kHz channels	*See* 47 C.F.R. § 21.909(g)(3). 18dBW is approximately 63 W.
Desired Power Flux Density at MDS/ITFS Hub	-88 dBW/m^2 for 125 kHz channels	63 watts EIRP from response station transmitter 35 miles away
Max. Undesired Co-channel Power Flux Density at ITFS Hub from Response Stations in Protected Service Area	-133 dBW/m^2 for 125 kHz channels	Calculated based on 45 dB D/U ratio.
Noise Floor of Hub Receiver	-150 dBW in 125 kHz channels	Calculated value of kTBF for hub receiver noise figure of F=2.5 dB and bandwidth B=125 kHz
Antenna Aperture of Hub Receivers	0.0162 m^2	Typical parabolic antenna with half-power beamwidth of 30° for mid-frequency of 2500-2690 MHz band
Incident Power Flux Density Equivalent to Noise Floor of Hub Receiver	-132 dBW/m^2	Calculated from noise floor in watts and antenna aperture (line loss neglected)
Max. Increase in Undesired Co-channel Power Flux Density at ITFS Hub from Transmitter outside Protected Service Area	0 dB	Specified in 47 C.F.R. §§ 21.909(i)(1) and 74.939(I)(1).
Max. Power Flux Density at ITFS Hub from Transmitter outside Protected Service Area, Relative to Noise Floor	1 dB	Also specified in 47 C.F.R. §§ 21.909(i)(1) and 74.939(i)(1).
Max. Undesired Co-channel Power Flux Density at ITFS Hub from Transmitter outside Protected Service Area	-139 dBW/m^2 for 125 kHz channels	Calculated to produce 1 dB increase in undesired co-channel power flux density (¼ of undesired power already present). Within 1 dB of limit calculated similarly from noise floor criterion.

Table 4-C: Calculation of Co-channel Separation Distances of a 500 watt 3G Base Station to ITFS/MDS[1] Stations

MDS/ITFS System Parameters		3G System Parameters				Maximum Undesired 3G Power	Minimum Distance Separation[3]	
Protected Receiver Type	Bandwidth (kHz)	Modulation Type	EIRP (dBW)	Bandwidth (kHz)	Bandwidth Factor (dB)	Flux Density[2] (dBW/m^2)	km	mi
Hub	125	CDMA	27	1250	10	-129	160.9	100
	125	CDMA	27	3750	15	-124	160.9	100
	125	W-CDMA	27	5000	16	-123	160.9	100
	125	TDMA	27	30	-6	-145	160.9	100
	125	TDMA	27	200	2	-137	160.9	100
Response Station	6000	CDMA	27	1250	-7	-127	160.9	100
	6000	CDMA	27	3750	-2	-122	160.9	100
	6000	W-CDMA	27	5000	-1	-121	160.9	100
	6000	TDMA	27	30	-23	-143	160.9	100
	6000	TDMA	27	200	-15	-135	160.9	100

[1] To calculate the required separation distance based on free space loss, the maximum undesired 3G power flux density that could be present at the ITFS/MDS receiver before interference would occur is determined. Then, the distance away from the 3G transmitter where that power flux density would be present is calculated. The calculations of required free space separation are made using the values in the columns headed "EIRP" and "Max Undesired 3G Power Flux Density." For example, to reduce the EIRP of 27 dBW (500 watts) to -129 dBW/m^2 (7.9 $microwatts/m^2$), the 500-watts of power must be spread over the surface of a sphere with a total surface area of 500/(7.9x106) square meters. The free space column is the radius of a sphere with that surface area [distance = $\sqrt{(P_{transmit}/4\pi P_{received})}$].

[2] The values under “Max Undesired 3G Power Flux Density” are derived from the bottom row of the relevant planning factors table in Appendix 4, *i.e.*, -139 dBW/m^2 for the 125 kHz channels of hub receivers, and -120 dBW/m^2 for the 6 megahertz channels of response station receivers. Bandwidth factors modify these –139 and –120 values. For example, -139 dBW/m^2 becomes –129 dBW/m^2 due to the 10 dB bandwidth factor for interference to ITFS/MDS 125-kHz hub receivers by CDMA 1250-kHz channel transmitters.

[3] As a practical matter, interference will not occur beyond the radio horizon. The rules only require that an interference analysis be completed if the location of a proposed station is within 160.9 kilometers (100 miles) of an incumbent station. *See* 47 C.F.R. §§ 21.902 and 74.903. Therefore, any distance separation calculated beyond this limit is reduced to 160.9 kilometers (100 miles) in the table.

Table 4-D: Calculation of Co-channel Separation Distances of a 10 watt 3G Base Station to ITFS/MDS Stations

MDS/ITFS System Parameters		3G System Parameters				Maximum Undesired 3G Power	Minimum Distance Separation[3]	
Protected Receiver Type	Bandwidth (kHz)	Modulation Type	EIRP (dBW)	Bandwidth (kHz)	Bandwidth Factor (dB)	Flux Density[2] (dBW/m^2)	km	mi
Hub	125	CDMA	10	1250	10	-129	160.9	100
	125	CDMA	10	3750	15	-124	160.9	100
	125	W-CDMA	10	5000	16	-123	160.9	100
	125	TDMA	10	30	-6	-145	160.9	100
	125	TDMA	10	200	2	-137	160.9	100
Response Station	6000	CDMA	10	1250	-7	-127	160.9	100
	6000	CDMA	10	3750	-2	-122	160.9	100
	6000	W-CDMA	10	5000	-1	-121	160.9	100
	6000	TDMA	10	30	-23	-143	160.9	100
	6000	TDMA	10	200	-15	-135	160.9	100

[1] To calculate the required separation distance based on free space loss, the maximum undesired 3G power flux density that could be present at the ITFS/MDS receiver before interference would occur is determined. Then, the distance away from the 3G transmitter where that power flux density would be present is calculated. The calculations of required free space separation are made using the values in the columns headed "EIRP" and "Max Undesired 3G Power Flux Density." For example, to reduce the EIRP of 10 dBW (10 watts) to -129 dBW/m^2 (7.9 $microwatts/m^2$), the 10-watts of power must be spread over the surface of a sphere with a total surface area of 10/(7.9x106) square meters. The free space column is the radius of a sphere with that surface area [distance = $\sqrt{(P_{transmit}/4\pi P_{received})}$].

[2] The values under “Max Undesired 3G Power Flux Density” are derived from the bottom row of the relevant planning factors table in Appendix 4, *i.e.*, -139 dBW/m^2 for the 125 kHz channels of hub receivers, and -120 dBW/m^2 for the 6 megahertz channels of response station receivers. Bandwidth factors modify these –139 and –120 values. For example, -139 dBW/m^2 becomes –129 dBW/m^2 due to the 10 dB bandwidth factor for interference to ITFS/MDS 125-kHz hub receivers by CDMA 1250-kHz channel transmitters.

[3] As a practical matter, interference will not occur beyond the radio horizon. The rules only require that an interference analysis be completed if the location of a proposed station is within 160.9 kilometers (100 miles) of an incumbent station. *See* 47 C.F.R. §§ 21.902 and 74.903. Therefore, any distance separation calculated beyond this limit is reduced to 160.9 kilometers (100 miles) in the table.

Table 4-E: Calculation of Co-channel Separation Distances of a 3G Mobile Station to ITFS/MDS Stations

MDS/ITFS System Parameters		3G System Parameters				Maximum Undesired 3G Power Flux Density[2] (dBW/m^2)	Minimum Distance Separation[3]	
Protected Receiver Type	Bandwidth (kHz)	Modulation Type	EIRP (dBW)	Bandwidth (kHz)	Bandwidth Factor (dB)		km	mi
Hub	125	CDMA	-10	1250	10	-129	160.9	100
	125	CDMA	-10	3750	15	-124	148.1	92
	125	W-CDMA	-10	5000	16	-123	127.1	79
	125	TDMA	-10	30	-6	-145	160.9	100
	125	TDMA	-10	200	2	-137	160.9	100
Response Station	6000	CDMA	-10	1250	-7	-127	160.9	100
	6000	CDMA	-10	3750	-2	-122	114.3	71
	6000	W-CDMA	-10	5000	-1	-121	99.8	62
	6000	TDMA	-10	30	-23	-143	160.9	100
	6000	TDMA	-10	200	-15	-135	160.9	100

1 To calculate the required separation distance based on free space loss, the maximum undesired 3G power flux density that could be present at the ITFS/MDS receiver before interference would occur is determined. Then, the distance away from the 3G transmitter where that power flux density would be present is calculated. The calculations of required free space separation are made using the values in the columns headed "EIRP" and "Max Undesired 3G Power Flux Density." For example, to reduce the EIRP of -10 dBW (100 milliwatts) to -129 dBW/m^2 (7.9 $microwatts/m^2$), the 100-milliwatts of power must be spread over the surface of a sphere with a total surface area of 0.1/(7.9x106) square meters. The free space column is the radius of a sphere with that surface area [distance = $\sqrt{(P_{transmit}/4\pi P_{received})}$].

2 The values under "Max Undesired 3G Power Flux Density" are derived from the bottom row of the relevant planning factors table in Appendix 4, *i.e.*, -139 dBW/m^2 for the 125 kHz channels of hub receivers, and -120 dBW/m^2 for the 6 megahertz channels of response station receivers. Bandwidth factors modify these –139 and –120 values. For example, -139 dBW/m^2 becomes –129 dBW/m^2 due to the 10 dB bandwidth factor for interference to ITFS/MDS 125-kHz hub receivers by CDMA 1250-kHz channel transmitters.

3 As a practical matter, interference will not occur beyond the radio horizon. The rules only require that an interference analysis be completed if the location of a proposed station is within 160.9 kilometers (100 miles) of an incumbent station. *See* 47 C.F.R. §§ 21.902 and 74.903. Therefore, any distance separation calculated beyond this limit is reduced to 160.9 kilometers (100 miles) in the table.

Table 4-F: Calculation of Adjacent channel Separation Distances of a 500 watt 3G Base Station to ITFS/MDS Stations

MDS/ITFS System Parameters		3G System Parameters				Maximum Undesired 3G Power Flux Density[2]	Minimum Distance Separation[3]	
Protected Receiver Type	Bandwidth (kHz)	Modulation Type	EIRP (dBW)	Bandwidth (kHz)	Bandwidth Factor (dB)	(dBW/m^2)	km	mi
Hub	125	CDMA	27	1250	10	-129	101.4	63
	125	CDMA	27	3750	15	-124	57.9	36
	125	W-CDMA	27	5000	16	-123	51.5	32
	125	TDMA	27	30	-6	-145	160.9	100
	125	TDMA	27	200	2	-137	160.9	100
Response Station	6000	CDMA	27	1250	-7	-127	160.9	100
	6000	CDMA	27	3750	-2	-122	160.9	100
	6000	W-CDMA	27	5000	-1	-121	160.9	100
	6000	TDMA	27	30	-23	-143	160.9	100
	6000	TDMA	27	200	-15	-135	160.9	100

[1] To calculate the required separation distance based on free space loss, the maximum undesired 3G power flux density that could be present at the ITFS/MDS receiver before interference would occur is determined. Then, the distance away from the 3G transmitter where that power flux density would be present is calculated. The calculations of required free space separation are made using the values in the columns headed "EIRP" and "Max Undesired 3G Power Flux Density." For example, to reduce the EIRP of 27 dBW (500 watts) to -129 dBW/m^2 (7.9 $microwatts/m^2$), the 500-watts of power must be spread over the surface of a sphere with a total surface area of 500/(7.9x106) square meters. The free space column is the radius of a sphere with that surface area [distance = $\sqrt{(P_{transmit}/4\pi P_{received})}$].

[2] The values under "Max Undesired 3G Power Flux Density" are derived from the bottom row of the relevant planning factors table in Appendix 4, *i.e.*, -139 dBW/m^2 for the 125 kHz channels of hub receivers, and -120 dBW/m^2 for the 6 megahertz channels of response station receivers. Bandwidth factors modify these –139 and –120 values. For example, -139 dBW/m^2 becomes –129 dBW/m^2 due to the 10 dB bandwidth factor for interference to ITFS/MDS 125-kHz hub receivers by CDMA 1250-kHz channel transmitters.

[3] As a practical matter, interference will not occur beyond the radio horizon. The rules only require that an interference analysis be completed if the location of a proposed station is within 160.9 kilometers (100 miles) of an incumbent station. *See* 47 C.F.R. §§ 21.902 and 74.903. Therefore, any distance separation calculated beyond this limit is reduced to 160.9 kilometers (100 miles) in the table.

Table 4-G: Calculation of Adjacent channel Separation Distances of a 10 watt 3G Base Station to ITFS/MDS Stations

MDS/ITFS System Parameters		3G System Parameters				Maximum Undesired 3G Power Flux Density[2]	Minimum Distance Separation[3]	
Protected Receiver Type	Bandwidth (kHz)	Modulation Type	EIRP (dBW)	Bandwidth (kHz)	Bandwidth Factor (dB)	(dBW/m^2)	km	mi
Hub	125	CDMA	10	1250	10	-129	14.3	8.9
	125	CDMA	10	3750	15	-124	8.2	5.1
	125	W-CDMA	10	5000	16	-123	7.2	4.5
	125	TDMA	10	30	-6	-145	92.5	57.5
	125	TDMA	10	200	2	-137	35.9	22.3
Response Station	6000	CDMA	10	1250	-7	-127	99.3	61.7
	6000	CDMA	10	3750	-2	-122	57.5	35.7
	6000	W-CDMA	10	5000	-1	-121	49.7	30.9
	6000	TDMA	10	30	-23	-143	160.9	100.0
	6000	TDMA	10	200	-15	-135	160.9	100.0

1 To calculate the required separation distance based on free space loss, the maximum undesired 3G power flux density that could be present at the ITFS/MDS receiver before interference would occur is determined. Then, the distance away from the 3G transmitter where that power flux density would be present is calculated. The calculations of required free space separation are made using the values in the columns headed "EIRP" and "Max Undesired 3G Power Flux Density." For example, to reduce the EIRP of 10 dBW (10 watts) to -129 dBW/m^2 (7.9 $microwatts/m^2$), the 10-watts of power must be spread over the surface of a sphere with a total surface area of 10/(7.9x106) square meters. The free space column is the radius of a sphere with that surface area [distance = $\sqrt{(P_{transmit}/4\pi P_{received})}$].

2 The values under "Max Undesired 3G Power Flux Density" are derived from the bottom row of the relevant planning factors table in Appendix 4, *i.e.*, -139 dBW/m^2 for the 125 kHz channels of hub receivers, and -120 dBW/m^2 for the 6 megahertz channels of response station receivers. Bandwidth factors modify these –139 and –120 values. For example, -139 dBW/m^2 becomes –129 dBW/m^2 due to the 10 dB bandwidth factor for interference to ITFS/MDS 125-kHz hub receivers by CDMA 1250-kHz channel transmitters.

3 As a practical matter, interference will not occur beyond the radio horizon. The rules only require that an interference analysis be completed if the location of a proposed station is within 160.9 kilometers (100 miles) of an incumbent station. *See* 47 C.F.R. §§ 21.902 and 74.903. Therefore, any distance separation calculated beyond this limit is reduced to 160.9 kilometers (100 miles) in the table.

Table 4-H: Calculation of Adjacent channel Separation Distances of a 3G Mobile Station to ITFS/MDS Stations

MDS/ITFS System Parameters		3G System Parameters				Maximum Undesired 3G Power Flux Density[2] (dBW/m^2)	Minimum Distance Separation[3]	
Protected Receiver Type	Bandwidth (kHz)	Modulation Type	EIRP (dBW)	Bandwidth (kHz)	Bandwidth Factor (dB)		km	mi
Hub	125	CDMA	-10	1250	10	-129	1.4	0.9
	125	CDMA	-10	3750	15	-124	0.8	0.5
	125	W-CDMA	-10	5000	16	-123	0.6	0.4
	125	TDMA	-10	30	-6	-145	9.3	5.8
	125	TDMA	-10	200	2	-137	3.5	2.2
Response Station	6000	CDMA	-10	1250	-7	-127	10.0	6.2
	6000	CDMA	-10	3750	-2	-122	5.8	3.6
	6000	W-CDMA	-10	5000	-1	-121	5.0	3.1
	6000	TDMA	-10	30	-23	-143	64.2	39.9
	6000	TDMA	-10	200	-15	-135	24.8	15.4

[1] To calculate the required separation distance based on free space loss, the maximum undesired 3G power flux density that could be present at the ITFS/MDS receiver before interference would occur is determined. Then, the distance away from the 3G transmitter where that power flux density would be present is calculated. The calculations of required free space separation are made using the values in the columns headed "EIRP" and "Max Undesired 3G Power Flux Density." For example, to reduce the EIRP of -10 dBW (100 milliwatts) to -129 dBW/m^2 (7.9 $microwatts/m^2$), the 100-milliwatts of power must be spread over the surface of a sphere with a total surface area of 0.1/(7.9x106) square meters. The free space column is the radius of a sphere with that surface area [distance = $\sqrt{(P_{transmit}/4\pi P_{received})}$].

[2] The values under "Max Undesired 3G Power Flux Density" are derived from the bottom row of the relevant planning factors table in Appendix 4, *i.e.*, -139 dBW/m^2 for the 125 kHz channels of hub receivers, and -120 dBW/m^2 for the 6 megahertz channels of response station receivers. Bandwidth factors modify these –139 and –120 values. For example, -139 dBW/m^2 becomes –129 dBW/m^2 due to the 10 dB bandwidth factor for interference to ITFS/MDS 125-kHz hub receivers by CDMA 1250-kHz channel transmitters.

[3] As a practical matter, interference will not occur beyond the radio horizon. The rules only require that an interference analysis be completed if the location of a proposed station is within 160.9 kilometers (100 miles) of an incumbent station. *See* 47 C.F.R. §§ 21.902 and 74.903. Therefore, any distance separation calculated beyond this limit is reduced to 160.9 kilometers (100 miles) in the table.

APPENDIX 4.2

Feasibility Study on Spectrum Sharing between Fixed Terrestrial Wireless Services and proposed Third Generation Mobile Services in the 2500-2690 MHz Bands

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ABSTRACT

The frequency bands from 1710-1885 MHz and 2500-2690 MHz have been identified at WRC-2000 as spectrum for consideration in the implementation of proposed third generation ("3G") mobile services internationally. However, it was recognized that full utilization of any identified band might not be possible because of domestic uses in certain countries. In the US, the bands 2150-2162 and 2500-2690 MHz are utilized extensively for fixed wireless services commonly know as Multichannel Multipoint Distribution Services ("MMDS") and Instructional Television Fixed Services ("ITFS"). These point-to-multipoint services have been in existence for over 40 years and have numerous transmission and reception points throughout the country. Historically utilized for video distribution, these services have undergone important regulatory changes over the past several years to allow the industry to evolve into a bi-directional digital high speed Internet access service. The first regulatory filing period has now concluded and implementation of these broadband data services on a wide scale basis has begun.

Co-frequency utilization by existing and planned MMDS/ITFS services and proposed 3G services will not be possible because of unavoidable and unacceptable interference between the two services. Interference from 3G services into MMDS/ITFS will be severe because of (1) the sensitivity of the MMDS/ITFS receivers (both hub and CPE) based on the need to utilize higher order modulation techniques, (2) the commercial necessity of utilizing economical receive antennas and the inability to discriminate the mobile 3G services for interference isolation, (3) the already compromised interference environment created by existing levels of co-channel interference between neighboring markets and (4) the need for high degrees of frequency reuse within urban markets to meet the expected capacity demands. Likewise, interference from MMDS/ITFS services into 3G services will be severe because of (1) the use of omnidirectional mobile receive antennas with no ability to discriminate, (2) the high power levels of the fixed services at the hub broadcast over a wide or omnidirectional area, (3) the power levels of the CPE return path transmissions and (4) the high probability that 3G receivers will be in close proximity to either MMDS/ITFS hub or CPE sites.

MMDS/ITFS SYSTEM OPERATION

The architectures for MMDS/ITFS systems vary based on the service offering, the population of the market and the terrain characteristics of the market area. Currently there are four basic service offerings: analog television, digital television, unidirectional digital data and bi-directional digital data. The architecture that will be utilized in many second and third tier markets to deliver all of these services is a single cell or "super cell" configuration. This architecture utilizes a single transmit site located on a high building or tower to cover a large area (up to 35 miles in radius.) This architecture may utilize an omnidirectional or broad beamwidth cardioid antenna with power levels as high as the FCC rules will allow. In certain markets where terrain or foliage is severe, repeaters may be used to fill in areas of poor coverage. These repeaters rebroadcast all channels on the same frequencies as they are received. Therefore, self-interference can only be controlled by isolation between service areas created by terrain or other obstructions.

Cellular architectures are being developed primarily for larger markets where the expected demand for broadband data can support the increased costs. This architecture utilizes existing buildings or towers located in close proximity to potential customer locations with the minimum height and power necessary to achieve the path reliability throughout the desired coverage area. Interference is controlled by careful frequency planning utilizing polarization, sector geometry and receive antenna isolation.

Analog Television

A majority of the analog television MMDS/ITFS implementations in the US utilize an architecture where a single high power transmitter is located on a tall transmit site in or near a populated area. In urban environments, this site is usually a tall building or tower in or near the center of population. The transmit antenna pattern will typically be omnidirectional or a wide cardioid. In more rural markets the transmit site may be removed from the population center in order to take advantage of high terrain feature or an existing tower and a more directional cardioid antenna would be utilized to concentrate coverage in the desired area. The maximum EIRP allowed by the FCC is 2000 watts peak analog power when an omnidirectional transmit antenna is utilized. Slightly higher power levels may be allowed in certain cases when cardioid antennas are utilized. Typical EIRP's are in the 100 –1000 watt range. Either horizontal or vertical polarization is allowed.

Receive sites utilize directional antennas of various sizes and gains dependent upon distance from the transmit site and the quality of the propagation path to the transmit site. These antennas range in gain from 12 to 27 dBi and vary in size from approximately 0.2 – 1.2 meters in diameter. A copy of the antenna patterns for several representative antennas is attached as Attachment 1. The height of these antennas must be sufficient to achieve an unobstructed or very nearly unobstructed propagation path to the transmit site. Because of size and cost, the smaller antennas are practical for deployment on a broad scale at single family homes while the large antennas tend to be utilized at multi-dwelling units or businesses.

Analog television signals require a very high carrier-to-noise ratio ("C/N") at the receive site in order to produce a high quality video signal. Degradations in received signal strength due to obstructed paths or interference will very quickly manifest themselves as degraded picture quality. Current FCC rules require the carrier-to-interference ratio ("C/I") for incumbent stations to be maintained at 45 dB for co-channel stations operating in neighboring markets. This level of protection must be maintained at all unobstructed areas in a protected service area defined as a 35 mile radius circle around the desired transmit site. This level of co-channel interference protection will result in a subjective picture quality of grade 3 based on the ITU/R Recommendation 500 rating scale. This figure of merit categorizes the impairment caused by the interference as "slightly annoying."

Digital Television

Digital television systems utilize the same supercell architecture as analog television systems with similar technical configurations for the transmit and receive site equipment. Transmit power limits remain the same but the EIRP is now referenced to average digital power. The major difference is in the practical interference protection requirement. Although the current FCC rules require the same 45 dB co-channel protection as analog systems, digital systems can tolerate more interference. The modulation technique employed in digital TV MMDS/ITFS systems is 64-QAM with forward error correction included. This modulation allows receivers to tolerate lower C/I than the 45 dB FCC analog television requirement.

Data Transmissions

Data systems will utilize one of two different architectures depending on the location of the market, the number of potential subscribers, and the desired service offerings. In second and third tier markets where the number of potential subscribers and the desired service offering can only support a single transmit site, a supercell architecture is employed. The technical configurations for the downstream transmissions are the same as an analog or digital television system as described above with the addition of sectorization at the antenna to improve frequency reuse and capacity. These systems currently utilize various modulation techniques including QPSK, 64-QAM, VOFDM and TDMA or CDMA multiplexing techniques.

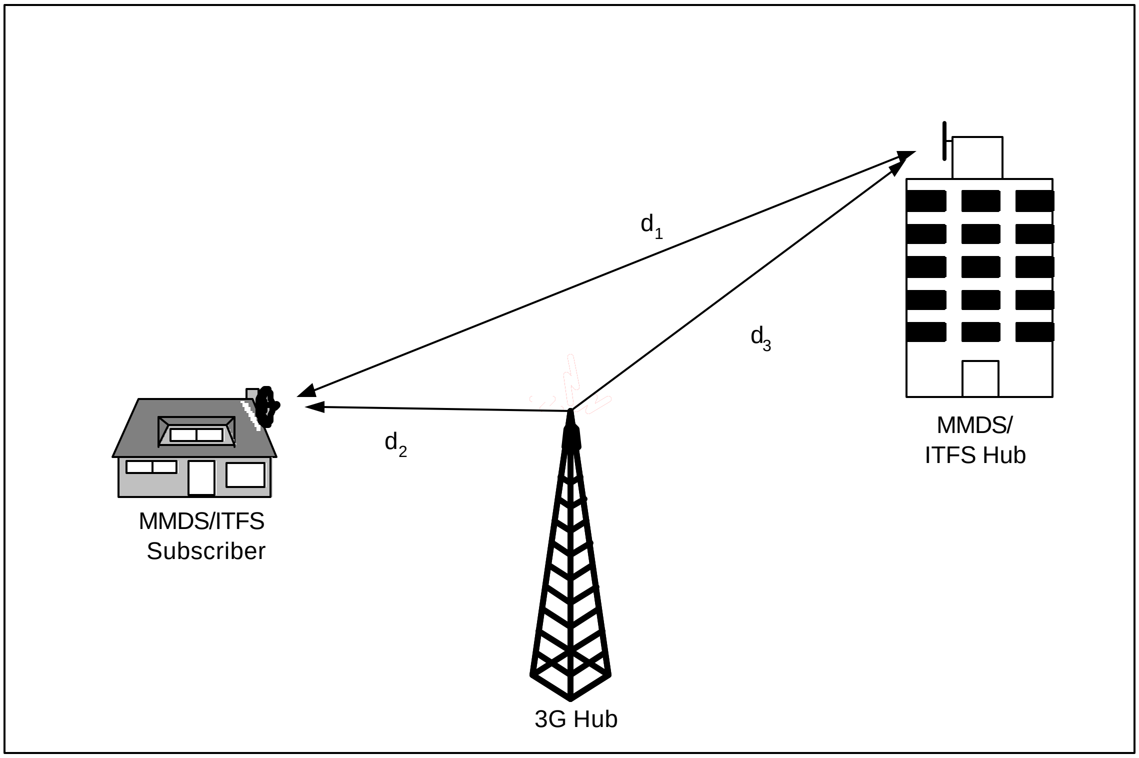
Upstream transmissions are accomplished at a subscriber site through a transverter, typically utilizing the same antenna for transmission as reception. These antennas have the same gain range as described previously of 12 to 27 dBi. Many of the transverters and antennas are built as integrated units. The upstream receive antennas for integrated units will have typical gains in the 10 to 24 dBi range.

In larger markets where the potential subscriber base can support multiple cell sites, frequency reuse is necessary to meet the capacity demands. In order to implement an aggressive frequency reuse plan, a cellular architecture must be employed. The technical characteristics will be similar to those discussed previously with downstream and upstream power levels in the range of 1 – 100 watts EIRP.

INTERFERENCE INTO MMDS/ITFS SYSTEMS

The interference potential from 3G mobile units to the fixed receive sites of an MMDS/ITFS system operating in the same frequency band is real but difficult to predict. These mobile units will be deployed in mass with expected high densities of transmitters. A simulation methodology has to be created in order to estimate the amount of interference power a system could be generating in the area of MMDS/ITFS receive sites. The development of this simulation methodology is beyond the scope of this paper.

However, predicting the potential for interference from 3G hubs or base stations to MMDS/ITFS receivers is a more manageable task. This potential for interference can best be described by first calculating the predicted level of interference between typical 3G and MMDS/ITFS system configurations and then determining a minimum required separation distance between systems to reduce the predicted interference to manageable levels. MMDS/ITFS receive sites can exist at subscriber locations for downstream transmissions or at hub locations for upstream transmissions. If interference is predicted to be small, then the minimum separation distance will be small and systems can coexist. However, if the predicted interference is severe and the separation distance is predicted to be large, the potential for widespread interference is large and coexistence becomes impossible.



The above diagram depicts the potential for interference from a 3G hub to MMDS/ITFS receive sites. It is assumed from a practical standpoint that 3G hubs will be distributed around a market area in a way that is similar to the distribution of current PCS and cellular towers, resulting in 3G hubs being located in close proximity (i.e., on the order of 500 - 1000 feet) to many homes and businesses that are potential subscribers to services offered by MMDS/ITFS systems. As shown below, however, the calculated minimum tolerable separation distances for coexistence between 3G hubs and MMDS/ITFS receive locations is on the order of tens of miles which would result in significant potential for harmful interference to both analog and digital MMDS/ITFS services.

Analog Television Receive Sites

Assuming the maximum acceptable level of co-channel interference from a 3G mobile unit or hub to a MMDS/ITFS analog television receive site is 45 dB (C/I), the expected degree of interference to typical system configurations from one or more 3G hubs can be calculated. This level of interference protection is currently required by the Commission in the rules covering MMDS and ITFS operation.

Assume for the first scenario a typical MMDS/ITFS transmit site configuration with an omnidirectional transmit antenna operating with an EIRP of 100 watts. The transmit antenna height will be placed at 90 meters AGL. The MMDS/ITFS receive site will use a 12 dBi antenna and will be located 1 to 35 miles from the transmit site.

The 3G hub is assumed to be operating with 100 watts of average EIRP spread across a 4.5 MHz bandwidth. The 3G hub is also assumed to be broadcasting omnidirectional. This assumption may not be reasonable on a single frequency, however, if all of the frequencies used by the various 3G sectors are co-channel with the MMDS/ITFS frequencies then the study will represent a composite of all the potential for interference across the band. The 3G hub is assumed to be located approximately 8 miles away from the MMDS/ITFS hub. This distance is very conservative and presents a scenario where 3G services have the best chance of not creating interference to MMDS/ITFS services.

The results of the study are shown below in Figure 1. The various colored regions represent different levels of predicted interference. An area that meets or exceeds the 45 dB requirement appears on the figure in green. As the study shows, a majority of the 35 mile service area would receive harmful interference from a single 3G hub. This area of interference represents approximately 60% of the total MMDS/ITFS potential service area. In fact, a majority of the interference area experiences interference levels of 20 dB or greater.

3G Hub Interference to MMDS/ITFS

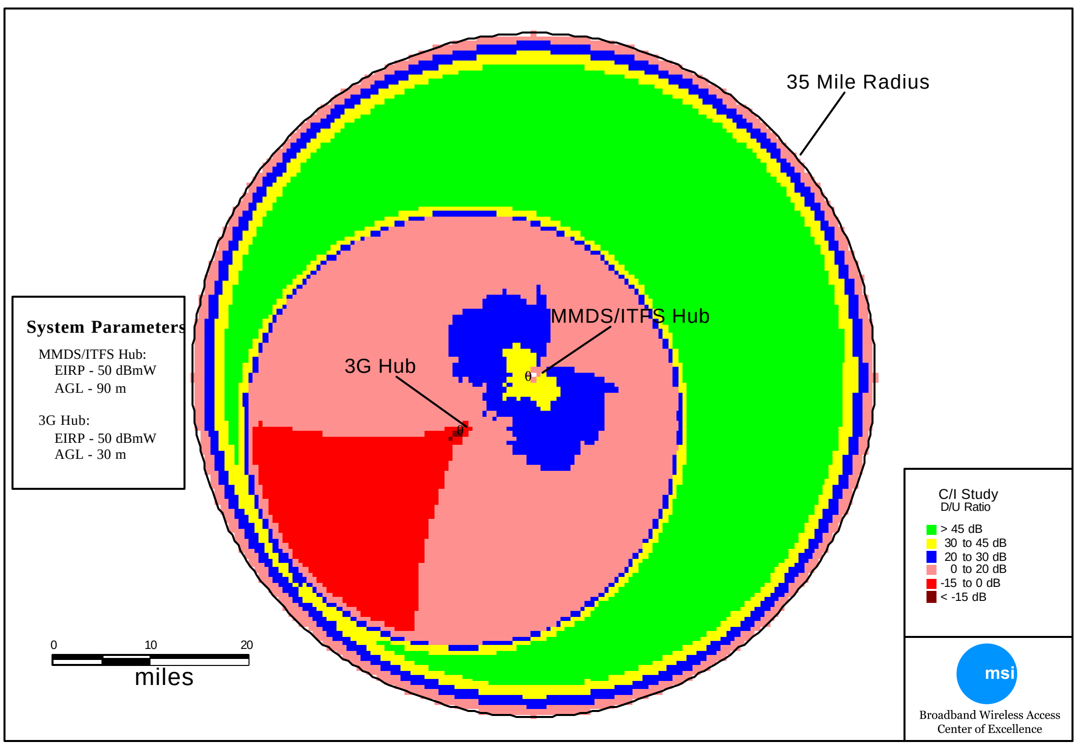


Figure 1 - Interference from a single 3G hub to an MMDS/ITFS service area.

A minimum separation distance between a 3G transmitter and an MMDS/ITFS receive site can be calculated using the same assumptions regarding system operation specified above. Antenna discrimination will not be considered as there will certainly be locations oriented towards both the 3G and MMDS hub. The table below shows the required separation distances in order to reduce the interference shown above to acceptable levels. As one can see, the required separation distances are calculated to be in miles, not feet. In fact, all of the distances calculated are well beyond the radio horizon for normal 4/3 earth curvature. Therefore, the actual separations will be a function of the radio horizon and the excess path attenuation generated by terrain and obstruction blockage. Therefore, coexistence between 3G services and analog television services is impossible for this scenario.

Distance between MMDS Tx and Rx (miles)	Path Loss (dB)	MMDS Rx LVL (dBm)	Required 3G Rx Lvl for 45 dB C/I (dBm)	Discrimination (dB)	Required Separation (miles)
1	104.9	-54.9	-99.9	0	177.8 **
2	110.9	-60.9206	-105.921	0	355.7 **
3	116.9	-66.9412	-111.941	0	711.3 **
4	123.0	-72.9618	-117.962	0	1422.6 **
16	129.0	-78.9824	-123.982	0	2845.2 **
32	135.0	-85.003	-130.003	0	5690.5 **

****** These distances are beyond the radio horizon and will therefore be limited by the radio horizon.

Table 1. Required Separation Distance between 3G Base Station and MMDS/ITFS Analog Television Rx Sites

A similar prediction can be performed for multiple 3G hubs in the same 35 mile radius service area as shown in the Figure 2 below. These hubs are assumed to be operating on the same frequency as the MMDS/ITFS hub. This is a reasonable assumption since the hubs are separated by a relatively large distance. The interference levels become significantly worse, increasing the interference zone to 80-85% of the available service area.

3G Hub Interference to MMDS/ITFS

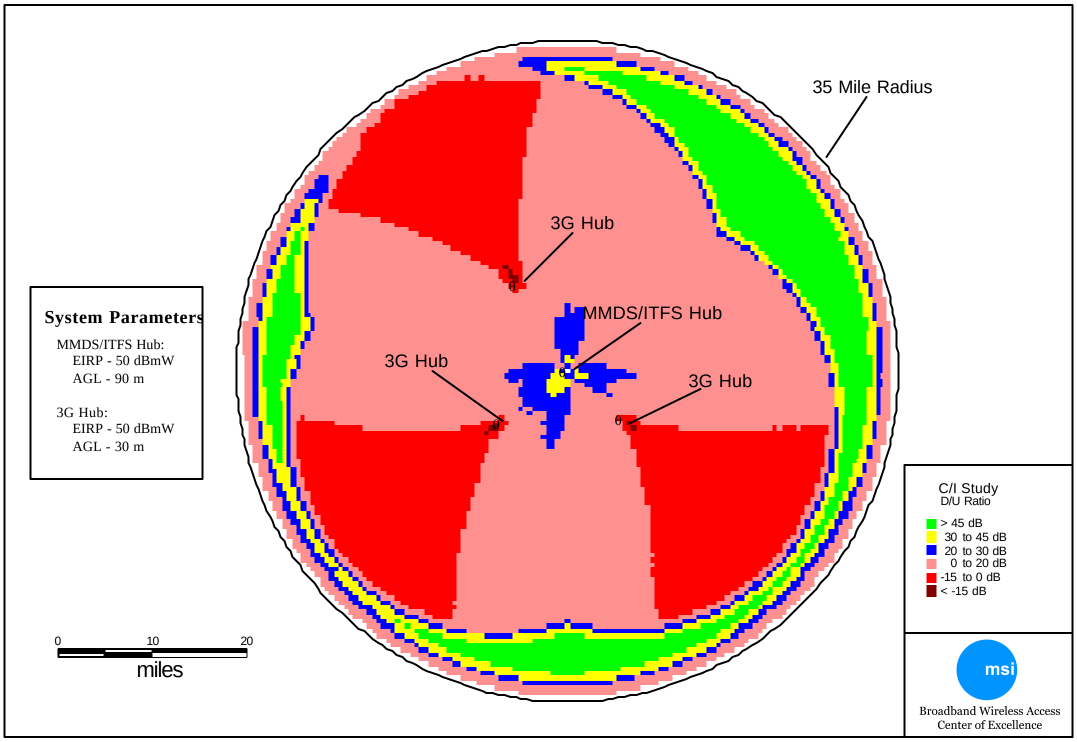


Figure 2 - Interference from multiple 3G hubs to MMDS/ITFS Analog Television Rx Sites

Data Transmissions

Similar calculations can be performed for an MMDS/ITFS high-speed data system. Assume the same technical characteristics for the system as in the previous analysis with the exception of lowering the MMDS/ITFS hub site to 30 meters as might be the case in a cellularized digital data system. In addition, the service area will be reduced to 15 miles in radius. Also, the interference protection requirement will change based on the digital transmission and the modulation technique. The lower order modulation techniques will tolerate higher levels of interfering signal than the higher order techniques. Therefore, several different modulation techniques will be analyzed.

The current technologies being utilized in MMDS/ITFS data transmission systems utilize various modulation techniques and densities. The highest order modulation technique currently utilized is 64-QAM. This modulation technique requires a minimum C/I+N of 22-24dB. Lower order modulation techniques are possible as well, with a minimum C/I+N requirement of 9-11 dB. These C/I+N values represent theoretical limits and do not incorporate additional margins for practical equipment operation or system design margins.

Below is an area wide interference study for MMDS/ITFS data transmission and a single 3G hub. Again, the service area is significantly reduced because of the 3G hub interference into

CPE receive sites. For the higher order modulation techniques such as 64-QAM, the area of unacceptable interference is approximately 60% of the total potential service area. While lower order modulation techniques would reduce the percentage somewhat, there would be a severe economic penalty in loss of capacity.

The table below shows the minimum separation distance requirements for QPSK through 64-QAM modulation techniques. The same assumptions regarding power levels were used as in the previous calculations. These calculations are applicable to supercell or cellular architectures. Again, the results show the required separation distances to be in miles, not feet.

Antenna discrimination could improve these conditions at MMDS/ITFS hub locations. However, the probability that MMDS/ITFS hubs and 3G hubs would have unobstructed propagation paths to each other is high. In these situations the ability to use discrimination will be diminished if not completely eliminated. Therefore, co-frequency operation is again not feasible between the two services.

Likewise, Figure 4 contains an interference study with multiple 3G hubs causing interference to a single MMDS/ITFS data reception system. For higher order modulation densities, the area of interference is approximately 85% of the total potential service area. Again, the area of interference could be reduced somewhat by use of lower order modulation techniques, but at a significant reduction in overall capacity.

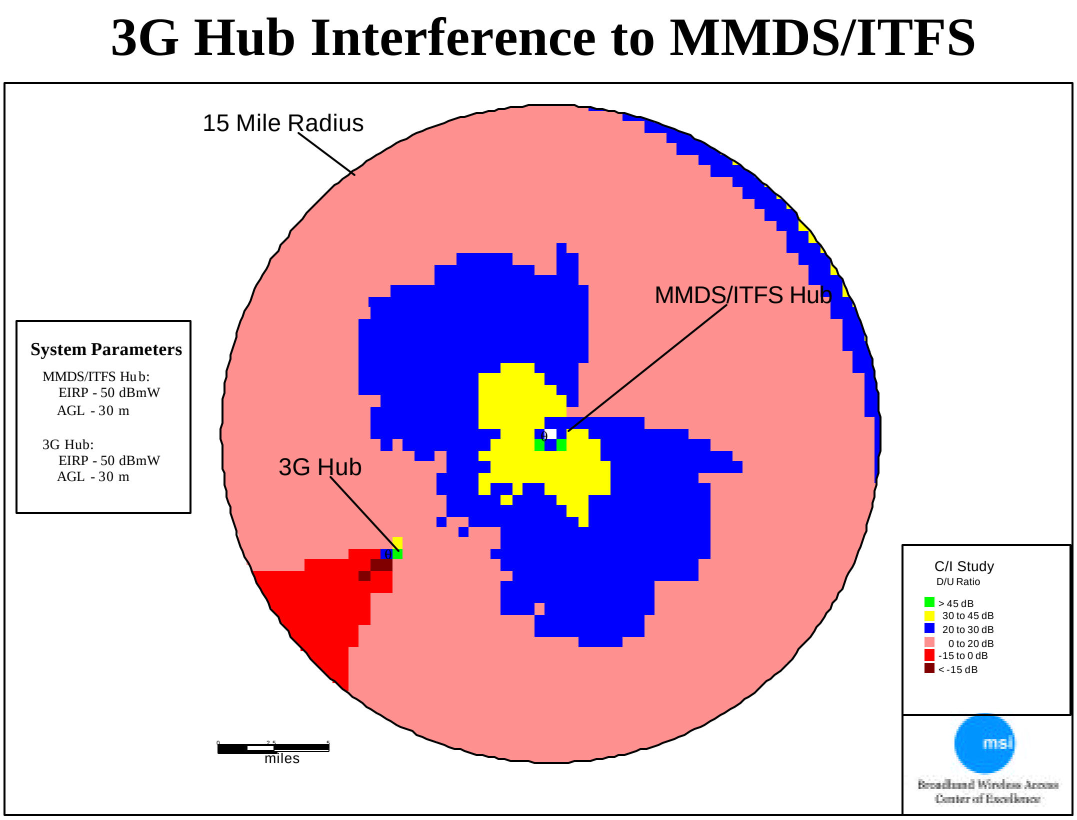


Figure 3 - Interference from a single 3G hub to MMDS/ITFS data receive sites

Distance between MMDS Tx and Rx (miles)	Path Loss (dB)	MMDS Rx LVL @ Input to Antenna (dBm)	Required 3G Rx Lvl for Min C/I with FEC (dBm)				Rx Ant Discrim (dB)	Required Separation (miles)			
			QPSK	16-QAM	64-QAM	256-QAM		QPSK	16-QAM	64-QAM	256-QAM
1	104.9	-54.9	-63.9	-71.2	-77.2	-83.2	0	2.8	6.5	13.0	26.0
2	110.9	-60.9	-69.9	-77.2	-83.2	-89.2	0	5.6	13.1	26.1	52.0
4	116.9	-66.9	-75.9	-83.2	-89.2	-95.2	0	11.3	26.1	52.1	104.0
8	123.0	-73.0	-82.0	-89.3	-95.3	-101.3	0	22.5	52.3	104.3	208.0
16	129.0	-79.0	-88.0	-95.3	-101.3	-107.3	0	45.1	104.5	208.5	416.0
32	135.0	-85.0	-94.0	-101.3	-107.3	-113.3	0	90.2	209.0	417.0	832.1

Table 2. Required Separation Distance between 3G Base Station and MMDS/ITFS Data Rx Site

3G Hub Interference to MMDS/ITFS

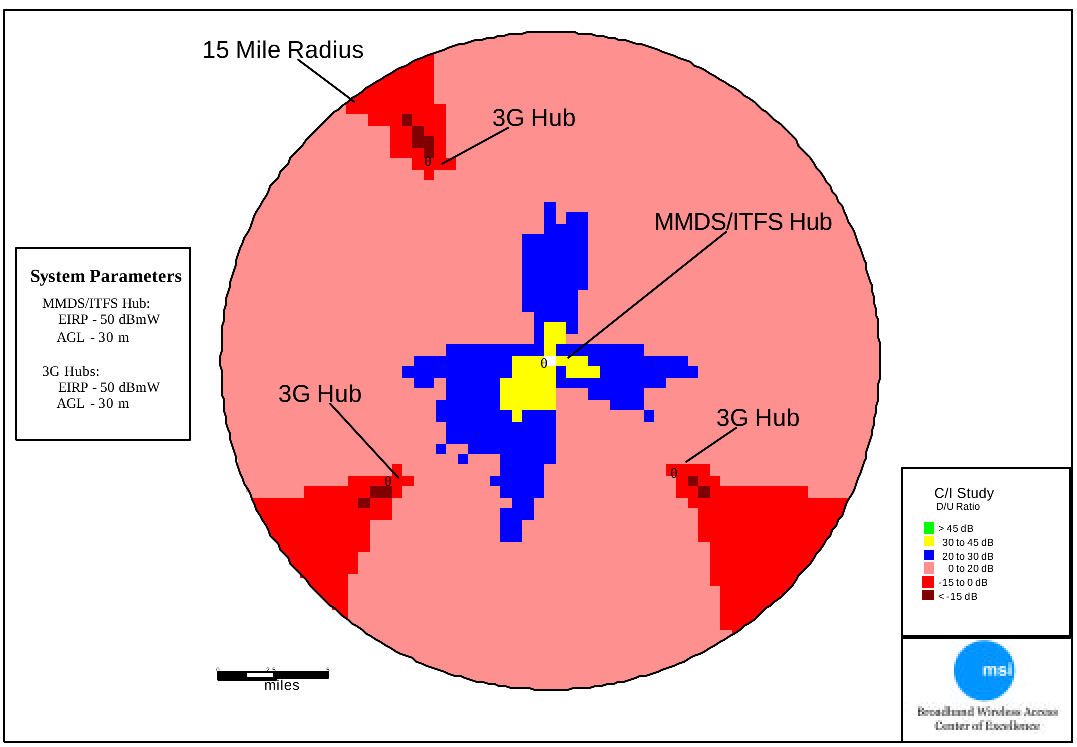


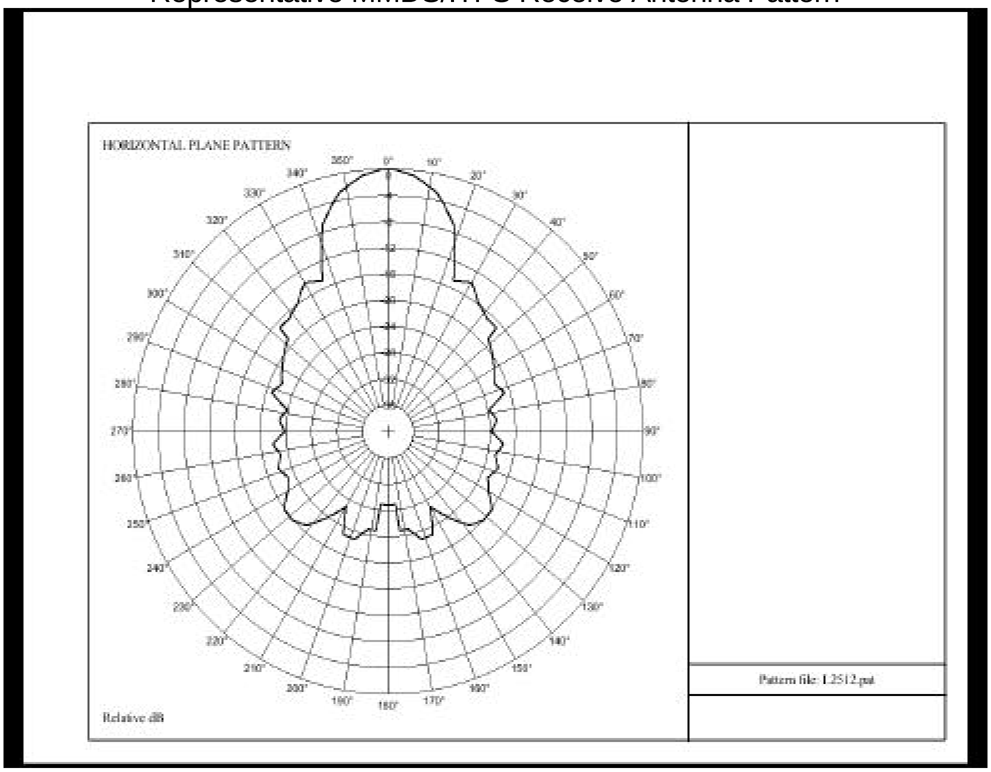
Figure 4 - Interference from multiple 3G hubs to MMDS/ITFS data receive sites.

CONCLUSIONS

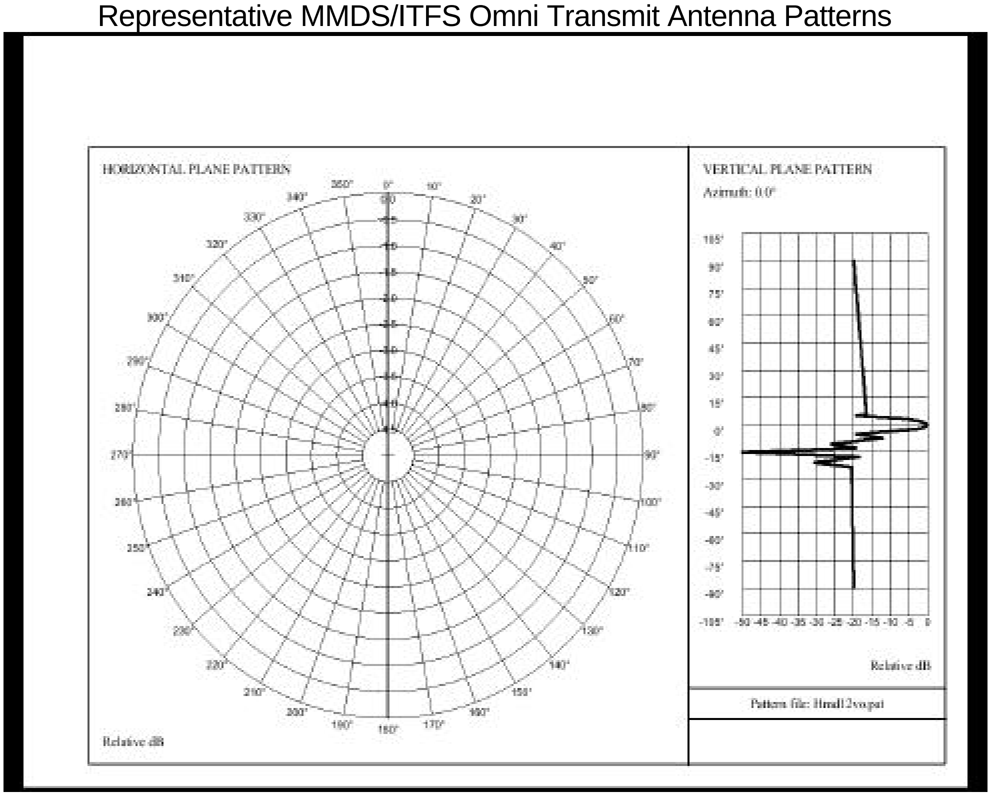
The studies presented in this paper have shown that it is impossible for 3G services to coexist in the same frequency band with MMDS/ITFS fixed services. The level of co-channel interference from 3G hubs alone is sufficient to devastate the commercial operation of a MMDS/ITFS system. If the potential for interference from 3G hubs to MMDS/ITFS hubs and from 3G mobile units to MMDS/ITFS hubs and CPE's is added into the equation, the MMDS/ITFS system will be completely unusable. In addition, the studies in this paper have been extremely conservative with regard to the operational characteristics of the postulated 3G system. For example, there typically would be significantly more 3G hubs in an area than the one to three used in these studies.

Attachment 1 to Appendix 4.2

Representative MMDS/ITFS Receive Antenna Pattern



Representative MMDS/ITFS Omni Transmit Antenna Patterns



APPENDIX 4.3

INTERFERENCE TO 3G SYSTEMS FROM ITFS/MDS SYSTEMS SHARING THE SAME FREQUENCIES

George W. Harter
Director of Broadband Engineering
MSI

III. INTRODUCTION AND SUMMARY

The purpose of this paper is to analyze the potential for interference to proposed 3G systems from ITFS/MDS systems sharing the same frequency of operation. This analysis examines all of the proposed IMT-2000 standards for which interference thresholds were available, based on the technical specifications set forth in the January 25, 2001 draft Report of the 3G Characteristics Group of the Industry/Government Informal Working Group (the "3G Characteristics Report").[2] The analyses calculate the required separation distances between proposed 3G base and mobile units and ITFS/MDS base stations and customer premise units (response stations). As summarized in Appendix 1, substantial separation from MDS/ITFS systems is required in order for 3G systems to operate on a cochannel basis without interference.

IV. ANALYSIS

Table 1 to the 3G Characteristics Report defines two interference thresholds for base and mobile 3G units. Threshold 1 is defined by the received signal level being at sensitivity, with an interference-to-noise equal to –6 dB, resulting in a 10 percent loss in the range of the system. The received signal level being 10 dB above the sensitivity point with the signal-to-noise ratio resulting in a bit error rate of 10-3 defines threshold 2. These thresholds were not defined for some categories of 3G technologies and therefore calculations were not performed in all cases.

Using these interference thresholds, the separation distance between 3G receivers and ITFS/MDS transmitters necessary to avoid interference can be calculated. For purposes of the calculations, 3G mobile units were assumed to utilize a receive antenna with unity gain and hub antennas were assumed to utilize an antenna with 17 dBi gain.

ITFS/MDS base stations and response stations (subscriber CPE) operate with a variety of power levels. The maximum power level allowed by the FCC for stations that utilize an omnidirectional transmit antenna is 2000 watts EIRP in a 6 MHz bandwidth. In those situations where the station is transmitting an analog signal, this is measured as peak power, while for digital transmissions it is measured as average power. Most single cell ITFS/MDS systems, the most prevalent type to date, operate with EIRP levels between 500 and 2000 watts. Individual cells within cellular systems will operate with a wider range of power levels, depending on the number of cells, the service area of the particular cell, and the propagation characteristics of the market. Therefore, three power levels, 2000, 500 and 100 watts EIRP, were considered in the analysis.

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[2] There is no reason to believe that the results would be significantly different for the cases where interference thresholds were not included in the 3G Characteristics Report.

ITFS/MDS response stations (the CPE) also operate with a variety of power levels and bandwidths. The maximum power level allowed by the FCC is 2000 watts in a 6 MHz bandwidth. As the bandwidth is reduced or increased, the maximum power level of the upstream transmitter is adjusted based on equivalent power spectral density. For purposes of this analysis, a typical power level of 668 watts EIRP in a 2 MHz bandwidth was utilized.

Attached as Appendix 1 is a table showing the separation distance required between an MDS/ITFS transmitter and each proposed 3G technology. These calculations assume an unobstructed electrical path to the radio horizon limit of 161 kms. Calculations resulting in separation distances beyond the radio horizon were limited to 161 kms. Also, the worst case geometry resulting in bore sighted conditions between the transmit and receive antenna was assumed. No cross polarization discrimination was considered since ITFS/MDS systems use both horizontal and vertical polarization liberally to maintain isolation with adjacent markets. In addition, these studies did not consider the effects of multiple ITFS/MDS radiators within a market. Note however that in all markets there will inevitably be multiple response stations (CPE) operating simultaneously and that in multicell markets, multiple downstream transmission may be occurring on the same frequency at the same time. A more detailed analysis accumulating the signal levels generated by these multiple radiators was not conducted in light of the compelling results when even a single radiator is considered.

V. INTERFERENCE TO 3G MOBILE RECEIVERS

As the results show, interference threshold 1 for mobile 3G receivers is only met when the receiver is isolated from the ITFS/MDS base or CPE transmitters using the radio horizon for separation. The required separation distance is always beyond the radio horizon and is therefore for purposes of Appendix 1 is limited to the defined radio horizon distance of 161 kms.

Likewise, for a majority of the cases analyzed based on interference threshold 2 the separation requirement for mobile 3G receivers remains at or very close to the radio horizon. However, when the ITFS/MDS base station power is lowered to 100 watts EIRP, the separation distance is reduced to 66 kms for CDMA 2000 1X. Note, however that this power level of 100 watts is only likely to be employed by MDS/ITFS multicell systems. Therefore, as a practical matter it will be necessary to consider the accumulation of signals from multiple MDS/ITFS cells and greater separation will be required to protect the 3G system.

VI. INTERFERENCE TO 3G BASE STATION RECEIVERS

The results show for all cases at interference threshold 1 that the level of interference into 3G hubs requires separation distances equal to the radio horizon. When the interference threshold is relaxed to threshold 2, certain 3G technologies will allow a 3G base station to operate within 102 kms or a 100 watt MDS/ITFS base station.

VII. CONCLUSIONS

These calculations prove conclusively that cochannel frequency sharing between 3G and ITFS/MDS systems is not a practical solution. MDS/ITFS systems are operating in most markets across the country, and the required separation distances would only permit 3G systems to operate without interference in the most rural areas.

Appendix 1 – Interference to 3G Receivers from ITFS/MDS Transmitters

3G System Parameters			***ITFS/MDS Base Station (2000 Watts)***				***ITFS/MDS Base Station (500 Watts)***				***ITFS/MDS Base Station (100 Watts)***			
Protected Receiver Type	Modulation Type	Bandwidth (MHz)	Bandwidth (MHz)	EIRP (dBm)	Separation 1 (kms) (1)	Separation 2 (kms) (2)	Bandwidth (MHz)	EIRP (dBm)	Separation 1 (kms) (1)	Separation 2 (kms) (2)	Bandwidth (MHz)	EIRP (dBm)	Separation 1 (kms) (1)	Separation 2 (kms) (2)
Mobile	CDMA 2000 1X	1.25	6	63	161	161.0	6	57	161	148.2	6	50	161	66
	CDMA 2000 3X	3.75	6	63	161	161.0	6	57	161	161.0	6	50	161	72
	UWC-136	0.03	6	63	N/A	N/A	6	57	N/A	N/A	6	50	N/A	N/A
	UWC-136	0.2	6	63	N/A	N/A	6	57	N/A	N/A	6	50	N/A	N/A
	TD-CDMA	5	6	63	161	161.0	6	57	161	161.0	6	50	161	105
	W-CDMA	5	6	63	161	161.0	6	57	161	161.0	6	50	161	74
Base Station	CDMA 2000 1X	1.25	6	63	161	161.0	6	57	161	161.0	6	50	161	105
	CDMA 2000 3X	3.75	6	63	161	161.0	6	57	161	161.0	6	50	161	102
	UWC-136	0.03	6	63	161	161.0	6	57	161	161.0	6	50	161	115
	UWC-136	0.2	6	63	161	161.0	6	57	161	161.0	6	50	161	118
	TD-CDMA	5	6	63	161	161.0	6	57	161	161.0	6	50	161	161
	W-CDMA	5	6	63	N/A	N/A	6	57	N/A	N/A	6	50	N/A	N/A

(1) Separation required to limit loss in range of 3G system to 10%.

(2) Separation required to keep desired signal 10 dB above sensitivity and S/(I+N) for a 10^{-3} BER.

APPENDICES

FOR

SECTION 5

APPENDIX 5.1
NUMBER OF INCUMBENT ITFS/MDS LICENSEES IN MAJOR METROPOLITAN AREAS

The following table indicates the licensed data for the 50 most populated major metropolitan areas within the United States.

	ITFS Incumbents		MDS Incumbents		Total Incumbents	
	Number of Licensees	Number of Licensees	Number of Licensees	Number of Licensees	Number of Licensees	Number of Licensees
New York	9	5	5	4	14	9
Los Angeles	1	1	3	2	4	3
Chicago	6	4	5	4	11	8
Philadelphia	1	1	5	2	6	3
Detroit	6	6	5	3	11	9
Boston	3	3	6	3	9	6
San Francisco	5	2	9	4	14	6
Washington, DC	4	2	3	3	7	5
Dallas-Fort Worth	7	5	14	6	21	11
Houston	4	4	6	3	10	7
St. Louis	3	3	7	6	10	9
Miami	6	3	5	4	11	7
Pittsburgh	1	1	4	1	5	2
Baltimore	3	3	4	2	7	5
Minneapolis-St. Paul	6	5	7	4	13	9
Cleveland	1	1	3	1	4	2
Atlanta	4	4	7	5	11	9
San Diego	4	3	4	4	8	7
Denver	4	3	8	1	12	4
Seattle	3	1	4	4	7	5
Milwaukee	4	4	7	5	11	9
Tampa	2	1	5	5	7	6
Cincinnati	3	1	3	1	6	2
Kansas City	3	3	6	1	9	4
Buffalo	0	0	2	1	2	1
Phoenix	5	5	7	4	12	9
San Jose	2	2	5	1	7	3
Indianapolis	2	2	7	3	9	5
New Orleans	5	5	6	3	11	8
Portland	3	2	7	2	10	4
Columbus	0	0	6	4	6	4
Hartford	0	0	2	1	2	1
San Antonio	2	2	6	3	8	5
Rochester, NY	0	0	4	2	4	2
Sacramento	5	4	6	5	11	9
Memphis	2	2	7	4	9	6

	ITFS Incumbents		MDS Incumbents		Total Incumbents	
	Number of Licensees	Number of Licensees	Number of Licensees	Number of Licensees	Number of Licensees	Number of Licensees
Louisville	3	3	4	1	7	4
Providence	1	1	2	2	3	3
Salt Lake	0	0	4	1	4	1
Dayton	2	1	6	2	8	3
Birmingham	0	0	0	0	0	0
Bridgeport	0	0	0	0	0	0
Norfolk	1	1	6	5	7	6
Albany	2	2	7	3	9	5
Oklahoma City	4	3	7	3	11	6
Nashville	0	0	3	3	3	3
Toledo	0	0	6	5	6	5
New Haven	1	1	0	0	1	1
Honolulu	0	0	17	4	17	4
Jacksonville	7	6	6	3	13	9
Akron	0	0	0	0	0	0
Average	2.7	2.2	5.3	2.8	8	5.0
Standard Deviation	2.3	1.8	3.0	1.6	4.4	2.9
Median	3	2	5	3	8	5

APPNEDIX 5.2

Planning Factors for Guard Band to Protect ITFS/MDS Response Station Receivers from 3G Transmitters

Quantity	Value	Comment
Mid-frequency of 2500-2690 Band	2595 MHz	Arithmetic mean for estimation of antenna aperture areas
Gain of Receiving Antennas of Response Stations	Factor of 100, or 20 dBi	See §21.902(f)(3) and §74.937(a).
Antenna Aperture of Receiving Systems	0.106 m^2	$(\text{wavelength})^2 * (\text{gain}) / (4\pi)$
Desired Signal Strength for Response Stations on Periphery of Protected Service Area	-83 dBW for 6 MHz channels	See §21.902(f)(6)(iii).
Desired Power Flux Density for Response Station on Periphery of Protected Service Area	-73 dBW/m^2 for 6 MHz channels	Value calculated from that given in §21.902(f)(6)(iii) and antenna aperture of 0.106 m^2.
Desired-to-undesired Signal Ratio (D/U) for Adjacent-channel Interference	0 dB	See §21.902(f)(6)(iv) and §74.739(d)(3)(v).
Power Flux Density of Adjacent - channel Undesired Signals Causing Harmful Interference	-73 dBW/m^2 for 6 MHz channels	D/U ratio of 0 dB with no guard band
Response Station Receiver (TV) Interference Rejection Characteristic attainable by Greater Frequency Separation	40 dB per MHz	FCC Laboratory measurements of television receivers
Power of 3G Transmitters	Maximum of 1.64 kW EIRP	Base station power dominates all guard band considerations because mobile power is less.

Planning Factors for Guard Band
to Protect ITFS/MDS Hub Receivers
from 3G Transmitters

Quantity	Value	Comment
Transmitter Power of Response Stations (source of ITFS/MDS desired signals)	Maximum 18 dBW EIRP for 125 kHz channels	See §21.909(g)(3). 18 dBW is approximately 63 W.
Desired Power Flux Density at ITFS/MDS Hub	-88 dBW/m^2 for 125 kHz channels	63 watts EIRP from response station transmitter 35 miles away
Maximum Undesired Adjacent-channel Power Flux Density at ITFS/MDS Hub	-88 dBW/m^2 per 125 kHz	0 dB D/U ratio assumed
Interference Immunity Attainable by Greater Frequency Separation	40 dB per MHz	Assumed on basis of typical spectrum emission mask requirements for 3G transmitters and adjacent-channel rejection capability of hub receiver.
Power of 3G Transmitters	Maximum of 1.64 kW EIRP	Base station power dominates all guard band considerations because mobile power is less.

Planning Factors for Guard Band
to Protect 3G Base Station Receivers from ITFS/MDS Base Stations

Quantity	Value	Comment
Mid-frequency of 2500-2690 Band	2595 MHz	Arithmetic mean for estimation of antenna aperture areas
Gain of Receiving Antennas of Response Stations	Factor of 50, or 17 dBi	"Characteristics of International Mobile Communications (IMT) 2000 Technology", Report of Industry Working Group on 3G Characteristics, Chair Gerry Flynn, 20 Feb 2001
Antenna Aperture of Receiving Systems	0.0533 m^2	$(wavelength)^2$ * (gain) / (4π)
Desired Signal Strength for Response Stations on Periphery of Protected Service Area	-83 dBW for 6 MHz channels	See §21.902(f)(6)(iii).
Desired Power Flux Density for Response Station on Periphery of Protected Service Area	-70 dBW/m^2 for 6 MHz channels	Value calculated from that given in §21.902(f)(6)(iii) and antenna aperture of 0.0533 m^2.
Desired-to-undesired Signal Ratio (D/U) for Adjacent-channel Interference	0 dB	See §21.902(f)(6)(iv) and §74.739(d)(3)(v).
Power Flux Density of Adjacent-channel Undesired Signals Causing Harmful Interference	-70 dBW/m^2 for 6 MHz channels	D/U ratio of 0 dB with no guard band
Interference Immunity Attainable by Greater Frequency Separation	At least 40 dB per MHz	Assumed on basis of emission mask requirement of §74.936(c) plus adjacent-channel interference rejection capability of 3G base receiver
Maximum Power of ITFS/MDS Main Transmitters (in any single direction)	7943 W EIRP	See §74.935(b) and §21.904(b). This maximum applies in the case of sectored radiation patterns. It is assumed that less protection is needed from response station transmitters, even though the combination of directional radiation patterns and bandwidth factors might make response station considerations dominant in some cases.

APPENDIX 5.3

Table 5-A: Calculation of Separation Distances, 3G Base Station to ITFS/MDS

Guard Band Analysis Based on Interference Power in Adjacent or Nearby Channels

The required separation for adjacent channels (zero-width guard band) is the distance needed to reduce the 3G EIRP to an acceptable power flux density at the ITFS/MDS receiver. The latter is determined as the amount which would be received in the ITFS/MDS adjacent channel at a level equal to the desired signal (D/U = 0 dB). The bandwidth factor accounts for the difference in width between channels in the two systems.

The required separation for guard bands of greater width is determined by allowing 40 dB reduction of interfering power per MHz of guard band.

3G System Parameters			ITFS/MDS System Parameters					Required Separation (km)			
Modulation Type	EIRP (dBW)	Bandwidth (kHz)	Protected Receiver	Bandwidth (kHz)	Desired Signal Power Density (dBW/m^2)	Bandwidth Factor (dB)	Maximum Acceptable 3G Power Flux Density (dBW/m^2)	Adjacent Channels (No Guard Band)	Guard Band Width (MHz)		
									0.5	1	2
CDMA	27	1250	Hub	125	-90	10	-100	161	16	1.6	0.02
CDMA	27	3750		125	-90	15	-105	161	16	1.6	0.02
W-CDMA	27	5000		125	-90	16	-106	161	16	1.6	0.02
TDMA	27	30		125	-90	-6	-84	100	10	1.0	0.02
TDMA	27	200		125	-90	2	-92	161	16	1.6	0.02
CDMA	27	1250	Response Station	6000	-67	-7	-60	6.4	0.6	0.06	0.00
CDMA	27	3750		6000	-67	-2	-65	11.3	1.1	0.11	0.00
W-CDMA	27	5000		6000	-67	-1	-66	12.9	1.3	0.13	0.00
TDMA	27	30		6000	-67	-23	-44	1.6	0.2	0.02	0.00
TDMA	27	200		6000	-67	-15	-52	3.2	0.3	0.03	0.00

Table 5-B: Calculation of Separation Distances, 3G Base Station to ITFS/MDS

Guard Band Analysis Based on Co-Channel Interference Power (Spill-over)

The bandwidth factor is the number of 100-kHz segments in the ITFS/MDS channel subject to interference.

Guard bands are assumed to provide 40 dB reduction of interfering power per MHz.

3G System Parameters			ITFS/MDS System Parameters					Required Separation (miles)			
Modulation Type	Off-Channel EIRP (dBW per 100 kHz)	Bandwidth (kHz)	Protected Receiver	Bandwidth (kHz)	Noise Floor (NF), or Desired Signal (DS) (dBW)	Bandwidth Factor (dB)	Maximum Acceptable 3G Power Flux Density (dBW/m^2)	Adjacent Channels (No Guard Band)	Guard Band Width (MHz)		
									0.5	1	2
CDMA	-16	1250	Hub	125	-118 (NF)	1	-114	16	1.6	0.16	0.00
CDMA	-16	3750		125	-118 (NF)	1	-114	16	1.6	0.16	0.00
W-CDMA	-16	5000		125	-118 (NF)	1	-114	16	1.6	0.16	0.00
TDMA	-16	30		125	-118 (NF)	1	-114	16	1.6	0.16	0.00
TDMA	-16	200		125	-118 (NF)	1	-114	16	1.6	0.16	0.00
CDMA	-16	1250	Response Station	6000	-83 (DS)	18	-118	161	16	1.6	0.02
CDMA	-16	3750		6000	-83 (DS)	18	-118	161	16	1.6	0.02
W-CDMA	-16	5000		6000	-83 (DS)	18	-118	161	16	1.6	0.02
TDMA	-16	30		6000	-83 (DS)	18	-118	161	16	1.6	0.02
TDMA	-16	200		6000	-83 (DS)	18	-118	161	16	1.6	0.02

Table 5-C: Calculation of Separation Distances, ITFS/MDS to 3G Base Station

Guard Band Analysis Based on Interference Power in Adjacent or Nearby Channels

The required separation for adjacent channels (zero-width guard band) is the distance needed to reduce the EIRP of the ITFS/MDS transmitter to an acceptable power flux density at the ITFS/MDS receiver. The maximum acceptable adjacent channel power is set equal to desired channel noise floor for systems that operate below the noise; equal to the desired signal power (D/U=0) otherwise.

The required separation for guard bands of greater width is determined by allowing 40 dB reduction of interfering power per MHz of guard band.

ITFS/MDS System Parameters			3G Base Receiver Parameters				Maximum Acceptable ITFS/MDS Power Flux Density (dBW/m^2)	Required Separation (miles)			
Type of Transmitter	Bandwidth (kHz)	EIRP (dBW)	Modulation Type	Bandwidth (kHz)	Noise in Receive Bandwidth (dBW)	Receiver Sensitivity (dBW)		Adjacent Channels (No Guard Band)	Guard Band Width (MHz) 0.5	1	2
Main	6000	39	CDMA	1250	-138	-149	-125	161	161	161	4.7
	6000	39	CDMA	3750	-133	-149	-121	161	161	161	2.7
	6000	39	W-CDMA	5000	-132	-140	-119	161	161	161	2.4
	6000	39	TDMA	30	-154	-147	-147	161	161	161	57.1
	6000	39	TDMA	200	-146	-138	-138	161	161	161	20.3
Response Station	125	22	CDMA	1250	-138	-149	-125	161	161	161	2.3
	125	22	CDMA	3750	-133	-149	-121	161	161	161	2.1
	125	22	W-CDMA	5000	-132	-140	-119	161	161	161	2.1
	125	22	TDMA	30	-154	-147	-147	161	161	161	4.0
	125	22	TDMA	200	-146	-138	-138	161	161	161	3.5

Table 5-D: Calculation of Separation Distances, ITFS/MDS to 3G Base Station

Guard Band Analysis Based on Co-channel Interference Power (Spill-over)

For main stations, the attenuation required by Sections 21.908(a) and 74.936(c) of FCC Rules for frequencies below the main TV transmissions is applied to the ITFS/MDS EIRP; for 125-kHz response station transmitters the attenuation is calculated per Sections 21.908(d) and 74.936(f). The attenuated ITFS/MDS power per 100 kHz is then multiplied by the number of 100-kHz segments in the desired 3G receiver bandwidth to determine the spill-over power.

Guard bands are assumed to provide 40 dB reduction of interfering power per MHz.

ITFS/MDS System Parameters			3G Base Receiver Parameters				Spill-over	Required Separation (miles)			
Type of Transmitter	Bandwidth (kHz)	EIRP (dBW)	Modulation Type	Bandwidth (kHz)	Noise in Receive Bandwidth (dBW)	Desired Flux Density (dBW/m^2)	EIRP in 3G Receiver Bandwidth (dBW)	Adjacent Channel (No Guard Band)	Guard Band Width (MHz)		
									0.5	1	2
Main	6000	39	CDMA	1250	-138	-136	-2	161	153	75.6	0.1
	6000	39	CDMA	3750	-133	-136	-5	161	101	51.5	0.1
	6000	39	W-CDMA	5000	-132	-127	-4	161	42	20.9	0.05
	6000	39	TDMA	30	-154	-134	-5	161	161	161	0.4
	6000	39	TDMA	200	-146	-125	2	161	161	161	0.3
Response Station	125	22	CDMA	1250	-138	-136	-10	161	61	30.6	0.06
	125	22	CDMA	3750	-133	-136	-14	161	37	17.7	0.03
	125	22	W-CDMA	5000	-132	-127	-17	90	10	4.8	0.02
	125	22	TDMA	30	-154	-134	-9	161	161	119.1	0.24
	125	22	TDMA	200	-146	-125	-6	161	16	66.0	0.13

APPENDICES

FOR

SECTION 6

APPENDIX 6.1

LIST OF BANDS THAT MET THE SELECTION CRITERIA

Band (MHz)	Block Size	Allocation (Radio Services)	
3650-3700	50	NG	Fixed, Fixed-Satellite (S-E)
3700-4200	500	NG	Fixed, Fixed-Satellite (S-E)
4940-4990	50	NG	proposed… Fixed, Mobile except aeronautical mobile
5850-5925	75	G	Radiolocation
		NG	Fixed-Satellite, Mobile
5925-6425	500	NG	Fixed, Fixed-Satellite (E-S)
6425-6525	100	NG	Fixed-Satellite (E-S), Mobile
6525-6875	350	NG	Fixed, Fixed-Satellite (E-S)
6875-7075	200	NG	Fixed, Fixed-Satellite (E-S), Mobile
7075-7125	50	NG	Fixed, Mobile
7125-7190	65	G	Fixed
7190-7235	45	G	Fixed, Space Research
7235-7250	15	G	Fixed
7250-7300	50	G	Fixed-Satellite, Mobile-Satellite
7300-7450	150	G	Fixed, Fixed-Satellite
7450-7550	50	G	Fixed, Fixed-Satellite, Meteorological-Satellite
7550-7750	200	G	Fixed, Fixed-Satellite
7750-7900	150	G	Fixed
7900-8025	125	G	Fixed-Satellite, Mobile-Satellite
8025-8175	150	G	Earth Exploration-Satellite, Fixed, Fixed-Satellite
8175-8215	40	G	Earth Exploration-Satellite, Fixed, Fixed-Satellite
8215-8400	185	G	Earth Exploration-Satellite, Fixed, Fixed-Satellite
8400-8450	50	G	Fixed, Space Research
8450-8500	50	G	Fixed, Space Research
		NG	Space Research (Only)
10550-10600	50	NG	Fixed
10600-10680	80	G	Earth Exploration-Satellite, Space Research
		NG	Earth Exploration-Satellite, Fixed, Space Research
10700-11700	1000	NG	Fixed, Fixed-Satellite (S-E)
11700-12200	500	NG	Fixed-Satellite (S-E)
12200-12700	500	NG	Fixed, Broadcasting-Satellite
12700-13250	550	NG	Fixed, Fixed-Satellite (E-S), Mobile
13750-14000	250	G	Radiolocation
		NG	Fixed-Satellite
14000-14200	200	G	Radionavigation
		NG	Fixed-Satellite, Radionavigation
14200-14500	300	NG	Fixed-Satellite (E-S)
17300-17800	500	NG	Fixed-Satellite (E-S)
17800-18300	500	G	Fixed-Satellite
		NG	Fixed
17800-18300	500	G	Fixed-Satellite
		NG	Fixed

APPENDIX 6.2

RADIO SERVICE DEFINITIONS

DEFINITIONS –

allocation (of a frequency band): Entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radiocommunication services or the radio astronomy service under specified conditions. This term shall also be applied to the frequency band concerned.

primary service: a service the name of which is printed in "capitals" (example: FIXED). Stations of a primary service take precident over stations of a secondary service.

secondary service: a service the name of which is printed in "normal characters" (example: Mobile). Stations of a secondary service:

a) shall not cause harmful interference to stations of primary services to which frequencies are already assigned or to which frequencies may be assigned at a later date;

b) cannot claim protection from harmful interference from stations of a primary service to which frequencies are already assigned or may be assigned at a later date;

c) can claim protection, however, from harmful interference from stations of the same or other secondary service(s) to which frequencies may be assigned at a later date.

SELECTED RADIO SERVICES –

aeronautical fixed service: A radiocommunication service between specified fixed points provided primarily for the safety of air navigation and for the regular, efficient and economical operation of air transport. A station in this service is an aeronautical fixed station. [*See* 47 C.F.R. § 87.5]

broadcasting-satellite service: A radiocommunication service in which signals transmitted or retransmitted by space stations are intended for direct reception by the general public. In the broadcasting-satellite service, the term "direct reception" shall encompass both individual reception and community reception.

earth exploration-satellite service: A radiocommunication service between earth stations and one or more space stations, which may include links between space stations, in which:

- information relating to the characteristics of the Earth and its natural phenomena, including data relating to the state of the environment, is obtained from active sensors or passive sensors on Earth satellites;
- similar information is collected from airborne or Earth-based platforms;
- such information may be distributed to earth stations within the system concerned;
- platform interrogation may be included.

This service may also include feeder links necessary for its operation.

fixed service (FX): A radiocommunication service between specified fixed points.

fixed-satellite service (FSS): A radiocommunication service between earth stations at given positions, when one or more satellites are used; the given position may be a specified fixed point or any fixed point within specified areas; in some cases this service includes satellite-to-satellite links, which may also be operated in the inter-satellite service; the fixed-satellite service may also include feeder links for other space radiocommunication services.

meteorological-satellite service: An earth exploration-satellite service for meteorological purposes.

mobile service (MO): A radiocommunication service between mobile and land stations, or between mobile stations.

radio astronomy (RA): Astronomy based on the reception of radio waves of cosmic origin.

radiodetermination service: A radiocommunication service for the purpose of radiodetermination. Radiodetermination is the determination of the position, velocity and/or other characteristics of an object, or the obtaining of information relating to these parameters, by means of the propagation properties of radio waves.

radiolocation service: A radiodetermination service for the purpose of radiolocation. Radiolocation is radiodetermination used for purposes other than those of radionavigation.

radionavigation service: A radiodetermination service for the purpose of radionavigation. Radionavigation is radiodetermination used for the purposes of navigation, including obstruction warning.

space research service (SR): A radiocommunication service in which spacecraft or other objects in space are used for scientific or technological research purposes.

standard frequency and time signal-satellite service: A radiocommunication service using space stations on earth satellites for the same purposes as those of the standard frequency and time signal service. This service may also include feeder links necessary for its operation.

APPENDIX 6.3

TABLE OF FREQUENCY ALLOCATION FOOTNOTES

792A The use of the bands 4500-4800 MHz, 6725-7025 MHz, 10.7-10.95 GHz, 11.2-11.45 GHz and 12.75-13.25 GHz by the fixed-satellite service shall be in accordance with the provisions of Appendix 30B.

US74 In the bands 25.55-25.67, 73.0-74.6, 406.1-410.0, 608-614, 1400-1427, 1660.5-1670.0, 2690-2700 and 4990-5000 MHz and in the bands 10.68-10.7, 15.35-15.4, 23.6-24.0, 31.3-31.5, 86-92, 105-116 and 217-231 GHz, the radio astronomy service shall be protected from extraband radiation only to the extent that such radiation exceeds the level which would be present if the offending station were operating in compliance with the technical standards or criteria applicable to the service in which it operates.

US203 Radio astronomy observations of the formaldehyde line frequencies 4825-4835 MHz and 14.470–14.500 GHz may be made at certain radio astronomy observatories as indicated below:

Bands to be observed		Observatory
4 GHz	14 GHz	
X		National Astronomy and Ionosphere Center, Arecibo, Puerto Rico.
X	X	National Radio Astronomy Observatory, Green Bank, W. Va.
X	X	National Radio Astronomy Observatory, Socorro, New Mexico.
X	X	Hat Creek Observatory (U of Calif.), Hat Creek, Cal.
X	X	Haystack Radio Observatory (MIT-Lincoln Lab), Tyngsboro, Mass.
X	X	Owens Valley Radio Observatory (Cal. Tech.), Big Pine, Cal.
	X	Five College Radio Astronomy Observatory, Quabbin Reservoir (near Amherst), Massachusetts

Every practicable effort will be made to avoid the assignment of frequencies to stations in the fixed or mobile services in these bands. Should such assignments result in harmful interference to these observations, the situation will be remedied to the extent practicable.

US211 In the bands 1670-1690, 5000-5250 MHz and 10.7-11.7, 15.1365-15.35, 15.4-15.7, 22.5-22.55, 24-24.05, 31.0-31.3, 31.8-32.0, 40.5-42.5, 84-86, 102-105, 116-126, 151-164, 176.5-182, 185-190, 231-235, 252-265 GHz, applicants for airborne or space station assignments are urged to take all practicable steps to protect radio astronomy observations in the adjacent bands from harmful interference; however, US74 applies.

US251 The band 12.75-13.25 GHz is also allocated to the space research (deep space) (space-to-Earth) service for reception only at Goldstone, California. 35° 18' N. 116° 54' W.

US259 Stations in the radiolocation service in the band 17.3-17.7 GHz, shall be restricted to operating powers of less than 51 dBW eirp after feeder link stations for the broadcasting-satellite service are authorized and brought into use.

US271 The use of the band 17.3-17.8 GHz by the fixed-satellite service (Earth-to-space) is limited to feeder links for broadcasting-satellite service.

US292 In the band 14.0-14.2 GHz stations in the radionavigation service shall operate on a secondary basis to the fixed-satellite service.

US334 In the band 17.8-20.2 GHz, Government space stations in both geostationary (GSO) and non-geostationary satellite orbits (NGSO) and associated earth stations in the fixed-satellite service (space-to-Earth) may be authorized on a primary basis. For a Government geostationary satellite network to operate on a primary basis, the space station shall be located outside the arc, measured from east to west, 70 West Longitude to 120 West Longitude. Coordination between Government fixed-satellite systems and non-Government space and terrestrial systems operating in accordance with the United States Table of Frequency Allocations is required.

(a) In the sub-band 17.8-19.7 GHz, the power flux-density at the surface of the Earth produced by emissions from a Government GSO space station or from a Government space station in a NGSO constellation of 50 or fewer satellites, for all conditions and for all methods of modulation, shall not exceed the following values in any 1 MHz band:

(1) -115 dB(W/m²) for angles of arrival above the horizontal plane (δ) between 0° and 5°,

(2) -115 + 0.5(δ - 5) dB(W/m²) for δ between 5° and 25°, and

(3) -105 dB(W/m²) for δ between 25° and 90°.

(b) In the sub-band 17.8-19.3 GHz, the power flux-density at the surface of the Earth produced by emissions from a Government space station in an NGSO constellation of 51 or more satellites, for all conditions and for all methods of modulation, shall not exceed the following values in any 1 MHz band:

(1) -115 - X dB(W/m²) for δ between 0° and 5°,

(2) -115 - X + ((10 + X)/20)(δ - 5) dB(W/m²) for δ between 5° and 25°, and

(3) -105 dB(W/m²) for δ between 25° and 90°; where X is defined as a function of the number of satellites, n, in an NGSO constellation as follows:

For $n \leq 288$, X = (5/119) (n - 50) dB; and

For $n > 288$, X = (1/69) (n + 402) dB.

US355 In the band 10.7-11.7 GHz, non-geostationary satellite orbit licensees in the fixed-satellite service (space-to-Earth), prior to commencing operations, shall coordinate with the following radio astronomy observatories to achieve a mutually acceptable agreement regarding the protection of the radio telescope facilities operating in the band 10.6-10.7 GHz:

Observatory	West Longitude	North Latitude	Elevation
Arecibo Obs.……………………………	..……66° 45’ 11”	…..18° 20’ 46”	…..…..496 m
Green Bank Telescope (GBT)………………	..…...79° 50’ 24”	...…38° 25’ 59”	...……..825 m
Very Large Array (VLA)……………………	..….107° 37’ 04”	..…34° 04’ 44”	...……2126 m

Observatory	West Longitude	North Latitude	Elevation
Very Long Baseline Array (VLBA) Stations:			
Pie Town, NM…………………………...	..….108° 07’ 07”	..…34° 18’ 04”	…..……2371 m
Kitt Peak, AZ…………………………….	..….111° 36’ 42”	..…31° 57’ 22”	...……1916 m
Los Alamos, NM………………………...	..….106° 14’ 42”	..…35° 46’ 30”	…..……1967 m
Ft. Davis, TX…………………………….	..….103° 56’ 39”	..…30° 38’ 06”	…..……1615 m
N. Liberty, IA……………………………	..…...91° 34’ 26”	..…41° 46’ 17”	…..……..241 m
Brewster, WA……………………………	..….119° 40’ 55”	..…48° 07’ 53”	…..……..255 m
Owens Valley, CA……………………….	..….118° 16’ 34”	..…37° 13’ 54”	…..……1207 m
St. Croix, VI……………………………...	..…...64° 35’ 03”	..…17° 45’ 31”	…..………16 m
Hancock, NH…………………………….	..…...71° 59’ 12”	..…42° 56’ 01”	...……..309 m
Mauna Kea, HI…………………………..	..….155° 27’ 29”	..…19° 48’ 16”	…..……3720 m

NG41 Frequencies in the bands 3700-4200 MHz, 5925-6425 MHz, and 10.7-11.7 GHz may also be assigned to stations in the international fixed public and international control services located in U.S. Possessions in the Caribbean area.

NG53 In the band 12.7-13.15 GHz, television pickup stations and CARS pickup stations shall be assigned channels on a co-equal basis and shall operate on a secondary basis to fixed stations operating in accordance with the Table of Frequency Allocations. In the 13.15-13.20 GHz band television pickup stations and CARS pickup stations shall be assigned on an exclusive basis in the top one hundred markets, as set out in Section 76.51.

NG104 The use of the bands 10.7-11.7 GHz (space-to-Earth) and 12.75-13.25 GHz (Earth-to-space) by the fixed-satellite service in the geostationary-satellite orbit shall be limited to international systems, *i.e.*, other than domestic systems.

NG118 In the bands 2025-2110 MHz, 6875-7125 MHz, and 12.7-13.25 GHz, television translator relay stations may be authorized to use frequencies on a secondary basis to other stations in the Television Broadcast Auxiliary Service that are operating in accordance with the Table of Frequency Allocations.

NG143 In the band 11.7-12.2 GHz, protection from harmful interference shall be afforded to transmissions from space stations not in conformance with ITU Radio Regulation S5.488 only if the operations of such space stations impose no unacceptable constraints on operations or orbit locations of space stations in conformance with S5.488.

NG144 Stations authorized as of September 9, 1983 to use frequencies in the bands 17.7-18.58 GHz and 19.3-19.7 GHz may, upon proper application, continue operations. Fixed stations authorized in the band 18.58-19.3 GHz that remain co-primary under the provisions of §§ 21.901(e), 74.502(c), 74.602(g), 78.18(a)(4), and 101.174(r) may continue operations consistent with the provisions of those sections.

NG145 In the band 11.7-12.2 GHz, transponders on space stations in the fixed-satellite service may be used additionally for transmissions in the broadcasting-satellite service, provided that such transmissions do not have a maximum e.i.r.p. greater than 53 dBW per television channel and do not cause greater interference or require more protection from interference than the coordinated fixed-satellite service frequency assignments. With respect to the space services, this band shall be used principally for the fixed-satellite service.

NG163 The allocation to the broadcasting-satellite service in the band 17.3-17.7 GHz shall come into effect on 1 April 2007.

G59 In the bands 902-928 MHz, 3100-3300 MHz, 3500-3650 MHz, 5250-5350 MHz, 8500-9000 MHz, 9200-9300 MHz, 13.4-14.0 GHz, 15.7-17.7 GHz and 24.05-24.25 GHz, all Government non-military radiolocation shall be secondary to military radiolocation, except in the sub-band 15.7-16.2 GHz airport surface detection equipment (ASDE) is permitted on a co-equal basis subject to coordination with the military departments.

G117 In the bands 7.25-7.75 GHz, 7.9-8.4 GHz, 17.8-21.2 GHz, 30-31 GHz, 33-36 GHz, 39.5-40.5 GHz, 43.5-45.5 GHz, and 50.4-51.4 GHz, the Government fixed-satellite and mobile-satellite services are limited to military systems.

APPENDIX 6.4

BAND INVENTORY

Band occupancy:

The table below contains assignment counts for several bands being consider as relocation candidates for one-way and two-way ITFS/MDS operations in the 2150-2162 MHz and 2500-2690 MHz band. The following figures graphically display the deployment of assignments in these bands.

Table 6.4.1

Band (MHz)	Number of Links		
	Fixed [3]	Mobile [4]	Fixed-Satellite [5]
3700-4200	11,072	--	13,499 (down)
5925-6425	38,610	--	8,298 (up)
6425-6525	--	854	522 (up)
6525-6875	25,508	--	6 (up)
6875-7125	5,987	1,996	119 (down)
10700-11700	31,497	--	596 (up)
11700-12200	65	--	4,235 (down)
12200-12700	418	--	73 (down)
12700-13250	147,986	4,492	116 (up)

[3] For fixed operations, a "Link" is defined as a unique frequency/polarization combination between a specific transmitter site and specific receiver site. Any number of links can be on a path. (A "Path" is defined as the pairing of a transmit site with an associated receive site.)

[4] For mobile operations (as well as temporary fixed operation), a "Link" is defined as a unique frequency/polarization combination for an authorized mobile antenna. The area of operation for a mobile operation can be specified as a point radius or a descriptive area (*e.g.,* State of Florida or country-wide). Furthermore, each link could have an unspecified number of mobile units associated the license.

[5] For fixed-satellites, a "Link" is defined as a unique frequency/polarization combination for an antenna at an earth station which are not tied to a specific space station. It should also be noted that in many cases, the antennas can support communications with one or more transponders aboard a space station within a specified band segment. The details of the transponder interfaces are not recorded in the station license. In most cases, an earth station is authorized to communication with all domestic spaces stations. Although the licensee is required to provide information on the total number of VSAT stations to be deployed, that number is not necessarily what has be truly been deployed.

Map Legend:

Solid Lines represents the path between a fixed transmitter site and a fixed receiver site with up to four passive repeater sites if any are present.

A Point represents either a base station around which one or more mobile stations are assumed to be operating or an Earth station (transmitting or receiving)

A Box defines the area of operation of temporary fixed or mobile stations.

Figure 6.4.1

3700.0 to 4200.0 MHz: Fixed (p-p) and Fixed-Satellite (s-E)

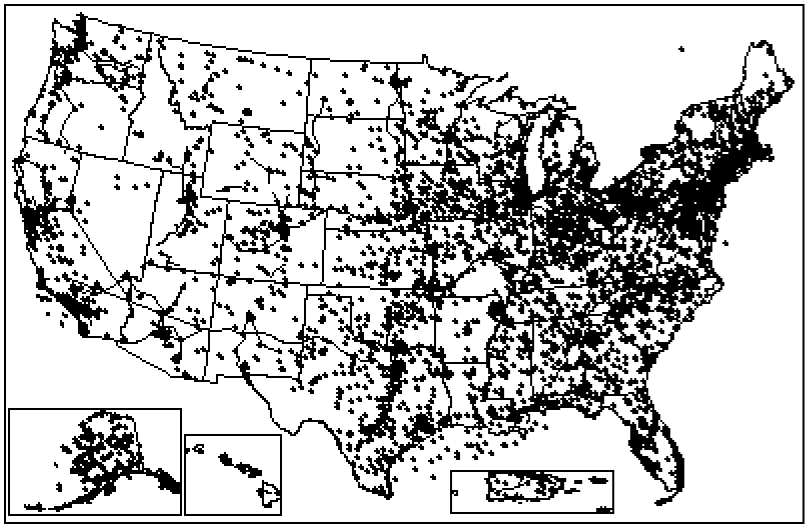


Figure 6.4.2

5925.0 to 6425.0 MHz: Fixed (p-p) and Fixed-Satellite (E-s))

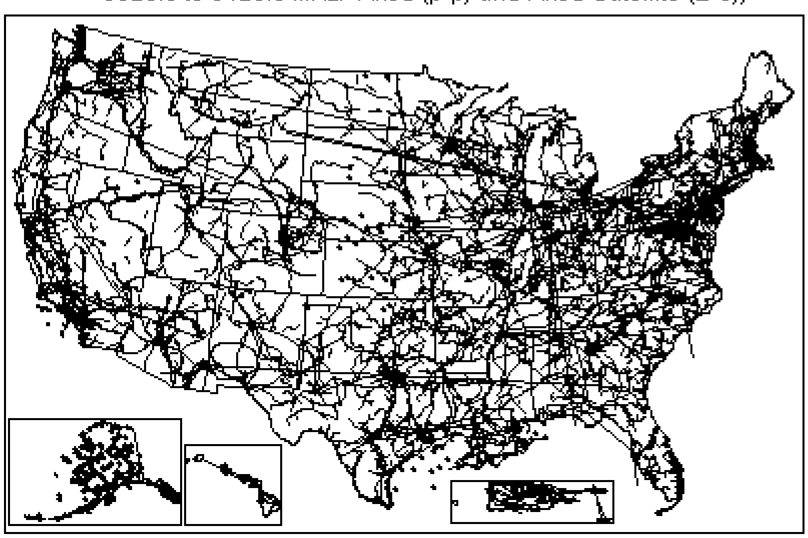


Figure 6.4.3

6425.0 to 6525.0 MHz: Fixed (p-p), Fixed-Satellite (E-s) and Mobile

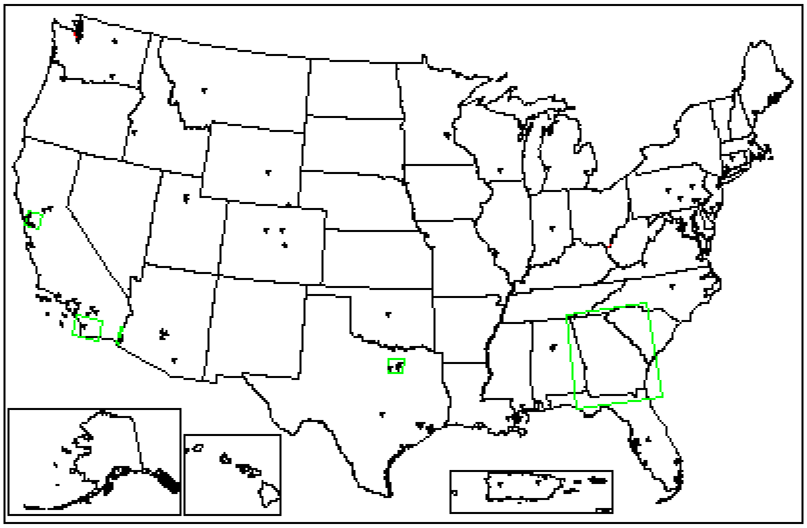


Figure 6.4.4

6525.0 to 6875.0 MHz: Fixed (p-p) and Fixed-Satellite (s-E)

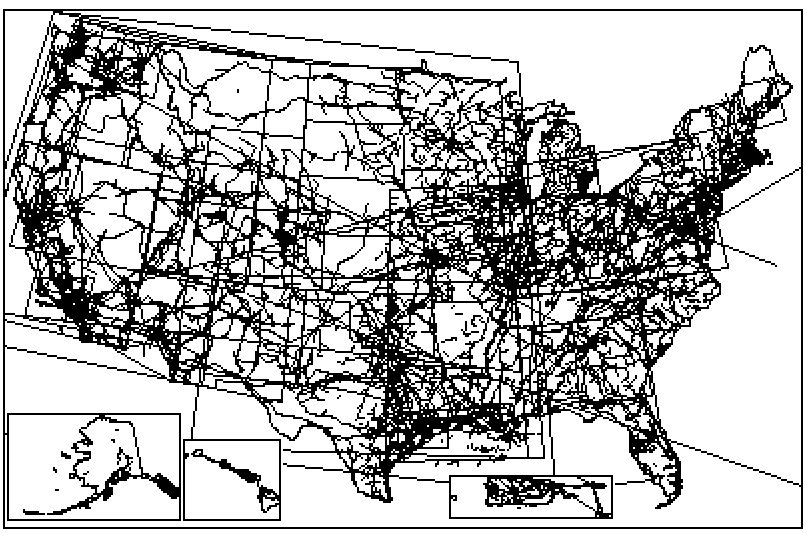


Figure 6.4.5

6875.0 to 7125.0 MHz: Fixed (p-p), Fixed-Satellite (s-E) and Mobile

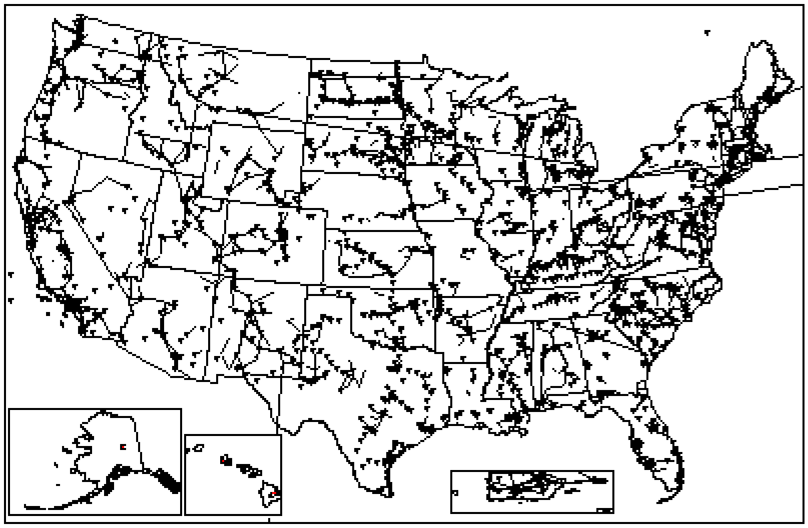


Figure 6.4.6

10700.0 to 11700.0 MHz: Fixed (p-p) and Fixed-Satellite (E-s)

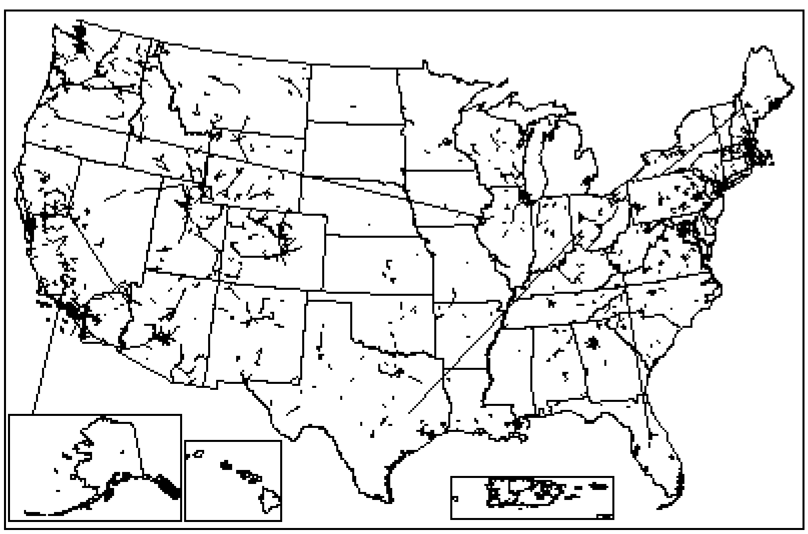


Figure 6.4.7

11700.0 to 12200.0 MHz: Fixed (p-p) and Fixed-Satellite (s-E)

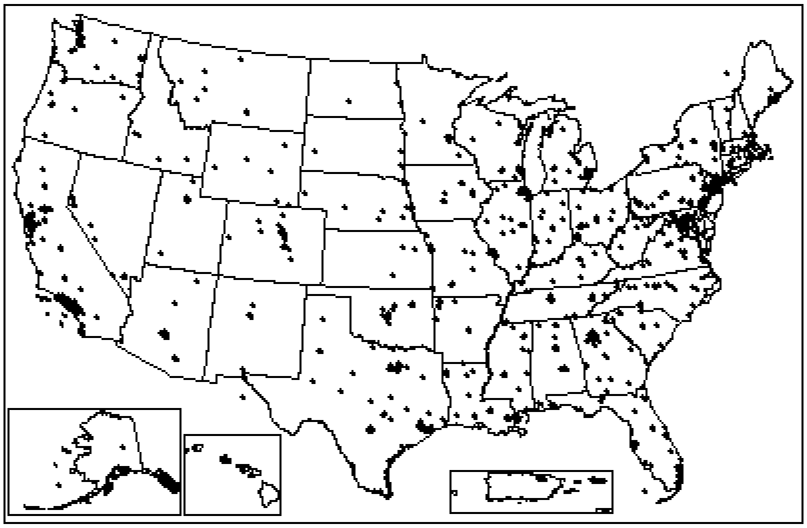


Figure 6.4.8

12200.0 to 12700.0 MHz: Fixed (p-p) and Broadcast-Satellite (s-E)

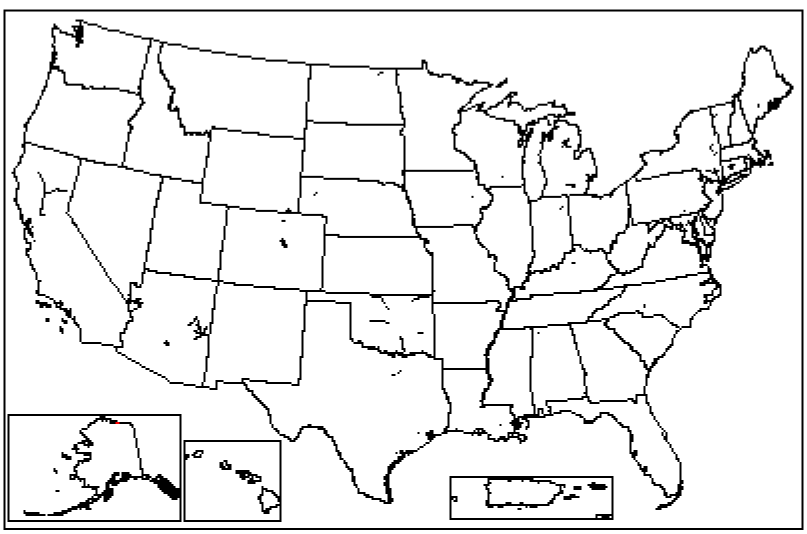
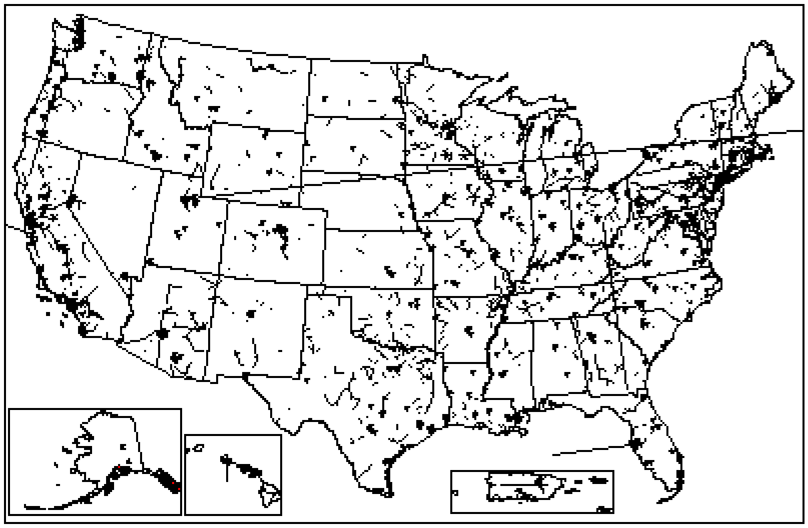


Figure 6.4.9

12700.0 to 13250.0 MHz: Fixed (p-p), Fixed-Satellite (E-s) and Mobile



APPENDIX 6.5

"PCS" 2GHz BAND INVENTORY

Band occupancy:

The table below contains assignment counts for 2 GHz band segments which must be vacated pursuant to the action taken in ET Docket 92-9 ("Emerging Technology proceeding"). The following figures graphically display the deployment of assignments in these bands.

Table 6.5.1

Band (MHz)	**Number of Links**
	Fixed
1850-1990	2,202
2110-2130 / 2160-2180	11,852
2130-2150 / 2180-2200	10,425

For fixed operations, a "Link" is defined as a unique frequency/polarization combination between a specific transmitter site and specific receiver site. Any number of links can be on a path. (A "Path" is defined as the pairing of a transmit site with an associated receive site.)

<u>Map Legend</u>:

Solid Lines represents the path between a fixed transmitter site and a fixed receiver site with up to four passive repeater sites if any are present.

Figure 6.5.1

1850.0 to 1990.0 MHz

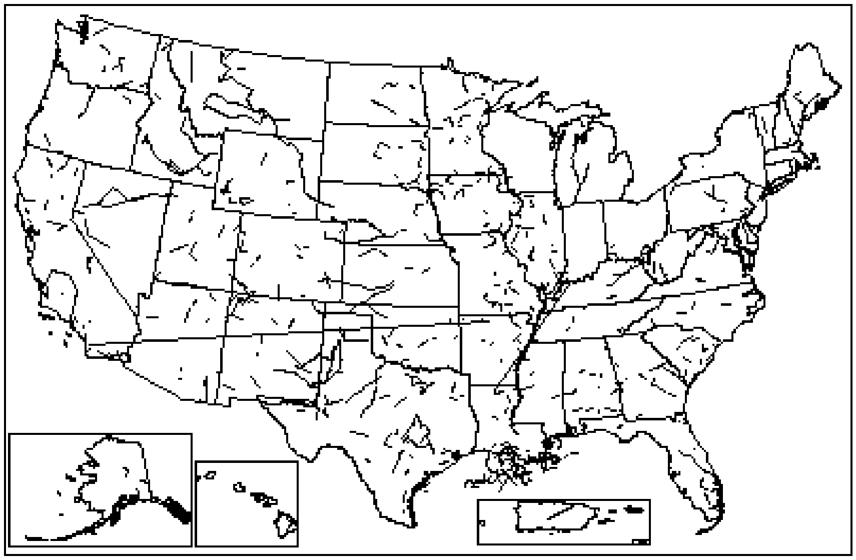


Figure 6.5.2

2110.0 to 2130.0 & 2160 to 2180 MHz

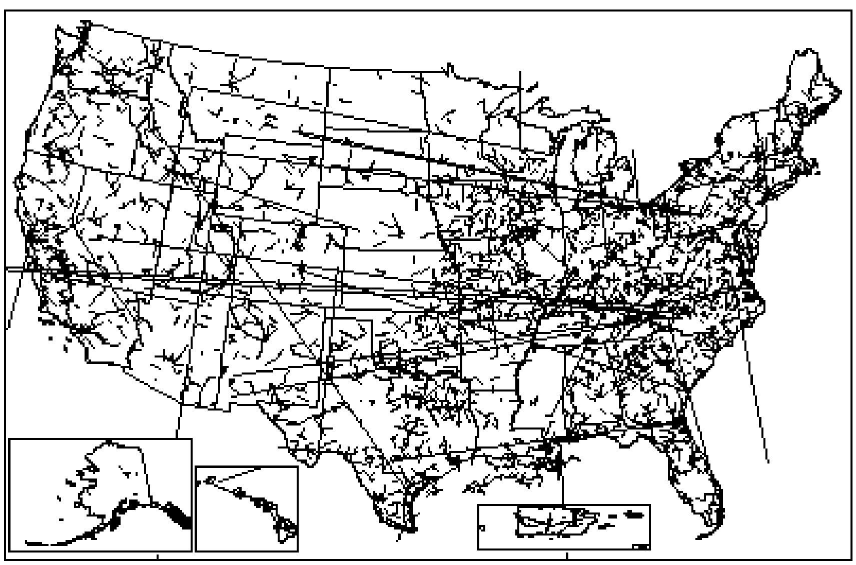


Figure 6.5.3

2130.0 to 2150.0 & 2180 to 2200 MHz