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THE POTENTIAL FOR ACCOMMODATING THIRD GENERATION MOBILE SYSTEMS IN THE 1710–1850 MHz BAND:

Federal Operations, Relocation Costs, and Operational Impacts

Final Report

March 2001

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Acronyms and Abbreviations

3G	Third Generation
ACE	Army Corps of Engineers
ACMI	Air Combat Maneuvering Instrumentation
ACTS	Air Combat Training Systems
ACUS	Army Common User System
AFB	Air Force Base
AFS	Air Force Station
AFSCN	Air Force Satellite Control Network
BBA-97	Balanced Budget Act of 1997
BER	Bit Error Ratio
CDMA	Code Division Multiple Access
COTS	Commercial-off-the-shelf
dB	Decibel
dBi	dB Referred to Isotropic
dBm	dB Referred to 1 milliWatt
dBw	dB Referred to 1 Watt
DMSP	Defense Meteorological Satellite Program
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of the Interior
DOJ	Department of Justice
DSN	Deep Space Network
DSP	Defense Support Program
DWTS	Digital Wideband Transmission System
EAC	Echelon Above Corps
EMC	Electromagnetic Compatibility
ENG	Electronic News Gathering
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FLTSATCOM	Fleet Satellite Communications
FPA	Federal Power Agencies
FSK	Frequency Shift Keying
FY02	Fiscal Year 2002
GEO	Geosynchronous
GFO	GEOSAT Follow-On
GHz	Gigahertz (10^9 Hertz)

GMF	Government Master File
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GSO	Geosynchronous Orbit
HCLOS	High Capacity Line-of-Sight
HEO	Highly Elliptical Orbit
IAG	Industry Association Group
IMT-2000	International Mobile Telecommunications-2000
I/N	Interference-to-Noise Ratio
I+N	Interference plus Noise
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication Sector
ITU-T	ITU Telecommunication Standardization Sector
JTCTS	Joint Tactical Combat Training System
kbps	Kilobits per Second
kHz	Kilohertz (10^3 Hertz)
km	Kilometer
LEO	Low Earth Orbit
LOS	Line-of-Sight
m	Meter
mbps	Megabits per Second
MHz	Megahertz (10^6 Hertz)
MILSTAR	Military Strategic and Tactical Relay
MSE	Mobile Subscriber Equipment
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NDAA	National Defense Authorization Act
NGSO	Non-Geostationary Orbit
non-GEO	Non-Geostationary
NPRM	Notice of Proposed Rulemaking
NSF	National Science Foundation
NTIA	National Telecommunications and Information Administration
OBRA-93	Omnibus Budget Reconciliation Act of 1993
PCS	Personal Communications Service
PDT	Proliferation Detection Technology

RTS	Remote Tracking Station
RTT	Radio Transmission Technology
SATCOM	Satellite Communication
SBIRS	Space Based Infrared System
SCN	Satellite Control Network
SGLS	Space Ground Link Subsystem
SOCC	Satellite Operations Control Center
STS	Space Transportation System (Space Shuttle)
TACTS	Tactical Air Combat Training System
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
TRI-TAC	Tri-Services Tactical Communications
TRR	Tactical Radio Relay
TT&C	Tracking, Telemetry, and Commanding
TVA	Tennessee Valley Authority
TY$	Then Year Dollars
UAV	Unmanned Aerial Vehicle
UFO	UHF Follow-On
UK	United Kingdom
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
US&P	United States and Possessions
VHF	Very High Frequency
W-CDMA	Wideband Code Division Multiple Access
WARC-92	1992 World Administrative Radio Conference
WRC-97	1997 World Radiocommunication Conference
WRC-2000	2000 World Radiocommunication Conference

Executive Summary

Background

The National Telecommunications and Information Administration (NTIA) is the Executive Branch agency principally responsible for developing and articulating domestic and international telecommunications policy. Accordingly, NTIA conducts studies and makes recommendations regarding telecommunications policies and presents Executive Branch views on telecommunications matters to the Congress, the Federal Communications Commission (FCC), and the public. NTIA also serves as manager of the Federal Government's use of the radio frequency spectrum.

The President signed an executive memorandum dated October 13, 2000, that stated 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 third generation (3G) wireless systems; and the direction to the Federal agencies to carry out the selection of spectrum. The President directed the Secretary of Commerce to work cooperatively with the FCC to develop a plan to select spectrum for 3G wireless systems, and to report on the current spectrum uses and the potential for reallocation or sharing of the bands identified at the International Telecommunication Union (ITU) 2000 World Radiocommunication Conference (WRC-2000) that could be used for 3G systems.

Objectives

The objectives of this study were to document the Federal Government use of the 1710-1850 MHz band, and to address other issues relevant to the possible accommodation of 3G mobile systems in this band. These issues include sharing options, continuity of Federal operations, time lines for relocation, and the estimated costs related to any relocation of Federal users from the band.

Spectrum Under Consideration

The 1710-1885 MHz and 2500-2690 MHz bands were two bands, among others, identified by the WRC-2000 as additional bands for 3G mobile systems, also called International Mobile Telecommunications-2000 (IMT-2000). The United States is planning for the introduction of IMT-2000 services by commercial providers, but unused spectrum to accommodate such services is currently not available. Both NTIA and the FCC are examining these candidate frequency bands (1755-1850 MHz and 2500-2690 MHz, respectively) identified by the conference that are under their respective jurisdictions, with a view towards accommodating IMT-2000 systems. Since the WRC-2000 identified these candidate bands for IMT-2000 operations, promoting worldwide harmonization of spectrum is a desired long-term goal.

The 1710-1755 MHz band will be transferred to the FCC on a mixed-use basis pursuant to the requirements of the Omnibus Budget Reconciliation Act of 1993 (OBRA-93), and the National Defense Authorization Act (NDAA) for Fiscal Year 1999, but Federal operations can continue in the band within 16 protected areas. The Federal Power Agencies and public safety fixed links will also be protected. The 1850-1885 MHz band is under FCC regulatory jurisdiction and is currently used for personal communications services (PCS). The remaining 1755-1850 MHz band, which is the focus of this study, is under the jurisdiction of NTIA. Within the United States, the 1755-1850 MHz band is allocated on an exclusive basis to the Federal Government for fixed and mobile services. Footnote G42 to the National Table of Frequency Allocations provides for the co-equal accommodation of Federal space command, control, and range and range-rate systems for earth station transmission in the 1761-1842 MHz band. The Department of Defense (DOD) is the predominant user of the 1755-1850 MHz band. However, 13 other Federal agencies operate extensive fixed and mobile systems in this band throughout the United States.

In addition to the above two bands identified by the conference, other bands that could be considered in the United States are: 698-746 MHz, 747-762 MHz, 777-792 MHz, 806-960 MHz, 1850-1990 MHz, 2110-2150 MHz, and 2160-2165 MHz.

Schedules

The FCC, in conjunction with NTIA, is expected to identify spectrum by July 2001, and auction licenses to competing applicants by September 30, 2002. The following report provides NTIA's assessment of the potential for accommodating 3G mobile systems in the 1710-1850 MHz band, including the feasibility of sharing the band, operational impacts to incumbent users, and estimated relocation costs in the event that incumbent users would be required to relocate to alternate spectrum. The FCC report on the 2500-2690 MHz band, addressing similar issues, will be released concurrently by the FCC.

Analysis Approach

This report examines the technical feasibility of accommodating 3G systems in the 1710-1850 MHz band, and develops the estimated costs associated with any relocation of Federal systems. In this report, the 1710-1850 MHz band will be considered in two parts: the 1710-1755 MHz portion, and the 1755-1850 MHz portion. As noted above, the 1710-1755 MHz band was identified by NTIA to be reallocated and transferred to the FCC under OBRA-93 as a mixed-use band. The 1755-1850 MHz band is a vital national asset to support Federal operations, particularly national defense, the control of electrical power transmission, and law enforcement. The Federal use of the 1755-1850 MHz band can be categorized into several broad classes of systems, 1) tracking, telemetry, and commanding for Federal space systems, 2) medium-capacity, conventional fixed microwave communications systems, 3) military tactical radio relay (TRR) systems, 4) air combat training systems (ACTS), 5) precision guided munitions (PGMs), 6) high resolution airborne video data links, and various other aeronautical mobile applications, and 7) land mobile video functions such as robotics, surveillance, etc.

NTIA examined the Federal use of the 1710-1850 MHz band for possible accommodation of advanced mobile telecommunications systems, such as IMT-2000. To aid in NTIA's evaluation of accommodating IMT-2000 services in the 1755-1850 MHz band, the DOD provided to NTIA on February 15, 2001, a report that detailed the electromagnetic compatibility (EMC) between major DOD systems in the 1755-1850 MHz band and IMT-2000 systems, relocation costs and operational impacts as a result of any potential DOD migration from the band, and an examination of time requirements should DOD systems move from the band. NTIA did not perform independent technical analyses on DOD systems. Data from those analyses furnished by the DOD in its final report were incorporated into this report.

If possible, sharing the spectrum would allow for a more efficient use of this resource than would relocating incumbent users. It is recognized that some systems will not be able to share with a nationwide build out of 3G mobile systems. These systems will have to be moved to another frequency band if accommodation is to occur.

Results

General. This NTIA Final Report examines the feasibility of accommodating IMT-2000 systems by sharing the 1710-1850 MHz band with incumbent Federal users, or segmenting the band. In the 1755-1850 MHz band, predicted interference to both IMT-2000 and incumbent systems would preclude compatible operation at a large number of metropolitan areas and over large geographic areas of the country. Unacceptable operational restrictions would be required on DOD systems in order to mitigate the interference with IMT-2000 systems. Therefore, it was concluded that full-band sharing was not feasible.

This report also examines whether Federal agencies can fully vacate the 1755-1850 MHz band to accommodate IMT-2000 systems. The most optimistic estimates, based on funding being available in Fiscal Year 2002, indicate that all Federal agencies will be unable to fully vacate this band until well beyond the time lines established for this study (i.e., 2003, 2006, and 2010). The examination revealed that regardless of funding, vacating the band could not be accomplished for most DOD non-space systems until 2010 and beyond. Legacy space systems would require continued protected access to the 1761-1842 MHz band until 2017, and possibly as late as 2030 for some satellites. Migration prior to these dates would require premature satellite loss, which would have extremely serious implications to Federal agencies' abilities to effectively accomplish their missions.

Moreover, for DOD systems, total relocation from any band requires alternate spectrum that is technically comparable, with the same degree of regulatory protection that currently exists in the 1755-1850 MHz band. NTIA has found, however, that comparable spectrum may not be available.

The DOD EMC analyses showed that all major DOD systems will encounter serious challenges in accommodating IMT-2000 systems, and could face significant operational restrictions in any frequency sharing situation.

Space Operations. Federal satellite control is an essential function and is authorized to use the 1761-1842 MHz portion of the band. This function could not be completely relocated until all satellites using this band have expired, which could be as late as 2030. The DOD analysis indicated that co-channel sharing between satellite control uplinks and transmitting IMT-2000 base stations would result in excessive interference to the uplink signal, and is not feasible due to the potential for harmful interference to satellite control signals at the orbiting satellites.

The DOD analysis showed that co-channel sharing with transmitting IMT-2000 mobile stations in a fully built-out scenario results in less interference to the uplink signals. The potential for sharing the satellite control uplinks with IMT-2000 mobile units seems to be technically feasible, and the potential interference is within the range of prudent risk management. Interference to IMT-2000 systems from satellite control station transmissions could be mitigated by either IMT-2000 systems operating outside of the interference distances calculated for each satellite control station, or some real-time means for the IMT-2000 system to avoid assigning channels on frequencies that satellite control stations are using.

Therefore, with regard to possible near-term use of the band for IMT-2000 systems, sharing considerations with the satellite control systems presents a fundamental go/no-go decision, since near-term replacement or changing frequencies in orbiting satellites is not possible. All satellites supported in this band use receivers that are set to specific channels and cannot be re-tuned after launch. The lifetimes of these satellites can exceed 10 years. Uplink sharing is further complicated by the fact that transportable satellite control stations will be operated at deployed locations when necessary to accomplish the satellite control mission. The 2025-2110 MHz band could possibly accommodate satellite control functions in the future. However, it would take several years to fund, develop, acquire, test, and qualify space flight hardware, and frequency allocations for the band would need to be revised via an FCC rulemaking process for space services that provides comparable regulatory protection.

The satellite control stations can potentially cause interference to co-channel IMT-2000 stations at significant distances, depending on the terrain surrounding the satellite control station. Near-worst-case interference distances in excess of 300 km were calculated using a smooth-Earth propagation model. Actual interference distances will generally be less because of terrain shielding.

Tactical Radio Relay Operations. Loss of significant spectrum to support TRR training would lead to the requirement for replacement of the military TRR systems. An examination of the spectrum below 3 GHz did not yield any available frequency band comparable to the 1710-1850 MHz band for accommodation of the DOD use of TRR and other DOD spectrum-dependent systems in support of test and training or large-scale military exercises. Therefore, lacking comparable spectrum, the TRR systems cannot be relocated.

Air Combat Training Operations and Precision Guided Munitions. For the ACTS, the 2010 time frame may allow for an accelerated Joint Tactical Combat Training System program to provide replacements for the current ACTS systems. Modifications to current ACTS systems could also be complete by that time. The point-to-point fixed links could be relocated to the 4400 MHz or 7/8 GHz bands. However, compatibility issues with incumbent systems in the air/ground alternate bands (2200-2290 MHz and 4400-4940 MHz bands) could prevent successful relocation of the air/ground links.

Under any frequency sharing scenario, ACTS and PGMs will require modifications to relocate to alternate bands. Sharing frequencies between these airborne systems and IMT-2000 is not feasible because interference can occur over very large areas.

Fixed Services. Conventional fixed systems are also a cause for concern because of their widespread use. NTIA concluded that general sharing of IMT-2000 operations with the current nationwide fixed service systems would not be feasible

Other Government Systems. Other systems operating in the band, such as PGMs, unmanned aerial vehicles, advanced data links, and electronic identification of friendly forces, were studied to determine if they could share with IMT-2000 systems, or be relocated. Generally, sharing was found to be problematic, and the systems would need to be re-designed to work in other frequency bands.

Options

The DOD EMC analyses further indicated that the extensive use of the 1755-1850 MHz band by DOD, coupled with the projected build out of IMT-2000 systems, would make uncoordinated sharing with IMT-2000 systems infeasible. However, three sharing and segmentation options were considered in this report as shown below.

Option 1: In-Band Pairing. In this sharing option, the 1710-1850 MHz band is considered as divided into three segments, 1710-1755 MHz, 1755-1805 MHz, and 1805-1850 MHz. In this approach, mobile (handset) IMT-2000 units would share and transmit in the 1710-1755 MHz segment, the Federal Government would retain exclusive use of the 1755-1805 MHz segment, and the IMT-2000 base stations would share and transmit in the 1805-1850 MHz segment. This segmentation might make up to two 45-MHz segments available for IMT-2000 services (i.e., 1710-1755 MHz paired with 1805-1850 MHz), under certain conditions. IMT-2000 operators would coordinate their operations within *protection areas*, defined by separation distances from major Federal systems required to reduce mutual interference to an acceptable level. However, since both mobile and base stations transmit (and receive) in the 1710-1850 MHz band, simultaneous coordination of both base and mobile frequencies may be necessary. These factors, plus sharing satellite control uplinks with IMT-2000 base stations, would preclude sharing under these conditions. Since sharing was shown not to be feasible, this is not a viable option.

Option 2: Out-of-Band Pairing. A second sharing option would provide for IMT-2000 mobiles to share and transmit in the 1710-1790 MHz range, in phases, with the base stations transmitting in frequency bands above 2110 MHz, e.g., 2110-2150 MHz and 2160-2165 MHz. The Federal Government would retain exclusive use of the 1790-1850 MHz segment. This segmentation option would have three phases, the first phase allowing IMT-2000 mobile operations to share in the 1710-1755 MHz band, then adding shared use in the 1755-1780 MHz band, and finally in the 1780-1790 MHz band, if required. As described above, IMT-2000 mobile operators would coordinate their operations with DOD users whenever they operate within *protection areas,* which are defined by separation distances from major Federal systems that would reduce mutual interference to an acceptable level. These *protection areas* would be in addition to the current 16 protected sites, and would include satellite control sites. This coordination of the mobile terminals might be technically implemented in the IMT-2000 base stations by the receiving base station not assigning mobile stations to a channel that was occupied by a Federal user.

This option presents certain advantages compared to the in-band pairing option from an interference standpoint, because only half of the IMT-2000 system needs to be coordinated, and IMT-2000 base stations would not operate co-channel with satellite control uplinks. Co-channel sharing with mobiles shows less interference potential to the satellite uplink, and may be feasible. In this case, satellite control uplinks would share with IMT-2000 mobiles in the 1761-1790 MHz band. This option could, in the long-term, make up to 80 MHz available for mobiles in the 1710-1790 MHz band to be paired with equivalent spectrum in a higher frequency band. The alternatives to sharing would be for IMT-2000 services to be implemented in other frequency bands, or, Federal systems in the band segments required for IMT-2000 to be relocated to comparable spectrum. IMT-2000 operators would reimburse Federal operators if relocation, modification, or re-tuning of the systems is necessary. Essential Federal Government capabilities must be maintained.

Option 3: Out-of-Band Pairing & Federal Migration From Band. The third approach considers that the 1710-1755 MHz band might be vacated by Federal operations, in stages. IMT-2000 systems, paired with spectrum above 2100 MHz, would then have unrestricted operation nationwide. Until replacement systems are funded and deployed, the 16 protected areas would be replaced by new protected areas, selected to allow for full training on DOD systems in the 1710-1755 MHz band. When deployed, new DOD TRR equipment, designed to operate up to 2690 MHz, would then be authorized to operate in the new protected areas in 45 MHz of comparable replacement spectrum somewhere below 2690 MHz. As with any option that may necessitate the relocation of existing Federal users, reimbursement guidelines, appropriate time lines and access to comparable spectrum are issues that will need to be resolved.

Costs

In order to evaluate options associated with possible relocation of Federal systems to alternate frequency bands, a determination of estimated relocation costs, operational impacts, and time schedules for moving were developed. Estimated costs for DOD systems were submitted to NTIA in the DOD Final Report. Costs for Federal civil agencies' systems were submitted in writing by each agency. Costs for DOD systems were submitted as "budget-year" amounts (called "then-year" dollars (TY$) in the DOD Final Report), while other Federal agencies' costs are given in Fiscal Year 2002 (FY02) dollars. Direct addition of these amounts will yield an inconsistent value. A deflator factor of 1.102 was used to equate TY$ to FY02 dollars. NTIA has relied on the cost data furnished by the Federal agencies as being representative of estimated total system replacement costs, realizing that there are some unknown factors that will affect the final costs.

The total cost to relocate Federal operations from the 1755-1850 MHz band is estimated to be $4,640 million (FY02), if the time line specified by DOD and the other Federal agencies is accommodated and alternate spectrum is made available. Although all relocation options have an estimated total cost, this does not mean that relocation of all Federal systems is possible. For example, no adequate alternate spectrum was found for the DOD TRR system.

NTIA is developing rules for private sector reimbursement for relocating to other frequency bands Federal systems currently operating in certain frequency bands (including the 1710-1755 MHz band) identified for reallocation. This reimbursement process is similar in some respects to the procedures used in clearing the commercial PCS band. NTIA has released a Notice of Proposed Rulemaking, and is in the process of establishing rules for private sector reimbursement for relocating Federal systems. The procedures established by NTIA's rulemaking will be used as a basis for reimbursement for the relocation of Federal systems, where necessary, from parts of the 1755-1850 MHz band.

Sharing Versus Options

Sharing is proposed for two options (Options 1 and 2). If sharing could be accomplished, the government reimbursement costs incurred would be minimal, since the responsibility for coordination would be borne by the commercial IMT-2000 service providers. However, under the condition that sharing is not feasible, total costs are presented for complete relocation of Federal systems. If some sharing is possible, then the costs would be less. These cost estimates are appropriate only as guidelines in determining what the final relocation expenses might be. Estimated costs are based on very specific assumptions and schedules. Departures from these assumptions would substantially change the cost of relocation. Some cost factors, such as final selection of alternative frequency bands, are unknown at this time, and could influence the final cost. The DOD indicated that under any circumstance they would not be able to vacate portions of the 1755-1850 MHz band until beyond 2010. Support in the 1755-1850 MHz band for Federal space assets would need to continue until at least 2017, and possibly until 2030 for some satellites.

Costs versus Options

Total estimated relocation costs in FY02 dollars for the three options as described in this report are as follows:

- Option 1 - $3,448 million
- Option 2 - $4,548 million
- Option 3 - $2,192 million

Reallocation Considerations

In implementing any of the options involving band segmentation, many Federal systems in the 1755-1850 MHz band would need to be either relocated to different frequency bands or modified to operate in the remaining portions of the band. Major performance, compatibility, funding, and regulatory issues would have to be thoroughly addressed before any relocation could begin. A major uncertainty with the concept of large-scale relocation is that critical issues regarding the costs, risks, and engineering efforts to assure the incumbent systems in the alternate bands are protected are not addressed. In the aggregate, this would be a complex, costly, and lengthy process. The major risk in relocating major national defense systems is the uncertainty of future successful mission accomplishment.

Specifically, there are several issues that must be resolved before any spectrum can be made available in the 1755-1850 MHz for reallocation, including continuity of essential government operations, interference, and regulatory protection of Federal Government systems during any migration period; assurance of comparable spectrum available to which Federal Government systems can relocate; and timely resolution of any regulatory actions necessary to make such spectrum available.

Note that the NDAA for Fiscal Year 1999 also requires that Federal Government agencies required to relocate or modify their radiocommunications systems to accommodate private sector use of the spectrum be reimbursed for the costs associated with such relocation or modification. NTIA is in the process of developing and implementing rules for reimbursement. These rules will be applicable to relocation costs associated with the 1710-1755 MHz band and any spectrum that is or would be reallocated in the 1755-1850 MHz band.

Further, with respect specifically to surrender of spectrum in which the DOD is a primary user, the NDAA for Fiscal Year 2000 also requires that:

> "(A) the National Telecommunications and Information Administration, in consultation with the Federal Communications Commission, identifies and makes available to the Department for its primary use, if necessary, an alternative band or bands of frequencies as a replacement for the band to be so surrendered; and
>
> (B) the Secretary of Commerce, the Secretary of Defense, and the Chairman of the Joint Chiefs of Staff jointly certify to the Committee on Armed Services and the Committee on Commerce, Science, and Transportation of the Senate, and the Committee on Armed Services and the Committee on Commerce of the House of Representatives, that such alternative band or bands provides comparable technical characteristics to restore essential military capability that will be lost as a result of the band of frequencies to be so surrendered."

Findings

NTIA finds that unrestricted sharing of the 1755-1850 MHz band is not feasible, and any other sharing options would require considerable coordination by IMT-2000 operators when operating in the presence of Federal systems. In the event of Federal relocation resulting from sharing/segmentation options, issues involving comparable spectrum, reimbursement, and the time required for Federal entities to either modify or replace equipment would need to be addressed.

Three sharing/segmentation options were examined for 3G accommodation. Option 1, which included in-band pairing and sharing with both IMT-2000 mobiles and base stations, was found not to be viable because of sharing difficulties. Option 2, which considered sharing and out-of-band pairing, was found to be on option that could be further considered, but sharing problems with some Federal systems remain to be solved. Option 3 considers migrating Federal users out of the 1710-1755 MHz band in the long-term, and pairing this with spectrum in the 2110-2150 MHz and 2160-2165 MHz bands. This option may be possible if, along with considerations of reimbursement and appropriate time lines, 45 MHz of comparable replacement spectrum can be allocated to Federal use to accommodate the military training requirements for TRR systems.

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I. Introduction

Background

The National Telecommunications and Information Administration (NTIA) is the Executive Branch agency principally responsible for developing and articulating domestic and international telecommunications policy. Accordingly, NTIA conducts studies and makes recommendations regarding telecommunications policies and presents Executive Branch views on telecommunications matters to the Congress, the Federal Communications Commission (FCC), and the public. NTIA's responsibilities include fostering new technology and encouraging the expansion of domestic wireless services, while ensuring that the Federal agencies have adequate access to the spectrum to perform their critical missions.

NTIA is also responsible for managing the Federal Government's use of the radio frequency spectrum. The FCC is responsible for managing spectrum used by the private sector, including state and local governments.

In support of these responsibilities, the NTIA has undertaken numerous spectrum-related studies. The objectives of these studies were to assess spectrum utilization, feasibility of reallocating government spectrum or relocating government systems, identify existing or potential compatibility problems between systems, provide recommendations for resolving any compatibility conflicts, and recommend changes to promote efficient and effective use of the radio spectrum and to improve spectrum management procedures.

Over the past decade, there has been enormous worldwide growth in the use of cellular-type personal mobile communications systems. Many countries initially introduced analog systems and are now transitioning to digital systems. Studies in the International Telecommunication Union (ITU) and elsewhere indicate that this growth in personal communications is likely to continue.

Third generation (3G) wireless systems will provide terrestrial and satellite-based broadband and multi-media capabilities, and represent a path for the evolution of existing cellular and personal communications services (PCS). Discussions relative to spectrum for 3G advanced mobile telecommunications systems are vital for administrations to plan their spectrum use, and for industry to plan how it will meet the marketplace requirements of the future.

The International Mobile Telecommunications-2000 (IMT-2000) is an advanced mobile communications standard, and is considered to be a 3G wireless system. Key features of the IMT-2000 include a high degree of design commonality worldwide, compatibility of services within IMT-2000 and other fixed networks, and high-quality worldwide use and roaming capability for multi-media applications (e.g., video-teleconferencing and high-speed internet access). The ITU established an agenda item for the 2000 World Radiocommunication Conference (WRC-2000), which considered the "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 1710-1850 MHz and 2500-2690 MHz bands were two of the candidate bands that WRC-2000 considered for IMT-2000 terrestrial systems. The U.S. position for this conference was negotiated by 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 suggested three possible bands for 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 these bands domestically. Since the WRC-2000 identified these candidate bands for IMT-2000 operations, promoting worldwide harmonization is a desired long-term goal.

In addition to the 1885-2025 MHz and 2110-2200 MHz bands already identified internationally for IMT-2000, the United States proposed and the WRC-2000 adopted regulatory flexibility, giving each administration the right to determine which bands or part of the three bands it may want to identify for IMT-2000. Also, the United States proposed to keep bands identified for IMT-2000 open to any technology rather than specifying a technology or standard for use in the spectrum.

Such national and international activities emphasize the need to investigate the accommodation of IMT-2000 wireless systems in several candidate frequency bands to include all or parts of the 698-746 MHz, 747-762 MHz, 777-792 MHz, 806-960 MHz, 1710-1850 MHz, 1850-1990 MHz, 2110-2150 MHz, and 2500-2690 MHz bands.

Subsequent to the WRC-2000, the Assistant Secretary of Commerce for Communications and Information, the Chairman of the FCC, and representatives of the State Department and the Department of Defense (DOD) met with White House staff to define the process by which spectrum would be identified for advanced mobile telecommunications systems, such as IMT-2000, in the United States. It was decided that studies would be performed by NTIA (on the 1755-1850 MHz band) and the FCC (on the 2500-2690 MHz band) to determine if either or both of these bands would be viable candidates for accommodation of future 3G mobile systems.

President Clinton signed an executive memorandum dated October 13, 2000, that stated 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 advanced wireless systems; and the direction to the Federal agencies to carry out studies to identify spectrum that could be used by 3G wireless systems.[2] In summary, the President directed that the Secretary of Commerce, in cooperation with the FCC:

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1 Resolution 721 (WRC-97) Agenda for the 1999 World Radiocommunication Conference, International Telecommunication Union Radio Regulations, Volume 3, (Geneva: ITU 1998) at 319.

2 Presidential Memorandum, Subject: Advanced Mobile Communications/Third Generation Wireless Systems, The White House, October 13, 2000.

- ! 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 advanced wireless providers by September 30, 2002;

- ! Issue interim reports by November 15, 2000, on the current spectrum uses and the potential for reallocation or sharing the bands identified at the WRC-2000 that could be used for advanced wireless systems, in order that the FCC can identify, in coordination with NTIA, spectrum by July 2001, and auction licenses to competing applicants by September 30, 2002; and

- ! Develop an outreach program to work with government and industry representatives through a series of public meetings to develop recommendations and plans for identifying spectrum for advanced wireless systems.

The DOD released to NTIA on October 30, 2000, an initial report detailing the electromagnetic compatibility (EMC) interactions between major DOD radiocommunications systems operating in the 1755-1850 MHz band and IMT-2000 systems. That report, entitled, *Department of Defense IMT-2000 Technical Working Group - Interim Report - Investigation of the Technical Feasibility of Accommodating the International Mobile Telecommunications (IMT) 2000 Within the 1755-1850 MHz Band*,[3] was used by NTIA for preliminary evaluation of the potential for sharing the 1710-1850 MHz band with IMT-2000 systems. The above work led to the issuance of an NTIA interim report that described the potential for the 1755-1850 MHz band to be used for advanced wireless applications.

Subsequent to the release of the NTIA and FCC interim reports, the FCC issued a Notice of Proposed Rulemaking (NPRM)[4] that requested comments regarding the accommodation of advanced mobile wireless systems. The FCC listed three options for possible pairing of frequency bands for the introduction of advanced wireless systems. These options are:

- FCC's Option 1 - 1710-1755 MHz paired with 2110-2150 MHz and 2160-2165 MHz (A variation to this option would be the addition, in phases, of the bands 1755-1790 MHz. This is similar to the NTIA Option 2);

- FCC's Option 2 - 1710-1755 MHz paired with spectrum in the 1755-1850 MHz band; and

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[3] Department of Defense, IMT-2000 Technical Working Group, Interim Report, *Investigation of the Technical Feasibility of Accommodating the International Mobile Telecommunications (IMT) 2000 Within the 1755-1850 MHz Band, IMT-2000 Technical Working Group*, Department of Defense, (Oct. 27, 2000) [hereinafter DOD Initial Report], available at <http://www.ntia.doc.gov/osmhome/reports/dodreport>.

[4] *See Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, including Third Generation Wireless Systems*, ET Docket No. 00-258, FCC 00-455, NPRM and Order, 66 Fed. Reg. 7438 (Jan. 23, 2001) [hereinafter FCC 3G NPRM].

- FCC's Option 3 - 2110-2150 MHz and 2160-2165 MHz paired with spectrum in the 2500-2690 MHz band.

Since the Presidential Memorandum directed the Secretary of Commerce to work with government and industry representatives to develop recommendations and plans for identifying spectrum for 3G wireless services, NTIA has convened several government-industry outreach meetings. These meetings have been held to provide an open dialog to address various issues and concerns pertaining to accommodation of 3G wireless systems in the 1755-1850 MHz band and 2500-2690 MHz bands. It was recommended by the participants at the initial government-industry outreach meeting that to address the numerous complex technical issues regarding the accommodation of 3G systems in a timely manner, smaller subgroups would be required. These subgroups would consist of technical experts from both government and industry.[5]

To that end, the Industry Association Group (IAG) was formed, with five subgroups, each chaired by industry personnel. The subjects of the subgroups include: 1) 2500-2690 MHz, 2) 3G Characteristics, 3) Satellite Group, 4) Fixed and Tactical Radio Group, and 5) Air Combat Training Group. The main topics that were addressed in each subgroup include: technical sharing analysis between 3G systems and existing systems, mitigation options, and migration strategies to alternative bands. As of March 30, 2001, there have been four meetings of the subgroups with both government and industry personnel in attendance. A final report of the IAG, including the outputs of these subgroups, was forwarded to NTIA.

The DOD released to NTIA on February 15, 2001, a final report entitled, *Department of Defense Investigation of the Feasibility of Accommodating the International Mobile Telecommunications (IMT) 2000 Within the 1755-1850 MHz Band*,[6] which refined the analyses of the DOD Initial Report, and included operational impacts that would occur under sharing scenarios or if DOD systems were to be relocated, and the associated relocation costs. Data from that DOD Final Report are extracted and included here, and the complete report, minus Attachment 1, is included as part of this report as Appendix D.

According to the Secretary of Commerce's Spectrum Plan,[7] this NTIA final report would consist of the information contained in the NTIA Interim Report, plus relocation costs and operational impact data as submitted by the DOD and other Federal agencies.

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[5] Memorandum from Michael Altschul/Cellular Telecommunications Industry Association, Robert L. Hoggart/Personal Communications Industry Association, and Grant E. Seiffert/Telecommunications Industry Association to Assistant Secretary Rohde/NTIA and Chairman Kennard/FCC, establishing the Industry Association Group, December 8, 2000.

[6] Dept. of Defense IMT-2000 Technical Working Group, Final Report, *Investigation of the Technical Feasibility of Accommodating the International Mobile Telecommunications (IMT) 2000 Within the 1755-1850 MHz Band* (Feb. 9, 2001) [hereinafter *DOD Final Report*], available at <http://www.ntia.doc.gov/osmhome/reports/>.

[7] U.S. Department of Commerce, *Plan To Select Spectrum for Third Generation (3G) Wireless Systems in the United States* (Oct. 20, 2000), available at <http://www.ntia.doc.gov/ntiahome/threeg/3g_plan14.htm>.

Objectives

The objectives of this study are:

1. To document Federal Government use of the 1710-1850 MHz band, and to address issues relevant for possible use of the 1710-1850 MHz band to accommodate advanced mobile telecommunications systems, such as IMT-2000, in the United States relative to:

(A) the current and emerging Federal uses,

(B) an examination of sharing options between Federal systems and IMT-2000 systems,

(C) operational impacts to Federal agencies if Federal systems were to be relocated, and

(D) the estimated costs for relocation of these systems.

2. To compile information on the Federal use of the 1710-1850 MHz band for use as a response to the FCC's 3G NPRM on advanced mobile telecommunications. This report specifically addresses paragraphs 41 through 49 of the NPRM.

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II. Third Generation System Description[8]

Introduction

Third generation, or IMT-2000 services, are the names commonly used to refer to the next generation mobile wireless telecommunications services. The 3G family of services, and the systems that will provide them, are intended to reflect a high degree of commonality and to be compatible with each other. These services will support mobile and fixed users employing a wide range of devices, including small pocket terminals, handheld telephones, laptop computers, and fixed-receiver equipment. Third generation services are envisioned to be ubiquitous throughout the world, as available in a remote part of a developing country as they are in an urban area in a highly developed country. Seamless roaming is a key attribute, and access to services is expected to be uniform. Furthermore, the user will be able to roam from an urban to a suburban and into a rural setting without loss of basic services.

The ITU has been fostering the development of the underlying radio and network standards for what is now defined as IMT-2000 services for over 15 years. The radio transmission technologies (RTTs) providing for standardized 3G air-interfaces adopted in November 1998 were the culmination of many years of effort under the auspices of the ITU's Radiocommunication Sector (ITU-R) Task Group 8/1. These RTTs form the basis for connecting the user's mobile or portable device to the physical infrastructure supporting IMT-2000 services. ITU-R Task Group 8/1 also developed methods that can be used to assess the amount of additional spectrum needed to accommodate the expected future growth in demand for 3G mobile services.[9] The ITU's Telecommunication Standardization Sector (ITU-T) is actively working to develop 3G signaling and communication protocols, network requirements needed to support expected 3G services, and service definitions for IMT-2000 applications. Table 2-1 below, derived from ITU-T Draft Recommendation Q.1701,[10] describes selected essential capabilities of IMT-2000 systems.

Consumer demand for services available at any place, coupled with the expectation of high quality and increased transmission speed, are key drivers in the effort to establish commonality and compatibility of 3G terrestrial telecommunication systems. It is estimated that by the year 2010 there will be 1 billion wireless subscribers worldwide on 3G networks.[11] At the present time, the worldwide penetration of wireless service is approximately 7½ percent and it is expected to exceed 30 percent by the end of the first decade of the new millennium.[12] There are over 1,300 cellular and second-generation terrestrial mobile service networks currently operating

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[8] Material for this section was initially furnished by the Federal Communications Commission, and has been updated with data furnished by the IAG via contributions in various meetings with NTIA and the FCC.

[9] ITU-R Recommendation M. [IMT.SPEC], ITU-R Radiocommunication Assembly, Istanbul, Turkey (May 2000).

[10] ITU-T Draft Recommendation Q.1701, Geneva.

[11] United States Talking Points for World Communication Conference 2000 on IMT-2000 spectrum requirements.

[12] *Id.*

worldwide, each with limited geographic coverage. It becomes increasingly important to harmonize spectrum allocations for 3G services if companies are to provide uniform services and seamless roaming on a regional or global scale.

Table 2-1
IMT-2000 Services/Capabilities

Capabilities to support circuit and packet data at high bit rates: - 144 kbs or higher in high mobility (vehicular) traffic - 384 kbs or higher for pedestrian traffic - 2 mbs or higher for indoor traffic
Interoperability and roaming among IMT-2000 family of systems
Common billing/user profiles: - Sharing of usage/rate information between service providers - Standardized call detail recording - Standardized user profiles
Capability to determine geographic position of mobiles and report it to both the network and the mobile terminal
Support of multimedia services/capabilities: - Fixed and variable rate bit traffic - Bandwidth on demand - Asymmetric data rates in the forward and reverse links - Multimedia mail store and forward - Broadband access up to 2 mbs

Spectrum Identified for IMT-2000

The ITU concluded that IMT-2000, or 3G, systems will require use of spectrum that extends beyond that already encumbered by first and second generation mobile systems. A major issue in the global debate regarding 3G system design, standards, and services that must be resolved is the amount of common or "harmonized" spectrum that will be available on a global and regional basis to support 3G systems. For ease in roaming, to help stimulate commonality in services and economies of scale, proponents of 3G services believe it is important to identify as much contiguous, harmonized spectrum to support worldwide 3G operations as is practical. This will stimulate the development of global and regional coverage of 3G systems by reducing the cost and complexity for system development, thus providing users with more cost-effective services.

WARC-92. At the 1992 World Administrative Radio Conference (WARC-92), 230 MHz of spectrum at 1885-2025 MHz and 2110-2200 MHz was identified for use by countries wishing to implement 3G systems. Shortly after WARC-92, the FCC conducted auctions for licenses in the paired 1850-1910/1930-1990 MHz band, which led to the rapid deployment of advanced mobile wireless communications services throughout the United States. The success of the PCS rollout has done much to increase competition in the provision of mobile telecommunications services in the United States, and, at the same time has stimulated the demand for even more advanced wireless services. Recently, countries around the world have started to license 3G systems within paired frequency bands identified at WARC-92: 1920-1980/2110-2170 MHz. The United Kingdom (UK) and Germany have, for example, conducted auctions for IMT-2000 spectrum. The United States and the European experience indicates that the demand for advanced mobile services is projected to continue to grow for some time to come.

WRC-2000. At the WRC-2000, additional spectrum to support IMT-2000 services was identified.[13] Three frequency bands, consistent with those proposed by the United States to the conference, were identified for use by administrations wishing to implement IMT-2000 services in addition to those adopted at WARC-92.

IMT-2000 System Characteristics. During preparations for WRC-2000, the United States committed to studying the feasibility of using the 1755-1850 MHz and 2500-2690 MHz bands (or parts thereof) for IMT-2000 operations. Such a study would involve determining the impact of the operation of IMT-2000 systems on the systems already licensed to operate in these bands. The 1755-1850 MHz band is used in the United States to support critical Federal Government services. The 1710-1755 MHz portion of the 1700/1800 MHz band identified at WRC-2000 is currently in the process of becoming available for commercial use. The 1850-1885 MHz portion of the same IMT-2000 band is already used to support PCS operations in the United States. The 2500-2690 MHz band is used to provide instructional television fixed services and multi-point distribution services throughout the United States.

Because of the physical processes governing the propagation of radio waves in the frequency range below 3 GHz, these frequencies can be efficiently transmitted and received by small, compact, relatively lightweight user terminals. This feature, coupled with the ability to support high-data rates, makes them ideally suited for uses requiring mobility and portability of telecommunications services. Any 3G service that is targeted to mobile users is most effectively provided by taking advantage of the properties of radio waves operating below 3 GHz. Those 3G applications where the data rates are so high that fixed terminals are needed, or terminals that require antennas so large that they can only be employed in a stationary configuration, are better provided using frequencies above 3 GHz that can more effectively support higher data rate systems. It is the problem of identifying the spectrum bands that *can and cannot* be used to support 3G services that forms the crux of the effort to assess the degree to which IMT-2000 services can be included in bands already encumbered by services operating at 1755-1850 and 2500-2690 MHz.

In order to determine the impact of operating IMT-2000 systems in bands that are encumbered, it is necessary to assess to what degree the proposed and incumbent systems can co-exist in the same band. Stated in simple radio engineering terms, it is necessary to determine whether or not harmful interference is generated into one of the systems (incumbent or proposed) by the operation of the other(s). Furthermore, if it is determined that harmful interference is likely to occur, it is desirable to isolate the conditions under which it occurs and whether or not there exist means to mitigate its effects and costs associated with implementing such mitigation techniques.

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13 Provisional Finals Acts of WRC 2000, 8 May-2 June 2000, Istanbul, Turkey, International Telecommunication Union.

The interference assessment mentioned above requires values of the technical characteristics for the systems being studied and the ability to quantify the systems' performance. For the case of the incumbent systems in the bands 1755-1850 MHz and 2500-2690 MHz, it is reasonable to assume that the pertinent parameters required for interference analysis studies are readily available to the individuals tasked with performing the studies. This is not the case, however, for all the parameters that are required to characterize IMT-2000 systems. These systems, many of which are in the planning or development stage, do not have well-defined or universally accepted values associated with every system parameter. Thus, we assume values for certain IMT-2000 system parameters that are to be used in the conduct of the interference studies. When assumptions had to be made concerning values to be used in characterizing IMT-2000 systems, an attempt was made to adopt values that are consistent with values documented in readily available material such as the reports and recommendations of the ITU-R, reports and findings of industry-led working groups addressing IMT-2000 issues. In addition to values for the technical parameters themselves, it is also necessary to assume certain characteristics of the rollout of proposed IMT-2000 services, such as when they are likely to occur, whether there will be a time-phasing of the rollout, what regions of the world are likely to support rollout earlier than others, and within a region, whether there will be a geographical preference, i.e., urban versus suburban versus rural, for the rollout. These assumptions also were based on as readily available material and information as possible.

Tables 2-2 through 2-5 provide information on the various IMT-2000 system parameters and rollout characteristics that are to be used in undertaking the studies being addressed here. These are the most recent industry-approved characteristics, but actual 3G systems may have different parameters. If these parameters change, additional analyses will be required.

Table 2-2.
Characteristics of IMT-2000 Mobile Stations

Parameter	**CDMA-2000 1X**	**CDMA-2000 3X**	**UWC-136[f] (TDMA) EDGE**		**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]

Table 2-2.
Characteristics of IMT-2000 Mobile Stations

Parameter	CDMA-2000 1X	CDMA-2000 3X	UWC-136† (TDMA) EDGE		TD-CDMA [21,22,23,24]	W-CDMA [23]
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°
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

Table 2-2.
Characteristics of IMT-2000 Mobile Stations

Parameter	CDMA-2000 1X	CDMA-2000 3X	UWC-136 (TDMA)† EDGE		TD-CDMA [21,22,23,24]	W-CDMA [23]
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]
E_b/N_o for $P_e = 1^{0-3}$	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]

Notes:

† 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 kbps) accommodating high mobility (designated as 136HS Outdoor), and a 1.6 MHz carrier component for very high speed data (2 mbps) in low mobility applications (designated as 136HS Indoor). The combined result constitutes the IMT-2000 Radio Interface referred to as UWC-136.
[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. This data was furnished by the IAG, but data furnished by the FCC was used in the analysis.
[e] Desired signal 10 dB above sensitivity, S/(I+N) for a 10^{-3} BER. This data was furnished by the IAG, but data furnished by the FCC was used in the analysis.
[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] 10Log(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 10^{-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 time slots (577 us) per single TDMA frame (4.615 ms). For user packet data service, 1-4 time slots 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-time slots 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 = 10^{-6} without diversity.

Table 2-3.
Characteristics of IMT-2000 Base Stations

Parameter	CDMA-2000 1X	CDMA-2000 3X	UWC-136 (TDMA) EDGE		TD-CDMA [21,22,23,24]	W-CDMA [23]
Operating Bandwidth	1.25 MHz	3.75 MHz	30 kHz	200 kHz	5 MHz (nominal)	5 MHz +/- n*0.2MHz
Duplex Method	FDD	FDD	FDD	FDD	TDD	FDD
Transmitter Power	10 W	10 W	10 W	10 W	10 W	10 W
Antenna Gain	17 dBi per 120 deg. sector	17 dBi per 120 deg. sector	17 dBi per 120 deg. sector	17 dBi per 120 deg. sector	17 dBi per 120 deg. sector	17 dBi per 120 deg. sector
Antenna Height	40 m	40 m	40 m	40 m	40 m	40 m
Tilt of Antenna	2.5 degs down	2.5 degs down	2.5 degs down	2.5 degs down	2.5 degs down	2.5 degs down
Access Techniques	CDMA	CDMA	TDMA	TDMA	TDMA/CDMA	CDMA
Data Rates Supported	153.6 kbps (standard supports up to 625.35 kbps on forward link and up to 433.35 on reverse link)	460.8 kbps (standard supports up to 2084.55. kbps on forward link and up to 1354.95 on reverse link)	30 kbps 44 kbps	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	QPSK

Table 2-3.
Characteristics of IMT-2000 Base Stations

Parameter	CDMA-2000 1X	CDMA-2000 3X	UWC-136 (TDMA) EDGE		TD-CDMA [21,22,23,24]	W-CDMA [23]
Emission Bandwidth	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				cf. Section 6.6.2 of [22]	
-3 dB			0.03 MHz	0.18 MHz		3 GPP
-20 dB			0.03 MHz	0.22 MHz		TS25.104
-60 dB			0.04 MHz	0.24 MHz		
Receiver Noise Figure, (worst case)	5 dB	5 dB	5 dB	5 dB	5 dB	5 dB
Receiver Thermal Noise Level	-129 dBm -117dBma -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		Reference
-20 dB			0.04 MHz	0.25 MHz		Reference
-60 dB			0.09 MHz	0.58 MHz		Reference
E_b/N_o for $P_e = 1^{0-3}$	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]

Notes:
[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. This data was furnished by the IAG, but data furnished by the FCC was used in the analysis.
[e]Desired signal 10 dB above sensitivity, S/(I+N) for a 10^{-3} BER. This data was furnished by the IAG, but data furnished by the FCC was used in the analysis.
[f] The thermal noise figure for a W-CDMA receiver is -108 dBm based on kTf where k is Boltzmann'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 = 10^{-6} without diversity.

Table 2-4.
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

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

Table 2-5.
Rate of IMT-2000 Network Development[a]

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

Note: [a] For some interactions the potential for interference will be influenced by the degree to which IMT-2000 networks are built out. Table 2-4 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.

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:

[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.

[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:

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

[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:

[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.

[24] TD-CDMA differs from the other air interfaces in the table in that it uses time division duplexing ¾ uplink and downlink transmissions occur in the same spectrum, alternating in time ¾ 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.

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III. Federal Use of the 1710-1850 MHz Band

Overview

The entire 1710-1850 MHz frequency range is heavily used by the Federal Government. In the 1755-1850 MHz portion alone 4,782 Federal Government assignments are registered in the Government Master File (GMF), as of January 2001. Internationally, the 1755-1850 MHz band falls in the 1710-1930 MHz band allocated on a primary basis to the fixed and mobile services for all three ITU Regions. Nationally, the 1710-1850 MHz band is allocated on a exclusive basis to the Federal Government for fixed and mobile services. Footnote G42 to the National Table of Frequency Allocations provides for the co-equal accommodation of Federal space command, control, and range and range-rate systems for earth station transmission in the 1761-1842 MHz band. The band supports many Federal functions: (1) tracking, telemetry, and commanding (TT&C) for Federal Government space systems; (2) medium-capacity, conventional fixed microwave communications systems; (3) military tactical radio relay (TRR) systems; (4) air combat training systems (ACTS); (5) precision guided munitions (PGM); (6) high resolution video data links, and various other aeronautical mobile applications; and (7) land mobile video functions such as explosive ordnance disposal and other robotics, surveillance, etc. The radio systems supporting these functions are located across the United States. Figure 1 is a pictorial representation of the functions of major Federal systems supported in the 1710-1850 MHz band.

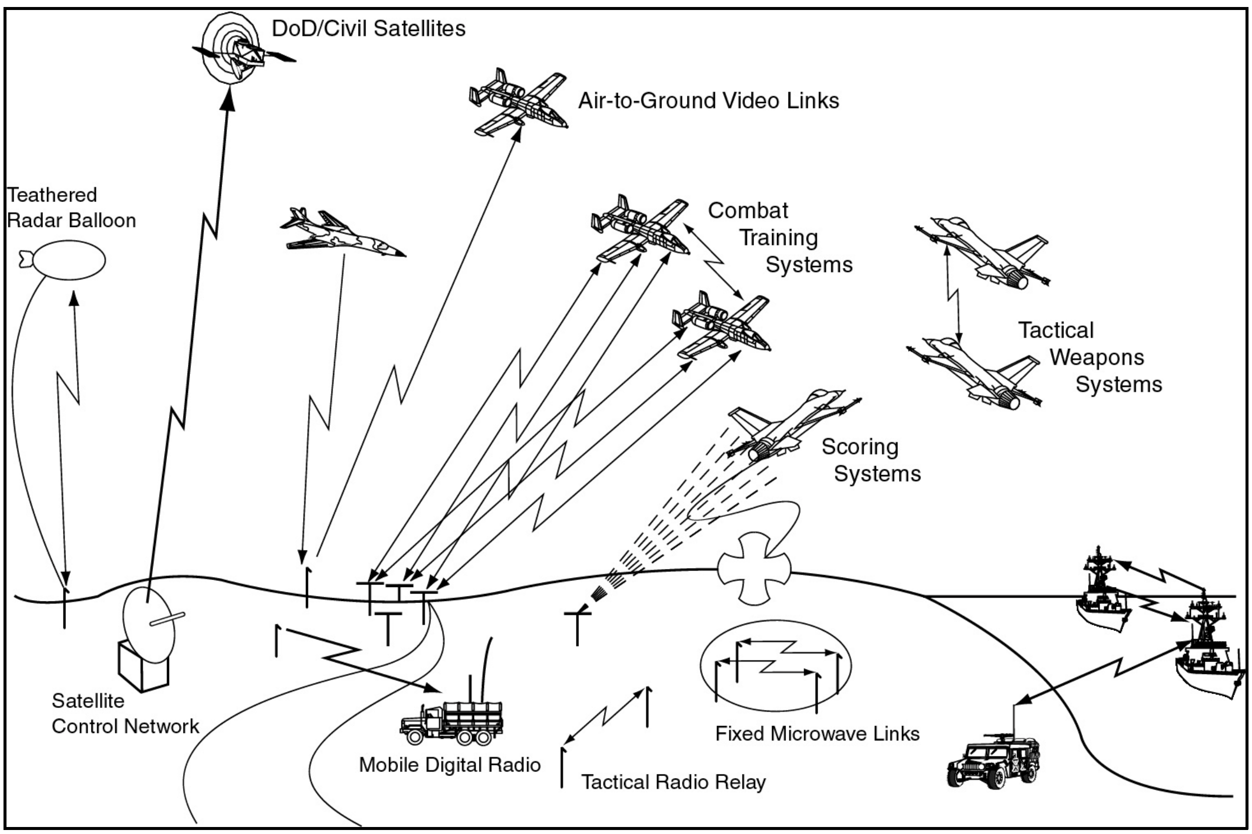

Figure 1. Pictorial Representation of Major Systems in the 1710-1850 MHz Frequency Band.

The 1710-1755 MHz portion of the band was identified to be transferred to the FCC under the Omnibus Budget Reconciliation Act of 1993 (OBRA-93) as a mixed-use band.[14] Certain military facilities, safety-of-life, and power transmission fixed links were exempted from the reallocation. *Protection Areas* were established around certain military facilities as shown in the NTIA Final Reallocation Report. The Balanced Budget Act of 1997 (BBA-97)[15] required NTIA to accelerate the availability of the 1710-1755 MHz band for commercial use, and required the FCC to grant licenses by competitive bidding after January 1, 2001. The National Defense Authorization Act (NDAA) for Fiscal Year 1999[16] required reimbursement for Federal systems relocated from the 1710-1755 MHz band and other bands transferred to the FCC. NTIA has issued an NPRM to compile and review comments prior to making rules for the reimbursement process.[17]

Satellite control is one of the major services, and is carried out in the 1761-1842 MHz portion of the band. The Air Force is responsible for controlling DOD, allied, and certain other Federal satellites. These satellites are used for many purposes, including navigation, missile warning, surveillance, weather, communications, and civil functions, all of which contribute significantly to the defense and well being of the American civilian population. Although the Air Force owns and operates the Air Force Satellite Control Network (AFSCN), it is a national asset that serves many organizations in addition to the military. The satellite control stations transmit to the satellites in the 1761-1842 MHz band from several stations in the United States, and stations in host nations.

Fixed microwave networks in the 1755-1850 MHz band support backbone communications systems for many of the Federal agencies. 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; 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 fixed links include data relay, timing distribution signals, video relay, video surveillance systems, and robot video systems for hazardous material response in support of explosive and forensic investigations.

As an example of DOD fixed systems, the U.S. Army Corps of Engineers (ACE) uses this band extensively for its fixed microwave radio systems serving backbone communications for the engineering districts in the continental United States. The Corps also uses this frequency band for various purposes such as operating remotely-controlled hydro-electric generating stations; providing communications support for emergency civilian relief, flood control and

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14 "Mixed Use" is a term defined in the Omnibus Budget Reconciliation Act of 1993, Pub. L. 103-66, 107 Stat. 312, for frequency bands reallocated from Federal to private use in accordance with this Act, which are partially retained for continued use by Federal stations.

15 *See* Balanced Budget Act of 1997 (BBA-97), Pub. L. No. 105-33, 111 Stat. 251 (1997).

16 *See* National Defense Authorization Act for 2000, Pub. L. No. 106-65, 113 Stat. 512 (1999).

17 *See Mandatory Reimbursement Rules for Frequency Band or Geographic Relocation of Federal Spectrum-Dependent Systems*, NPRM, 66 Fed. Reg. 4771 (Jan. 18, 2001) [hereinafter NTIA NPRM].

sensor telemetry; temporary communications in each district; and maintenance and traffic control of approximately 48,000 kilometers of inland waterways, including harbors, locks, and dams.

Federal civil agencies also have extensive fixed service links in the band to support the various missions of the government. For example, the U.S. Department of Agriculture (USDA) owns and maintains microwave systems operating in the 1755-1850 MHz band throughout the United States. These microwave systems are used primarily in the Forest Service as backbone links to interconnect land mobile radio system mountaintop repeaters and remotely-controlled base stations. The land mobile systems are installed to 1) support the health and safety of employees and the public on and around public lands, 2) provide communications in the fighting of wildfires and responses to other natural disasters, and 3) aid in the protection of property. All of the installations are standard commercial off-the-shelf (COTS) analog microwave transmitters, receivers, and associated equipment.

Transportable radio relay systems are used by the military for nodal communications stations that support tactical communications for a wide area. These systems operate in the fixed service. The most common system is called the Mobile Subscriber Equipment (MSE). This system is used extensively in the United States by warfighters to establish tactical communications supporting command and control for wide-area networks. Several thousand TRR systems are in the military inventory and used at many military establishments throughout the country. The propagation characteristics of the band permit excellent tactical nodal connectivity. Radio relay systems link various subordinate, lateral and strategic headquarters, functional and component nodes, into an integrated area-wide network. Congestion and use of the band are heavy in proximity to military bases and training areas. Naval task forces (Navy and Marine Corps) use a variant of this system known as the Digital Wideband Transmission System (DWTS), which are ship- and vehicular-mounted, point-to-point systems used for ship-to-shore and ship-to-ship communications. There are approximately 600 of these systems currently deployed.

One of the most difficult training missions is the training of air combat crews. Current air combat training involves actual air-to-air encounters, with a network of ground stations monitoring the training activity. Information regarding the aircraft's flight parameters are relayed to ground stations, and other information is sent to the aircraft from the ground stations. Several systems are in use by the military services, and are variations of the ACTS. These systems currently operate in the 1755-1850 MHz band, and new systems will be coming online soon.

The National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA) conduct radio astronomy observations in the 1718.8-1722.2 MHz band under authority of Footnote US256 to the National Table of Frequency Allocations. Continued use of this band is very important to the scientific community.

Additionally, the Federal law enforcement agencies use this band to employ undercover low-power video surveillance devices during criminal investigations. These devices may be authorized throughout the United States and Possessions (US&P) for both protective operations and criminal investigations. The video footage obtained during these investigations is critical for providing rapid response support to undercover officers and agents, and is used as evidence during criminal trials and procedures.

In this report, the 1710-1850 MHz band will be considered in two parts: the 1710-1755 MHz portion, and the 1755-1850 MHz portion. There are 1,825 frequency assignments for Federal stations in the 1710-1755 MHz band listed in the GMF as of January 2001. The GMF is the Federal Government's master list of frequency assignments authorized by NTIA, but does not necessarily represent the number of equipments associated with each assignment. In addition, the GMF does not contain all of the classified Federal frequency assignments. Also, there may be many pieces of radio equipment operating under a single frequency assignment. Table 3-1 shows the GMF summary count of assignments by station class per agency and radio service in the subject band as of January 2001 A plot of the location of these assignments is shown in Figure 2. Appendix C contains a table of 1710-1755 MHz assignments categorized by state/location, agency, and station class.

Table 3-1
Number of Frequency Assignments In the 1710-1755 MHz Band[18]

Agency	Total Number	Fixed Service	Mobile Service	Aeronautical Mobile Service	Land Mobile Service	No Specific Service
Army	541	513	11	1	2	14
USDA	430	430	0	0	0	0
DOE	244	239	1	2	2	0
Navy	156	65	40	25	25	1
DOJ	113	113	0	0	0	0
FAA	89	89	0	0	0	0
Air Force	64	40	5	7	1	11
DOI	64	64	0	0	0	0
TVA	34	34	0	0	0	0
USCG	33	33	0	0	0	0
Treasury	20	18	1	1	0	0
Other Agencies	37	32	5	0	0	0
Totals	1,825	1,670	63	36	30	26

18 The number of assignments in the 1710-1755 MHz band has been decreasing because of the migration of Federal agencies from the band as a result of OBRA-93.

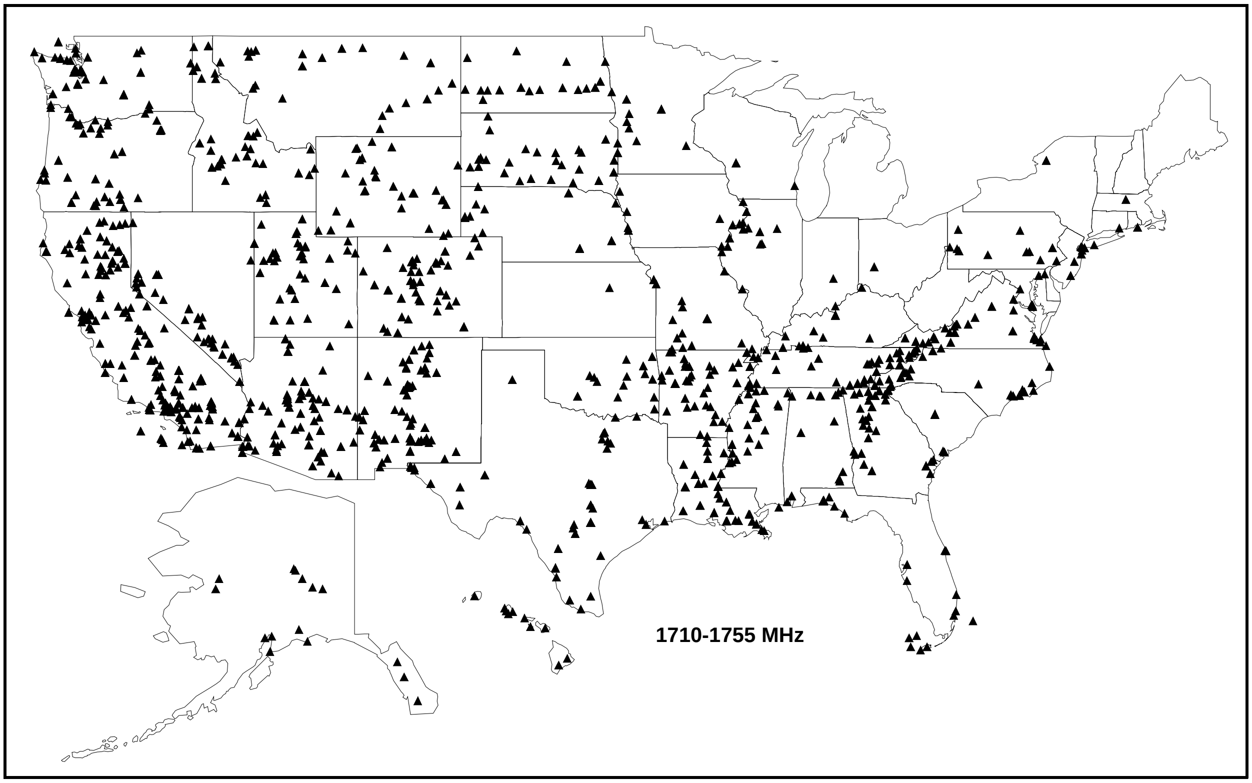

Figure 2. Plot of Frequency Assignments in the 1710-1755 MHz Band.
Note: The symbols may indicate multiple assignments at a geographic location, assignments may cover multiple emitters, and assignments authorized on a US&P basis are not reflected.

There are 4,782 frequency assignments for Federal stations in the 1755-1850 MHz band listed in the GMF as of January 2001. Some assignments listed may be for nationwide use. The majority of these assignments are in the fixed service (80 percent), followed by mobile, space, land mobile, and aeronautical-mobile services. The five categories of radio services (plus experimental stations) support the four main functions that are carried out in this band. Presently, 25 Federal entities are authorized to operate in the 1755-1850 MHz band. The major users are: Army, Air Force, Navy, USDA, the Department of Energy (DOE), the Department of Justice (DOJ), the Federal Aviation Administration (FAA), and the Department of the Interior (DOI). Table 3-2 shows the GMF summary count of assignments by station classes per agency and radio service in 1755-1850 MHz band as of January 2001 A plot of the location of these assignments is shown in Figure 3. Appendix C contains a Table of 1755-1850 MHz assignments categorized by state/location, agency, and station class. Tables 3-3, 3-4, 3-5, and 3-6 (with accompanying figures) provide a summary count of assignments by station class for the 1755-1780 MHz, 1780-1790 MHz, 1790-1805 MHz, and 1805-1850 MHz sub-bands, respectively. These sub-bands other than the 1790-1805 MHz segment have been identified for various segmentation options described in Section IV.

Table 3-2
Number of Frequency Assignments in the 1755-1850 MHz Band

Agency	Total Number	Fixed Service	Mobile Service	Aeronautical Mobile Service	Land Mobile Service	Maritime Mobile Service	Radiolocation Service	Space Services	No Specific Service
Agriculture	671	671	0	0	0	0	0	0	0
Air Force	893	378	170	16	23	0	0	224	82
Army	1177	1124	17	3	8	0	5	0	20
USCG	71	71	0	0	0	0	0	0	0
Energy	503	480	0	2	19	0	0	1	1
FAA	212	212	0	0	0	0	0	0	0
Interior	133	133	0	0	0	0	0	0	0
Justice	241	235	0	0	6	0	0	0	0
Navy	714	353	274	17	23	7	0	40	0
NASA	20	3	8	7	1	0	0	1	0
TVA	64	64	0	0	0	0	0	0	0
Treasury	34	31	0	3	0	0	0	0	0
Other Agencies	49	45	0	0	3	0	0	1	0
Totals	4782	3800	469	48	83	7	5	267	103

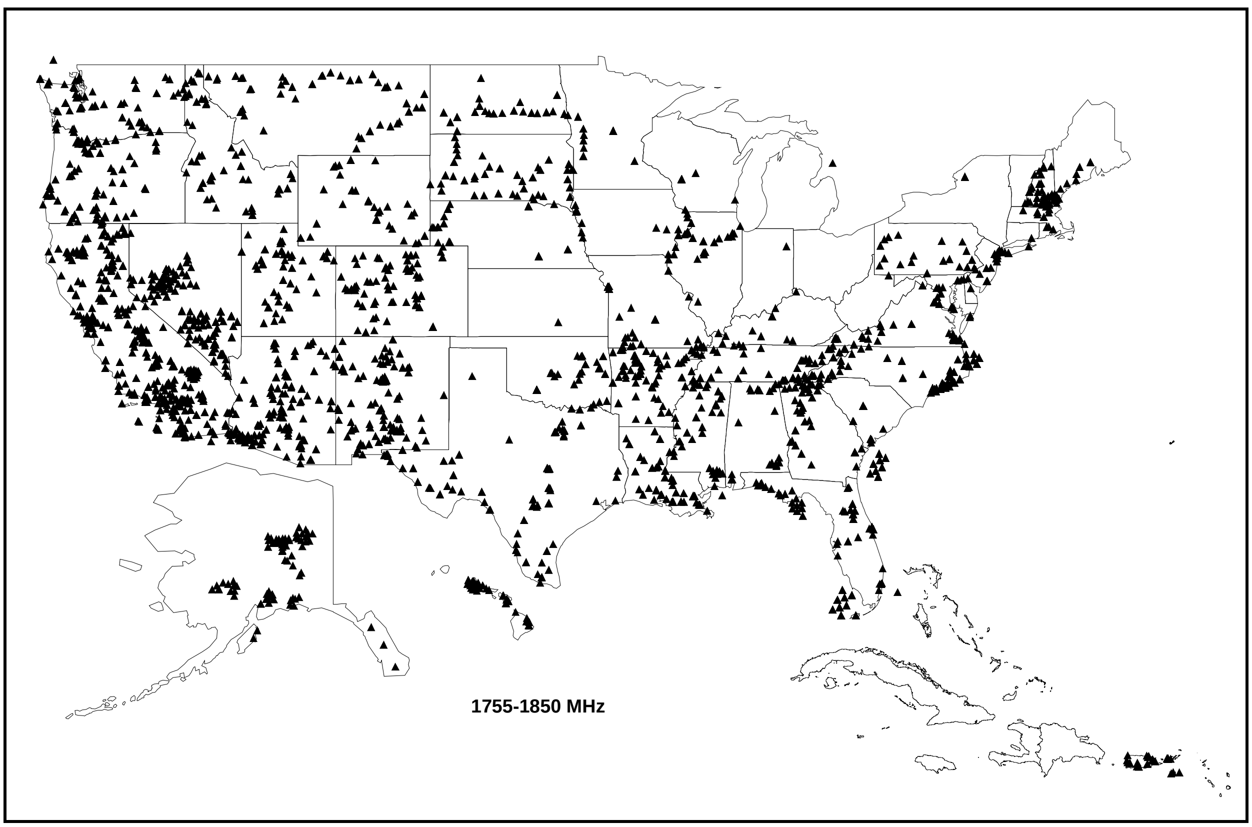

Figure 3. Plot of Frequency Assignments in the 1755-1850 MHz Band.
Note: The symbols may indicate multiple assignments at a geographic location, assignments may cover multiple emitters, and assignments authorized on a US&P basis are not reflected.

Table 3-3
Number of Frequency Assignments in the 1755-1780 MHz Sub-Band

Agency	Total Number	Fixed Service	Mobile Service	Aeronautical Mobile Service	Land Mobile Service	Maritime Mobile Service	Radiolocation Service	Space Services	No Specific Service
Agriculture	166	166	0	0	0	0	0	0	0
Air Force	180	76	23	3	2	0	0	56	20
Army	378	355	6	2	4	0	5	0	6
USCG	27	27	0	0	0	0	0	0	0
Energy	135	126	0	1	6	0	0	1	1
FAA	60	60	0	0	0	0	0	0	0
Interior	40	40	0	0	0	0	0	0	0
Justice	51	50	0	0	1	0	0	0	0
Navy	138	68	45	8	4	3	0	10	0
NASA	5	1	3	0	0	0	0	1	0
TVA	15	15	0	0	0	0	0	0	0
Treasury	10	9	0	1	0	0	0	0	0
Other Agencies	14	14	0	0	0	0	0	0	0
Total	1219	1007	77	15	17	3	5	68	27

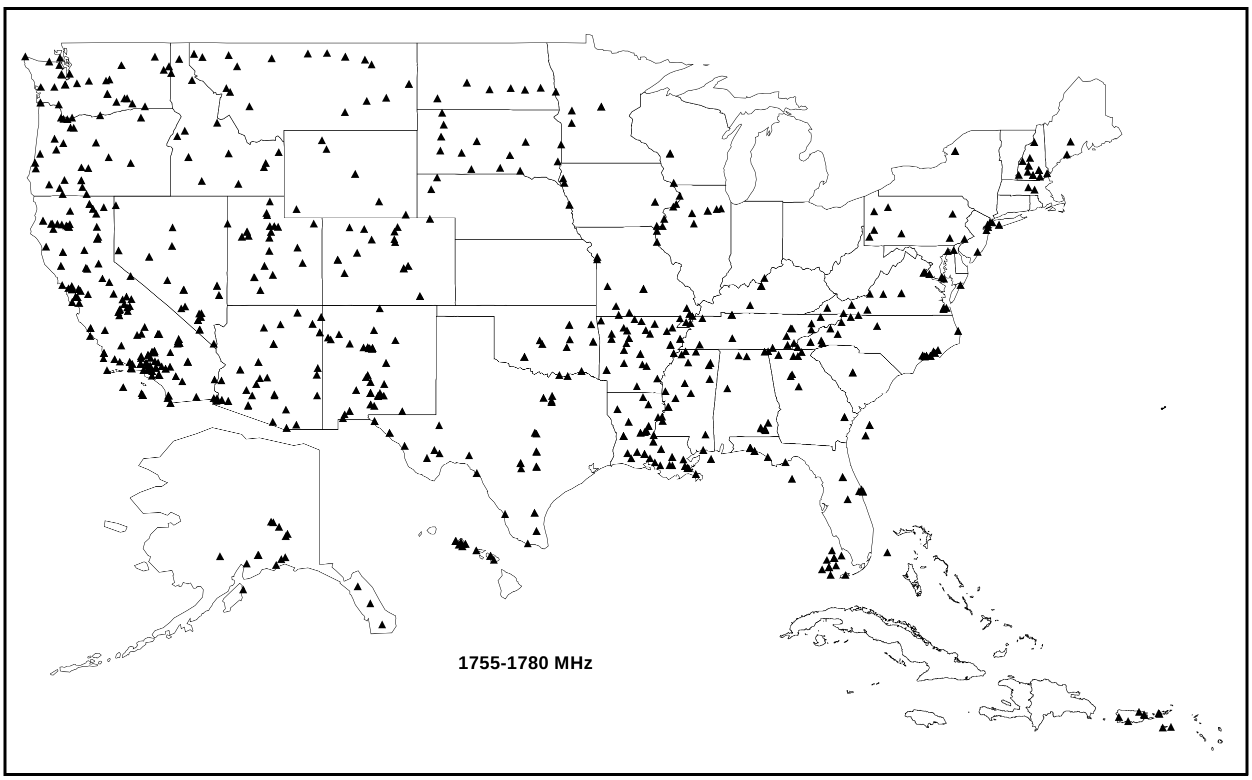

Figure 4. Plot of Frequency Assignments in the 1755-1780 MHz Sub-Band.
Note: The symbols may indicate multiple assignments at a geographic location, assignments may cover multiple emitters, and assignments authorized on a US&P basis are not reflected.

Table 3-4
Number of Frequency Assignments in the 1780-1790 MHz Sub-Band

Agency	Total Number	Fixed Service	Mobile Service	Aeronautical Mobile Service	Land Mobile Service	Maritime Mobile Service	Radiolocation Service	Space Services	No Specific Service
Agriculture	49	49	0	0	0	0	0	0	0
Air Force	60	13	13	0	0	0	0	25	9
Army	151	151	0	0	0	0	0	0	0
USCG	2	2	0	0	0	0	0	0	0
Energy	31	27	0	0	4	0	0	0	0
FAA	19	19	0	0	0	0	0	0	0
Interior	11	11	0	0	0	0	0	0	0
Justice	16	16	0	0	0	0	0	0	0
Navy	51	24	23	0	0	0	0	4	0
NASA	3	2	0	1	0	0	0	0	0
TVA	3	3	0	0	0	0	0	0	0
Treasury	3	2	0	1	0	0	0	0	0
Other Agencies	4	4	0	0	0	0	0	0	0
Total	403	323	36	2	4	0	0	29	9

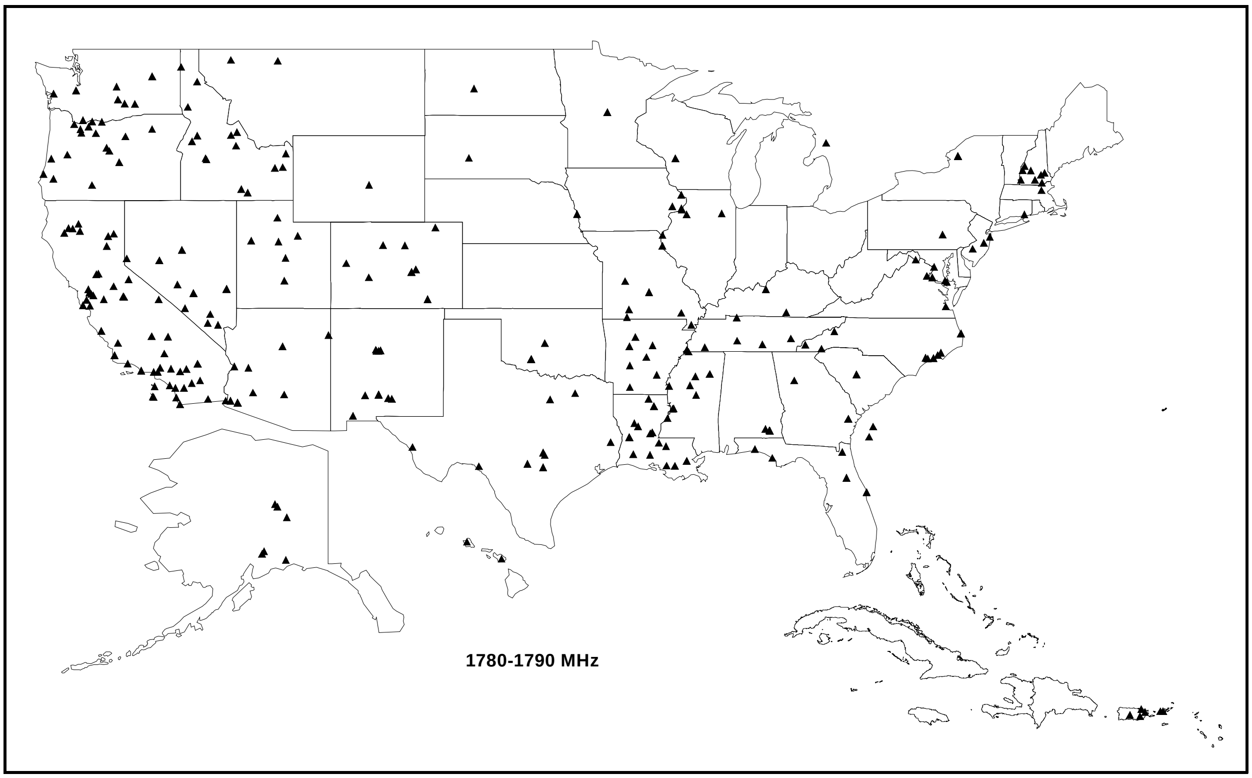

Figure 5. Plot of Frequency Assignments in the 1780-1790 MHz Sub-Band.
Note: The symbols may indicate multiple assignments at a geographic location, assignments may cover multiple emitters, and assignments authorized on a US&P basis are not reflected.

Table 3-5
Number of Frequency Assignments in the 1790-1805 MHz Band

Agency	Total Number	Fixed Service	Mobile service	Aeronautical Mobile Service	Land Mobile Service	Maritime Mobile Service	Radiolocation Service	Space Services	No Specific Service
Agriculture	100	100	0	0	0	0	0	0	0
Air Force	138	68	5	1	2	0	0	45	17
Army	183	173	2	0	1	0	0	0	7
USCG	11	11	0	0	0	0	0	0	0
Energy	91	89	0	0	2	0	0	0	0
FAA	23	23	0	0	0	0	0	0	0
Interior	13	13	0	0	0	0	0	0	0
Justice	44	44	0	0	0	0	0	0	0
Navy	70	48	10	0	3	1	0	8	0
NASA	6	0	2	4	0	0	0	0	0
TVA	18	18	0	0	0	0	0	0	0
Treasury	7	7	0	0	0	0	0	0	0
Other Agencies	15	12	0	0	2	0	0	1	0
Total	719	606	19	5	10	1	0	54	24

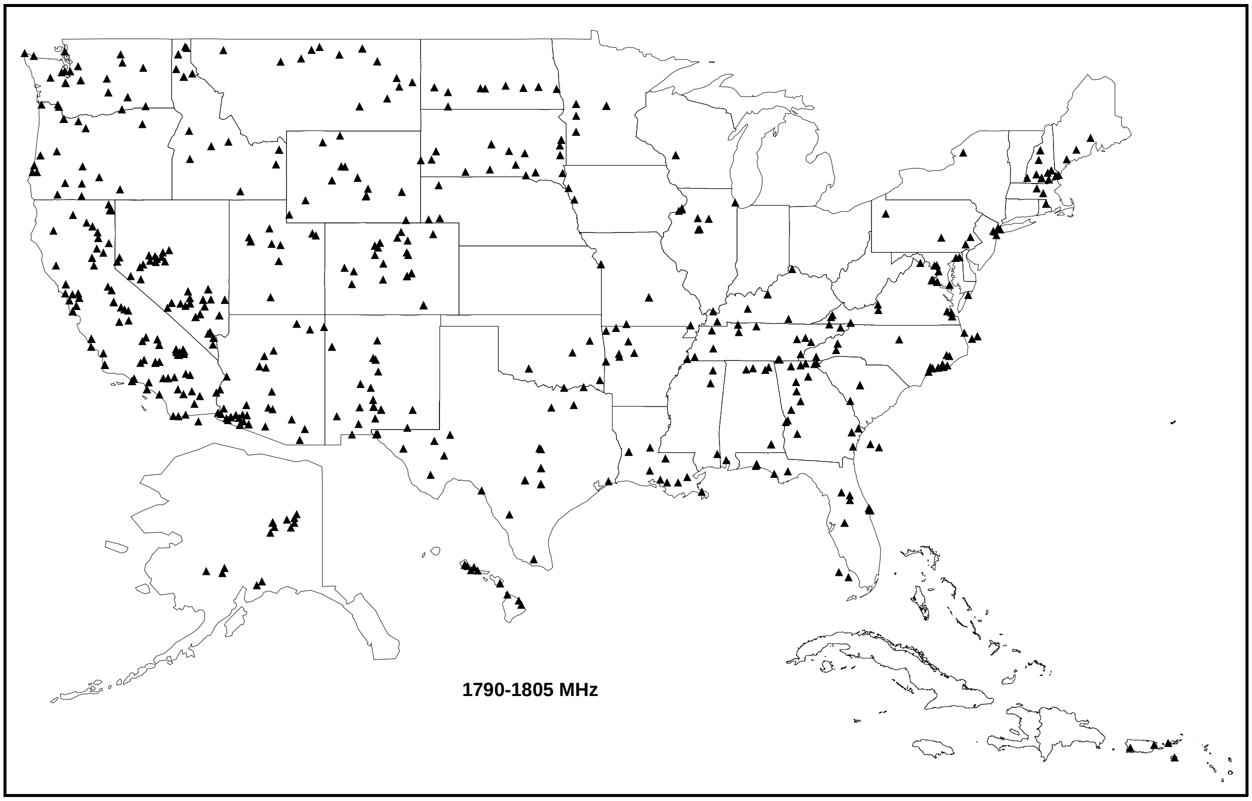

Figure 6. Plot of Frequency Assignments in the 1790-1805 MHz Band.
Note: The symbols may indicate multiple assignments at a geographic location, assignments may cover multiple emitters, and assignments authorized on a US&P basis are not reflected.

Table 3-6
Number of Frequency Assignments in the 1805-1850 MHz Sub-Band

Agency	Total Number	Fixed Service	Mobile Service	Aeronautical Mobile Service	Land Mobile Service	Maritime Mobile Service	Radiolocation Service	Space Services	No Specific Service
Agriculture	356	356	0	0	0	0	0	0	0
Air Force	515	221	129	12	19	0	0	98	36
Army	465	445	9	1	3	0	0	0	7
USCG	31	31	0	0	0	0	0	0	0
Energy	246	238	0	1	7	0	0	0	0
FAA	110	110	0	0	0	0	0	0	0
Interior	69	69	0	0	0	0	0	0	0
Justice	130	125	0	0	5	0	0	0	0
Navy	455	213	196	9	16	3	0	18	0
NASA	6	0	3	2	1	0	0	0	0
TVA	28	28	0	0	0	0	0	0	0
Treasury	14	13	0	1	0	0	0	0	0
Other Agencies	16	15	0	0	1	0	0	0	0
Total	2441	1864	337	26	52	3	0	116	43

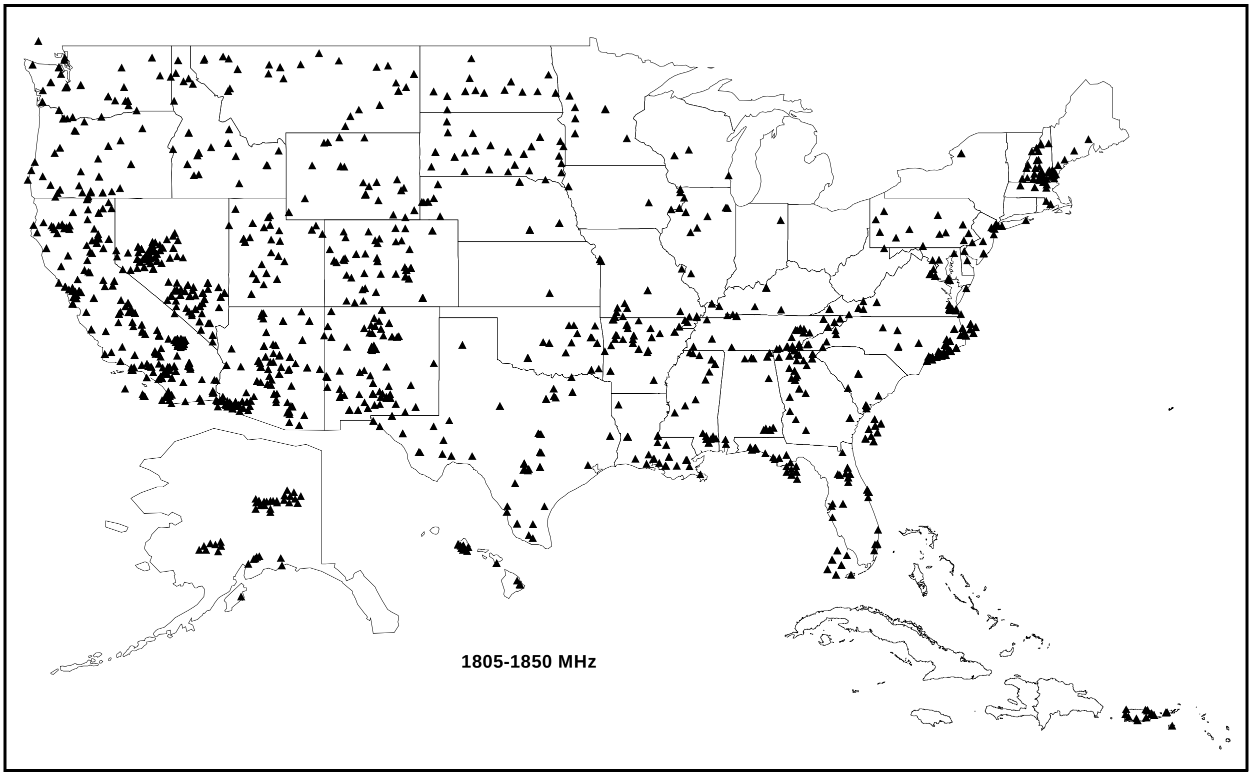

Figure 7. Plot of Frequency Assignments in the 1805-1850 MHz Sub-Band.
Note: The symbols may indicate multiple assignments at a geographic location, assignments may cover multiple emitters, and assignments authorized on a US&P basis are not reflected.

Satellite Control Systems

Introduction. Satellites orbit the Earth in either geostationary satellite orbits (GSO) or non-geostationary satellite orbits (NGSO). Satellites operated by the DOD include both GSO and NGSO, and are used for such functions as communications, navigation, surveillance, missile early warning and attack characterization, weather monitoring, and research and development. The critical nature of the Satellite Control Network (SCN) functions is such that DOD satellites can neither be launched nor operated without the SCN. These satellites must be supported by the SCN to achieve proper orbit, be initialized for operations, maintain orbit and configuration, perform emergency recovery operations following on-orbit failures, and be used for disposal operations at end-of-life. Satellites are controlled to maintain proper orbit, and must be commanded to perform certain functions. This is the control function. The satellite controller must know the location of the satellite to determine its present orbit. This is called a tracking function. The operators also need to know the "health" of the satellites, so a telemetry link sends back to the ground station information relating to the status of all platform functions such as electrical, stabilization, temperature, and propulsion systems onboard the satellite. This is the telemetry function. The combination of these functions for satellite control is termed TT&C. The uplink TT&C function is performed in the 1761-1842 MHz band for military satellites. The associated downlink for these satellites is in the 2200-2290 MHz band.

Tracking, Telemetry, and Commanding. The 1761-1842 MHz band segment supports the TT&C for the DOD satellites, in addition to the North Atlantic Treaty Organization (NATO), UK military satellites, and various space and ballistic missile test programs. TT&C supports automatic space vehicle acquisition and tracking, ranging, reception and recording of vehicle telemetry data, and transmissions of commands to the space vehicle.

The TT&C subsystem monitors and controls all of the other systems on the spacecraft, transmits the status of those systems to the control segment on the ground, and receives and processes instructions from the control segment. Telemetry is the data collected by sensors throughout the satellite that determine the status of various system components, including transmitters and antennas. This information is then transmitted to the ground segment.[19] The SCN is critical to launch and early orbit functions and emergency recovery for most U.S. government satellites.

Telemetry also includes data on the operation and status of the satellite's payload. For example, on a communications satellite, telemetry would include data on power output of transponders, pointing direction of antennas, and antenna and transponder switch configurations. Tracking involves determining a satellite's position, altitude and other orbital parameters. Many satellites carry a beacon that transmits a signal to help ground tracking receivers locate the satellite. Onboard sensors, such as star trackers, horizon scanners, and inertial navigation sensors provide other tracking data. Tracking information is essential to determine a satellite's orbital parameters so that accurate predictions can be made of where the satellite will be in the

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[19] U.S. Department of the Army, Army Training and Doctrine Command, *Army Space Reference Text*, Chapter 7, Space Systems, at Section 7-1: Control Segments (Telemetry, Tracking and Commanding), (visited Sept. 13, 2000), htt;://<www.tradoc.army.mil/dcscd/spaceweb/chap07a.htm>.

future. In this way, the satellite's orbital position can be adjusted so that it will be in its proper position at the proper time.

Commanding is the act of controlling a satellite. Commanding a satellite is accomplished by sending signals to it that initiate an action or change the configuration in some way. Commands may be executed by the satellite immediately upon receipt, or stored for later execution. Some commands are part of onboard software that allows the satellite to execute certain functions autonomously when a predefined condition exists. Commands may direct the thrusters to fire to change the orbit, or may reconfigure the payload to meet the needs of users.

The major system operating in this band segment that supports the TT&C functions is the Space Ground Link Subsystem (SGLS). The band plan for SGLS comprises 20 discrete channels within the 1761-1842 MHz band segment beginning at 1763.721 MHz and ending with 1839.795 MHz. Each channel is 4.004 MHz wide. Although most TT&C operations are provided by fixed sites, the Air Force also uses transportable SGLS-compatible earth stations to provide additional coverage during launches, early orbit operations, anomaly resolution, and critical orbit insertion maneuvers. These transportable stations are moved as necessary to accomplish the mission. It is not possible to change the TT&C frequencies for satellites that have already been launched. While it may be possible to change the frequencies of satellites that are yet to be launched, this would be expensive, time consuming, and could impact scheduled launch dates of critical national space assets, thus affecting the government’s ability to meet satellite replacement requirements.

In addition to supporting TT&C for military satellites, the 1761-1842 MHz band segment supports TT&C for the cooperative DOE/DOD Proliferation Detection Technology (PDT) Program. The PDT Program will demonstrate advanced system technologies for remotely monitoring nuclear facilities and for identifying and characterizing undeclared and clandestine nuclear facilities. Although this program is directed at nuclear proliferation monitoring, the technology could potentially serve a variety of other national security and civilian needs.[20] The civilian and commercial communities also derive significant benefit from the Global Positioning System (GPS), which is controlled and supported through the use of the 1761-1842 MHz band.

The operation of U.S. satellite control facilities internationally is authorized by specific host nation agreements in those countries in which the SGLS-compatible stations are deployed. The lack of spectrum support for continued satellite control operations in the 1761-1842 MHz band would have implications for U.S. allies as well, since both NATO and the UK depend on satellite control stations operating in the 1761-1842 MHz band to provide military spacecraft TT&C support for the NATO SATCOM IV and the UK SKYNET satellites, respectively.

Air Force Satellite Control Network. The Air Force is the designated service responsible for platform control of most DOD satellites. The organizations and facilities involved are organized into the AFSCN. The principal organization in the AFSCN is the 50^{th}

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20 *See* National Telecommunications and Information Administration, U.S. Department of Commerce, NTIA Special Publication 95-32, Spectrum Reallocation Final Report (1995), at 4-13 [hereinafter NTIA Final Reallocation Report].

Space Wing of the Air Force Space Command, with headquarters at Schriever Air Force Base (AFB), Colorado.

The AFSCN provides support for the operation, control and maintenance of a variety of DOD and some non-DOD satellites. This involves continual execution of the tasks involved in TT&C. In addition, the AFSCN provides pre-launch simulation, launch support, and early orbit support while satellites are in initial or transfer orbits and require maneuvering to their final orbit. The AFSCN provides tracking data to help maintain the catalog of space objects and distributes various data such as satellite ephemeris, almanacs, and other information.

The AFSCN consists of satellite control centers, tracking stations, and test facilities located around the world. Satellite Operations Centers are located at Schriever AFB near Colorado Springs, Colorado, and Onizuka AFB, Sunnyvale, California. These centers are staffed around the clock and are responsible for the command and control of their assigned satellite systems. The control centers are linked to remote tracking stations (RTSs) around the world. The RTSs provide the link between the satellite being controlled and the control center. A similar relationship exists for dedicated networks. RTSs around the world are needed to maintain frequent communications with the satellite. Without RTSs, the control centers would only be able to contact a satellite when it came into the control center's view. Some satellites, especially those in geostationary orbit, never come within view of their control center (most control centers do not have antenna capabilities to communicate directly with satellites in this band). Space vehicle checkout facilities are used to test launch vehicles and satellite platforms to ensure that the onboard systems operate within specifications.

Remote Tracking Stations. Each RTS performs essential mission operations on a 24-hours/day, 7-days/week basis. The AFSCN performs approximately 400 satellite contacts per day. The operations are driven by the requirements to support U.S. national security space operations, as well as by NATO, and the UK. Each RTS has one to four antennas used for transmitting in the 1761-1842 MHz band. On the occasion of major maintenance or antenna replacement, transportable assets are deployed to the RTS sites to ensure continuity of operations. The antennas used are typically 60, 46, and 33 feet (18, 14, 10 meters) in diameter. They are supported by transmitters operating between 250 and 7,000 Watts, depending on the required mission operation. Filters are employed to limit out-of-band radiation. The antennas may be pointed low on the horizon to communicate with low-altitude satellites which have very short visibility times. Low-angle radiation will also occur at Vandenberg AFB, California, and Cape Canaveral Air Force Station (AFS), Florida, to conduct open loop check-out of satellites on launch pads and to verify communications links prior to launch. For other satellite contacts, the antennas are typically pointed at higher elevation angles. The infrastructure at each RTS has evolved over the last 40 years and is extensive and sophisticated with regard to facility power, emergency power, and connectivity to commercial terrestrial communications. For the most part, the RTSs are located on U.S. military or host nation military/government facilities. RTSs are located as follows:

1. Vandenberg Tracking Station, Vandenberg AFB, California.
    - Three antennas
    - Missions: satellite operations, space launch, and ballistic missile test launch
2. New Hampshire Tracking Station, New Boston Air Station, New Hampshire.
    - Three antennas
    - Missions: satellite operations and space launch
3. Thule Tracking Station, Thule Air Base, Greenland.
    - Four antennas
    - Mission: satellite operations
4. Guam Tracking Station, Andersen AFB, Guam.
    - Two antennas
    - Mission: satellite operations
5. Hawaii Tracking Station, Kaena Point, Oahu, Hawaii.
    - Two antennas
    - Missions: satellite operations and ballistic missile test launch
6. Colorado Tracking Station, Schriever AFB, Colorado.
    - One antenna
    - Mission: satellite operations
7. Oakhanger Telemetry and Command Station, Borden, Hampshire, England.
    - Two antennas
    - Mission: satellite operations
8. Diego Garcia Tracking Station, British Indian Ocean Territory, Diego Garcia.
    - One antenna
    - Mission: satellite operations
9. Camp Parks Communications Annex, Pleasanton, California.
    - Two antennas
    - Mission: satellite operations
10. Eastern Vehicle Checkout Facility, Cape Canaveral AFS, Florida.
    - One antenna
    - Mission: pre-launch spacecraft compatibility testing
11. Onizuka AFS, California.
    - One antenna
    - Mission: satellite operations

The AFSCN sites at Vandenberg, Thule, New Hampshire, Camp Parks, and at Onizuka AFS include a data link terminal antenna, which provides communications functions using SGLS.

Other Transmitting Sites. Other than the AFSCN stations, certain satellites are controlled through dedicated sites to support specific programs. Typical examples of these sites follow. The Defense Meteorological Satellite Program (DMSP) has a dedicated network operated by the Suitland Satellite Operations Control Center (SOCC) in Suitland, Maryland. The SOCC performs all primary TT&C functions for the DMSP through the use of AFSCN assets. The SOCC has a back-up facility at Schriever AFB, Colorado. The GPS has a Mission Control Center at Schriever AFB operated by the Air Force Space Command, 50th Space Wing, 2nd Satellite Operations Squadron. There are also dedicated GPS monitoring stations at Ascension Island, Diego Garcia, Kwajalein, and Cape Canaveral tracking stations.[21]

In addition to the AFSCN, the GMF lists the following facilities that are authorized to transmit on SGLS frequencies:

1. Blossom Point, Maryland
2. Buckley Air National Guard Base, Colorado
3. Fairbanks, Alaska
4. Laurel, Maryland
5. Kelly AFB, Texas
6. Kirtland AFB, New Mexico
7. Quantico, Virginia

The Navy operates additional sites at:

1. Prospect Harbor, Maine
2. Laguna Peak, California

Further, the Air Force also has transportable tracking facilities that are relocated worldwide to satisfy immediate requirements for TT&C, such as anomaly resolution, that cannot be accomplished at the fixed facilities. Under those conditions, the transportable terminals usually operate on Federal land (e.g., military bases and installations). Figure 8 shows the locations of SGLS-compatible uplink stations in the United States.

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[21] Some of the satellite systems are for the Defense Support Program (missile warning), GPS (navigation), Nuclear Detonation Detection System, DMSP (weather and environmental monitoring), Defense Satellite Communications System (communications), MILSTAR (communications), Fleet SATCOM (communications), and the UHF Follow-on (communications).

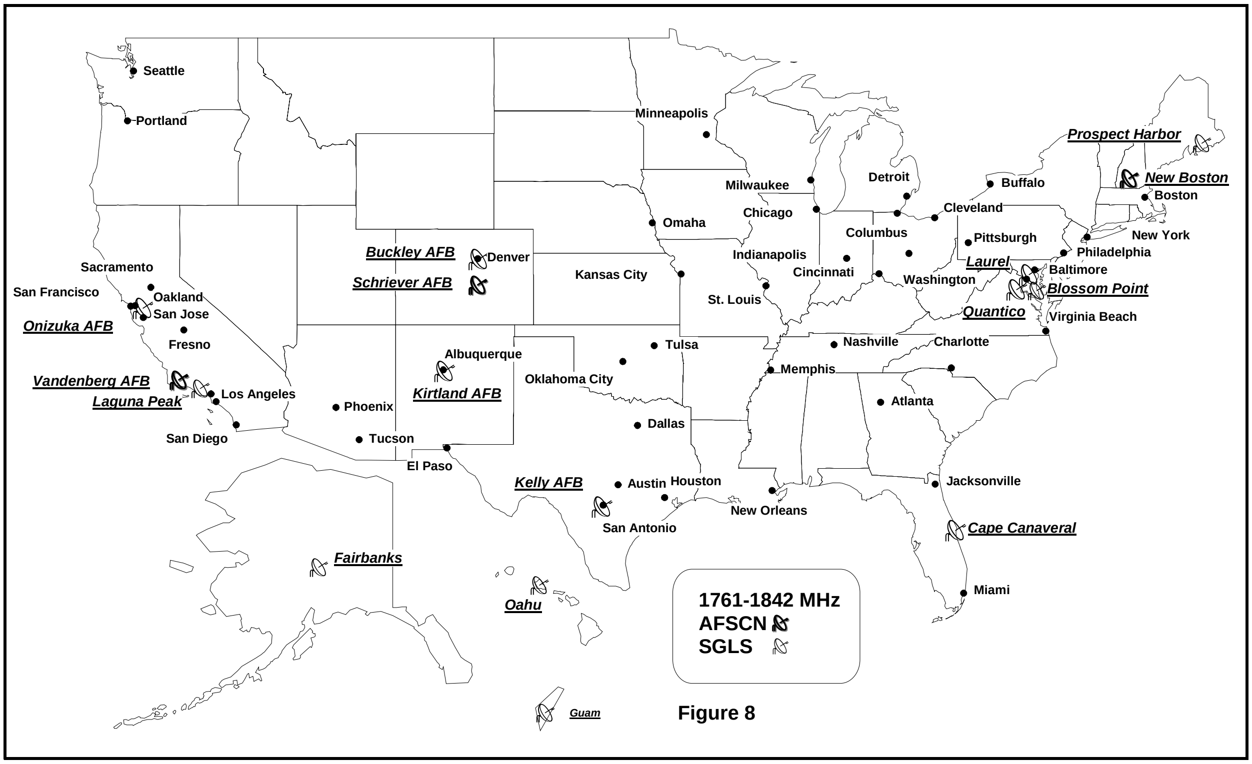

Figure 8. Satellite Control Network Sites.

<u>Satellites Supported</u>. The following is an unclassified summary of typical satellite systems supported by DOD.

Unclassified Summary of Typical Satellites Supported by DOD

Short Name	Orbit*	Short Name	Orbit*
USGCSS PH 2/3/3B	GEO	USGCSS PH5	GEO
FLTSATCOM	GEO	USOBO	GEO
MILSTAR	Inclined GEO	DMSP	Non-GEO
UFO	GEO	GPS	Non-GEO
Skynet (UK)	GEO	STS (Shuttle)	Non-GEO
NATO III/IV	GEO	GFO	Non-GEO
DSP		P-Series	Non-GEO
SBIRS (Planned)	GEO	USAPEX	Non-GEO
USGAE	GEO	OTF	Non-GEO
USGBS	GEO	Various R&D	Non-GEO (LEO, HEO)

* Note: Geostationary Orbit (GEO), Highly Elliptical Orbit (HEO), Low Earth Orbit (LEO)

Conventional Fixed Systems[22]

The military services are extensive users of conventional fixed microwave relay systems in the 1755-1850 MHz band. As mentioned earlier in this report, the ACE operates fixed microwave systems throughout the country. All of the military services employ fixed microwave systems on military installations and test and training ranges to support a variety of functions. These functions include general purpose communications to remote areas, relaying radar data from remote range areas back to control centers, relaying video data from remote bombing and gunnery ranges, sending command and control data to tethered aerostat radars, and relaying radar data from tethered aerostats to ground control facilities.

The Forest Service of the USDA is one of the Federal Government's largest users of fixed microwave radio sites. These sites provide backbone communications support to land mobile radios in national forests and lands managed by USDA for the public. The backbone links provide primary radio interconnection between mountaintop radio repeaters and the base stations, which further interconnects with either mobile or portable handheld radios. Some USDA microwave links are shared with other agencies such as the DOJ. These systems are essential for law enforcement, firefighting, and emergency preparedness disaster control (e.g., earthquake, volcanic eruption, and hurricane) communications.

The DOI manages its natural resources programs using fixed microwave links to accomplish congressionally mandated missions. These microwave operations support a variety of functions including: firefighting, law enforcement, disaster control within national forest and parks, communications services to Native American Tribal lands, and earthquake monitoring. Operations are spread throughout the United States in suburban, urban, and rural areas, some of which are remote and almost inaccessible so that commercial service is not available or reliable.

As a result of the 1710-1755 MHz band being identified for reallocation under the OBRA-93, the FAA and U.S. Coast Guard (USCG) are in the process of procuring fixed microwave links in the 7/8 GHz band. The FAA uses fixed microwave links as part of a nationwide network to interconnect the nation's air traffic control facilities. The USCG uses are for vessel traffic control and safety operations, communications support of the national distress system, and remote distress and safety communications.

The DOJ uses a nationwide network of fixed point-to-point links to connect its land mobile users. Bureaus within the DOJ have also begun the transition to higher frequency bands (e.g., 7/8 GHz band). These Federal law enforcement systems require secure communications to prevent monitoring, which could disrupt investigations and/or cause life-threatening situations for law enforcement personnel.

The DOE has fixed microwave operations in support of the National Defense and Petroleum Reserve Programs with a variety of functions such as remote keying of high-frequency

[22] Conventional fixed systems as used herein refer to point-to-point systems using commercial off-the-shelf, or equivalent equipment.

transmitters, backbone communications and security, and remote control of robots, cranes and alarms.

Other specific agency applications of the fixed microwave wide-area network systems include the following: the FAA remote data transmission in support of aviation safety systems; the USDA and the DOI backbone links for control of land mobile radio systems necessary in firefighting, law enforcement, and disaster control within national forests, and for provision of voice data connections between sites where commercial service is not available; and the Department of the Treasury and DOJ microwave links related to law enforcement. This band is also used by the USCG for vessel traffic safety systems, for communications support of the VHF national distress system, and remote distress and safety communications and control networks.

One example of a wide-area network is the DOE and Tennessee Valley Authority (TVA) use of this band for supervision, control, and protection of electrical power transmission. The channels are used for high speed data relaying, supervisory control, load control, telemetering, data acquisition, land mobile radio dispatching, operations and maintenance. The present system connects, via wireline and radio, all Federal Government power marketing control facilities in the western half of the United States and TVA region. Common equipment exists with the non-Federal sector allowing interconnectivity for critical communications dealing with all aspects of generating and transmission of power.

The U.S. Customs Service currently operates and maintains an analog microwave system in Hawaii, commonly referred to as the Rainbow Microwave System, that provides a common backbone system servicing Federal, state, and local agencies. The Rainbow system was included in the list of Federal stations that are protected from interference under the mixed-use criteria established by Title VI of the OBRA-93 due to the high priority, public safety missions it supports. This system currently employs frequencies throughout the entire 1710-1850 MHz band. There is no digital equipment available to replace the aging analog microwave system in this band; therefore, any replacement digital microwave system must operate in higher frequency bands at a higher cost to the users.

Tactical Radio Relay Equipment

The DOD uses TRR for command and control of military forces. The majority of TRR in the band is supported by the MSE. Primary areas of operations for MSE in the United States are shown in Figure 9. Some training areas for National Guard and Army Reserve units are not shown.

The AN/GRC-103, AN/GRC-226, and A/N GRC-245 Radio Sets are line-of-sight (LOS) trunk radios used to link nodes (switching centers) in the Army's tactical telecommunications system or the Army Common User System (ACUS). These radios operate in the 1755-1850 MHz band.

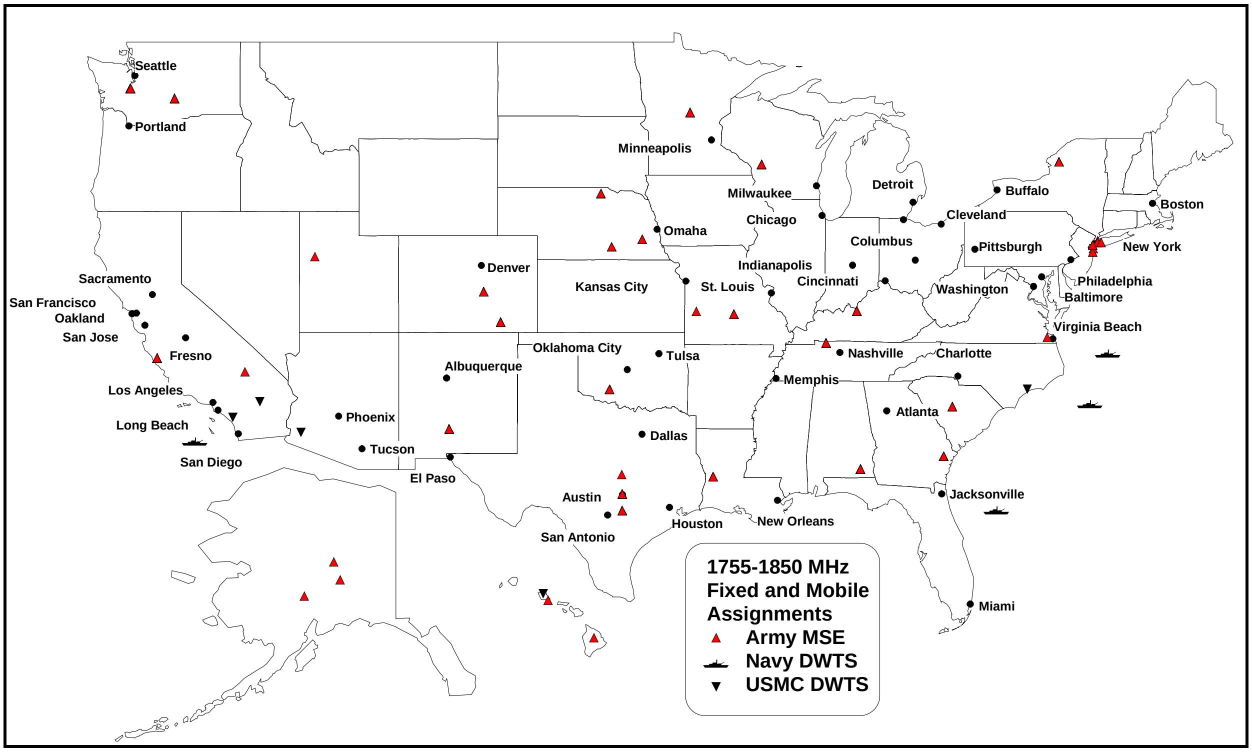

Figure 9. Concentrations of Fixed and Mobile Sites in the 1755-1850 MHz Band.

The ACUS is a seamless, tactical communications system that provides secure, highly reliable voice and data communications for both mobile and static subscribers in a tactical environment. The ACUS operates from the maneuver battalion to the theater rear boundary. This communication system is also known as the MSE and the Tri-Services Tactical Communications (TRI-TAC) system. The MSE system is deployed at Echelons Corps and Below and the TRI-TAC system is deployed at Echelons Above Corps (EAC).

There are over 4,000 AN/GRC-226 Radio Sets fielded of which about 2,800 operate from 1350 MHz to 1850 MHz, and the balance operate from 225 MHz to 400 MHz. There are 872 AN/GRC-103 Radio Sets fielded at EAC. The AN/GRC-103 only operates from 1350 MHz to 1850 MHz. The AN/GRC-245 Radio Set, also known as the High Capacity Line of Sight (HCLOS) Radio is the planned replacement for both the AN/GRC-103 and AN/GRC-226. Fielding of the AN/GRC-245 Radio Set began this past summer to the 124th Signal Battalion at Fort Hood, Texas. To date 90 HCLOS radios have been fielded. The HCLOS radio has an expanded operating frequency range over both the AN/GRC-103 and AN/GRC-226 in that it operates from 1350 MHz to 2690 MHz (called Band III+), but the tuning range from 1850-2690 MHz is rarely available for MSE operations. The spectrum efficiency of the AN/GRC-245 is more than twice that of its predecessors, enabling it to better handle the growing information requirements of today's Army.

These LOS radios use directional antennas mounted on top of portable masts 15 to 30 meters in height separated by distances of up to 40 km from each other to connect the Army's tactical communications or switching centers. The radio sets with ancillary equipment are installed in shelters mounted on trucks providing the mobility needed to meet tactical requirements.

The DWTS used by the Navy and Marine Corps is a surface-based, frequency modulated, point-to-point and mobile communications system that carries 9, 18, or 36 voice channels or digital data, and can be carried on a high mobility multipurpose wheeled vehicle. The DWTS is used at Camp LeJeune, North Carolina; Twentynine Palms, California; Oahu, Hawaii; and at other military installations and proving grounds where training exercises are conducted. This system is fully deployed with approximately 600 units in the field. The DWTS consists of two systems: the AN/MRC-142 operating in the fixed service at land-based facilities and the AN/SRC-57 operating in the mobile service for ship-to-ship and ship-to-shore communications (with land-based AN/MRC-142 units). The key feature of these systems is their transportability. These TRR systems are designed to be set up and disassembled rapidly to support the communications needs of maneuvering troops.

Air Combat Training Systems

The ACTS are used extensively in the 1755-1850 MHz band. ACTS are complex by the nature of their operations because both fixed and aeronautical mobile equipment are used.

ACTS that operate in this band segment include the Air Force's Air Combat Maneuvering Instrumentation (ACMI), and the Navy's Air Combat Maneuvering Range and Tactical Air Combat Training System (TACTS). Two types of currently deployed ACTS systems are described in the DOD Final Report: the current ACMI and TACTS (both called ACTS, herein).[23] ACTS is a “system of systems” in that specific ACTS-equipped ranges may implement different ACTS frequencies depending on the surrounding electromagnetic environment. These systems provide critical training for, and evaluation of, aircrews in air combat tactics and performance. These systems are in operation at test and training ranges as well as other bases including Reserve and Air National Guard locations that may include civilian airports. Recent information indicates that the original program to replace these systems with a follow-on system called Joint Tactical Combat Training System (JTCTS) is currently in the process of being restructured. A new JTCTS contract is expected to be awarded within about a year.

Figure 10 represents permanent Air Force and Navy training sites in the United States. Air Force and Navy ACTS employ factory-preset frequencies throughout the 1761-1842 MHz band segment that are used to transmit information to and from aircraft. 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.

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[23] *See* DOD Final Report, *supra* note 6.

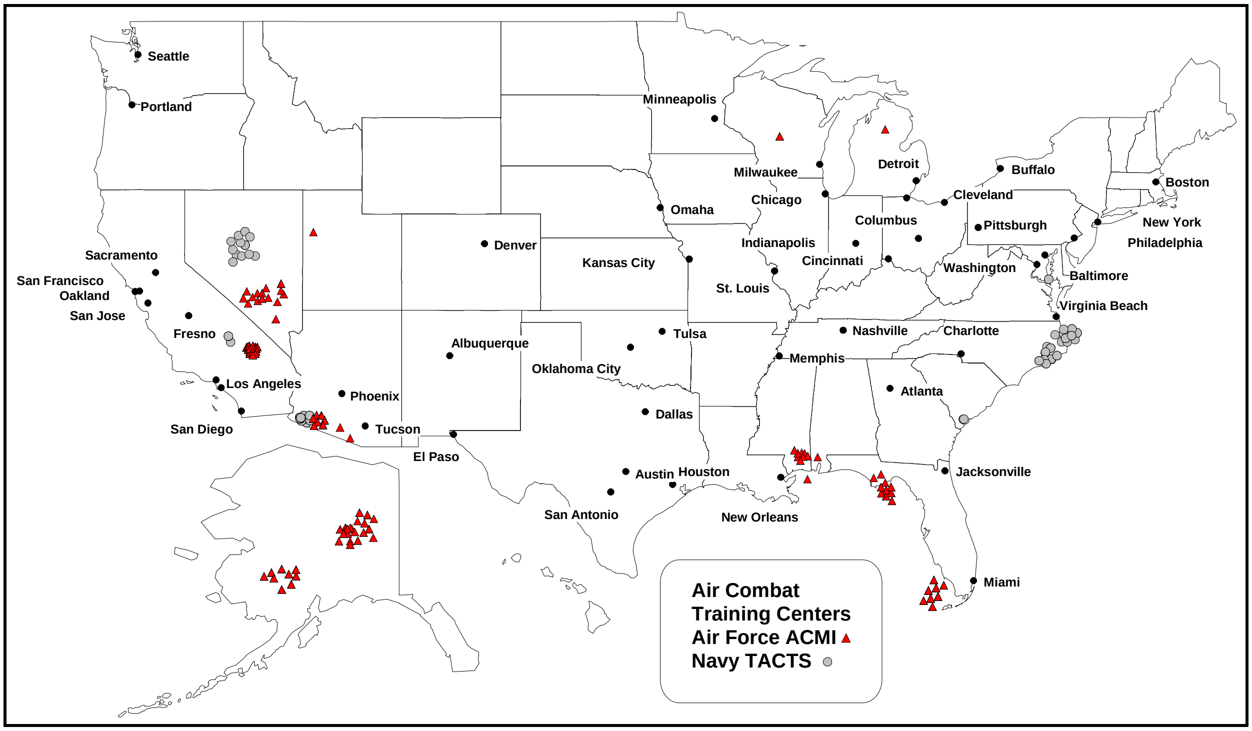

Figure 10. Air Combat Training Center Sites.

The U.S. Air Force ACMI/ACTS, the U.S. Navy TACTS, and its several variants, provide training associated with aircraft missions ranging from squadron level up to and including joint force missions. The Navy and Air Force use these systems for daily proficiency training and as the final readiness training prior to deployment to combat areas around the world. ACTS provides real-time monitoring of aircraft combat operations and maneuvering, such as gun-scoring, no-drop bombing training, and evasion and intercept tactics and electronic warfare during exercises and training. It also records and plays back aircraft maneuvers for mission analysis and debriefing. Most systems are composed of the ground-based tactical instrumentation subsystem (ground-to-air) and the aircraft instrumentation subsystem (air-to-ground) mounted internally or via a pod on the aircraft. The two-way data link between these two subsystems is the only means by which they interact and allow the overall system to function.

On the ground, there are remote stations that receive the aircraft downlink signal and transmit commands to the aircraft, and relay the received aircraft data to a master station. Six frequencies are used in the 1755-1850 MHz band for remote stations, and one frequency for the master station to transmit to the remote stations. There are two ground-to-air frequencies, and two air-to-ground frequencies.

During a mission, active Aircraft Instrumentation Subsystem pods are sequentially interrogated on a periodic basis using the same frequency, and each responds when addressed by its unique digital address code. The Aircraft Instrumentation Subsystem transmits both ranging signals and stored digital data over a single channel. A typical training range uses a minimum of

10 frequencies within the 1755-1850 MHz band. A typical ACTS range is configured with more than one master station and more than six remote stations that may require additional frequency assignments, depending on spatial separation and radio frequency line-of-sight interference considerations.

ACTS is employed at ranges in United States, Canada, Taiwan, Thailand, Egypt, Okinawa, Korea, the UK, and Italy. Canadian F-18 fighter aircraft are fitted with an internal ACTS box (and dedicated 1710-1850 MHz antenna) for use on the ranges similar to the U.S. Navy F-18's. The Royal Netherlands Air Force uses ACTS with the Arizona Air National Guard at Goldwater Air Field, Arizona. This system is fully deployed and includes approximately 120 tracking instrumentation systems and 1,400 aircraft instrumentation systems.

Some ACTS configurations are not reliant on an air-to-ground or ground-to-air data link, and are not restricted to any particular geographic location. Therefore, these systems can operate anywhere over the United States (or the world) in airspace set aside for military operations.

The JTCTS will operate in the same band and perform the same function/mission as the ACTS. However, the JTCTS will differ from the current ACTS equipment in several important respects. From the spectrum management aspect, the most significant of these are the dual-bandwidth operation capability, and the spread spectrum nature of the signal. The JTCTS is designed to tune throughout the 1710-1850 MHz band in 5 MHz increments for a total of 27 possible channels. The second major difference is that the JTCTS does not require a dedicated range with numerous ground stations. This mode of operation, called “rangeless,” operates in a air-to-air configuration, and therefore, can be used anywhere over the United States or the world in airspace set aside for military operations.

The JTCTS has host nation coordination and permanent frequency assignments for Japan. The United States has also requested host nation coordination for several other countries.

Both the Tracking Instrumentation Subsystem and the Aircraft Instrumentation Subsystem have planned replacements. The Aircraft Instrumentation Subsystem began upgrading to the AN/ASQ-T31 in June of 1996. The AN/ASQ-T31 is portable and includes provisions for data encryption. The Tracking Instrumentation Subsystem will be replaced by the JTCTS, which is being developed by the Navy and is becoming operational. Most of the combat training ranges will be upgraded to JTCTS within a 10-18 year period.

Precision Guided Weapons

Other critical DOD systems, such as PGM and high resolution video links, operate in this band and are vital to national defense. Precision munitions include a number of weapons systems that employ communications in this band between a launched weapon and a controlling platform allowing for precision delivery of the weapon’s payload. These advanced systems are normally employed against high-value and hardened enemy targets. DOD PGMs (e.g., AGM-130 and GBU-15) were designed for employment against fixed, high-value targets. These weapons, in the 2,000-pound class, are launched from tactical aircraft from either low or high altitude at ranges from 5 to in excess of 30 nautical miles. Equipped with television or infrared sensors, and aided by GPS, these weapons provide operators the ability to attack targets in all weather conditions, day or night. These weapons can be controlled from either the launch aircraft or a standoff aircraft at a range of more than 100 nautical miles. Weapons operators require access to a video and a command link frequency at any time during the mission, including ground operations, post take-off pre-launch operations, and post-launch weapon flight operations. Access to frequencies is critical during all training operations—these operations require use of the frequencies for two hours at a time. The Navy currently operates similar PGMs against fixed and relocatable land targets as well as ships.

The weapon control data link systems provide operators with the ability to control the precision guided weapons. Video from the weapon seeker is transmitted to a weapon systems officer who identifies the target and manually controls the bomb to the designated impact point. The AGM-130 provides a longer range, compared to the GBU-15, because its flight is assisted by use of a rocket motor. Both data link systems associated with these munitions, the AXQ-14 and ZSW-1, use multiple frequencies within the 1710-1850 MHz band for both video and command links. The AXQ-14 and ZSW-1 weapon control pods carried on the centerline station on the aircraft, receive the weapon video for display, and transmit weapon guidance signals through the command link.

If the weapon control data link system could not be used on its current frequencies in 2003, there would be an immediate loss of combat capability to the warfighter. The AGM-130 and GBU-15 could not be used to their full potential. These systems provide precision attack capability from fighter aircraft, and they represent the majority of the total man-in-the-loop precision capability from all military aircraft. Without this system, last-minute target identification and the ability to minimize collateral damage would be lost.

Figure 11 depicts the contours of nominal radio line-of-sight distances surrounding the many operational training areas where PGM-equipped aircraft operate. Because of the large geographic areas involved, establishing protection areas for these operations is not feasible.

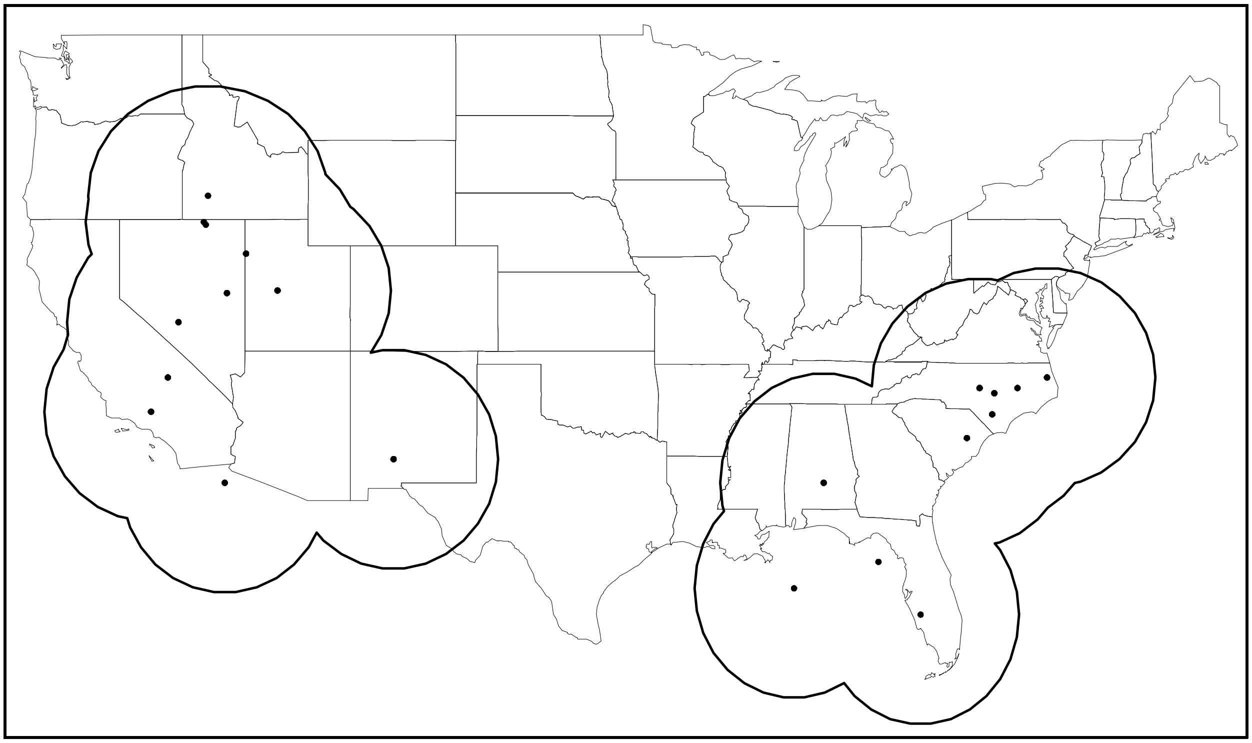

Figure 11. Line-of-Sight Distances from Precision Guided Munitions Operational Areas.

Other Systems

In addition to precision munitions and high resolution video links, the 1755-1850 MHz band also supports deployable emergency communications systems, combat identification systems, mobile tactical voice and data systems (Land Warrior), robotic control functions, and target scoring systems. Appendix E of the DOD Final Report contains data on these systems.

IV. Approaches for IMT-2000 Accommodation

Sharing Potential Employing Protection Areas

One potential method for accommodation of IMT-2000 would be for these systems to share Federal and commercial frequency bands that are currently occupied. Co-channel sharing is generally accomplished either by geographical separation, time separation, or by transmitting waveforms that are designed specifically to reduce interference to other systems in shared bands. The discussion in this section will focus on the potential for geographical and time separation as the main mechanisms to reduce interference, but one segmentation option is also included. The DOD Final Report concluded that unrestricted, full-band sharing was not feasible in the 1755-1850 MHz band. The discussion in this section references the DOD Final Report, based on considerations of only the 1.25 MHz and 3.75 MHz IMT-2000 bandwidths with minimal interference thresholds, as listed in the DOD Final Report. The 1.25 MHz and 3.75 MHz bandwidths were selected to only represent the typical technical characteristics for evaluating the EMC between IMT-2000 systems and selected DOD systems, and not as a forecast of future IMT-2000 technology. Different technical parameters (e.g., other data rates, powers, or modes, such as TDMA) will change the results accordingly.

1. Satellite Control (SGLS) Systems

In the 1994 Preliminary Spectrum Reallocation Report, NTIA noted the extensive studies conducted on the possible interference to space research and space operations from terrestrial systems.[24] Various studies of interference to satellite uplinks generally concluded that "... the introduction of ... land mobile systems in the frequency bands used by the space service would cause unacceptable interference to the space services."[25] Although those studies were focused on the 2025-2110 MHz (uplink) and 2200-2290 MHz (downlink) bands, the results would apply equally for the 1761-1842 MHz band segment.

Satellite support requires that the SGLS stations transmit to the space vehicle during the time of its visibility. Some LEO satellites have only a short (approximately 10 minutes) window of visibility. The goal is to acquire the satellites as close to the horizon as possible. Acquiring satellites at angles between 5-10 degrees above the horizon begins to have operational impacts to the satellite's mission. The SGLS station will want to acquire the satellite as soon as possible, and may start the acquisition process with the antenna pointed at the horizon point where the satellite will appear. The SGLS antenna will track the satellite through its arc of visibility, which could be up to 180 degrees. For non-geostationary satellites, the main beam of the antenna will be pointed in any given direction for a relatively short time.

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[24] National Telecommunications and Information Administration, U.S. Department of Commerce, NTIA Special Publication 94-27, Preliminary Spectrum Reallocation Report (1994).

[25] International Telecommunication Union, Use by the Mobile Service of the Frequency Bands 2025-2100 MHz and 2200-2290 MHz, Resolution 211, WARC-92 (Malaga-Torremolinos, 1992).

The DOD Final Report contains an analysis of the potential for interference between these operations and IMT-2000 systems.[26] The potential for interference is analyzed as a result of (1) interference to orbiting satellites caused by the aggregate transmissions from IMT-2000 transmitters, and (2) the potential interference to IMT-2000 receivers from SGLS transmitters.

A finding in the DOD Final Report summarizes the problem of SGLS sharing with IMT-2000: "Operational impact to TT&C uplinks from IMT-2000 emissions is expected in the time period 2006 and beyond when IMT-2000 system build-out has exceeded 50 percent of ITU estimates for full capacity. In 2003, it is not expected that IMT-2000 build-out will be sufficient to impact satellite operations uplink operations. These results are based upon realistic uplink parameters. It should be noted that if uplinks were conducted from worst-case disadvantaged (size, power, restricted viewing, etc.) terminals using antennas smaller than 33 feet (10 meters) or lower transmitter powers, there is a potential for impact to link closure reliability[27] in 2003. The degree of operational impact will vary as a function of the degree to which link closure is affected. It is expected that impact would occur for a subset of systems and operating conditions, although at critical junctures such as launch or anomaly resolution, such impact would be critical."[28] This impact could increase if contributions from 3G emitters outside metropolitan areas are considered.

Interference to the satellite receivers is a limiting factor in sharing the 1761-1842 MHz band, since the frequencies on the satellites cannot be changed to avoid interference, and the satellites continually "see" a large portion of the Earth. IMT-2000 transmissions will be received by the satellites and can interfere with uplink signals sent by the SGLS sites. The DOD analysis indicates that the link margin (the amount of signal in excess of that minimally required) would be increasingly degraded as the build-out of IMT-2000 systems progresses. The study finds that mobile IMT-2000 units would degrade the link margin (for a satellite altitude of 833 km) by up to 4 dB in 2003, up to 11 dB in 2006, up to 13 dB in 2010, and by 14 dB when full build-out is accomplished. For transmitting IMT-2000 base stations, the degradation in link margin would be up to 21 dB in 2003, up to 28 dB in 2006, up to 30 dB in 2010, and up to 31 dB for full build-out.[29] Under this scenario, sharing with base stations would not be feasible, but sharing with mobile stations may be possible. Increasing SGLS transmit power to provide an adequate signal-to-interference ratio at orbital distances will have the detrimental effect of increasing the level of interference to IMT-2000 receivers from SGLS transmitters, thereby increasing the required separation distances.

To protect IMT-2000 systems on co-channel operations, *protection areas* around SGLS sites could be determined based on the distance from an SGLS transmitter such that interference would not be caused to an IMT-2000 receiver. Within the *protection areas*, some method of coordination is necessary to achieve sharing. Using smooth-Earth propagation analyses, Tables

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[26] DOD Final Report at Appendix B (Potential Interference to and From Satellite Operations), *supra* note 6.

[27] Link closure is the successful receipt of an expected downlink signal as a result of an uplink command.

[28] DOD Final Report at Appendix B (Potential Interference to and From Satellite Operations) at B-14, *supra* note 6.

[29] *Id.* at B-41 through B-44.

4-1 and 4-2 list the nominal radii of *protection areas* around SGLS sites that would be necessary to reduce SGLS signals to the interference threshold of IMT-2000 mobile and base stations. The DOD Final Report also includes sample plots of received signal levels as a function of SGLS transmitter power and antenna elevation angles.[30] The propagation prediction used in the DOD Final Report was based on actual terrain surrounding sample SGLS stations. The interference distances using terrain data are generally less than distances derived from smooth-Earth data for the same signal level. As can be seen from Tables 4-1 and 4-2 using smooth-Earth data, the combination of low SGLS power and mobile IMT-2000 systems receiving produces the smallest *protection areas*. However, SGLS cannot always use the low power setting, as some satellites because of age, system degradations, and/or orbit, require higher power. Further, as the number of IMT-2000 transmitters increase, SGLS may need to increase power to maintain the required carrier-to-interference ratio at the satellites.

If sharing/relocation is implemented to reach an accommodation between IMT-2000 and the essential military capability as identified in the NDAA for Fiscal Year 2000, attention will need to focus on a realistic transition schedule. This schedule must preserve the essential military capability based on satellite lifetimes, satellite replenishment time lines and launch constraints. There is a need to quickly obtain Fiscal Year 2002 (FY02) funding (one of the key cost assumptions in the DOD Final Report), to allow sufficient time to design, engineer, acquire, test and implement satellite modifications, time to perform engineering and environmental impact studies, and fully fund if it is necessary to relocate ground facilities.

Table 4-1
Protection Distance in Kilometers for CDMA Carrier Spacing of 1.25 MHz
Using Smooth-Earth Propagation

IMT-2000 Station Type	SGLS Antenna Elevation	SGLS Transmitter Power		
		250 Watts	2000 Watts	7000 Watts
Mobile	3 degrees	46 km	59 km	88 km
Mobile	5 degrees	41 km	48 km	59 km
Base	3 degrees	206 km	301 km	355 km
Base	5 degrees	164 km	238 km	298 km

30 *Id.* at B-23 through B-32.

Table 4-2
Protection Distance in Kilometers for CDMA Carrier Spacing of 3.75 MHz Using Smooth-Earth Propagation

IMT-2000 Station Type	SGLS Antenna Elevation	SGLS Transmitter Power		
		250 Watts	2000 Watts	7000 Watts
Mobile	3 degrees	41 km	49 km	62 km
Mobile	5 degrees	37 km	44 km	49 km
Base	3 degrees	171 km	243 km	307 km
Base	5 degrees	134 km	193 km	242 km

Table 4-3
AFSCN Transmit Parameters

AFSCN Transmitter Power	250 W, 2000 W, 7000 W
AFSCN Antenna Gain Towards Horizon (49 dBi main beam gain)	23.4 dBi (3° elevation angle) 17.7 dBi (5° elevation angle)
AFSCN Antenna Height	15 meters

2. Conventional Fixed Systems

As a result of OBRA-93, some systems that were in the 1710-1755 MHz band were retuned to the remaining 1755-1850 MHz portion of the band. For example, the Forest Service of the USDA, determined the feasibility of this option based on the scarcely populated and remote geographical areas of its operations.

Recommendation ITU-R F.1334 concludes "in order to cover all possible sharing scenarios-separation distances on the order of 70-120 kilometers are needed for co-channel sharing between the fixed service in the 1-3 GHz and IMT-2000 stations."[31] Because of the number and distribution of Federal fixed service stations in the United States, co-channel sharing with IMT-2000 systems does not seem to be feasible. The IAG also found that general sharing with nationwide fixed stations was not feasible.

3. Tactical Radio Relay

The TRR system in use is generally the MSE for the Army, and the DWTS for the Navy/Marine Corps. The MSE is a multi-band, multi-channel, tactical LOS trunk radio system composed of several components. The part of the MSE that operates in the 1755-1850 MHz band (and in the 1710-1755 MHz band) is the AN/GRC-226 (V)2 radio. This radio is capable of tuning from 1350 to 1850 MHz, transmitting from 0.5 to 5.0 Watts, and using a 20 dBi gain antenna. The system is capable of 16 kbps per channel with 16, 32, or 64 channels per trunk, at

[31] International Telecommunication Union, Geneva, Switzerland, ITU-R Recommendation F.1334 [hereinafter ITU-R F.1334].

256, 512, and 1,024 kbps total capacity. A 50 MHz separation is required between transmit and receive frequencies. The system is designed to support the rapid set-up and disassembly required to meet the needs of maneuver warfare.

As a result of OBRA-93, operation of TRR in the 1710-1755 MHz band will be restricted to the 16 protected sites listed in Appendix F of the NTIA Final Reallocation Report[32] shown in Figure 12.[33] Operations at other training areas will be limited to the 1350-1390 MHz and 1755-1850 MHz bands, and in some locations, the 1432-1435 MHz band.

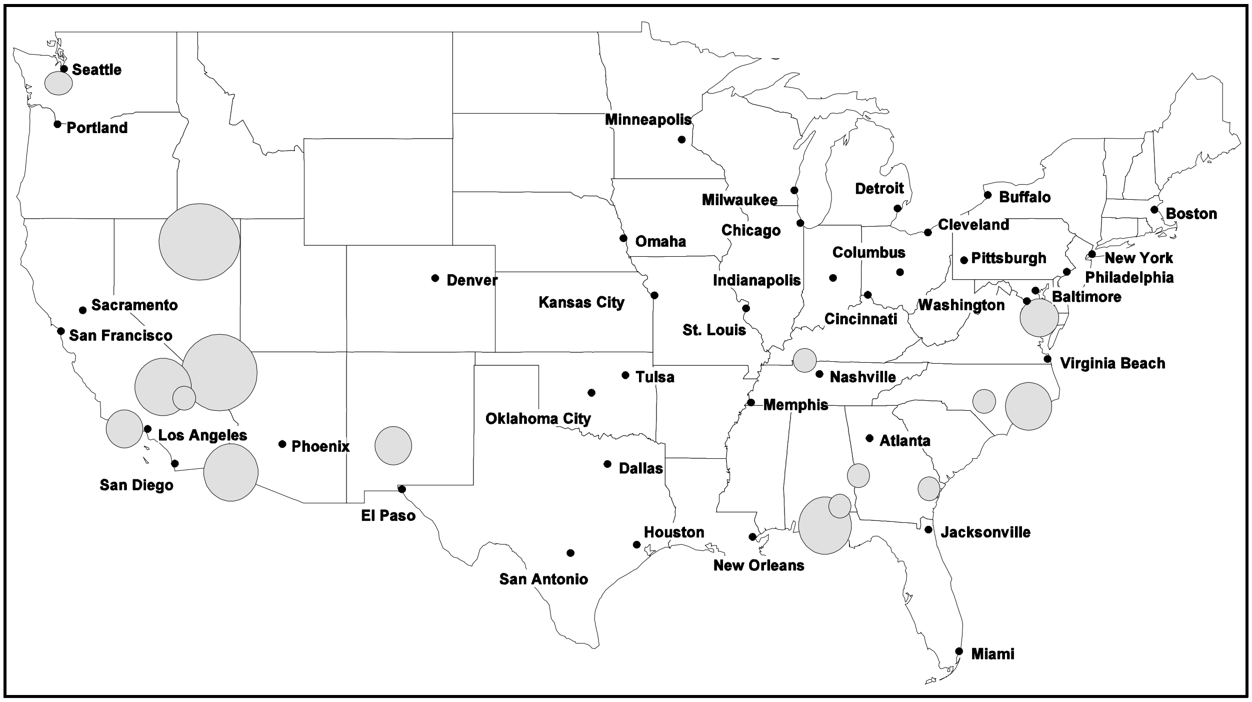

Figure 12. Federal Sites Operating Fixed Microwave, Tactical Radio Relay, and Aeronautical Mobile Stations in the 1710-1755 MHz Band Will Be Retained Indefinitely per OBRA-93.

The analysis in the DOD Final Report addresses the potential for interference between IMT-2000 systems and the Army's AN/GRC-226, the Tri-Services Tactical radio (e.g., AN/GRC-103) and also the AN/MRC-142 and AN/SRC-57 as part of the Navy's DWTS. The use of military radio relay, employing relatively broad beamwidth antennas, is unique to military operations, and hence is chosen for specific analysis in the DOD Final Report. Recommendation ITU-R F.1334 addresses the sharing situation between fixed point-to-point microwave links using high gain, directive antennas.[34] The potential for interference is analyzed as a result of (1) interference to fixed service systems, such as TRR, caused by the aggregate

32 *See* NTIA Final Reallocation Report at F-4, *supra* note 20.

33 The NTIA interim report cited 17 protected areas. There are 17 facilities, but two of them are co-located, resulting in 16 protected areas.

34 *See* ITU-R F.1334, *supra* note 31.

transmissions from IMT-2000 transmitters, and (2) the potential interference to IMT-2000 receivers from TRR transmitters.

Co-channel sharing of TRR and IMT-2000 systems is not feasible based on the significant distance separations required to prevent interference. To ensure compatible operations between TRR and IMT-2000 systems on co-channels, *protection areas* around TRR sites would require separation distances similar to the 75 kilometer radii example shown in Figure 13. If IMT-2000 systems were required to operate only outside of the protected areas, this approach would be unrealistic in that it would deny use of IMT-2000 services to numerous sizeable segments of the population.

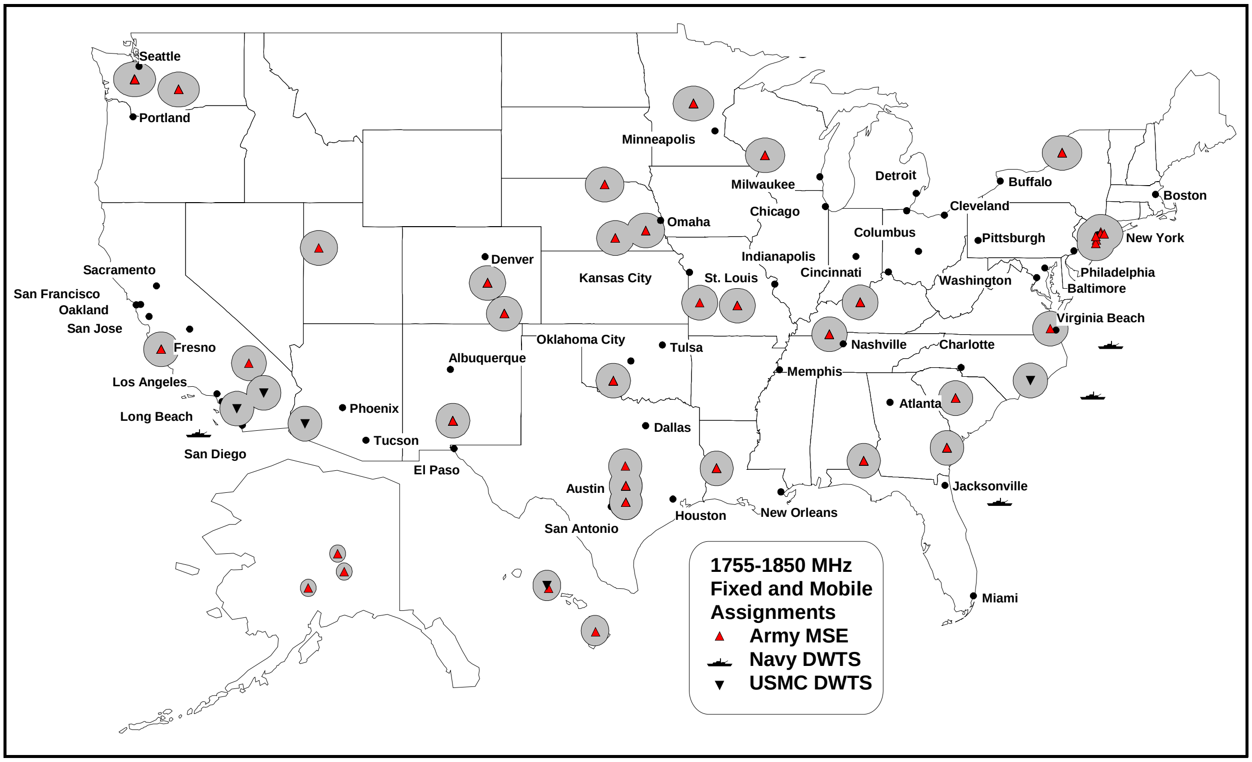

Figure 13. Protection Areas of 75 Kilometers Around TRR Sites.

Table 4-4
AN/GRC-226 (MSE) Parameters

Transmitter Power	-3 dBw or 7 dBw
Antenna Gain	20 dBi main beam, 11 dBi (20°-90°), 2 dBi (90°-180°)
Antenna Height	30 meters
Receiver Bandwidth	0.85 MHz (-3 dB)
Receiver Noise Figure	8 dB
Receiver Noise Power Level	-137 dBw
Allowed Interference Power	-143 dBw

4. Air Combat Training Systems

The existing ACTS ground stations transmit data to the aircraft on factory-preset frequencies of 1830 MHz or 1840 MHz, and receive data from the aircraft on 1778 MHz or 1788 MHz. Phase-modulated ranging tones and 62.5 kbps or 198 kbps data, using frequency shift keying (FSK), transmit altitude, location, velocity, angle of attack, missile firing events, and other data from up to 100 aircraft. The ACTS uses either omni-directional, or sector antennas with gains of 0 dBi and 12 dBi, respectively. The geographical area of coverage for ACTS systems is up to 65 nautical miles in diameter and operations may last up to 10 hours a day. Additionally, point-to-point links in this band are used to communicate the data from remote sites to a central location (master station).

It should be noted the restructured JTCTS is scheduled to complement the existing ACMI/TACTS. For purposes of this study, it was assumed that the restructured JTCTS has similar operational requirements as the ACMI/TACTS, and that the restructured JTCTS has the same technical parameters as the original JTCTS (described in J/F 12-06999/2) and has the additional flexibility to tune across the 1710-1850 MHz band in 5 MHz increments. The restructured JTCTS is expected to have the capability to operate without ground stations, in a “rangeless” air-to-air mode.

In the NTIA Final Reallocation Report, NTIA addressed the technical issues regarding the 1761-1842 MHz band segment used for ACTS systems such as ACMI and TACTS.[35] The report addressed interference to ACTS airborne receivers from mobile service stations as well as interference to terrestrial stations from ACTS ground station transmitters. NTIA determined ACTS airborne receivers are most susceptible to interference in the FSK demodulation stage. NTIA concluded reallocation of the 1845-1850 MHz band segment for terrestrial mobile and personal stations with a 5 MHz guard band will degrade uplink ACTS transmissions.[36]

The DOD Final Report contains analyses of the potential for interference between IMT-2000 base and mobile stations and ACTS and the original JTCTS operating in the frequency band 1755-1850 MHz.[37] The analyses assess the 1) potential for interference between IMT-2000 and ACTS ground stations, and 2) the potential for interference between IMT-2000 systems and ACTS airborne stations.

Interference to the ACTS airborne receiver may be the limiting factor in sharing, since the factory-fixed frequencies on the ground transmitters and aircraft receivers cannot be readily changed to avoid interference. Depending on operational altitudes (100-60,000 feet), IMT-2000 transmissions could potentially degrade the ACTS airborne receivers requiring large *protection areas* around training sites.

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35 *See* NTIA Final Reallocation Report at 4-11 and D-14 through D-18, *supra* note 20.

36 *Id.*

37 *See* DOD Final Report at D 15-17, *supra* note 6.

ACTS systems require large ground separation from IMT-2000 systems in order to operate co-channel. To ensure compatible ACTS operations and protect IMT-2000 systems on co-channel operations, *protection areas* around ACTS (ACMI/TACTS) sites could be determined, for example, based on the distances shown in the DOD Final Report.[38] An example is shown in Figure 14. These *protection areas* are shown, as an example, with radii of 400 kilometers. However, higher operating altitudes will increase the diameter of the circles. Figure 14 does not include potential "rangeless" ACTS operating areas.

Table 4-5
ACTS Parameters

Aircraft Altitude	30-20,000 meters
Ground-to-Air Transmitter Power	7 dBw
Ground-to-Air Antenna Height	30-45 meters
Ground Receiver Noise Figure	3 dB
Ground-to-Air Antenna Gain	3 dBi
System Losses	2 dB
Transmitted Data Rate	198.4 kbps
Aircraft Antenna Gain	0 dBi
Aircraft Receiver Noise Figure	7 dB
E_b/N_o for BER = 1^{0-5}	13.35 dB

Note: The listed ACTS parameters were considered only for conducting the preliminary EMC analysis and are not considered representative of these range systems and its operational scenario for the aircraft attitude.

5. Precision Guided Munitions (PGM)

PGMs are weapons that provide the capability to attack single military targets with one aircraft or one standoff weapon with greater probability of success than by flying waves of aircraft dropping conventional, unguided bombs. The tactical control links that operate in this band to support PGMs provide a decisive combat edge to U.S. military forces. PGMs increase aircrew survivability by allowing the launch of weapons outside of enemy anti-air system threat envelope, thereby significantly decreasing aircrew vulnerability. PGMs require regular testing and training in the United States by operational units to maintain operational readiness and also for systems testing and evaluations of upgrades.

[38] *Id.* at E-16.

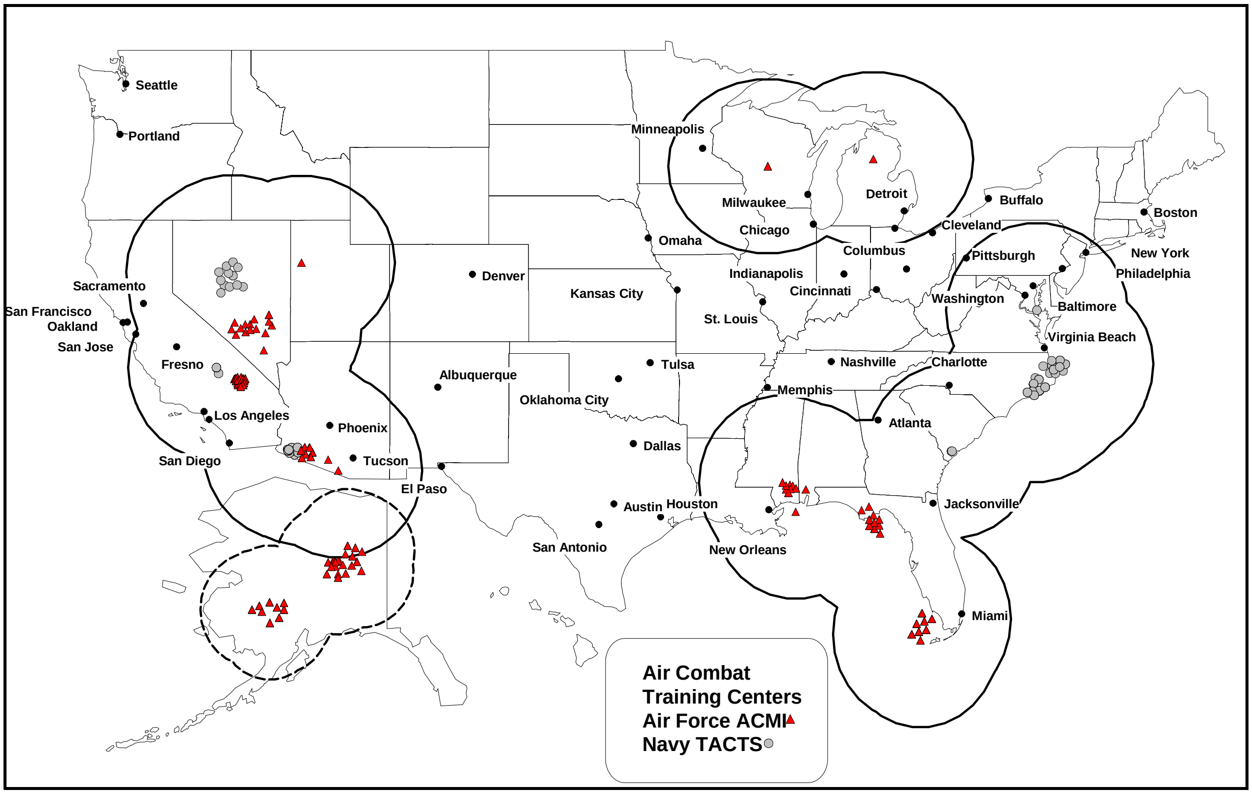

Figure 14. Protection Areas of 400 Kilometers Around ACTS Sites.
Note: This figure does not include potential rangeless ACTS operating areas. Higher operating altitudes will increase the diameter of the circles.

6. Other Systems

Other systems that operate in this band are critical to national defense and the missions of other Federal agencies. These systems include deployable range training systems, deployable emergency communications systems, combat identification systems, mobile tactical voice and data systems, high resolution video links, robotic control functions, and target scoring systems. There are over 200 individual systems that currently operate in the 1755-1850 MHz band. Systems not already addressed will need to be analyzed on a case-by-case basis as necessary to determine the potential for sharing or for relocation.

Band Sharing and Segmentation Options

This section examines three approaches to either sharing or segmentation of the 1710-1850 MHz band. The first sharing approach considers in-band pairing with IMT-2000 mobiles transmitting in the 1710-1755 MHz band, and base stations transmitting in the 1805-1850 MHz band. The second sharing approach considers mobiles transmitting in the 1755-1790 MHz band and the base stations transmitting in band(s) above 2110 MHz, such as 2110-2150 MHz and 2160-2165 MHz. The third approach involves segmenting the band, but with all Federal operations migrating from the 1710-1755 MHz band in the long-term, and pairing the 1710-1755 MHz band with the 2110-2150 MHz and 2160-2165 MHz bands.

Option 1: In-Band Pairing of the 1710-1850 MHz Band

1. *Discussion*

The 1710-1885 MHz band is available in Europe primarily for Global System for Mobile Communications (GSM) systems. GSM mobiles transmit in the 1710-1785 MHz band, and the base stations transmit in the 1805-1880 MHz band. This results in up to 2x75 MHz for GSM second generation usage. The 1850-1880 MHz portion might not be available in the United States since it is currently used for PCS. Dividing the 1710-1850 MHz band into segments of 1710-1755 MHz and 1805-1850 MHz would yield a maximum of 2x45 MHz (90 MHz) as a candidate for IMT-2000 deployment. ITU-R Working Party 8F has initially concluded that this could potentially facilitate the global harmonization of 2x45 MHz of spectrum, but also notes that this would perpetuate the existing incompatible use in part of this band (1850-1880 MHz) globally, and does not offer a full worldwide solution for IMT-2000.[39]

The NTIA Interim Report found that sharing Federal operations in these band segments with IMT-2000 systems would be possible only if restrictions in space and/or time prove feasible. The conditions for sharing would include (1) IMT-2000 operations not impacting Federal military operations, and that (2) most, if not all, of the Federal conventional fixed systems would be relocated to alternative bands under a reimbursement plan.[40] This sharing would protect both the remaining Federal operations and IMT-2000 operations. IMT-2000 sharing with the present nationwide set of Federal fixed systems was found not to be feasible. The satellite control function, and military radio relay would operate as normal, with the IMT-2000 systems sharing on the basis of geography and time. Any mitigation burden or operational restrictions would need to be borne by the IMT-2000 community. Alternately, either all Federal systems would need to be relocated, at a cost and time line shown in Section V, or IMT-2000 would not be deployed in this band.

Sharing in the 1710-1755 MHz Band Segment. The 1710-1755 MHz band was identified to be reallocated and transferred to the FCC under OBRA-93 as a mixed-use band.[41] Certain military facilities, safety-of-life, and power transmission fixed links were exempted from the reallocation. *Protection Areas* were established around the 16 military facilities as shown in the NTIA Final Reallocation Report. In this segmentation option (Option 1), IMT-2000 mobiles would transmit in this portion of the band. To allow IMT-2000 operation within the *protection areas*, IMT-2000 operators would coordinate their operation with the appropriate military officials.

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[39] Report of the San Diego Meeting of ITU-R 8F, August 2000, ITU-R 8F/63 at 55.

[40] *See* NTIA NPRM, *supra* note 17. This NPRM addresses reimbursement of costs incurred for relocating Federal radio systems as a result of the OBRA-93 and the BBA-97.

[41] "Mixed Use" is a term defined in the OBRA-93 for frequency bands reallocated from Federal to private use in accordance with this Act, which are partially retained for continued use by Federal stations.

Most Federal stations operating in the 1710-1755 MHz band may be entitled to compensation for relocation to another frequency band.[42] Although the currently-exempt fixed links are not required to relocate, and compensation is not mandated, they might be voluntarily moved at the expense of commercial IMT-2000 operators. This would clear the band of most Federal operations, with the exception of the 16 protected military operations areas, and various other Federal users.

Sharing in the 1805-1850 MHz Band Segment. The 1805-1850 MHz portion of the band is currently used as described earlier in this report. This part of the band includes one-half of the SGLS channels, i.e., channels 11 through 20. This band also includes multiple ACTS ground-to-ground frequencies and two ground-to-air frequencies. The MSE also operates in this band with assignments generally spaced 500 kHz apart.

There are 1,864 Federal frequency assignments in this portion of the band for stations in the fixed service. If this band were to be reallocated, these conventional fixed stations would be eligible for compensation for relocation by IMT-2000 operators. It is postulated that this band could be cleared of most conventional fixed systems by a reimbursement process.

There are also a variety of other Federal operations not detailed in this report. Many of these operations involve law enforcement, and operate nationwide. These systems would also need to be relocated from the 1710-1755 MHz and 1805-1850 MHz segments by a reimbursement process. The estimated costs to relocate these systems are shown in Section V.

2. *Option 1 Sharing Considerations*

In this Section we address the sharing issues associated with sharing the 1710-1850 MHz band with IMT-2000 systems. While total sharing is not feasible, some sharing may be possible under certain conditions. The first condition is that DOD operations within the 16 protected areas as shown in the NTIA Final Reallocation Report areas are not impacted. Second, that it would be possible to determine *protection areas* around other Federal operations, such as SGLS sites, such that IMT-2000 systems operate normally outside of these areas. These systems would need to accept interference from DOD emitters or dynamically reassign frequencies to avoid interference if operating within the protection areas. Third, it would be necessary to relocate most conventional Federal fixed service systems to alternate bands by a method of reimbursement. Fourth, the SGLS uplink command signals to Federal satellites must be protected. Finally, various other Federal operations would need to relocate to other bands or re-tune to the remaining 1755-1805 MHz segment. The size of the *protection areas* may vary from the values shown in this report, and would be determined by either a detailed analysis of each site, using terrain data, or by field measurements of signal strengths.

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[42] *See* NTIA NPRM, *supra* note 17.

1710-1755 MHz Segment

Tactical Radio Relay. The MSE and DWTS systems are used to support the warfighters' data communications capabilities at all echelons of tactical operations. Because MSE systems are transportable and used to support total Army missions, they can be in operation at any time. Unlike conventional fixed systems, the antennas associated with MSE systems are pointed in different directions when activated at new locations. Using the interference thresholds presented in Table C-7 from the DOD Final Report, IMT-2000 mobile stations could cause interference to MSE receivers at distances from 9 to 20 km for 3.75 MHz IMT-2000 systems, and from 11 km to 23 km for 1.25 MHz systems, depending on the position of the mobile station relative to the main beam of the MSE antenna.[43]

The MSE transmitters could cause interference to IMT-2000 base receivers at ranges from 60 to 75 km for 3.75 MHz systems, and from 62 to 82 km for 1.25 MHz systems, depending on the location of the base station antenna relative to the main beam of the MSE antenna, and interference thresholds for different IMT-2000 systems.[44]

Since the required separation distance, as a factor of the antenna coupling of the IMT-2000 station to the MSE antenna, is shown to be less outside of +/- 20 degrees of the MSE antenna boresight, and minimum outside of +/- 90 degrees, there is about a 50 percent probability of a IMT-2000 station being in a minimum interference zone for any given MSE station. Within this minimum interference zone, the protection distances would be from 9 km to11 km for co-channel mobile transmitters (3.75 MHz and 1.25 MHz systems respectively),[45] and from 60 km to 62 km for IMT-2000 base receivers (3.75 MHz and 1.25 MHz systems respectively).[46] The AN/GRC-245 and other similar radios performing radio relay functions have nominally the same protection distances.

Conventional Fixed. The Federal Government operates many fixed, point-to-point service links in the 1710-1755 MHz band. This band is identified for transfer to the FCC on a mixed-use basis. Fixed links in this band that are within the military *protection areas,* and those power transmission and public safety links shown in the NTIA Final Reallocation Report, will be protected. These *protection areas* vary in size from 50 to 160 km. ITU-R Recommendations have concluded that separation distances up to 120 km are necessary to prevent interference between mobile and fixed stations.[47] Due to the significant number of protected fixed systems, the establishment of *protection areas* surrounding each of these protected fixed service links is not considered practical. Federal stations, other than those in a protected status, may be entitled to reimbursement for relocation to alternate frequency bands. Figure 15 illustrates the 16 protected areas and the protected fixed links remaining in the 1710-1755 MHz band after other

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43 *See* DOD Final Report, at C-10 *supra* note 6.

44 *Id.* at C-11.

45 *Id.* at C-10.

46 *Id.* at C-11.

47 *See* ITU-R F.1334, *supra* note 31.

Federal stations have been relocated. However, those protected fixed stations (outside of the 16 protected areas) may be able to voluntarily accept reimbursement for relocation.

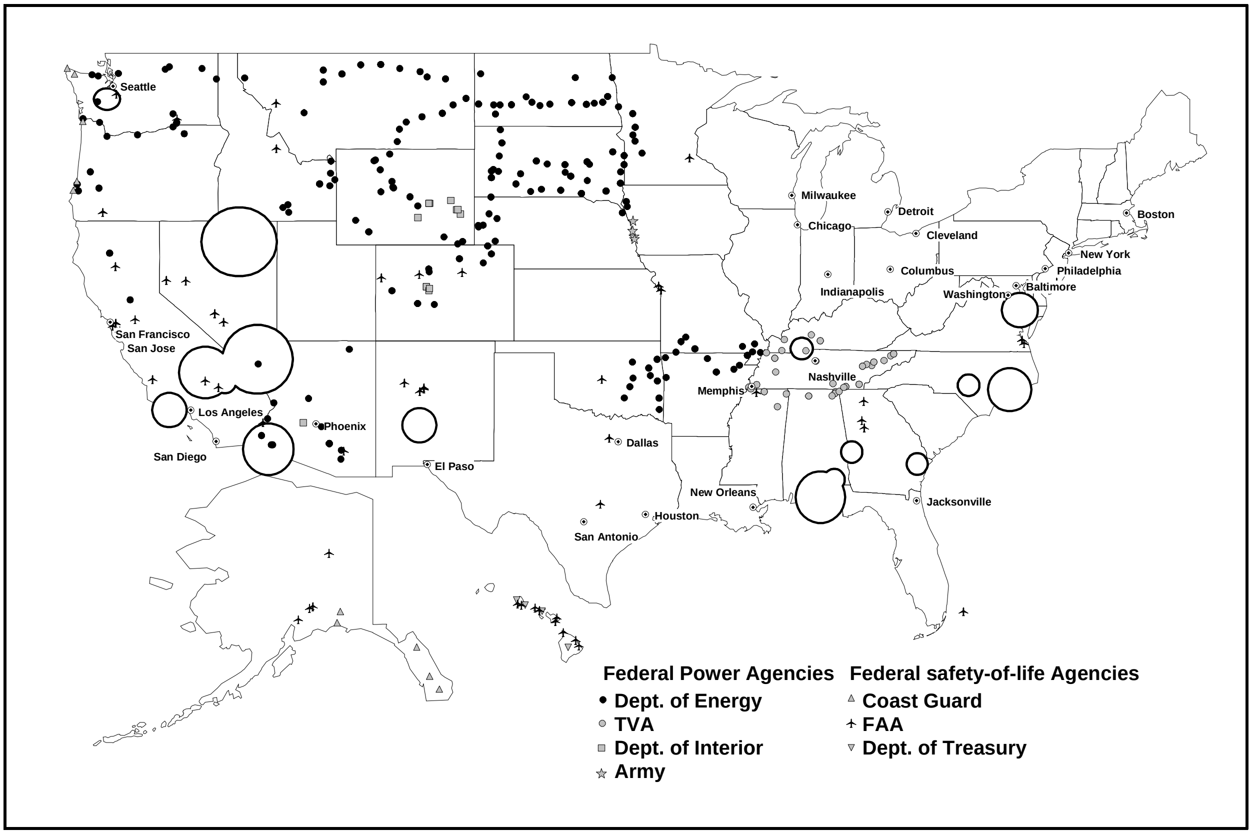

Figure 15. Protected areas and protected fixed links in 1710-1755 MHz per OBRA-93.

Sharing in the 1805-1850 MHz Segment

Government Satellites. Under this segmentation option, the IMT-2000 base stations would be transmitting (and mobile stations receiving) in the 1805-1850 MHz portion of the band. A large number of base stations transmitting simultaneously would cause interference to the satellite uplinks. The DOD Final Report shows that IMT-2000 base station transmitters would cause a degradation to the link margin of DOD satellites (at orbital altitude of 833 km) from 21 to 31 dB, depending on degree of IMT-2000 build-out.[48] Analyses conducted by members of the IAG arrive at different values of interference.[49] These differences are due to the methodologies employed in estimating the amplitude of interfering power emanating from terrestrial IMT-2000 base stations worldwide. The DOD study used as a basis an ITU-R approved approach for IMT-2000 interfering power density from areas visible from an orbiting

[48] *See* DOD Final Report, at B-43 and B-44 *supra* note 6.

[49] Cellular Telecommunications & Internet Association, Telecommunications Industry Association, and Personal Communications Industry Association, *Report of the Industry Association Group on Identification of Spectrum For 3G Services*, at Attachment II (Feb. 22, 2001).

satellite. Other approaches to establish this input parameter may be valid, but there is no general agreement at this time as to the total aggregated IMT-2000 emissions that may be seen at orbital altitudes.

If the interference to the satellite results in the link margin to be less than specified by the satellite user, operational integrity of the satellite-based mission would be impaired. The DOD Final Report finds that satellite operations could be impaired by the year 2003 due to IMT-2000 build-out in the 1805-1850 MHz band. Migration of the satellite receive operations to an alternate band, even if feasible, could not be completed by 2010, and some operations could last until 2030.

Satellite Control Stations. Data from Tables 4-1 and 4-2 show that when satellite control stations are transmitting, the IMT-2000 mobile receivers could receive interference at distances from 37 km to 62 km for 3.75 MHz mobile systems, and from 41 km to 88 km for 1.25 MHz mobile systems, depending on SGLS transmitter power and antenna elevation. Actual distances will be less than was calculated using a smooth-Earth model, because actual SGLS signals will be propagated over rough terrain. For comparison, several plots of interference contours surrounding SGLS sites, using actual terrain data, are included in the DOD Final Report.[50]

During SGLS operations, the satellite control stations must transmit during the times of satellite availability, and to service the satellite, the transmitting antenna cannot be operationally restricted in azimuth or elevation. Sharing with IMT-2000 receiving stations around a SGLS site may be possible by allowing sufficient geographical separation, or by a real-time IMT-2000 channel assignment method that avoids co-channel operations within a protection area during SGLS transmit times.

Tactical Radio Relay. The MSE and DWTS systems are used to support the warfighters' data communications capabilities at all echelons of tactical operations. Because MSE systems are transportable and used to support total Army missions, they can be in operation at any time. Unlike conventional fixed systems, the antennas associated with MSE are pointed in different directions when activated at new locations. Using the interference thresholds presented in Table C-7 from the DOD Final Report, IMT-2000 base stations could cause interference to MSE receivers at distances ranging from 61 km to 78 km for 3.75 MHz systems, and from 64 km to 87 km for 1.25 MHz systems, depending on the position of the mobile station relative to the main beam of the MSE antenna.[51] The MSE transmitters could cause interference to IMT-2000 mobile receivers at ranges from 18 km to 32 km for 3.75 MHz systems, and from 20 km to 34 km for 1.25 MHz systems, depending on the location of the mobile station relative to the main beam of the MSE antenna and the interference threshold used.[52]

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50 *See* DOD Final Report, *supra* note 6 at B-23 through B-32.

51 *Id.* at C-10.

52 *Id.* at C-11.

Since the required separation distance, as a factor of the antenna coupling of the IMT-2000 station to the MSE antenna, is indicated to be minimum outside of +/- 20 degrees of the MSE antenna boresight, and minimum outside of +/- 90 degrees, there is about a 50 percent probability of a IMT-2000 station being in a minimum interference zone for any given MSE station. Within this minimum interference zone, the protection distances would range from 61 km to 64 km for co-channel base transmitters (3.75 MHz systems and 1.25 MHz, respectively).[53] Protection distances would range from 18 km to 20 km for co-channel IMT-2000 mobile receivers (3.75 MHz systems and 1.25 MHz systems respectively).[54] The AN/GRC-245 and other similar radios performing radio relay functions have nominally the same protection distances.

Air Combat Training Systems. Generally, the analysis in the DOD Final Report shows that the airborne receiving component of the air combat systems would suffer degradation throughout much of the United States, with a 33 dB reduction in link margin in fairly large areas due to IMT-2000 base stations transmitting (the only ACTS aircraft links in this band segment are ground-to-air links).[55] Multiple ground-to-ground and two ground-to-air frequencies would be impacted. Data from the DOD Final Report indicates that the ACTS ground stations would require separation distances ranging from 70 km to 146 km from transmitting IMT-2000 base stations,[56] but the mobile stations could operate at distances of from 12 to 48 km (51 km for TDMA systems) from transmitting ACTS ground stations.[57]

The ground-based fixed links could be reaccommodated in alternate bands, or possibly retuned to the 1755-1805 MHz portion, but the current airborne systems could not realistically share without frequency separation. The air-to-ground and ground-to-air links could be retuned to the 1755-1805 MHz band, but not before 2006. Because of the interaction of electronic systems on modern aircraft, extensive co-site EMC analyses will be required to finalize any relocation option.

Unlike the ACMI/TACTS, the JTCTS will employ an air-to-air communication function as its primary link. The separation distances for the air-to-ground function of the JTCTS, which is similar to ACMI/TACTS, are nominally the same.[58] This function will be a secondary link for JTCTS. The ground-to-ground function of the JTCTS will be considered a tertiary data link and will not always be used. The DOD Final Report finds that the JTCTS may possibly be reconfigured to operate with the two primary channels in the 1755-1805 MHz band; however, further investigation is necessary to determine the extent of guard bands that would be required to prevent interference near the band edges. The tertiary link could be relocated in an alternate

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53 *Id.* at C-10.

54 *Id.* at C-11.

55 *Id.* at E-10.

56 *Id.* at E-13.

57 *Id.* at E-15.

58 *Id.* at E-13, E-19.

band. JTCTS could not replace the current TACTS/ACMI range systems until after the 2010 time frame.

Summary of the Sharing Potential for Option 1

It should be noted that in a general sharing scenario there will be a greater potential for interference to and from IMT-2000 systems when both IMT-2000 radio links (mobile and base) operate within the 1710-1850 MHz band, as opposed to only one link being in the band. Satellite uplink sharing with IMT-2000 base stations is problematic in the 1805-1850 MHz band, and IMT-2000 mobile receive stations must either stay outside of the protection areas or avoid co-channel operations during SGLS transmit times.

The DOD Final Report concludes that significant loss of spectrum in the 1755-1850 MHz band would cause an unacceptable loss in proficiency training in the deployment of the TRR systems. The MSE replacement system could not be deployed before Fiscal Year 2006. There is no planned replacement for the DWTS, and a new system could not be fielded before at least 2010. No comparable alternate spectrum was identified for the MSE and other TRR systems.

The ACTS could possibly be reaccommodated within the 1755-1805 MHz band, with some links relocated in alternate bands, but co-site EMC analyses are critical for any final resolution.

Based on the above, Option 1 appears not to be feasible.

Option 2: Dual-Band Pairing Using the 1710-1790 MHz Band

1. *Discussion*

A second option for accommodation of IMT-2000 (Option 2) considers IMT-2000 mobiles transmitting from 1710 MHz up to 1790 MHz in phases,[59] and base stations transmitting in frequency bands above 2110 MHz. This would, in the long-term, yield up to 2x80 MHz for IMT-2000 implementation. This pairing arrangement is included in the work being undertaken by ITU-R Working Party 8F, which had the preliminary comments: "[This pairing] could provide global arrangements in the longer term and hence economies of scale, but would require substantial re-planning of existing allocations, might not provide enough forward-link capacity, and accommodation of TDD requirements needs to be considered."[60] Some countries in the Americas have endorsed this approach in order to promote long-term harmonization.[61]

The analysis of the DOD Final Report shows that IMT-2000 mobile transmitters would cause from 4 to14 dB degradation to the link margin of DOD satellites (at 833 km altitude) as a

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59 *Id*. at 1-3

60 Report of the San Diego, CA meeting of ITU-R 8F, (Aug. 2000) ITU-R 8F/63 at 62 .

61 *See* October 2000 contribution to ITU-R WR8F, ITU-R Doc 8F/148, (Oct. 20, 2000).

function of IMT-2000 build-out. SGLS link margins remain positive, but it is not known if sufficient margins remain for mission success in all cases.

IMT-2000 base receiving stations could possibly share in the 1761-1790 MHz portion, using a combination of geographical and time separation. For example, the base stations might be able to detect SGLS transmissions and not assign mobile units to that particular frequency. Coordinating with Federal operations on a time-sharing basis would reduce the IMT-2000 system capacity within these protected areas during the times of Federal operation. In this case, the spectrum in the 1755-1790 MHz band would be available to make up for the shortfall in capacity in the protected areas. In geographical areas outside of the *protection areas* where this additional spectrum would not be required, other IMT-2000 systems, such as Time Division Duplex (TDD), could operate since paired frequencies are not needed for TDD operation. This sharing arrangement would consist of three phases, however, NTIA has not estimated the timing of Phases 2 or 3. The three phases are as follow:

Phase 1. In Phase 1, IMT-2000 mobiles would transmit in the 1710-1755 MHz band, under conditions similar to the 1710-1755 MHz part of the in-band sharing Option 1 described above, except that the mobile stations are now paired with base stations transmitting above 2110 MHz, e.g., 2110-2150 MHz and 2160-2165 MHz, as proposed in the FCC's 3G NPRM. *Protection Areas* are areas around military facilities as shown in the NTIA Final Reallocation Report.[62]

As noted in the discussion of Option 1, some Federal stations operating in the 1710-1755 MHz band may be entitled to compensation for relocation to another frequency band. Although the currently exempt fixed links are not required to relocate and are not entitled to compensation, they might be voluntarily moved at the expense of commercial IMT-2000 operators. This would clear the band of most Federal operations, with the exception of the 16 protected military operations areas and various other Federal users.

Phase 2. In Phase 2, the 1755-1780 MHz band would be added for sharing with mobiles, paired with base stations above 2110 MHz (e.g., in the 2500-2690 MHz band). However, the potential for interference to satellite control uplinks from mobile transmitters would exist, since this band segment contains SGLS channels 1-5. New *protection areas* could be established around satellite control stations. Federal conventional fixed stations are assumed to be relocated from the 1755-1780 MHz band by a reimbursement process.

The ACTS would not be able to share co-channel with IMT-2000 systems. Therefore, multiple frequencies would need to be relocated by a reimbursement process. Within the *protection areas* for satellite control sites, there may be technical solutions to sharing for some types of IMT-2000 systems.

Phase 3. In Phase 3, the1780-1790 MHz band could be added for mobiles to transmit, paired with base stations above 2110 MHz, e.g., in the 2500-2690 MHz band. Federal

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62 *See* NTIA Final Reallocation Report, at F-4 *supra* note 20.

conventional fixed stations could be relocated from the 1780-1790 MHz band by a process of reimbursement. Within the *protection areas,* coordination would be required.

2. ***Sharing Considerations for Out-of-Band Pairing***

1710-1755 MHz Segment

The sharing potential would be the same as discussed under sharing Option 1. It is assumed that in the long-term, most conventional fixed links outside on the *protection areas* will be relocated to alternate frequency bands by a reimbursement process. It should be noted that those protected fixed links are not required to relocate. Fixed links within the *protection areas* may remain indefinitely, or volunteer to be relocated by reimbursement.

1755-1790 MHz Segment

The 1755-1790 MHz segment has in it the kinds of Federal systems seen in both the 1710-1755 MHz and the 1805-1850 MHz segments.

Government Satellites. An analysis of the potential for IMT-2000 mobile (handheld) stations to interfere with the SGLS uplink is contained in the DOD Final Report. This analysis shows that IMT-2000 mobile transmitters would cause from 4 to 14 dB degradation to the link margin of DOD satellites as a function of IMT-2000 build-out. The 1780 MHz end point for Phase 2 was chosen to avoid IMT-2000 interference to the GPS uplink control channel (SGLS channel 6) at 1783.74 MHz (+/- 2.002 MHz). If further analysis shows possible adjacent band interference to GPS, then the Phase 2 additional band would be reduced and Phase 3 not implemented.

Satellite Control Stations**.** The IMT-2000 mobile stations would be transmitting (and base stations receiving) in the1755-1790 MHz portion of the band. This portion of the band contains SGLS channels 1-8, including the GPS uplink channel. The data from Tables 4-1 and 4-2 show that the radius of the *protection areas* surrounding satellite control sites would vary from 134 km to 307 km for 3.75 MHz systems, and 164 km to 355 km for 1.25 MHz systems, based on a smooth-Earth propagation model, depending on the uplink transmitting power and the antenna elevation angle. Actual distances will be less, due to propagation over rough terrain. For comparison, several plots of interference contours surrounding SGLS sites, using actual terrain data, are included in the DOD Final Report.

Tactical Radio Relay**.** The assessment for TRR in the 1755-1790 MHz segment is the same as for the 1710-1755 MHz segment.

Air Combat Training Systems. Generally, the DOD Final Report shows that the ACTS downlink at 1778 MHz and the ACTS master ground station transmitting at 1768 MHz would cause interference to IMT-2000 receiving base stations at distances ranging from 48 km to 405 km[63] and from 49 km to158 km (180 km for TDMA systems) from the ground stations,[64]

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63 *See* DOD Final Report, *supra* note 6 at E-16.

64 *Id.* at E-15.

respectively. The ground-based links could be reaccommodated in the 1790-1850 MHz portion, or relocated to an alternate band. The airborne links could be retuned to the remaining 1755-1850 MHz portion of the band.

Unlike the ACMI/TACTS, the JTCTS will employ an air-to-air communication function as its primary link. The EMC between IMT-2000 systems and this JTCTS air-to-air link needs to be investigated to determine the feasibility of sharing.[65] The separation distances for the air-to-ground function of the JTCTS, which is similar to ACMI/TACTS, are nominally the same.[66] This function will be a secondary link for JTCTS. The ground-to-ground function of the JTCTS will be considered a tertiary data link and will not always be used. The DOD analysis concludes that the JTCTS could be reconfigured to operate in the 1790-1850 MHz band by 2010; however, further investigation into relationships with IMT-2000 near band edges would be needed before a final decision could be made. Additionally, the compatibility of JTCTS operations at adjacent ranges under this scenario has not been studied. Such a replacement for the existing ACTS ranges could not be completed until much after 2010.

2110-2150 MHz Band

The band segment 2110-2120 MHz is also allocated via footnote US252[67] to the National Table of Frequency Allocations, for the Space Research service on a primary basis and is used by NASA's Deep Space Network (DSN) facility at Goldstone, California, for uplink transmissions to interplanetary spacecraft. Internationally, the band is allocated in all three ITU Regions to the Fixed, Mobile and Space Research (deep space) (Earth-to-space) services and is used by NASA at DSN facilities in Spain and Australia. In order to ensure link integrity over interplanetary distances, the DSN earth station employs a transmit power of 400 kilowatts. During command link operations it is likely that service disruption would be experienced by IMT-2000 mobile receivers when attempting to operate within the areas surrounding Goldstone. As a result, these areas would not be available for continuous IMT-2000 reception. See Appendix A for a NASA analysis regarding the calculation of a protection contour surrounding the Goldstone facility.

Summary of Sharing Potential for Option 2

Satellite uplink sharing with IMT-2000 mobile stations is less severe than sharing with base stations, but IMT-2000 base receive stations must either stay outside of the protection areas or avoid co-channel operations during SGLS transmit times.

The DOD Final Report concludes that loss of significant spectrum in the 1755-1850 MHz band would cause an unacceptable loss in proficiency training in the deployment of the TRR systems. The DOD states that the MSE system could not be fully replaced before 2010. There is no planned replacement for the DWTS, and a new system could not be fielded until after Fiscal

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65 *Id.* at E-23.

66 *Id.* at E-13, E-19.

67 Operations supporting deep space activities have been effected under a primary allocation initiated pursuant to FCC Report & Order (Docket No. 14712) released December 10, 1962.

Year 2007. IMT-2000 operators would need to coordinate with Federal users in the protected areas.

The ACTS could possibly be reaccommodated within the 1790-1850 MHz band but not before 2006.

IMT-2000 receivers could experience interference within 200 km of the NASA Goldstone facility.

Option 3: Migration From the 1710-1755 MHz Band.

1. *Discussion*

Previous options considered by NTIA and the DOD have included sharing, or vacating the 1755-1850 MHz band. The first option has merit in that a sharing approach is offered, contingent on DOD operations not being impacted. However, during the time since the release of the NTIA Interim Report, no workable co-channel sharing technique has been shown to be feasible. Although efforts on this front are continuing, the lack of an immediate solution to the several sharing problems leads to a possible third option, in which segmentation in the long-term, rather than sharing, is the main feature. This option is addressed here in addition to the other options that were predicated on a degree of long-term sharing between IMT-2000 systems and DOD systems. This option has not been evaluated by the DOD, and is not included in the DOD Final Report. Therefore, operational impacts to DOD operations are not known.

Technical analyses have shown that sharing requires frequency, distance, or time separation to be effective. The DOD Final Report documents the conditions required for sharing between many DOD and various possible IMT-2000 systems. The total scenario is complicated by the large number of systems affected, the required separation distances, and the absence of certain knowledge of what commercial mobile systems may be actually established in the 1710-1850 MHz band, what future commercial technology may be implemented in the years to come, and the future operational requirements of DOD. At best, sharing would be difficult, expensive, and would require extensive frequency use coordination. At worst, sharing would be unsuccessful, resulting in operational impacts to both DOD and commercial operations.

In Option 3, it is postulated that all Federal systems would be relocated from the 1710-1755 MHz band, except in new protected areas, selected to ensure adequate operational areas to support large-scale training operations. This band would be paired with the 2110-2150 MHz and the 2160-2165 MHz bands, as proposed by the FCC in the 3G NPRM. The DOD Final Report indicates that the TRR systems would be unacceptably impacted by a loss of significant spectrum in the 1710-1850 MHz band.[68] The requirement for the current spectrum stems from the high usage of TRR systems during large-scale exercises. These exercises are generally held in selected areas, and are somewhat remote from urban centers. During initial phases of IMT-2000 build-out, these areas would not have a significant IMT-2000 population. Therefore, if the TRR systems in the current 16 protected areas (OBRA-93 areas) would cease operation in the 1710-

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[68] *See* DOD Final Report, *supra* note 6 at B-9 and B-12.

1755 MHz band, and satisfy their requirements in the remaining 1755-1850 MHz band *where possible*, and new protected areas would be established that encompass only the military training areas needed for large-scale exercises,[69] the 1710-1755 MHz band could continue to be used within these new (*3G*) protection areas until replacement systems for the current MSE and DWTS have been deployed. In areas where sharing with space systems is feasible, the 1700-1710 MHz band may also considered for use as necessary by TRR systems.

With the procurement of the HCLOS TRR system (AN/GRC-245), TRR operations using HCLOS systems would use 45 MHz of alternate spectrum within the HCLOS tuning range in the new protected areas to compensate for the loss of the 1710-1755 MHz band. As the new HCLOS radios are phased in, the use of the 1710-1755 MHz band would be phased out in the *3G protected areas*, allowing full IMT-2000 build-out nationwide. Spectrum may also be made available for TRR use, as necessary, in the 2200-2290 MHz band in locations where sharing with the space downlinks is shown to be feasible.

Under this option, MSE systems would not need replacing in the near-term, other than as currently programmed, nor suffer restrictions when operating. The DWTS, however, will need a program to replace the current system with equipment possessing a tuning range similar to the HCLOS. ACTS systems and the SGLS stations would be unaffected. Also, IMT-2000 operations would be unrestricted in the 1710-1755 MHz band nationwide, other than within, in the near-term, the new *3G protection areas*. Federal conventional fixed systems in the 1710-1755 MHz band would be relocated in accordance with the reimbursement rules established by NTIA. DOD systems in the 16 OBRA-93 protected areas, including the DWTS, would be reimbursed to relocate. Certain other DOD systems, such as PGMs, will require engineering study to determine the feasibility of relocating to the remaining 1755-1850 MHz band, or other bands as appropriate.

2. *Potential Sharing Conflicts*

2110-2150 MHz Band

Sharing in the 2110-2120 MHz band will be similar to the discussion under Option 2. During command link operations at Goldstone, California, it is likely that service disruption would be experienced by IMT-2000 mobile receivers when attempting to operate in the 2110-2120 MHz band within the areas surrounding Goldstone. As a result, these areas would not be available for continuous IMT-2000 reception. See Appendix A for a NASA analysis regarding the calculation of a protection contour surrounding the Goldstone facility.

New 3G Protection Areas

The DOD Final Report addresses the requirements for Army and Navy/Marines to conduct large-scale exercises using TRR systems. Several locations are mentioned where these exercises occur. As a preliminary proposal for comment, it is suggested that from the list of areas mentioned, the training areas of 1) Camp Pendelton, California; 2) Ft. Irwin, California;

[69] These areas would be the same as certain of the OBRA-93 areas.

3) Ft. Bragg, North Carolina; and 4) Camp LeJeune, North Carolina be considered as candidates for the new *3G Protection Areas*. This would provide an Army and Navy/Marine training area on each coast of the United States for large-scale exercises. *Neither the reduction in protection areas nor the proposed new locations have been examined by the DOD to determine whether national security training and exercise requirements could be supported under this option.*

Alternate Frequency Bands for Federal Systems

1. Discussion

The concept of sharing has been a primary consideration for the accommodation of IMT-2000 systems thus far in this report. However, NTIA has not received any comments from industry that support our proposal for a technological solution to co-channel sharing with Federal systems. Absent a viable sharing scenario, either IMT-2000 operators would not be accommodated, or accommodated on a secondary basis, or Federal systems would migrate to alternate bands at the expense of the incoming commercial operators. Since the objective of this study is to consider the accommodation of IMT-2000, the possible relocation of Federal systems must be included as alternatives to sharing.

Federal systems operating in the 1710-1850 MHz band would require a band that is equivalent from a technical and regulatory perspective. This is termed a *comparable band* for the purposes of this report. The DOD Final Report examined several frequency bands as alternatives to the 1755-1850 MHz band. These bands are studied in the DOD Final Report's appendices associated with the subject radio system. The reader is referred to the DOD Final Report for details of the examination of alternate bands. For a complete discussion, see the appendices of the DOD Final Report where alternate bands are discussed in detail for each system. A brief summary of these examinations follows.

2. Alternate Bands for DOD Systems

Satellite Control Stations

The DOD satellite control stations have no existing *comparable band* in which to move. The band most suitable for this purpose is the 2025-2110 MHz band. This band currently accommodates the unified S-band systems that are used by NASA to control NASA satellites, and for control and communications with the space platforms associated with the manned space flight program. Technically, this band is suitable for satellite control uplinks. From a regulatory perspective, there are two major drawbacks. First, although the Federal Government has a co-primary allocation in this band, under US Footnote 342, however, Federal earth stations cannot impede the deployment of a variety of civil stations operating in the Auxiliary Broadcast Service. NASA is currently able to coordinate its limited geographically defined use with the electronic news gathering (ENG) operators. However, considering the number of SGLS sites, and the amount of use, coordinating with ENG users becomes problematic, and ultimately, unacceptable. If SGLS were to move to this band, the band would need to be reallocated to ensure Federal space operations were fully protected.

There are several issues that must be addressed and resolved that relate to migration of SGLS to the 2025-2110 MHz band.

It is important that mission capability provided to end users by U.S. space systems will not be degraded. Therefore, the Federal Government will need to maintain assured access to the 1761-1842 MHz band to satisfy mission objectives until the last satellite is no longer functioning. Federal satellites currently in orbit or awaiting launch must be supported to the end-of-life in the 1761-1842 MHz band, which could continue until 2030. It is expected that current regulatory provisions will remain in effect in the 1761-1842 MHz band through any period of SGLS migration.

Domestic regulatory provisions will need to be addressed so that the Federal Government has assured access to the 2025-2110 MHz band for Launch, Early Orbit Operations, and Anomaly Resolution and other space operations currently being performed in the 1761-1842 MHz band, with Federal Government allocation status that is equivalent to that currently provided in the 1761-1842 MHz band. Results of the WARC-92 have shown that sharing between high density and conventional land mobile systems on the one hand, and space services on the other hand is not feasible.

The DOD must determine if it is technically and operationally feasible to conduct satellite TT&C in the 2025-2110 MHz band. Further, the United States will need to determine if there is a reasonable prospect for international coordination of DOD satellite networks in the 2025-2110 MHz band.

Currently, the 2025-2110 MHz band is extensively used by major Federal Government users (i.e., NASA and NOAA) for satellite uplinks. The 2025-2110 MHz band is also widely used by other administrations for space operations. There is an extensive use of this band for TT&C of manned and unmanned Earth-orbiting satellites and space vehicles either through Earth-to-space links for satellites in all types of orbits or through space-to-space links using geostationary data relay satellites. All satellites are required to be coordinated internationally, which takes a significant time to accomplish. Current DOD satellites have been coordinated in the 1761-1842 MHz band with little problems, since few other administrations use this band for satellite control. The consummation of international coordination for constellations of U.S. Federal satellites for TT&C in the band would be a challenging task.

Also, an option mentioned in the DOD Final Report[70] considers operating some uplinks in the frequency bands used in the satellite's mission. This option, however, is not available to satellites without a separate communication function (e.g., GPS). SGLS operations for satellites with a communications function would then be limited to launch, early orbit, and anomaly resolution support operations. It remains to be seen if coordination of these uses internationally would be considerably easier.

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70 *See* DOD Final Report, at B-11 *supra* note 6.

Tactical Radio Relay

The MSE and the DWTS systems are transportable, fixed systems. Although other bands could accommodate a conventional fixed service, the transportability and rapid set-up requirements of the MSE/DWTS operations would cause the use of bands above 3 GHz be unsuitable for this type of operation. The DOD Final Report addressed several frequency bands for possible use by the TRR systems.[71] The 2025-2110 MHz, 2200-2290 MHz, 2500-2690 MHz, and 4400-4940 MHz bands were examined for comparability. The DOD Final Report concluded that no comparable bands were found.

Air Combat Training Systems

The DOD Final Report indicates that the ACTS could possibly be reaccommodated, either within the remaining portion(s) of the band, or by relocation of certain links in alternate bands. EMC studies of the implications to aircraft co-site systems will be required prior to any final decision.

Conventional Fixed Systems

The DOD Final Report addressed alternate bands for the conventional fixed microwave operations. Based on engineering judgment, the DOD Final Report concluded that 84 percent of the ACE fixed links have path lengths that would allow them to be replaced with equipment operating in either the 4400-4940 MHz or 7125-8500 MHz bands as single hop links. The remainder of the ACE links could be replaced with two-hop systems operating in one of the above alternate bands. Other DOD conventional fixed systems may also be able to operate in the above alternate bands, but further analysis would be required.[72]

Other Systems

Other systems that were addressed in the DOD Final Report are the Land Warrior Wireless Local Area Network, the Combat Identification for the Dismounted Soldier, the Pointer (FQM-151A) and the Exdrone (BQM-147A) unmanned aerial vehicles (UAV), the TCM-601 TOSS ordinance scoring system, and telemetry operations at the Aberdeen Test Center, located at Aberdeen, Maryland. These systems are considered in Appendix E of the DOD Final Report. Of these systems, only the UAVs were able to be placed in alternate frequency bands (1350-1390 MHz and 2200-2290 MHz). The DOD also studied several PGMs operating in the band. The results are contained in a classified annex to the DOD Final Report. It should be noted that not all DOD systems were addressed, since there are more than 200 different DOD systems currently authorized to operate in the 1710-1850 MHz band. All these systems will need to be addressed.

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[71] *Id.* at C-36 through C-45.

[72] *Id.* at E-9

Considerations for Reallocation

The DOD has stated that the DOD cannot accept any degradation to mission capability resulting from a spectrum reallocation action. The DOD says that loss of access to spectrum, above and beyond that already relinquished as a result of the OBRA-93 and the BBA-97, would jeopardize the DOD's ability to execute its mission.

In implementing any of the options involving band segmentation, many Federal systems in the 1755-1850 MHz band may need to be either relocated to different frequency bands or modified to operate in the remaining portions of the band. Major performance, compatibility, funding, and regulatory issues would have to be thoroughly addressed before any relocation could begin. A major uncertainty with the concept of large-scale relocation is that critical issues regarding the costs, risks, and engineering efforts to assure the incumbent systems in the alternate bands are protected are not addressed. In the aggregate, this would be a complex, costly, and lengthy process. The major risk in relocating major national defense systems is the uncertainty of future successful mission accomplishment.

Specifically, there are several issues that must be resolved before any spectrum can be made available in the1755-1850 MHz for reallocation, including continuity of essential government operations, interference, and regulatory protection of Federal Government systems during any migration period, assurance of comparable spectrum available to which Federal Government systems can relocate, and timely resolution of any regulatory actions necessary to make such spectrum available.

If a decision is made to vacate all or a part of the 1755-1850 MHz band, it is expected that the Federal Government will retain protected access for those systems that have not yet migrated. New users in the band would be allowed to operate to the extent that their operations do not interfere with remaining Federal systems.

The DOD states that the wide variety of systems operating in the 1755-1850 MHz band are unique to this band and crucial to the defense of the United States and its allies. The DOD further states that the United States and its national defense forces would be at a substantial strategic and tactical disadvantage in combat and the outcome of battles and peacekeeping operations could be jeopardized if the DOD were to lose its use of the band without provision of comparable spectrum and satisfaction of other conditions as presented in Section 2, *Essential Conditions*, of the DOD Final Report (Appendix D to this report).

The DOD also examined whether the DOD can fully vacate the 1755-1850 MHz band to accommodate IMT-2000. The DOD states that the most optimistic estimates, based on funding being available in FY02 to accomplish programmatic actions, indicate the *DOD would be unable to totally vacate this band until well beyond the time lines established for this study (i.e., by 2003, 2006, or 2010). Estimates indicate that, regardless of funding, vacating the band could not be accomplished for most non-space systems until 2010 and beyond; and legacy space systems would require continued protected access to this spectrum until 2017 and beyond.* These dates are also predicated on funding availability in FY02. The preliminary estimated cost to transition DOD systems out of the band in accordance with these time lines is estimated to be

$4,354 million in Then Year dollars (TY$) or $3,951 million in FY02 dollars. Migration prior to these dates would require premature system termination, which would have extremely serious implications to the DOD's ability to effectively execute its mission. Relocation from the band would require comparable spectrum that is operationally suitable. The DOD Final Report, however, indicates operationally suitable comparable spectrum may not be readily available.

Other Issues

International Concerns

Other countries are expected to implement advanced wireless mobile systems in the 1755-1850 MHz band. A particular concern in this case is the potential impact to United States space borne and airborne receivers since these receivers will be subject to the emissions of wireless systems operating in other countries.

National Defense Authorization Act of Fiscal Year 2000[73]

Sharing scenarios have been postulated in this report as a means of accommodating IMT-2000 systems. However, if sharing is determined not to be feasible, then either Federal systems in the band segments required for IMT-2000 operation would be relocated, and the band reallocated, or IMT-2000 services will not be implemented in the band.

Further, with respect specifically to surrender of spectrum in which the DOD is a primary user, the NDAA for Fiscal Year 2000 also requires that:

> "(A) the National Telecommunications and Information Administration, in consultation with the Federal Communications Commission, identifies and makes available to the Department for its primary use, if necessary, an alternative band or bands of frequencies as a replacement for the band to be so surrendered; and
>
> (B) the Secretary of Commerce, the Secretary of Defense, and the Chairman of the Joint Chiefs of Staff jointly certify to the Committee on Armed Services and the Committee on Commerce, Science, and Transportation of the Senate, and the Committee on Armed Services and the Committee on Commerce of the House of Representatives, that such alternative band or bands provides comparable technical characteristics to restore essential military capability that will be lost as a result of the band of frequencies to be so surrendered."

The DOD would be regarded as a primary user in the 1710-1755 MHz band in the 16 protected areas shown in Figure 12, and in the 1755-1850 MHz band, thus requiring the approval actions noted above.

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[73] *See* National Defense Authorization Act 1999, Pub. L. No. 106-65, 113 Stat. 512 (Oct. 5, 1999).

V. Estimates of Costs for Relocation of Federal Systems

Discussion

This section provides an examination of the estimated costs associated with the potential relocation to alternate frequency bands of current Federal operations within portions of the 1710-1850 MHz band. Descriptions of the systems operating in the 1755-1850 MHz band are provided in Section III. Included in this examination is a discussion of the estimated costs associated with each of the various segmentation options that would allow portions of the 1710-1755 and 1755-1850 MHz bands to be used for 3G accommodation, as discussed in Section IV. This section does not address the feasibility of whether any displaced systems can be adequately accommodated in alternate frequency bands. Further, because of certain factors (e.g., alternate frequency bands) for which there may currently be some uncertainty, the estimated costs as shown in this report are not necessarily identical to those costs that NTIA, under its reimbursement rules, will be required to transmit to the FCC prior to auctions.

In September 2000, the Administrator of NTIA sent letters to 11 Federal agencies[74] that had significant usage of the 1755-1850 MHz band requesting the costs and operational impacts resulting from a potential migration from the current operations in the 1755-1850 MHz band to alternate bands. As a follow-up to this request, Federal agencies were contacted to provide additional information regarding the cost estimates associated with the various segmentation options as discussed in Section IV. Appendix B contains the submissions received from the various Federal agencies. The cost estimates for relocating DOD operations are contained in Appendix D. All submissions received were submitted to the Office of Management and Budget for review.

The GMF is the Federal Government's master list of authorized frequency assignments. As noted earlier, an assignment in the GMF does not necessarily represent the number of transmitters associated with each assignment. There may be numerous transmitters and receivers operating under a single frequency assignment. In addition, the GMF does not contain all of the classified Federal frequency assignments. The majority of assignments are in the fixed service, followed by mobile, space, land mobile, and aeronautical-mobile services. From a spectrum management perspective, each class of radio station[75] presents a different degree of difficulty when being considered for relocation, and thus each station class must be considered on a case-by-case basis. Table 3-2 provides the GMF assignment count by station class per agency and radio service in the 1755-1850 MHz band as of January 2001. In general, agency submissions reflected the number of their assignments for November 2000, although some agencies have provided updates.

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74 The agencies are: DOD, USDA, DOE, DOJ, FAA, DOI, NASA, USCG, FEMA, NOAA, and the Department of the Treasury.

75 Each assigned radio station is classified by the service in which it operates permanently or temporarily (e.g., fixed, mobile). For Federal stations, various classes of stations are defined in Chapter 6 of the NTIA Manual. A list of station classes is given at the end of Appendix C.

Conventional fixed service assignments for stations that operate in the 1755-1850 MHz band are on discrete frequencies and operate at defined fixed locations. It should be noted that frequencies for fixed microwave assignments operating in the 1755-1850 MHz band are typically paired with frequencies in another portion of the 1755-1850 MHz portion of the band or in the 1710-1755 MHz band. A fixed microwave station operating on frequency 1761 MHz, for example, might be paired with another fixed link assignment operating on a frequency such as 1712 MHz or 1812 MHz. Typically, a frequency separation range of 50 to 80 MHz is required between fixed assignment pairs to ensure proper operation. Further, transportable fixed systems, such as TRR systems, have the capability to tune throughout the 1350-1850 MHz band and are used in several portions of their tuning range other than the 1710-1850 MHz band. However, the uncompensated loss of any significant spectrum that is within the tuning range would result in the system's inability to successfully accomplish its mission, and, therefore, would require a replacement of the entire system.

Other systems, such as mobile systems operating in the 1755-1850 MHz band may operate on authorized frequencies at various locations, or while in motion in defined areas. However, some mobile systems, (e.g., audio/video surveillance), may be authorized to operate anywhere in the US&P.

Federal space systems are one of the most difficult operations to consider for relocating to other frequency bands. Federal agencies using space radiocommunications have unique mission requirements, ranging from weather forecasting to nuclear detonation detection. Further, satellites are often limited to single- or dual-frequency use and cannot be retuned to other frequencies while in orbit. As explained previously, there are few frequency bands that can accommodate Federal satellite operations.

Another factor to consider regarding relocation is the time it would take to relocate existing operations to another frequency band. The time to relocate would vary depending on the type of equipment, mission, and location of the operation. For conventional non-military fixed systems, COTS-type of equipment may be readily available. As a result, these types of systems could be redeployed within a few years. These types of systems could be established in alternate bands relatively quickly once relocation funds were made available. For military systems, extensive lead times may be required to relocate to alternative frequency bands since these types of systems are typically complex and may require extensive re-engineering and development efforts. Complex military systems typically take in excess of 10 years to be fully deployed once funding is made available.

The 1710-1755 MHz segment of the 1710-1850 MHz band is currently allocated to the Federal Government exclusively for fixed and mobile services on a primary basis, but was identified by NTIA for transfer to the FCC under OBRA-93 as a mixed-use band. Because of the extensive Federal use of this band, the reallocation of this band segment from the Federal Government to the private sector will impact, in varying degrees, most major Federal Government agencies.

It is assumed that all Federal agencies would be fully reimbursed for all marginal costs associated with relocation from the 1755-1850 MHz band, or that facilities will be replaced by comparable facilities by incoming commercial operators. Factors influencing marginal relocation costs are: 1) whether the system can be retuned to another part of the band or must be replaced by a system that operates in another band, 2) if moved to another band, what new equipment must be purchased, 3) if moved to another band, must additional stations be established to maintain the connectivity, 4) will any research and development costs be required, and 5) other miscellaneous marginal costs. All these factors are not known at present, and some cost estimates are averaged over several frequency assignments, so the estimates for relocation costs may not reflect the actual per-assignment costs. Some of these unknown cost factors are discussed below.

Cost Estimates by Frequency Band

The information contained in the agencies' submissions (Appendix B) and the DOD Final Report (Appendix D) was used to estimate the costs associated with relocating from the 1755-1850 MHz band or with implementing the various segmentation/sharing options. Federal civil agencies and DOD used somewhat different conventions to report costs. Consistent with DOD's budgeting conventions, DOD estimated its costs in "Then Year Dollars" (TY$), which reflect expected inflation through the year funds are obligated. These years vary depending on the system. Federal civil agencies submitted estimates in current year dollars, assumed to be FY02. In order to estimate total relocation costs for a given option, DOD and Federal civil agencies' estimates have been made consistent. Since DOD cost estimates for each system as well as the total cost for each option are given in TY$s, a deflationary factor supplied by the DOD was used to determine an equivalent FY02 dollar amount. This deflationary factor of 1.102[76] was used to covert the DOD total cost for a given option in TY$s to FY02 dollars. For example, if the combined DOD cost estimate for an particular option was $4,354 million (TY$), this would be equivalent to $3,951 million in terms of FY02 dollars. DOD cost estimates are shown in both TY$ and FY02 dollars. All cost estimates for the 1710-1755 MHz band in Table 5-1 are presented in FY02 dollars.

1710-1755 MHz Band Costs

Title X of the NDAA for Fiscal Year 2000 (Defense Act) required the Secretary of Commerce, in coordination with the Chairman of the Federal Communications Communication, to convene an interagency review and assessment of, among other things, impact of the reallocation of Federal Government spectrum to non-Federal use, in accordance with the amendments made by Title VI of OBRA-93 and Title III of BBA-97 and the implications for each such reallocation to the affected Federal executive agencies.

In January 2001, the Secretary of Commerce submitted to the President and the Congress the impact assessment study of the reallocated spectrum called for by the Defense Act. This study included the estimated reallocation costs of the 1710-1755 MHz band.[77] In the OBRA-93

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[76] It is important to note that the precise deflationary factor for different DOD systems may vary because of different timing assumptions for each system.

[77] NTIA, U.S. Department of Commerce, NTIA Special Publication 01-44, Assessment of Electromagnetic Spectrum Reallocation (Jan. 2001).

Report, it was noted that some Federal civil agencies' fixed microwave links in the 1710-1755 MHz band may be paired with links in the 1755-1850 MHz band. The reimbursement strategy contained in that report is that if any part of a fixed service link is impacted and cannot be tuned and accommodated in another part of the same band, the entire link must be replaced. For the purposes of cost estimating, it is assumed that the links will be replaced rather than retuned. Because of that, in some instances the relocation cost estimates for a band may include costs for systems that operate partially in bands other than that for which the cost is estimated. A summary of the relocation costs per agency for the 1710-1755 MHz band is shown in Table 5-1. Note that $413 million was used throughout this report for this band.

Table 5-1
Total Estimated (OBRA-93) Relocation Costs For The 1710-1755 MHz Band

Federal Agency	Number of Frequency Assignments[78]	Estimated Relocation Costs (Millions)
Department of Agriculture	471	$48
Department of Defense	880	$38-$138[a]
Department of Energy	294	$3[b]
Department of the Interior	84	$8-$13
Department of Justice	204	$55[c]
National Aeronautics and Space Administration	5	$1
Department of Transportation	153	$109[d]
Department of the Treasury	22	$4-$46[e]
Total	2,113	$266-$413[f]

Notes:

a A revised and combined reallocation costs for the DOD (i.e., Army, Navy, and Air Force) is provided in the DOD Letter Report to the Chairman of the Committee on Armed Services of the United States Senate (The Hon. Strom Thurmond), Dec. 16, 1998. However, due to some reclaimed spectrum (i.e., 4635-4685 MHz band), the ***total*** OBRA-93 reallocation costs for DOD is adjusted to $226-$346 million (non-reimbursable) and $38-$138 million (reimbursable). Lower cost ($38M) applies if the mission can be accomplished with reduced spectrum capability. The higher cost ($138M) applies if mission function has to relocate to alternative spectrum.

b This cost does not include the protected fixed Federal Power Agencies' (FPA) service links.

c This is an updated cost recently provided by DOJ. It includes INS links in the 1710-1850 MHz band.

d This cost could significantly increase if unacceptable interference to or from non-Federal systems necessitates major hardware changes to Federal systems.

e This is an updated cost recently provided by the Treasury. It is unknown whether the Rainbow Microwave System in Hawaii, which is currently on the protected list, will be eligible for reimbursement. The higher cost is based on replacement of this system.

f This total is assumed to be in FY02 dollars.

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78 These assignments were current as of February 1999. The NTIA NPRM on mandatory reimbursement proposes that only "old assignments" within the affected bands, including the 1710-1755 MHz band would be eligible for reimbursement. In the NPRM, an old assignment is characterized as one that was authorized or submitted for authorization on or before October 17, 1998, because NTIA conducts EMC analysis on such request for frequency authorization and the process to authorize a request could take up to three months. The number of assignments that are entitled to reimbursement may currently be smaller than these numbers.

1755-1850 MHz Band Costs

Based on the submissions provided by both the Federal civil agencies (Appendix B) and the DOD Final Report (Appendix D), cost estimates for relocating their entire operations out of the 1755-1850 MHz band are summarized in Tables 5-2 and 5-3, respectively. Table 5-2 indicates that an estimated cost of $688.8 million (FY02) would be required to vacate the 1755-1850 MHz band for Federal civil agencies. The majority of the costs for the Federal civil agencies are for conventional fixed microwave links systems.[79] Table 5-3 indicates that an estimate of $4,354 (TY$)/$3,951 (FY02)[80] million would be required for the DOD to vacate the 1755-1850 MHz band. Combining Tables 5-2 and 5-3 would result in an estimated cost of $4,640 million (FY02) to vacate the 1755-1850 MHz band.

The DOD Final Report indicated that its cost estimates should be used only as guidelines in determining the final relocation expenses. Estimated costs are based on very specific assumptions and schedules. DOD states that to transition completely out of the band is not possible for all non-space systems until the year 2010 or later, and for space systems, it is not possible until the year 2017 or even to the year 2030 for some satellites. These time frames for relocation from the 1755-1850 MHz are based on funds received starting in FY02. If funds are not received as of FY02, then the DOD costs may change.

Many of the Federal civil agencies in their submissions expressed concerns about estimating the cost to relocate out of the 1755-1850 MHz band, since many factors critical to determine costs for relocation are unknown (e.g., selection of one or more alternative frequency bands). For example, available spectrum below 3 GHz to accommodate these relocated systems is severely limited. Use of spectrum above 3 GHz in some cases may adversely affect communications support to its missions. Potential frequency bands for relocating fixed microwave systems that are currently operating in the 1755-1850 MHz band are the 4400-4940 MHz and the 7.1-8.5 GHz (7/8 GHz) bands. Due to the propagation characteristics of microwave signals in higher frequency bands, additional relay stations may be needed to maintain the same performance as in the 1755-1850 MHz band. This may require additional cost in terms of additional repeaters and associated real estate.

In addition, moving 1755-1850 MHz fixed links to higher frequency band poses additional problems in that it necessitates a more rigid antenna support structure. At the higher frequencies the antenna has a narrower beam width and, in order not to compromise the antenna's directional orientation, existing towers may need to be refurbished or new, more rigid towers may have to be constructed to prevent the tower from swaying to an unacceptable degree. These additional requirements will also add to the relocation cost.

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[79] Several agencies' submissions in Appendix B assumed prior knowledge on part of the reader that the affected systems are fixed microwave links.

[80] To convert TY$ to FY02 dollars divide TY$ by 1.102.

Table 5-2
Total Estimated Federal Civil Agency Relocation Costs For The 1755-1850 MHz Band

Federal Agency	Number of Frequency Assignments	Estimated Relocation Costs (Millions)
Department of Agriculture	805[a]	$72.45[b]
Department of Energy	505	$340.56[c]
Department of Justice	241	$63.12[d]
Federal Aviation Administration	212[e]	$65.23[f]
Department of the Interior	197[g]	$27.95[h]
U.S. Coast Guard	37[i]	$13.9[j]
Department of Commerce	14[k]	$3.54[l]
Department of the Treasury	34	$88.5[m]
National Aeronautics and Space Administration	15[n]	$13.59[o]
Total	2,060	$688.8[p]

Notes:
a Based on 671 GMF fixed assignments, moving to 4 GHz or 7/8 GHz bands would require 20% additional sites or an equivalent 805 assignments.
b Total cost was calculated at $90K per assignment.
c Total includes $35M satellite replacement costs at Albuquerque, NM and various other operations.
d Cost includes 222 fixed assignments totaling $60M (average cost of $270.3K per assignment), 13 video (fixed/land mobile) systems totaling $3.1M, and six robotic (land mobile) links at totaling $22K.
e Based on telephone conversation with FAA personnel (2/5/01) the total number of assignments was reduced from 221 to 212.
f Cost reflects updated information based on 212 fixed assignments at an average cost of $307.7K per assignment. Total cost includes $17.13M for additional repeaters and equipment to move to higher frequency bands (i.e., 7/8 GHz).
g Based on combining 64 TVA fixed assignments and 133 DOI fixed assignments totaling 197 assignments.
h Cost reflects combining 64 TVA fixed assignments and 133 DOI fixed assignments at $125K per assignment and $150K per assignment, respectively.
i This number of GMF fixed assignments was based on updated information.
j In its submission, USCG included $12M replacement cost as its share to replace Treasury's Rainbow Microwave System in Hawaii. This $12M cost is not included in the estimate in the table since Treasury has included it as part of the total replacement cost for the Rainbow Microwave System (footnote m). Total includes 37 fixed assignments at $375.7K per assignment.
k Based on updated information via telephone conversation with DOC personnel (2/6/01) resulting in a total of 14 total assignments.
l Includes $275K cost (over 10-year period) to acquire a commercial T1 line for two assignments, 10 fixed assignments total $3.2M (average cost of $320K per assignment), and two assignments totaling $69K for operations at NIST. One experimental assignment for ITS in the 1850-1990 MHz band was not considered.
m Total includes $47M total replacement cost for the Rainbow Microwave System in Hawaii , seven fixed assignments totaling $1.2M (average cost $171.4K per assignment) over 10-year period to convert to commercial circuits, 18 fixed tactical assignments totaling $40M (average cost $2.22M per assignment), and two aeronautical assignments totaling $300K.
n This is an updated clarification of assignment count based on NASA telephone conversation (2/9/01) which deleted five assignments from the 20 assignments in the GMF.
o Total includes replacement at Wallops Flight Facility ($2M), Dryden Flight Research Center ($11M for ground/airborne based equipment to relocate to a new band), Kennedy Space Center ($40K), and Langley Research Center ($550K).
p This total is assumed to be in FY02 dollars.

Table 5-3
Total Estimated DOD Relocation Costs For The 1755-1850 MHz Band[81]

Agency	Estimated Relocation Costs (Millions)
Department of Defense	Beyond 2010[a]
Total	$4,354 (TY$)/$3,951 (FY02)[b]

Notes:
a The DOD states that relocating systems prior to 2010 is not feasible, so no costs are given.
b To convert TY$ to FY02 dollars divide TY$ by 1.102.

Further, during the transition period to other bands, the Federal agencies' operational capabilities should continue to be supported. It is noted that a number of frequency assignments in the 1755-1850 MHz band supports, *inter alia*, law enforcement and safety-of-life operations. These operations should not be jeopardized.

Replacement of some national security systems, due to their specialized missions, may require re-engineering and development efforts, resulting in several years from reimbursement to deployment. This would be true for systems such as the Navy's DWTS, since there is no currently planned replacement system that could be accelerated. Also satellite control systems cannot be replaced completely while current satellites are still operational. This latency factor for systems should be considered in order to maintain operational readiness.

Reimbursement for relocation, including the definition of marginal costs, will follow the rules established by NTIA as a result of the NPRM for reimbursement[82] for the 1710-1755 MHz band. To determine actual costs to relocate specific operations out of the 1755-1850 MHz, further discussions would be required between Federal agencies and IMT-2000 operators.

Cost Estimates by 3G Accommodation Option

Three approaches to sharing and/or segmentation of the 1710-1850 MHz band are provided in Section IV of this report. Within the 1755-1850 MHz band, the various options will have costs associated with relocating current operations from each of the 1755-1780 MHz, 1780-1790 MHz and 1805-1850 MHz sub-bands. The cost given for the various options assumes all operations within a particular sub-band would be relocated to an alternative frequency band(s). However, requiring all operations to vacate the entire sub-band may not be necessary if some sharing is possible and, thus, would result in potentially lower cost as compared to vacating the entire sub-band. Similarly, if systems could be configured to operate within the existing band then the costs may be significantly less when compared to vacating the entire sub-band.

[81] Details of the DOD costs are given in the DOD Final Report (Appendix D) at B-12, B-13, C-7, D-10, E-45, E-46, and classified supplement.

[82] *See* NTIA NPRM, *supra* note 17.

To simplify cost estimates, the 1755-1780 MHz and 1780-1790 MHz sub-bands have been combined into one 1755-1790 MHz sub-band. This section provides a discussion of the estimated costs associated with each option. The 1790-1805 MHz portion of the band was excluded as part of any segmentation option and was not evaluated separately for relocation costs. However, the cost would be included in the relocation cost for the entire 1755-1850 MHz band as provided in Table 5-2 and Table 5-3.

To estimate the cost for Federal civil agencies for each sub-band, submissions given in Appendix B were used. NTIA's initial request was for information relating to relocating the entire 1755-1850 MHz band. As other options were considered, additional information was requested from the agencies. Due to time constraints, some of these agencies were not able to fully assemble the additional information in the available time to provide sufficient detail for estimating the costs for relocating operations from the various sub-bands within the 1755-1850 MHz band. If sufficient details were not provided by the agencies, certain assumptions and extrapolations were used to estimate the costs for relocating systems for each sub-band.

For conventional fixed assignments, if the number of assignments was not provided, the number of assignments listed in the GMF was used, as shown in Tables 3-3, 3-4, and 3-6. The cost estimate for conventional fixed assignments for each sub-band was determined by multiplying the average cost per assignment by the number of assignments. Any variations in this method or discrepancy between agency assignment count and the GMF count is noted in the table for each sub-band cost estimate.

Non-conventional fixed systems, such as TRR, have the capability to tune on many frequencies within the 1755-1850 MHz band as well as in other frequencies bands. If one of the sub-bands contained assignments for this type of system, and the system could not satisfy mission support requirements by operating on the remaining spectrum, then the cost to replace the entire system was entered. While the cost of the entire systems may be included for each sub-band cost estimate, they would not be counted more than once if sub-band costs were aggregated. As a result, sub-band costs may approach costs equivalent to relocation of systems from the entire 1755-1850 MHz band.

The count of assignments in a sub-band may in some cases be biased, since some assignments may have center frequencies exactly on a band or sub-band edge and would impact more than one sub-band. It is noted that when the emission bandwidth of an assignment is such that it occupies parts of more than one sub-band, only one sub-band was used. The cost estimates are based on assignments contained in the GMF listing as of January 2001, unless otherwise noted in the agencies cost data submission (Appendix B) since assignments may have increased or decreased since then. To take into account these unknown factors, further discussions would be required between Federal agencies and IMT-2000 operators to determine actual costs on a case-by-case basis to relocate specific operations out of any portion of the 1755-1850 MHz band.

The DOD Final Report, contained in Appendix D, provides cost estimates for the segmentation options considering both the 1755-1790 MHz and 1805-1850 MHz portions of the 1755-1850 MHz band.

Costs for Option 1

Option 1 considers in-band pairing of the 1710-1850 MHz band. Under Option 1, the 1710-1755 MHz band would be considered for transmitting IMT-2000 mobiles and the 1805-1850 MHz band for transmitting IMT-2000 base stations. The 1710-1755 MHz band was identified by NTIA for transfer to the FCC under OBRA-93 as a mixed-used band with an estimated cost of between $266-$413 million as shown in Table 5-1. This would clear the 1710-1755 MHz band of most Federal operations, with an exception of systems in the 16 OBRA-93 protected areas and the Federal Power Agencies' (FPA) fixed service links. However, since sharing with the FPA links is problematic, the estimated costs for the relocation of FPA links is added for all options. The current number of protected fixed FPA links in the GMF as of January 2001 was 318. The cost to relocate the protected FPA was calculated assuming an average cost of $500K per assignment, multiplied by 318 assignments results in a total of $159 million.

The cost to clear the 1805-1850 MHz portion of the band is estimated to be $332.7 million for the Federal civil agencies and $2,802 TY$ /$2,543 (FY02) million for the DOD as summarized in Tables 5-4 and 5-5, respectively.

Table 5-4
Total Estimated Federal Civil Agency Relocation Costs For The 1805-1850 MHz Band

Federal Agency	Number of Frequency Assignments	Estimated Relocation Costs (Millions)
Department of Agriculture	427[a]	$38.43[b]
Department of Energy	260[c]	$138.32[d]
Department of Justice	130	$35.56[e]
Federal Aviation Administration	110	$33.85[f]
Department of the Interior	97	$13.85[g]
U.S. Coast Guard	19[h]	$7.14[i]
Department of Commerce	8[j]	$1.94[k]
Department of the Treasury	14	$63.05[l]
National Aeronautics and Space Administration	4[m]	$0.59[n]
Total	1,069	$332.7[o]

Notes:

a Based on 356 GMF fixed assignments, moving to 4 GHz or 7/8 GHz bands would require 20% additional sites or an equivalent 427 assignments.
b Cost was calculated at $90K per assignment.
c Includes 260 assignments. Based on updated information.
d Costs includes various assignments totaling $138.32M.
e Total includes 120 fixed assignments at $270.3K per assignment, $3.1M costs to replace video/surveillance equipment and $22K to replace robotic equipment.
f Cost reflects updated information based on 110 fixed assignments at average cost of $307.7K per assignment.
g Includes both DOI (69) and TVA (28) fixed assignments at $150K per assignment and $125K per assignment,

respectively.

h The 37 fixed assignments were assumed to be distributed as follows: 19 assignments in the 1805-1850 MHz band and 18 assignments in the 1755-1790 MHz band.

i In its submission, USCG included $12M replacement cost as its share to replace Treasury's Rainbow Microwave System. This $12M cost is not included in the estimate in the Table since Treasury included it as part of the total replacement cost for the Rainbow Microwave System. Total was based on 19 fixed assignments at $375.7K per assignment.

j One experimental assignment for ITS in the 1850-1990 MHz band was not considered.

k Includes $275K cost (over 10-year period) to acquire a commercial T1 line, five fixed assignments totaling $1.6M, and two fixed assignments totaling $69K.

l This includes $47M total replacement cost for the Rainbow Microwave System in Hawaii, three fixed assignments at $171.4K per assignment to convert to commercial circuits over 10-year period, and seven tactical assignments at $2.22M per assignment.

m This is an updated clarification of assignment count based on NASA telephone conversation (2/9/01).

n Cost total includes replacement at Kennedy Space Center ($40K), and Langley Research Center ($550K).

o This total is assumed to be in FY02 dollars.

Table 5-5
Total Estimated DOD Relocation Costs For The 1805-1850 MHz Band[83]

Agency	Estimated Relocation Costs (Millions)
Department of Defense	Beyond 2010[a]
Total	$2,802 (TY$)/$2,543 (FY02)[b]

Notes:

a The DOD states that relocating systems prior to 2010 is not feasible, so no costs are given for prior years.

b To convert TY$ to FY02 dollars, divide TY$ by 1.102.

The estimated total cost for Option 1 is the aggregated cost for the 1710-1755 MHz band (Table 5-1), excluding the 16 protected areas, plus FPA, and the Federal civil agencies and DOD costs for the 1805-1850 MHz band. This cost is $3,448 million (FY02). Sharing the band without impact to DOD operations would significantly reduce the cost.

[83] Details of the DOD costs are given in the DOD Final Report (Appendix D) at B-12, B-13, C-7, D-10, E-45, E-46, and classified supplement.

Costs for Option 2

In Option 2, Federal Government spectrum would be made available in three phases; 1710-1755 MHz (excluding systems in the 16 protected areas), 1755-1780 MHz and 1780-1790 MHz for IMT-2000 mobiles. Table 5-6 provides the cost estimates for Federal civil agencies in the1755-1790 MHz band. Table 5-7 provides the costs estimated for the DOD in the 1755-1790 MHz band. Table 5-1, shown previously, provides the cost estimates for the 1710-1755 MHz

Table 5-6
Total Estimated Federal Civil Agency Relocation Costs For The 1755-1790 MHz Band

Federal Agency	Number of Frequency Assignments	Estimated Relocation Costs (Millions)
Department of Agriculture	258[a]	$23.22[b]
Department of Energy	194[c]	$286.02[d]
Department of Justice	67	$19.07[e]
Federal Aviation Administration	79	$24.31[f]
Department of the Interior	69	$9.90[g]
U.S. Coast Guard	18[h]	$6.77[i]
Department of Commerce	6[j]	$1.88[k]
Department of the Treasury	13	$61.13[l]
National Aeronautics and Space Administration	4[m]	$2.55[n]
Total	708	$434.9[o]

Notes:
a Based on 215 GMF fixed assignments, moving to a 4 GHz or 7/8 GHz band would require 20% additional sites or an equivalent 258 assignments.
b Cost was calculated at $90K per assignment.
c Includes 194 assignments. Based on updated information.
d Includes $35M satellite replacement costs at Albuquerque, NM and various other operations.
e Total includes 59 assignments at $270.3K/ assignment, $3.1M costs to replace video/surveillance equipment and $22K to replace robotic equipment.
f Cost reflects updated information based on 79 fixed assignments at average cost of $307.7K per assignment.
g Includes both DOI (51) and TVA (18) fixed assignments at $150K per assignment and $125K per assignment, respectively.
h The 37 fixed assignments was assumed to be distributed as follows: 19 in the 1805-1850 MHz band, and 18 in the 1755-1790 MHz band.
i In its submission, the USCG has included $12M replacement cost as its share to replace Treasury's Rainbow Microwave System. This $12M cost is not included in the estimate since Treasury has included it as part of the total replacement cost for the Rainbow System. Total includes 18 fixed assignments at $375.7K per assignment.
j One experimental assignment for ITS in the 1850-1990 MHz band was not considered.
k Includes $275K cost (over 10-year period) to acquire a commercial T1 line, and five fixed assignments totaling $1.6M.
l This includes $47M total replacement cost for the Rainbow Microwave System in Hawaii, three fixed assignments at $171.4K per assignment to convert to commercial circuits over 10-year period, six tactical assignments at $2.22M per assignment, and two aeronautical assignments totaling $300K.
m This is an updated clarification of assignment count based on NASA phone conversation (2/9/01).
n Total includes replacement at Wallops Flight Facility ($2M) and Langley Research Center ($550K).
o This total is assumed to be in FY02 dollars.

Table 5-7
Total Estimated DOD Relocation Costs For The 1755-1790 MHz Band[84]

Agency	Estimated Relocation Costs (Millions)
Department of Defense	Beyond 2010[a]
Total	$3,902 (TY$)/$3,541(FY02)[b]

Notes:
a The DOD states that relocating systems prior to 2010 is not feasible; so no costs are given for prior years.
b To convert TY$ to FY02 dollars divide TY$ by 1.102.

The estimated total cost for Option 2 is the aggregated cost for the 1710-1755 MHz band (Table 5-1, excluding the 16 protected areas), FPA, the Federal civil agencies and DOD costs for the 1755-1790 MHz bands. The cost for relocating systems is estimated to be $4,548 million (FY02). Sharing the band without impact to DOD operations would significantly reduce the costs.

Costs for Option 3

Option 3 is an option that was not addressed in the interim NTIA report nor addressed within the DOD Final Report (Appendix D). The cost estimates provided for Option 3 should be considered preliminary since not all aspects to estimate the cost for Option 3 have been taken into account. As a result, further discussion with the DOD and Federal civil agencies would be required to determine the costs for this option. In Option 3, it is postulated that the number of protected areas within the 1710-1755 MHz would be reduced. It is noted that some of the systems within each of the 16 protected areas were not included in the cost estimates as given in Table 5-1.[85] The protected fixed FPA links within the 1710-1755 MHz band are also included in the estimated costs. Table 5-1, shown previously, provides the OBRA-93 cost estimates for the 1710-1755 MHz band. In addition, because of the long-term loss of the 1710-1755 MHz band, the relocation costs for TRR systems along with various DOD systems operating outside the 16 protected areas within the 1710-1755 MHz band, must also be included in the cost estimates. These systems and associated additional costs are listed in Table 5-8.

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84 Details of the DOD costs are given in the DOD Final Report in (Appendix D) at B-12, B-13, C-7, D-10, E-45, E-46, and classified supplement.

85 Systems such as telemetry, aircraft video, and telecommand have unique functions that will require further discussion with the DOD to determine the cost on a case-by-case basis.

Table 5-8
Estimated Additional DOD Relocation Costs For The 1710-1755 MHz Band[86]

Military Department	Type of System	Estimated Relocation Costs (Millions) 2010 [a]
Department of Army	MSE (HCLOS)[b]	$289.5
Department of Navy	DWTS[c]	$1,048.4
Department of Air Force	TCL/PGM[d]	$447.5
Total		$1,785 (TY$)/$1,620 (FY02)[e]

Notes:
a Assumes mission impact will prohibit relocation before 2010.
b Includes Army Corps of Engineers at $125M, $15M for Army's share of various additional fixed links, and $149.5M for the MSC (HCLOS). Details are provided in the DOD Final Report (Appendix D).
c Includes Tactical Control Links/Precision Guided Missiles at $432.5M, $15M for Navy's share of various additional fixed links, and $600.9M for the DWTS. Details are provided in the DOD Final Report (Appendix D).
d Tactical Control Links/Precision Guided Missiles at $432.5M, and $15M for Air Force's share of various additional fixed links. Details are provided in the DOD Final Report (Appendix D).
e To convert TY$ to FY02 dollars divide TY$ by 1.102.

The estimated total for Option 3 is the aggregated cost for the 1710-1755 MHz band (Table 5-1), FPA, and other DOD systems as given in Table 5-8. The estimated cost to relocate is $2,192 million (FY02). Costs for some systems in the 16 OBRA-93 protected areas were not known. Therefore, this is a partial cost. Option 3 was not part of the DOD Final Report and, therefore, estimates of DOD costs associated with this option were not provided by the DOD. Further discussions would be required with the DOD and Federal agencies to determine the costs for this option.

[86] Details of the DOD costs are given in the DOD Final Report in (Appendix D) at C-7, E-45, and classified supplement.

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Appendix A

Protection Contour Surrounding the Goldstone DSN Facility

NASA uses very high up-link transmit powers at its DSN facility in Goldstone, California in order to ensure link availability to deep space satellites. It is expected that IMT-2000 mobile receivers would experience service disruption in the 2110-2120 MHz band when attempting to operate in areas surrounding the Goldstone site and during uplink transmissions. The severity and duration of such disruption would depend upon the frequency channel assigned to the mobile unit, time, and power of transmission at Goldstone, orientation of the transmitting antenna, distance and terrain between Goldstone and the mobile unit, and weather in the area.

In order to assess the geographic extent of this interference potential, the Jet Propulsion Laboratory (JPL) has developed an interference contour based upon characteristics of anticipated IMT-2000 receivers, the DSN antennas and high power transmitter, the terrain around Goldstone, and upon ITU propagation models.

Using these models, interference power levels and required separation distances surrounding the DSN Goldstone transmitter has been calculated. The distances are those at which the radiation levels from DSN transmissions will exceed the IMT-2000 permissible interference levels for a given percentage of time. In calculating interference power, JPL has used the 70-meter DSN antenna with 400 kW (56 dBw) transmitting power, 62 dBi antenna gain for the main lobe, and -10 dBi gain for side lobes. For the IMT-2000 users, it is assumed that the receiving antenna is omni-directional with a 0 dBi gain. It is also assumed that the permissible interference level is -109 dBm based on UMTS mobile receiver specifications. The rain climatic zone used for the model is ITU region E, which includes Goldstone.

Figure A-1 presents a contour map showing anticipated interference distances (or required separation distances) in all directions around Goldstone. The contour encloses an area within which a mobile receiver would receive emissions from the DSN site above a threshold of -109 dBm for more than 1 percent of time. In the directions without the shielding of large mountains, as in the deserts southeast and northeast of Goldstone, the interference may propagate further, beyond the contour line.

It is expected that interference would occur in the 2110-2120 MHz band to IMT-2000 receivers in the region of southern California and part of Nevada surrounding the JPL facility at Goldstone. The interference contour associated with Goldstone is largely determined by mountains, with a radius of roughly 200 km. Mobile receivers using the 2110-2120 MHz band outside the contour could expect little or no interruption. Probabilities for interference outside the contour are less than 1 percent and are lower in areas shielded by large mountains.

It would be very difficult for mobile users inside the contour to time-share the same frequencies with Goldstone transmissions. The Goldstone site operates 24 hours a day, 7 days a week, with transmissions occurring on a daily basis and lasting, on average, 8 hours or longer.

These transmission periods, while normally scheduled, can at times be unpredictable because of unplanned spacecraft events.

Figure A-1. Calculated Interference Zones Surrounding DSN station at Goldstone.

Appendix B

Federal Agency Cost Submissions

NTIA requested cost data, time lines, and operational impacts from the Federal agencies with radiocommunications systems operating in the 1755-1850 MHz band. This appendix is a compilation of digitally replicated copies of the NTIA letter to the Federal agencies and correspondence received in response.

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NTIA Letter to Federal Agencies

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Communications and Information
Washington, D.C. 20230

Mailing
Address

July 24, 2000

Salutation:

The implementation of 3rd generation (3G) personal communications systems in the United States presents an opportunity for U.S. industry to maintain its global leadership in the manufacturing of telecommunications devices, and will give the American public an unparalleled choice of new communications services. The recent International Telecommunication Union (ITU) World Radiocommunication Conference-2000 has identified several frequency bands that administrations may use for the implementation of 3G systems. One of the two frequency bands under active consideration for 3G use in the United States is the 1755-1850 MHz band. This band is allocated for exclusive use of Federal Government agencies, and is heavily used by many of the Executive Branch agencies. The other band is the 2500-2650 MHz band, used exclusively by commercial entities, and regulated by the Federal Communications Commission (FCC).

In the near future, a national-level decision must be made to select a frequency band to accommodate the new 3G systems. The decision must maximize the public interest, considering the national potential for economic growth and increases in our quality of life, balanced by the cost and mission/business impact to incumbent users of the bands in question. This important decision must be based on the most accurate information available to us. The National Telecommunications and Information Administration (NTIA) is preparing a report that will detail the use of the 1755-1850 MHz band, alternate frequency bands for the reaccommodation of potentially displaced Federal radio systems if this band is selected for 3G use, and the costs and time lines associated with any transitions of Federal systems to new frequency bands.

To prepare the most comprehensive report possible, NTIA needs accurate cost data from the Federal agencies that operate spectrum-dependent systems in the 1755-1850 MHz band. (This data may be subject to review by the Office of Management and Budget or Congressional Committees.)

Therefore, I am requesting that you furnish NTIA with this cost data, to include the current value of your agency's infrastructure of radiocommunication systems in the 1755-1850 MHz band, and the marginal costs of relocating these radiocommunications systems to another appropriate frequency band. The marginal costs should include costs for retuning equipment should a minor shift in frequency be necessary, or costs for the purchase of new equipment, installation of this equipment and associated training, and, if necessary, additional real property should a move to a frequency band be required wherein the present equipment would not be serviceable. If you have previously submitted such data, I request that you review this information and certify its accuracy.

We know that relocation of communications systems is not without operational impact. It would be helpful to us to know what operational impacts such a relocation of these systems would have on your agency, and the approximate length of time required for transition to another frequency band, if this becomes necessary.

In order to meet our schedule for release of the NTIA report by March 2001, I request this data be furnished to me no later than November 15, 2000 so we can move forward on the selection of spectrum for 3G systems in the United States without excessive delays. Our point-of-contact for this effort is W. Russell Slye. He can be reached at 202-482-6497, or electronic mail at: rslye@ntia.doc.gov. I look forward to working with your agency on this most important effort.

Sincerely,

--Original Signed--

Gregory L. Rohde

Unites States
Department of Agriculture

Office of the Chief Information Officer

1400 Independence Avenue, SW

Washington, DC

January 30, 2001

Mr. Stephen R. Veader
Executive Secretary, IRAC
National Telecommunications and Information Administration
Department of Commerce
Herbert C. Hoover Building, Room 1087
1401 Constitution Avenue, N.W.
Washington, D.C. 20230

Dear Mr. Veader:

This is in response to Assistant Secretary Rohde's letter of July 24, 2000, requesting we provide the National Telecommunications and Information Administration (NTIA) with estimated cost data for relocating USDA radiocommunications systems from the 1755-1850 MHz band to support proposed 3rd Generation (3G) personal communications.

We fully support the goal of implementing 3G personal communications systems in the United States. We are also aware of the problems associated with selecting spectrum to support 3G implementation. One of the bands under consideration for 3G is the 1755-1850 MHz microwave band. This band is very heavily populated by Federal Government systems. We, therefore, understand the need to obtain estimated costs for Federal agencies to move to alternative frequency bands if the 1755-1850 MHz band is reallocated for non-Federal use. We appreciate the work you and your staff in NTIA are doing to support the financial needs of agencies who may have to vacate the 1755-1850 MHz band.

The Department of Agriculture (USDA) owns and maintains microwave systems operating in the 1755-1850 MHz band throughout the United States. These microwave systems are used primarily in the Forest Service as backbone links to interconnect land mobile radio system mountaintop repeaters and remote controlled base stations. The land mobile radio systems are installed to support the health and safety of employees and the public on and around public lands, the fighting of wildfires and other natural disasters, as well as the protection of property. All of the installations are standard off-the-shelf analog microwave transmitters, receivers, and associated equipment. Most operate within a 2 MHz bandwidth.

Equipment at all USDA microwave sites would have to be replaced to allow for operation on an alternate band if the 1755-1850 MHz band were to be reallocated to non-Federal use. There are two alternative bands that are considered reasonable for transition: 4 GHz and 7 GHz. If either of these bands were selected for the transition, our current systems would have to have their number of sites increased by approximately 20 percent. This is caused by a reduction in the effective communications distance between the sites due to the higher frequency of operation. The estimates provided below cover the cost of moving to an alternative band and include the additional installations required by the higher frequency band of operation.

Following the NTIA example of basing costs on the number of frequency assignments, we have averaged our transition costs to be approximately $90,000 per assignment. We mentioned previously that the alternative bands under consideration for transition would require approximately 20 percent additional sites to provide comparable communications. We have included that additional percentage in our calculations thereby increasing the estimated total number of frequency assignments under consideration to 805. At $90,000 each, the total cost for transition is estimated to be $72,450,000. Since USDA microwave systems are used to support safety-of-life communications, any replacement systems would have to be installed and operational before the old systems could be disabled. The steps of system redesign, equipment procurement (advertisement, selection, award and purchase), installation, and testing are estimated to take a minimum of 3 years once funding is provided. The schedule could be shortened at increased costs for additional contracting support. These steps are our basis for cost estimates.

If you have questions, please have a member of your staff contact Ms. Brenda F. Boger on (202) 720-8025.

Sincerely,

--Original Signed--

Ira L. Hobbs
Acting Chief Information Officer

U.S. Department
of Transportation

**United States
Coast Guard**

Commandant
U.S. Coast Guard

2100 2nd St. SW
Washington, DC 20593
Staff Symbol: G-SC
Phone: 202 267 2860
FAX: 202-267 4106

2000

Mr. Gregory L. Rohde
Assistant Secretary of Commerce for
Communications and Information
U. S. Department of Commerce
Washington, D C 20230

15 November 2000

Dear Mr. Rohde:

This responds to your letter of July 24, 2000, requesting cost data from Federal agencies that operate spectrum-dependent systems in the 1755-1850 MHz band, and the marginal costs of relocating these radiocommunications systems to another appropriate frequency band.

The Coast Guard has identified 37 microwave links that would require replacement if we were directed to move from the 1755-1850 MHz bands. The estimated existing value of these links is $9.7M. The replacement cost is estimated at $13.9M assuming necessary spectrum is available in the next higher Federal Government band. Wherever possible, commercial facilities vice government-owned or operated systems have been utilized in reaching this estimate. The remoteness of many of these sites, the short construction season in Alaska and along the Washington-Oregon coasts and the availability of personnel and equipment to perform this replacement are factors in the replacement costs.

Each of the circuits provided by the existing or replacement microwave paths supports Safety of Life, command and control and general communications utilized by the Coast Guard to support its various missions. I must emphasize that we cannot terminate an existing link until the replacement link is installed, tested and operational. Enclosure (1) provides a listing of circuits requiring replacement and a more detailed breakdown of associated costs.

In addition, the Coast Guard is a participant in the Hawaii Rainbow System that operates partially within this band along with the Department of the Treasury and the State of Hawaii. The radio frequencies associated with this system are grandfathered by your agency. However, if required to be replaced for 3rd generation personal communications systems, the estimated system replacement cost is $46M with the Coast Guard share of the cost being approximately $12M. The estimated cost of the Coast Guard share of the existing system is $6M. These costs are in addition to those outlined above.

2000

Please advise me if you require further information regarding these circuits.

Sincerely,

--Original Signed--

C.I. PEARSON
Captain, U. S. Coast Guard
Acting Assistant Commandant for Systems

Encl: (1) List of Circuits

Microwave Circuits

Location	# of paths	Replacement Cost
Berwick Bay, LA	4	$24K
Alaska	13	$7.465M

Naked Island (2)
Cape Hinchenbrook
Potato Point (2)
Valdez
Mount Thomas (4)
Pillar Mountain (2)
Pillar Point

Location	# of paths	Replacement Cost
Washington/Oregon	21	$6.4M

Winchester Hill (2)
Astoria
Seven Devils (3)
Adams Hill (3)
North Bend
Yaquina Head
Goodwin Peak
Cape Blanco
Seattle (3)
Raymond (2)
South Mountain
Naselle Ridge (2)

Encl (1)

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DEPUTY SECRETARY OF DEFENSE
1010 DEFENSE PENTAGON
WASHINGTON, DC 20301-1010

February 13, 2001

Honorable Donald L. Evans
Secretary of Commerce
U.S. Department of Commerce
Herbert C. Hoover Building
1401 Constitution Avenue N.W.
Washington, D.C. 20230

Dear Mr. Evans:

In response to President Clinton's October 13, 2000, Executive Memorandum on Advanced Mobile Communications/Third Generation Wireless Systems, the Department of Defense (DoD) provides the enclosed report for inclusion into the Final NTIA/ FCC Third Generation (3G) Band Study and Report scheduled for public release on or about March 30, 2001. Loss of access to spectrum, above and beyond that already relinquished as a result of the Omnibus Budget Reconciliation Act of 1993 and the Balanced Budget Act of 1997, would jeopardize the DoD's ability to execute its mission.

The DoD report examines. the, feasibility of accommodating International Mobile Telecommunications (IMT) 2000 systems by sharing the 1755-1850 MHz band, and concludes that full band sharing is not possible due to predictable, mutual interference over large geographic areas and major metropolitan centers. Mitigating that interference would require unacceptable restrictions on military operations, training, and readiness. The report concludes that regardless of financial investment, the Department cannot vacate or segment the band until at least 2010 for non-space systems and at least 2017 for space systems (possibly as late as 2030 for some satellites). Even then, vacation or segmentation of the band would be acceptable only if comparable, operationally suitable spectrum with equivalent regulatory protection is made available and the costs of relocation are fully reimbursed prior to any transition.

The conclusions of this report are based on the fundamental principle that the DoD cannot accept any degradation to mission capability resulting from a spectrum reallocation action. The 1755-1850 MHz band is indispensable to the defense of the United States and its allies. It is used, among other things, for satellite telemetry, tracking, and commanding of critical satellite systems (including Global Positioning System (GPS), Milstar, and Defense Support Program (DSP)); PGMs; Army and Navy/Marine Corps tactical radio relay systems; air combat training systems; targeting; intelligence; and the real-time delivery of voice, video, and data information to warfighters and their commanders. Our Nation's armed forces would be at a substantial strategic and tactical disadvantage in combat and the execution of military operations could be jeopardized if the Department lost its use of the band.

A final caution: This report is the result of an accelerated and preliminary review. The Department was required to make certain critical assumptions and was not able to take into account secondary and tertiary costs that would result if hundreds of defense systems were moved out of the 1755-1850 band with attendant changes in tactics, training, doctrine, personnel, and long-lead procurement and program execution.

We took forward to continuing close coordination with NTIA and FCC in reaching the best decision for the Nation in identifying spectrum for the next generation of wireless systems.

Sincerely,

--Original Signed--

Rudy de Leon

Enclosure

Enclosure to the Deputy Secretary of Defense Letter

See Appendix D

The enclosure is a DOD report titled: Department of Defense Investigation of the Feasibility of Accommodating the International Mobile Telecommunications (IMT) 2000 Within the 1755-1850 MHz Band). It is over 300 pages in length and is printed separately as Appendix D (less Attachment) to this report. The DOD report in its entirety can be viewed on the NTIA homepage at: www.ntia.doc.gov.

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL ENVIRONMENTAL SATELLITE, DATA,
AND INFORMATION SERVICE
Washington, D.C.20233

Office of Radio Frequency Management
Room 2246, SSMC-2
1325 East West Highway
Silver Spring, MD 20910
November 14, 2000

MEMORANDUM FOR: NTIA -W. Russell Slye

FROM: ORFM - Richard Barth --Original Signed--

SUBJECT: Impact of Losing 1755 - 1850 MHz

This responds to AS Greg Rohde's letter to DUS Scott Gudes dated July 24, 2000 asking for information about the radio systems currently operating in the band 1755 - 1850 MHz and the marginal cost of relocating these systems to other spectrum.

The Department of Commerce currently has 31 assignments in this band. Nine are no longer required and have been or will be deleted. The remainder are distributed as follows:

NWS - 17 ERL - 2 NIST - 2 ITS - 1

The cost of replacing these systems has been estimated by the element operating them, with the following results:

- NWS: $3.2 million estimated to relocate the 17 systems to the 7 GHz band. Further details are provided in the attachments. Note that about 3 years will be required after funding is obtained for the effort.
- ERL: The current system operates in knife-edge diffraction mode and higher frequencies are not expected to perform adequately. If forced to vacate the 1755 MHz band, users plan to lease a T1 line for a total cost of about $275K over a 10year period (the presumed life of a replacement microwave system.)
- NIST: $69,060. Details attached.
- ITS: $50-100,000. This experimental area assignment in the band 1850 - 1990 MHz is used for an active antenna test bed, for propagation tests in support of PCS standards definition. Continued use of the band is expected to be required, since it is here that PCS systems will operate.

Attachments

Attachment

IMPACT ASSESSMENT OF POTENTIAL LOSS OF THE MICROWAVE LINE OF SIGHT (MLOS) SYSTEMS IN THE BAND 1755-1810 MHz ON THE U.S. METEOROLOGICAL DOPPLER WEATHER SURVEILLANCE RADAR (WSR-88D)

1.0 Introduction

The 1710-1855 MHz band is being targeted worldwide for use by IMT-2000, the "3rd Generation" (3G) mobile system which is being promoted by industry and supporting governments in much of the world. This band is used worldwide, except in North America, for cellular telephone, and its availability on this continent would make it possible for cellular equipment producers to manufacture hardware that could be sold and used globally. Part of the band from 1710-1755 MHz was designated for auction under the Omnibus Budget Reconciliation Act of 1993 (OBRA-93), and the National Telecommunications and Information Administration (NTIA) is now considering the potential impact on Federal communications should the 1755-1850 MHz band be made available to industry.

2.0 Current Use of the Band 1755-1810 MHz

The National Weather Service (NWS) currently operates the WSR-88D MLOS system in the 1755-1810 MHz band. These systems were recently upgraded from the 1710-1755 MHz band in response to OBRA-93. The MLOS system is five terrestrial microwave data links operating in support of WSR-88D. These microwave links allow the data gathered at the radars located on remote mountain peaks where normal communication infrastructure is not feasible to be transmitted to the Weather Forecast Offices for processing. The WSR-88D MLOS system connects the following sites:

RADAR SITES	WEATHER FORECAST OFFICES
Sulphur Mountain, CA	Los Angeles, CA
Mauna Kapu, HI	Ewa Beach, HI
Point Six Mountain, MT	Missoula, MT
Twin Lakes, OK	Norman, OK
Mount Ashland, OR	Medford, OR

The data transmitted over these microwave links is vital for improving short-term forecasting and detection of life--threatening severe weather. Without these microwave links, the people living in these locations would not receive the protection of life and property that WSR-88D provides.

3.0 Frequency Relocation

Should the NTIA make the 1755-1810 MHz band available to IMT-2000 and require the MLOS to relocate, the next available Government frequency band is 4400-4800 MHz. However, a thorough analysis has determined a relocation to the 4400-4800 MHz band is not practical. A survey of radio manufacturers discovered there are no American manufacturers that build radios in this frequency band. A unique one-of-a-kind system would have to be built and the NWS would be very dependent on the vendor for replacements and repairs to the system. A system of this nature would also be too expensive.

A more practical solution would be to relocate to 7125-7250 MHz band which is the next available Government band after 4400-4800 MHz. There are numerous American radio manufactures that build systems in this frequency band. Obtaining commercial-off-the-shelf equipment would be advantageous and more cost effective over the life of the system.

3.1 Cost

The current value of the five existing NWS WSR-88D MLOS systems is estimated at $5M. The transition of the WSR-88D MLOS systems to a portion of the band 7125-7250 MHz is estimated at $3.2M. This estimate includes all costs associated with the system engineering, radios, antennas, tower extensions, associated hardware, installation, travel, and warranty.

3.2 Operational Impact

Operational impact to the MLOS should be minimal during the frequency relocation. Since there is not adequate room on the towers and in equipment shelters for the new antennas, radios and associated hardware required for this relocation, the old system will be removed from operation until the new systems is installed and tested. The cut-over can be performed with a radar downtime of 2 to 3 days.

3.3 Time-frame for Transition

The transition of the NWS WSR-88D MLOS system to the band 7125-7250 MHz is expected to require approximately 3 years from the notification and receipt of adequate funding.

4.0 Conclusion

The NWS considered the available options for the WSR-88D MLOS relocation out of the 1755-1810 MHz band. Relocation to the 7125-7250 MHz band was determined to be the most feasible solution. The costs for implementing this relocation is estimated to be $3.2M. There should be little operational impact to the WSR-88D MLOS system created by this relocation. The relocation will require 3 years to complete once funding is approved and obtained.

Subject:	**Impact of Loss of 1755-1810 MHz**
Date:	Fri, 22 Sep 2000 14:34:03 -0400
From:	Harold Fogle <harold.fogle@nist.gov>
To:	Richard.Barth@noaa.gov
CC:	john.antonishek@nist.gov, Rachel.Cockrell@nist.gov, Karl.Murphy@nist.gov

The National Institute of Standards and Technology (NIST) has two frequencies in the band width which are being considered for elimination by the Government.

Both frequencies, M1800 and M1833 are in support of the Intelligent Highway Systems Research Program at Gaithersburg, Md.

The users have researched the impact of replacing these frequencies and have estimated the following transition costs.

Transmitters	(2) at $6,545.00 ea.	Totaling $13,090.00
Receivers	(2) at $5,290.00 ea.	Totaling $10,580.00
Antennas	(5). at $748.00 ea.	Totaling $3,740.00
	(2) at $220.00 ea.	Totaling $440.00
	(2) at $605.00 ea.	Totaling $1,210.00
Labor		Totaling $40,000.00

Total cost of transition is $69,060.00.

One question everyone must have on their mind is the source of transition money in these tight budget years. The timing for transition will be dictated by our budget. Certainly, in the case of NIST, this will have a large affect on the project using these frequencies.

Please contact me should you require any other information. My email address is Harold.Fogle@nist.gov and my telephone number is 301-975-3330.

Department of Energy
Washington, DC 20585

November 15, 2000

Mr. Gregory L. Rohde
Assistant Secretary for Communications and Information
Department of Commerce
1401 Constitution Avenue
Washington, D.C. 20230

Dear Mr. Rohde:

The Department of Energy (DOE) is responding to your request for economic and operational impact data for the relocation of Departmental radio systems that operate in the 1755-1850 MHz band, as requested in your letter of July 24, 2000. We appreciate the national importance of implementation of third-generation personal communications systems as outlined in your letter, as well as the October 13, 2000, White House Memorandum on that subject. The estimated cost to relocate DOE radiocommunications systems from this band is $340,400,000. The cost data, as well as other operational impacts, are identified in the enclosed Table 1. Estimates are based on transition times from 3 to 10 years depending on the radio system in question. Accelerated transition schedules significantly increase costs and may not be feasible.

If you require additional information, please contact Brian Klug of my staff on 202-586-6095.

Sincerely,

--Original Signed--

Nancy W. Tomford
Acting Chief Information Officer

Enclosure

U.S. Department of Energy Summary Impact of National Reallocation of Band 1755 - 1850 MHz

Summary

Responses from field users that formed the basis to evaluate moving Department of Energy (DOE) systems operating in the band 1755-1850 MHz to a different frequency band are summarized in table 1. Data was structured based upon the incoming request from the National Telecommunications and Information Administration (NTIA). For each affected DOE Office, the table contains the original system costs, number of frequency authorizations in the 1755-1850 MHz band as of July 2000, projected cost to replace the current systems, impact summary, and expected transition time.

Table 1. 1755-1850 MHz Impact Assessment Summary

Field Office	Original Cost	Number Asgmts	Costs to Replace	Impact Summary	Transition Time
Albuquerque[a]	$35,135,000	16	$36,600,000	Possibly, some mission impact due to satellite	3-5 years without considering satellite
Bonneville Power Administration	$138,100,000	99	$115,500,000	Mission impact-see write-up	7-10 years
Oak Ridge		4	$400,000[d]	No mission impact reported	3-5 years
Oakland	$70,000	14	$150,000	Possible mission impact	3-5 years
Nevada	$408,000	19	$1,900,000	No mission impact	3-5 years
Rocky Flats		1	$0	Assume site shutdown in 2006	5 years
Savannah River		1	$100,000[d]	No mission impact reported	3-5 years
Strategic Petroleum Reserve[b]	$40,000	1	$150,000	Are relocating one link	2 years
Southwestern Power Administration[c]	$12,800,000	62	$31,000,000	Mission impact-see write-up	7 years (estimate)
Western Area Power Administration	$219,700,000	301	$154,600,000	Mission impact-see write-up	7-10 years
Totals	$406,253,000	502	$340,400,000		

Notes:
a: data includes a satellite that may be difficult to replace; the estimated cost is $35 million.
b: this system has been modified with part discontinued and part planned equipment replacement.
c: timeframes of these systems are highly dependent upon getting funding approved, possibly from the ratepayers.
d: assumed $100,000 for each frequency authorization, since data was not provided within the required NTIA timeframe for these 5 assignments

1

Field microwave users reported that other microwave bands would be used to replace systems in the bands 1755-1850 MHz. In cases where highly reliable systems are required, the 7/8 GHz band will be used. In a minority of cases, if allowed after considering reliability and interference potential due to high population density, unlicensed spread spectrum digital systems operating in the 2.4 and 5.8 GHz nonlicensed bands may be used. Since frequency changes in satellite systems are not practical, a replacement would require launch of a new satellite in cooperation with program partners.

Operational Impact

Operational impact is dependent upon allowing sufficient transition time. The impact will potentially be the greatest on the satellite system used to collect data for stockpile stewardship and the microwave systems serving Bonneville Power, Southwestern Power, and Western Area Power Administrations. The fixed point-to-point microwave communications systems support the supervision, control, and protection of the electrical power transmission system. The channels are used for high-speed relaying, supervisory control, load control, telemetering, data acquisition, land-mobile radio dispatching, operations, and maintenance. If forced to hastily vacate the 2 GHz band, the operational impact on the power transmission system could include extensive outages, loss of revenue, inability to deliver power to the customers, increased operating costs, power system instability, and potential loss of life and equipment. For systems listed in table 1 that have indicated no mission impact, it is assumed that the associated transition time will be given for relocation.

Transition Time

Transition times listed in table 1 span 2 to 10 years due to the complexity of systems and geographic locations. In many cases, lengthy lead times from manufacturers to acquire equipment and custom-built components, such as battery/charger systems, antenna/waveguide systems, and radio and/or fiber systems are required. In other cases, time is required to allow for budgeting, environmental approvals, and a billing process to customers. Many of the microwave systems are located in the western United States in mountainous areas that experience heavy snowfall. This results in a shorter construction season that limits the length of time work can be performed and restricts the number of new and existing sites that can be completed in a season. All of these factors contribute to a transition time of up to 10 years for some of the more critical systems.

The following supplemental information was provided to NTIA by Mr. Hollingsworth/DOE on 3/8/01. It was requested that this information be used to estimate the DOE costs to relocate systems from the 1755-1850 MHz band. In addition, as a result of this supplemental submission, it was requested that the various entries contained within the DOE letter on Pages B-19 and 20 be modified. The suggested modifications are as follows: 1) the number of assignments at Savannah River be increased to 1 to 4; 2) the costs for the four assignments at Savannah River results in a total of cost of $240,000; and 3) the cost for the one assignment at Rocky Flats would increase from $0 to $20,000. The results of these changes would increase the number of assignments from 502 to 505 and increase the total costs from $340,400 to $340,560. This change in the total costs would also be reflected on the cover page increasing the amount from $340,000 to $340,560.

Impact to DOE

	1805-1850 MHz	1780-1790 MHz	1755-1780 MHz	COST
Albuquerque Operations Office	7			$1.75M
		2		$470K
			7	$36.5M
Nevada Operations Office	9			$2.5M
		2		$559K
			5	$1.5M
Oak Ridge Operations Office	3			$750K
			1	$250K
Oakland Operations Office	5			$134K
		5		$134K
			4	$107K
Savannah River Operations Office	2			$40K
		1		$100K
Rocky Flats Field Office			1	$20K
Strategic Petroleum Reserve	1			$150K
Bonneville Power Administration	22			$19M
		24		$20M
			48	$41M
Southwestern Power Administration	38			$31M
		2		$31M
			17	$31M
Western Area Power Administration	173			$83M
		7		$78M
			68	$83M
Total Costs	$138.324M	$130.263M	$193.377M	$340.560M

Note: Relocation costs for vacating the combined 1755-1780 MHz and 1780-1790 MHz band segments would not exceed the total cost of vacating the entire 1755-1850 MHz band, so the estimated cost for vacating the 1755-1790 MHz band segment would be no more than $286.02M. The combined costs of all three band segments for some DOE field offices may be greater than the cost impact for having to relocate from the entire 1755-1850 MHz band. This is because these costs represent replacement of entire systems, where system path links in one band segment may also be in common with another band segment (e.g., SWPA has only one analog microwave system with path links across all 3 band segments). Also, there is an increased cost factor for having to vacate from just one band segment due to the cost of re-engineering whole new systems and procuring new equipment.

U.S. Department of Transportation
Federal Aviation Administration

Associate Administrator for Air Traffic Services

800 Independence Ave, SW
Washington, DC 20591

Mr. Gregory L. Rhode
Assistant Secretary for Communication
Department of Commerce
Washington, DC 20230

November 7, 2000

Dear Mr. Rhode:

In reference to your letter dated July 24, we have researched and prepared the enclosed estimated cost data required to relocate 221 Federal Aviation Administration frequency assignments remaining in the 1755-1850 MHz band. This is our best estimate at this time. Actual costs will depend on such factors as geographic location and final configuration of the relocated assignments. This estimate does not include any real estate costs.

While cost issues are important, the National Telecommunications and Information Administration will need to address the spectrum suitability and availability in alternative frequency bands for those systems being displaced. Keep in mind that due to the limited propagation characteristics of microwave signals in higher frequency bands, some of the 221 links may not be able to be moved to those bands if real estate is not available to accommodate repeaters.

If you require additional information, please contact Mr. Oscar Alvarez, Manager, Spectrum Assignment and Engineering Division, at (202) 267-7531.

Sincerely,
Steven J. Brown

--Original Signed--

Acting Associate Administrator
for Air Traffic Services

cc: Enclosure

Enclosure

COSTS TO RELOCATE LOW DENSITY RADIO COMMUNICATION LINKS (LDRCL):

221 Assignments	$48,096,893
50 Repeaters	10,881,650
200 ft Towers (for repeaters) (FREE STANDING) *Includes lighting, fencing, security @ $125,000.00 ea x 50	6,250,000
TOTAL COST:	$65,228,543

S\asr\1755el.doc

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240-0001

Ref Doc. 31744/1

Mr. Steven R. Veader
Executive Secretary, IRAC
National Telecommunications and
Information Administration (NTIA)
U.S. Department of Commerce
Herbert C. Hoover Building, Room 1087
1401 Constitution Avenue, NW
Washington, D.C. 20230

February 16, 2001

Dear Mr. Veader,

The purpose of this letter is to inform the NTIA that we are revising our initial estimate of marginal costs incurred by this Department in the 1755-1850 MHz band. Assistant Secretary Rohde's letter of July 24, 2000, requests Department of Interior (DOI) provide NTIA with estimate on costs for relocation of our radio communications systems operating in the 1755-1850 MHz band to support proposed 3rd Generation (3G) personal communications. Our initial response during November 2000 identifies 143 DOI frequency assignments having a six million dollar total marginal cost for relocation to another band.

Our first submission reflects information gathered from only four DOI bureaus. We are adding, The United States Geological Service (USGS), another DOI Bureau to our original cost estimate. The USGS uses frequencies in the 1755-1850 MHz band for earthquake and tidal wave monitoring operations. Because DOI has an existing agreement with TVA for spectrum management our revision includes relocation cost data from the Tennessee Valley Authority (TVA). The TVA uses frequencies in this band for automated remotely controlled hydroelectric power generation grid and its internal voice communications backbone.

Following the NTIA example of basing costs on the number of frequency assignments, we have compiled our transition costs in the following chart.

Bureau	Average Marginal Cost	Number Assignments	Cost to Replace
Interior	$ 150,000	133	$ 19,950,000
TVA	$ 125,000	64	$ 8,000,000
Totals	$ 275, 000	197	$ 27,950,000

Five DOI bureaus have 133 frequency assignments in this band with average transition costs of $150,000 per assignment. DOI total marginal costs equal $20 million dollars. The TVA has 64 frequencies with an average transition cost of $125,000 per assignment. The TVA total marginal cost equals $8 million dollars. The combined transition cost for Interior and TVA equal $28 million dollars. Since DOI/USDA microwave systems are used to support safety-of-life communications, any replacement systems would have to be installed and operational before the old systems could be disabled.

System redesign, equipment purchase, installation, testing and acceptance will take a minimum of 3 years for DOI systems once funding is available. The Bureau of Reclamation and TVA hydrological systems, and USGS earthquake monitoring/detection systems take approximately 7 years to go through the same process. They also require extensive engineering studies because of design constraints and environmental impact. Contracting out any of these missions will drive costs up. Please direct any requests for information about this system to the undersigned at (202) 208-3939

Sincerely,

--Original Signed--

Arthur L. Nelson
US Department of the Interior
Interdepartment Radio Advisory Committee Representative

U.S. Department of Justice

Washington, D.C. 20530

Mr. Gregory L. Rohde
Assistant Secretary for
Communications and Information
Department of Commerce
Washington, DC 20230

November 16, 2000

Dear Mr. Rohde:

In response to your request, the Department of Justice (DOJ) has reviewed its wireless operations in the 1755-1850 MHz band and has concerns with the ability to find suitable alternative spectrum below 3 GHz and the time and cost that will be incurred in developing replacement equipment and systems. DOJ uses the 1755-1850 MHz band for various wireless applications supporting law enforcement operations. These are primarily fixed microwave linking portions of our land mobile radio communications infrastructure, audio/video surveillance systems and wireless robot operations. We have concerns that other spectrum locations may not support these operations at a level equal to or better than that served by the present spectrum location. Alternative spectrum locations below 3 GHz are severely limited and may adversely affect these applications and DOJ's mission. Also, there may be significant costs incurred to support these applications in other areas of the spectrum.

The current estimate for relocating the fixed microwave links in this band is approximately $60 million. DOJ is considering a transition to alternative spectrum or services to coincide with the implementation of the consolidated Justice Wireless Network program, but this would have to take place over the next 5 to 8 years.

The cost for relocating the audio/video surveillance equipment is approximately $3.1 million. Operationally, this equipment is used to support collection of audio and video information for evidence in criminal, counterterrorism and foreign counterintelligence investigations. The time line to accomplish a relocation of this equipment and the operational impact is dependent on identifying suitable replacement spectrum and research development efforts. This may take additional time and money.

The estimated cost for relocating the robot operations is $22,000. The robots are used in suspected bomb scenes, with other hazardous materials and to support forensic investigations. As is the case with the audio/video equipment, the estimated time line to relocate the robot operations cannot be determined until adequate spectrum is identified, and research and development occurs.

DOJ relies on the ability to use advanced technologies as investigative tools in support of its mission. The increased demand on the limited spectrum resources supporting these technologies creates challenges for the users and the regulators. All spectrum alternatives for third generation personal communications systems must be explored before decisions are made that limit the resources available to support the DOJ operations. If you have any further questions please contact Merri Jo Gamble on 703-322-1660.

Sincerely,

--Original Signed--

Stephen R. Colgate
Assistant Attorney General
for Administration

U.S. Department of Justice

Wireless Management Office
Fairfax, Virginia 22033

January 29, 2001

Mr. Russell W. Slye
National Telecommunications and
Information Administration
Department of Commerce
Herbert C. Hoover Building, Room 4082
1401 Constitution Avenue, N.W.
Washington, D.C. 20230

Dear Mr. Slye:

During a meeting at the National Telecommunications and Information Administration (NTIA) with the Office and Management and Budget and several other federal agencies on January 23, 2001, the Department of Justice (DOJ) was asked to provide additional information on its use of the 1755-1850 MHz band. Specifically, DOJ was asked to break down its use of this band to include the number of frequency assignments, and to provide an explanation of how the existing microwave links relate to the Justice Wireless Network (JWN) implementation.

There are a total of 241 frequency assignments in the Government Master File for DOJ use of the 1755-1850 MHz band. The DOJ uses this band primarily for fixed microwave linking of our land mobile radio communications infrastructure, audio/video surveillance systems and wireless robot operations. Currently, there are 223 frequency assignments authorizing the fixed microwave links at specific geographic locations. The audio/video surveillance systems are authorized by 13 frequency assignments. These 13 frequency assignments allow a maximum of 736 individual pieces of equipment to operate anywhere in the United States and Possessions. The eleven wireless robots are authorized for operation anywhere in the United States and Possessions by 5 frequency assignments.

DOJ has been directed by Congress to combine the individual land mobile radio (LMR) systems used by each of the DOJ components into a consolidated JWN. The implementation of the JWN is a multi-year effort driven by the need to comply with the NTIA VHF narrowband mandate of January 1, 2005. The current individual component LMR systems are linked in some areas of the country by microwave equipment operating in the 1710-1850 MHz band. In many areas this equipment has been operational for approximately 15 to 20 years.

When the 1710-1755 MHz band was identified for reallocation from government to non-government use in 1993, the Federal Bureau of Investigation made the decision to convert its existing microwave links in the 1710-1850 MHz band to wireline modem where technically and operationally feasible. This effort is not yet completed. The Immigration and Naturalization Service (INS) currently has existing microwave links that operate in the 1710-1850 MHz band. No other DOJ components have microwave links in the 1710-1850 MHz band. As DOJ develops the design and implementation plans for the JWN, each geographic area is evaluated with a view towards consolidating redundant sites and retaining the existing infrastructure, especially if there is a system linking capability already in place. The existing microwave links are viewed as DOJ system assets that will need to be reaccommodated to comply with the reallocation of the 1710-1755 MHz band and should be taken into account in any evaluation of potential reallocation of the 1755-1850 MHz band.

If there are any further questions, please contact me at 703-322-1666.

Sincerely,

--Original Signed--

Merri Jo Gamble
Spectrum Manager

The following supplemental information was provided to NTIA by Ms Merri Jo Gamble/DOJ on 2/1/01. It was requested that this information be used as part of the information to estimate the DOJ costs to relocate systems from the 1755-1850 MHz band.

Breakdown on the Justice Assignments by Sub-Band

Fixed

1755-1780 = 47
1780-1790 = 12 (This total does not include 3 assignments listed in 1755-1780)
1790-1805 = 43
1805-1850 = 120 (This total does not include 14 assignments listed in 1790-1805)

Video

1755-1780 = 3
1780-1790 = 4
1790-1805 = 1 (This total does not include 4 assignments listed in 1780-1790)
1805-1850 = 5 (This total does not include 1 assignment listed in 1790-1805)

Robot

1755-1780 = 1
1780-1790 = 0
1790-1805 = 0
1805-1850 = 5

Total Number = 241

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National Aeronautics and
Space Administration

Headquarters
Washington, DC 20546-0001

Reply to Attn of: M-3

November 3, 2000

Mr. Gregory L. Rhode
Assistant Secretary
for Communications and Information
U. S. Department of Commerce
Herbert C. Hoover Building
14th & Constitution Avenue, NW
Washington, DC 20230

Dear Secretary Rhode:

I am responding to your July 24, 2000, letter describing the Federal Government's plans for implementing a third generation (3G) personal communications system in addition to requesting certain cost data related to migrating NASA operations from the 1755-1850 MHz band.

Action is underway by Agency Spectrum Management personnel who, as per your direction, are compiling both the actual value of our overall infrastructure of radiocommunications systems relying on use of the band, and the marginal costs of relocating these systems to other suitable spectrum areas in the time frame proscribed. This information will be provided to Mr. W. Russell Slye by Mr. James Hollansworth to meet your November 15, 2000 deadline.

If we can be of further assistance, please advise.

Sincerely,

--Original Signed--

Joseph H. Rothenberg
Associate Administrator
for Space Flight

cc:
GRC/54-2/Mr. J. Hollansworth
DOC/Mr. W. Slye

From- James E Hollanswofth <James.E.Hollansworth@lerc.nasa.gov>
To: <RSLYE@ntia.doc.gov>, <David.Struba@hq.nasa.gov>
Date: Wed, Nov 15,2000 5:31 PM
Subject: Action Item M/2000-00948, 3rd Generation (3G) Personal Communication System

Dave:

The following NASA frequencies are in the indicated IMT-2000 Band 1755-1850 MHz. Below is the partial information you requested. I am awaiting input from Dryden Flight Research Center and Wallops Flight Facility.

Johnson Space Center

Number	Center Frequency	Center	Indicated Use
NASA840033	1763.000000	JSC	NSTS Payload Integration. DoD payload frequency. No cost involved on this frequency.

Langley Research Center

Number	Center Frequency	Center	Indicated Use
NASA940130	1780.500000	LARC	Uplink Data Transmission
NASA760222	1804.500000	LARC	Air-to-Ground Command
NASA940173	1804.500000	LARC	Air-to-Ground Telecommand
NASA900122	1820.000000	LARC	Free Flight
NASA900123	1835.500000	LARC	Scale Model Aircraft Research
NASA940174	1835.500000	LARC	Scale Model Aircraft Research

Blended Wing Body at Langley and at Dryden. This link is imperative because the Blended Wing Body Low Speed Vehicle (LSV) is a remotely piloted research aircraft to be flown at Edwards AFB in 2001. Langley is impacted because the LSV is being built at Langley and all systems are integrated here.

Langley move costs would be approximately the following:

Design, Equipment and Installation $ 500,000.00.
each aircraft antenna, transmitters and receivers/demodulators $ 50,000.00 ea.
Move Costs will depend upon frequency availability and assignment.

Kennedy Space Center

Number	Center Frequency	Center	Indicated Use
NASA980091	1800.000000	KSC	CLIM

Cost of existing equipment is estimated at $ 20,000.00. No estimated replacement cost available at this time.

Kennedy Space Center

Number	Center Frequency	Center	Indicated Use
NASA970062	1846.000000	KSC	Video Link-Hazardous Ops Robot

Andros Hazardous Duty Robotics System plus additional equipment costs

$22,000.00. Hardware replacement cost and moving system are estimated to be $35,000.00-$40,000.00. Additional costs not determined are research, procurement and support equipment.

Wallops Flight Facility

Number	Center FrequencyCenter	Indicated Use	
NASA800313	1771.000000	WFF	Balloon
NASA800314	1780.000000	WFF	Balloon
NASA800320	1780.000000	WFF	Balloon

NASA800313 1771 MHz (Palestine, TX) - This frequency is used extensively at Palestine, Texas, Fort Sumner, New Mexico, and abroad in support of wideband video.

NASA800314 1780 MHz (Wallops Island) - This frequency is used on occasion. With the new Ultra Long Duration Balloon (ULDB) program under development at Wallops, it is anticipated that there will be increased demands for use of this frequency.

The current estimated cost of existing equipment in these bands is as follows: 1. Transmitters $ 30,000.00 and 2. GSE $ 324,000.00.

If we have to relocate above 2299 MHz the cost could be as much as $ 2,000,000.00.

Dryden Flight Research Center

Number	Center FrequencyCenter	Indicated Use	
NASA940205	1804.500000	DFRC	Air-to-Ground PCM
NASA900149	1804.500000	DFRC	Remote Pilot Telemetry
NASA990018	1804.500000	DFRC	Remote Pilot Telemetry

Existing NASA equipment currently in this band costs:
Ground Support: $ 5 Million
Airborne: $ 0.2 Million

Relocation costs would be determined by where we must relocate. The higher the frequency the higher the cost. There would be a minimum of twelve months lead time to build the ground support equipment depending on the band or bands relocated to. Program delays would be significant if we are forced out of these bands.

Russ if you have any questions about the above material please feel free to call or e-mail me.

Jim Hollansworth

James E. Hollansworth Telephone: (216) 433-3458
Glenn Research Center FAX: (216) 977-7444

NASA 1755-1850 MHz Impact Assessment Summary

		Johnson Space Center	Langley Research Center	Kennedy Space Center	Wallops Flight Facility	Dryden Flight Research Center
Number Asgmts		1	6	2	3	3
Number Transmitters		NA	14	2	Info not submitted	9 (ground) 4 (airborne)
Number Receivers		NA	14	2	Info not submitted	24 (ground) 6 (airborne)
Estimated Original Cost		NA	$277,500.00	$42,000.00	$354,000.00	$5,000,000.00 (ground) $200,000 (airborne)
Estimated Equip Replacement Cost		NA	• $500,000.00 (Design, equipment, and installation estimated). • $50,000.00 (Aircraft antenna, transmitter and receive demodulators).	$40,000.00	$2,000,000.00 (If we have to relocate above 2290 MHz)	• $2,000,000.00 (Ground based if inband where equipment exists). • $10,000,000.00 (Ground based in new band and no equipment exists). • $200,000.00 (Airborne based if in band where equipment exists). • $1,000,000.00 (Airborne based in new band and no equipment exists).
Move Cost		NA	See note below	NA	NA	See note below
Impact Summary		NSTS Payload Integration. DoD payload frequency.	Blended Wing Body at Langley and at Dryden. This link is imperative because the Blended Wing Body Low Speed Vehicle (LSV) is a remotely piloted research aircraft to be flown at Edwards AFB in 2001. Langley and all systems are integrated here.		The balloon program has ongoing operations year around to collect high altitude atmospheric data. Requirements call for broadband real-time video and highspeed data. This program is an international effort between the US and Canada. This is the second time this program has been forced to move due commercialization of Government spectrum.	Program delays due to the inability to conduct timely testing can be extremely costly if we are forced out of these bands. Delays in testing can cause significant program cost overruns. Test delays typically could cost up to $100,000.00 a day (Source NASA White Paper).
Transition Time	Existing Band	NA	3-5 years	2 years	3-5 years	3-5 years
	New Band	NA	to 10 years	------------	to 10 years	to 10 years

NASA 1755-1850 MHz Impact Assessment Summary

	Johnson Space Center	Langley Research Center	Kennedy Space Center	Wallops Flight Facility	Dryden Flight Research Center
Other Remarks		Assignments include: 1 ea Facility for Uplink data transmission. 2 ea Freq for air-to-gnd cmd and telecmd. 1 ea Free flight. 2 ea Scales model aircraft research.	Assignments include: 1 ea CLIM	Assignments include: 1 ea Facility used extensively at Palestine, TX., Ft Sumner, NM, and abroad in support of wideband video.	Assignments include: 1 ea Facility for air-to-ground PCM. 2 ea Facility for remote pilot telemetry.

Note: Before total move costs can be determined, we must know what band we are moving to.

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DEPARTMENT OF THE TREASURY
WASHINGTON, D.C. 20220

Mr. Gregory L. Rohde
Administrator and Assistant Secretary
for Communications and Information
U.S. Department of Commerce
National Telecommunications &
Information Administration
HCHB, Room 4898
1401 Constitution Avenue, N.W.
Washington, D.C. 20230

November 14, 2000

Dear Mr. Rohde:

The Department of the Treasury operates a number of radio communications systems in the subject band, which support the law enforcement missions of several of our bureaus. The loss of any spectrum in the 1755-1850 MHz band would have a significant impact, both financially and operationally, on the ability to support the Department's statutory protective and investigative missions. Should the Treasury Bureaus be required to relocate from the current band, our costs are estimated to be just over $100 million. These costs are explained in more detail in Attachment One.

However, while we are concerned about the financial impact resulting from the loss of the subject spectrum, our primary concern is more focused on the operational impact on our bureaus' ability to continue their specific law enforcement and investigative activities.

As the remaining Federal spectrum becomes more congested, it becomes more difficult for Federal users to identify and allocate spectrum with the appropriate propagation characteristics to support broadband video and data requirements. We are confident the availability of commercially provided services will increase, and technology will continue to improve. As these commercial services become more cost effective, a significant portion of the communications requirements supporting operations in this band can be shifted, thus vacating a portion of this spectrum. However, specific investigative and protective support requirements cannot be fulfilled with commercially provided services.

While Treasury is a strong supporter of emerging wireless technology and fully endorses the activities to locate and provide spectrum for the Third Generation (3G) Technology, we must also remain focused on our commitment to continue the fight against crime and consider the impact to our Federal law enforcement mission, as well as the public safety community.

We look forward to being an active participant in the working group that has been formed to address potential spectrum support for future wireless technologies. Treasury will also continue our involvement with the National Telecommunications and Information Administration (NTIA) in the development of analysis and reports concerning the utilization of this spectrum and feasibility of reallocation.

We thank you for the opportunity to address this important matter. Please direct any questions concerning this matter to Mr. James Downes, of my staff, at (202) 622-1582 or via email at james.downes@cio.treas.gov.

Sincerely,

--Original Signed--

James J. Flyzik
Deputy Assistant Secretary (Information Systems)
and Chief Information Officer

Attachment

Attachment One
Specific Treasury Utilization

Specifically, the Department of the Treasury utilizes the following systems, which operate in the 1755 - 1850 MHz band:

a. The U.S. Customs Service operates and maintains an analog microwave system, commonly referred to as the Hawaii Rainbow Microwave System, which provides a 120-channel intra- and inter-island backbone system throughout the Hawaiian Islands. The system currently utilizes spectrum in the 1710-1850 MHz band. This system is a joint agency endeavor utilized by Federal, State, and local users. The primary users of the system include the U.S. Coast Guard, Drug Enforcement Administration, National Oceanic and Atmospheric Administration (Tsunami Warning System), State Forestry Service and Civil Defense, as well as some local police and emergency services. The system carries search, rescue, and emergency distress information and other high priority communications.

A portion of the spectrum used in the Rainbow System was protected from interference under the mixed use criteria established by Title VI of the Budget Reconciliation Act of 1993 and was included in the list of Federal stations that will remain in the 1710 - 1755 MHz band. We strongly urge that any reallocation efforts in the 1755 - 1850 MHz band include provisions to also protect this portion of the band.

However, due to the reallocation of this spectrum, manufacturers no longer support equipment and systems operating in this frequency band. This impacts the cost in two ways. First, as the system continues to become more obsolescent, replacement parts are increasingly scarce and maintenance costs continue to rise. Second, there are no possible alternatives to upgrade/replace the system and remain in the 1710-1850 MHz band. Consequently, a study has been initiated to evaluate and consider replacement alternatives. As a new digital microwave system is considered it becomes obvious that the system must operate in a higher frequency band, which will increase the number of required sites due to the propagation characteristics of the higher frequencies. This will directly impact the cost of the system, which is currently estimated to be approximately $46 million. Although other alternatives are being investigated, the life cycle costs are expected to be of similar proportions. The preliminary study is expected to be complete in February 2001 and further system considerations will be addressed at that time.

b. One Treasury Bureau maintains microwave systems at various sites in Dallas, Texas and Los Angeles, California. The systems provide broadband connectivity to land mobile radio (LMR) systems supporting investigative and law enforcement activities, as well as protection of national leaders and visiting heads of State. The Department of the Treasury is evaluating the alternatives for replacing these microwave links with commercially provided circuits. The current estimate for this replacement is $40,000 to $50,000 for installation and monthly recurring charges of approximately $120,000 per year. The recurring monthly charges will

be approximately $1.2 million over a ten-year life cycle, although we anticipate these costs would decrease as technology and commercial competition improves.

c. The bureaus within the Department of the Treasury deploy tactical microwave (video surveillance) systems throughout the United States and possessions for both protective operations and criminal investigations. Although our analysis has just begun, we anticipate the cost to replace these tactical microwave systems into another band would exceed $40 million, more than triple the current cost for the same systems operating in the 1755-1850 MHz. Treasury has plans to replace this equipment over the next four years and has a contract currently in place for this type equipment. However, current plans reflect replacement in the same band at an estimated cost of $11.8 million.

Operational Impacts

While the cost impact is not insignificant, Treasury is more concerned with the operational impact that would be experienced should this band be reallocated. This is particularly true with the technical investigative activities supported with tactical microwave. The only available spectrum that could support the bandwidth for these activities is in the higher ranges above 4 GigaHertz, which becomes extremely problematic with range and antenna size. As the operating frequency increases, the directional orientation of the antennas becomes paramount and the coverage range also diminishes. Additional time and technical expertise will be necessary for the installation and use of tactical microwave. Not only will low profile surveillance activities become very expensive, the technology will put investigative operations at risk and jeopardize undercover missions.

We are extremely concerned that the loss of additional spectrum in this particular band will seriously impact our ability to continue our law enforcement and protective missions within not only the Department of the Treasury, but the entire Federal law enforcement community.

DEPARTMENT OF THE TREASURY
Washington, D.C.

March 5, 2001

Mr. W. Russell Slye
Manager, Strategic Spectrum
Planning Program
National Telecommunications &
Information Administration
HCHB, Room 4082
1401 Constitution Avenue, NW
Washington, D.C. 20230

Re: Mr. James Flyzik's Nov. 14, 2000 letter responding to Mr. Rohde's June 19, 2000 letter

Dear Mr. Slye:

This letter revises the referenced letter and responds to questions raised by Messrs. Patrick and Druhan after the January 23, 2001 Interdepartment Radio Advisory Committee meeting. The questions concerned Mr. James Flyzik's, Treasury Deputy Assistant Secretary (Information Systems) and Chief Information Officer, response to Assistant Secretary Rohde's June 19, 2000 letter, concerning the impact of possible reallocation of the 1755-1850 MHz band.

The Department of the Treasury bureaus' inability to continue utilizing the 1755 -1850 MHz band would have a detrimental effect on their ability to perform their statutory protective and investigative missions. The Department operates a number of radio communication systems in this band, particularly technical investigative activities supported with tactical microwave. Although the replacement bands have not been identified, the relatively wide bandwidth required for video surveillance activities will likely require these sensitive operations to move to higher bands. As you are aware, the propagation characteristics in a higher frequency band will significantly reduce the operating range and thus likely increase the cost of replacement systems. Although relocating Treasury's surveillance operations to another band would be a relatively expensive cost, it is not the primary concern. The primary interest is the additional risk to undercover missions that may unnecessarily endanger agents' lives and jeopardize mission integrity.

The following table lists Treasury's current use of frequencies by system and frequency sub-bands as discussed in phone conversations with Mr. Patrick.

System	1755 - 1780 MHz	1780 - 1790 MHz	1790 - 1805 MHz	1805 - 1850 MHz
Rainbow Microwave (para. b)	2		1	4
Fixed Microwave (para. c)	2	1	1	3
Tactical Microwave (para. D)	5	1	5	7
Aeronautical (para. e)	1	1		
Total	10	3	7	14

Response to the specific questions follows:

a. *Why is there a discrepancy between "just over $100 million" estimate and the total of $87.2 million listed in Attachment One?* Both of the amounts in the referenced letter were incorrect, the correct total estimate should be $88.5 million. The $100 million estimate listed in the first paragraph did not accurately reflect the estimated costs listed in attachment one of the original letter and the costs for the aeronautical systems were not included in the previous estimates. The revised estimates are listed in the following paragraphs.

b. *Coast Guard's estimate for their portion of the total cost of the Rainbow Microwave System is $12 million, how much should Treasury's portion of the total cost ($47 million) be?* The total cost for replacing the Rainbow system includes $9 million for site enhancements for upgrading the LMR network in Hawaii. The Coast Guard, along with the Departments of the Treasury and Justice, are currently the primary Federal users of the Rainbow Network and generally divide the system costs evenly. Coast Guard, however, does not have an LMR requirement in Hawaii, so they are proposing to pay one-third of the non-LMR portion of the Rainbow Digital Project which totals approximately $12 million. Treasury's portion of the replacement cost would be $35 million, however, Treasury will likely request the total $47 million project cost and will seek reimbursement from the other participating agencies.

c. *What are the estimated costs for the fixed microwave systems?* Treasury maintains microwave systems at various sites in Texas and California. The systems provide broadband connectivity to land mobile radio (LMR) systems supporting investigative and law enforcement activities, as well as protection of national leaders and visiting dignitaries. The Treasury Department is evaluating the alternatives for replacing these microwave links with commercially provided circuits. The current estimate for this replacement is $40,000 to $50,000 for installation and monthly recurring charges of approximately $120,000 per year. The recurring monthly charges will be approximately $1.2M over a ten-year life cycle, although we anticipate these costs would decrease as technology and commercial competition continues to emerge.

d. *Explain the reasons for "…more than triple the current cost for the same systems operating in the 1755 - 1850 MHz band."* There are several reasons for tripling the cost of the current systems in the band. First, the tactical microwave systems used by Treasury in this band are very specialized and designed to operate in the spectrum allocated for Federal government use. Currently, there are limited manufacturers of tactical microwave systems in higher bands due to the limited market for tactical microwave systems. Consequently, potential manufacturers are unwilling to invest resources for research and development without compensation. Second, operating in these higher frequency bands will diminish the range of equipment, so more equipment will likely be required to maintain equivalent capability. Further, it must be emphasized that the propagation and beamwidth characteristics of the antennas will likely endanger the covert nature of the undercover operations and jeopardize the mission and possibly the lives of the agents/officers. Currently, initial estimates from potential manufacturers are about $40 million, including R&D costs.

e. *What are Treasury's aeronautical requirements?* Treasury uses data from these systems for its border law enforcement activities. The U.S. Air Force's Air Combat Command Project Office currently manages this project, but Treasury is expecting to assume program management responsibilities in the near future. The Air Force estimates the costs for relocating systems out of the 1755 - 1850 MHz band to be between $250,000 and $300,000.

We thank you for the opportunity to address this important matter. Please direct any questions or comments concerning this matter to me or Ralph Robles at (202) 622-1582 or via email at james.downes@cio.treas.gov or ralph.robles@cio.treas.gov.

Sincerely,

--Original Signed--

James E. Downes
Assistant Director, Wireless

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Appendix C

Frequency Assignment Tables by State/Location

The following tables list the frequency assignments of the Federal Agencies by state, number of assignments, Federal agency, and station class. Assignments are listed for both the 1710-1755 MHz band and the 1755-1850 MHz band. The assignments are taken from the Government Master File of January 2001. Glossaries of abbreviations used may be found following the tables.

1710-1755 MHz

STATE/ LOCATION	No.	AGENCY	STATION CLASS
AK	2	AF	FX
AK	48	AR	FX
AK	5	CG	FX
AK	7	FAA	FX
AK	6	I	FX
TOTAL	68		
AL	22	AR	FX
AL	1	AR	XD
AL	2	AR	XT
AL	2	I	FX
AL	2	J	FX
AL	4	TVA	FX
TOTAL	33		
AR	12	A	FX
AR	30	AR	FX
AR	10	DOE	FX
AR	1	N	MOEA
TOTAL	53		
AZ	55	A	FX
AZ	7	AF	FX
AZ	5	AR	FX
AZ	2	AR	MOEA
AZ	13	DOE	FX
AZ	1	FAA	FX
AZ	2	I	FX
AZ	11	J	FX
AZ	1	N	FX
AZ	2	N	FXE
AZ	3	N	MAD
AZ	2	N	MOEB
AZ	1	SI	FX
TOTAL	105		
BAH	1	FAA	FX
TOTAL	1		
CA	95	A	FX
CA	1	AF	FX
CA	1	AF	FXD
CA	4	AF	XD
CA	31	AR	FX
CA	1	AR	ML
CA	2	AR	XT
CA	1	C	FX
CA	5	CG	FX
CA	9	DOE	FX
CA	11	FAA	FX
CA	7	I	FX
CA	1	I	FXE
CA	28	J	FX
CA	24	N	FX
CA	9	N	MAD
CA	1	N	ML
CA	12	N	MOEA
CA	5	N	MOEB
CA	1	N	MOEB
CA	1	N	MOEC
CA	1	NASA	MOEA
CA	2	T	FX
TOTAL	253		
CAN	2	N	FX
TOTAL	2		
CO	25	A	FX
CO	18	AR	FX
CO	3	C	FX
CO	12	DOE	FX
CO	3	FAA	FX
CO	7	I	FX
CO	1	TRAN	FLEC
TOTAL	69		
CT	1	AR	FX
TOTAL	1		
DC	1	AR	MA
TOTAL	1		
FL	7	AF	FX
FL	3	AF	MA
FL	1	AF	MAD
FL	1	AF	MLD
FL	2	AF	MO
FL	1	AF	MOEB
FL	1	AF	XD
FL	4	AF	XD
FL	1	AF	XT
FL	1	AR	MOEB
FL	3	J	FX
FL	4	N	MOEA
FL	2	N	MOEB
TOTAL	31		

1710-1755 MHz

STATE/ LOCATION	No.	AGENCY	STATION CLASS
GA	18	A	FX
GA	1	AF	FX
GA	9	AR	FX
GA	1	AR	XT
GA	3	FAA	FX
GA	12	J	FX
GA	2	N	FX
GA	1	TVA	FX
TOTAL	47		
GLM	4	AF	FX
TOTAL	4		
GUM	2	FAA	FX
TOTAL	2		
HI	2	C	FX
HI	1	CG	FX
HI	8	FAA	FX
HI	8	N	FX
HI	7	T	FX
TOTAL	26		
IA	10	AR	FX
IA	1	DOE	FX
TOTAL	11		
ID	34	A	FX
ID	1	AR	FX
ID	9	DOE	FX
ID	1	FAA	FX
TOTAL	45		
IL	12	AR	FX
TOTAL	12		
IN	1	AF	MOEA
IN	1	AR	FX
TOTAL	2		
KS	1	AR	FX
TOTAL	1		
KY	16	AR	FX
KY	4	TVA	FX
TOTAL	20		
LA	55	AR	FX
LA	1	J	FX
LA	2	N	MOEA
LA	1	VA	FX
TOTAL	59		
MA	1	AR	FX
TOTAL	1		
MD	1	AR	FX
MD	1	AR	ML
MD	2	N	FX
MD	3	N	MOEA
TOTAL	7		
ME	1	N	FXD
TOTAL	1		
MN	10	AR	FX
MN	7	DOE	FX
MN	1	FAA	FX
TOTAL	18		
MO	1	AF	XT
MO	21	AR	FX
MO	3	AR	XT
MO	8	DOE	FX
MO	4	FAA	FX
TOTAL	37		
MS	20	AR	FX
MS	1	FAA	FX
MS	7	I	FX
MS	4	TVA	FX
TOTAL	32		
MT	5	A	FX
MT	1	C	FX
MT	23	DOE	FX
MT	1	FAA	FX
TOTAL	30		

1710-1755 MHz

STATE/ LOCATION	No.	AGENCY	STATION CLASS
NC	12	A	FX
NC	1	AR	FX
NC	2	C	FX
NC	6	I	FX
NC	10	N	FX
NC	1	N	FXD
NC	3	N	MAD
NC	24	N	ML
TOTAL	59		
ND	1	AF	FX
ND	22	DOE	FX
TOTAL	23		
NE	20	AR	FX
NE	10	DOE	FX
TOTAL	30		
NJ	4	AR	FX
NJ	3	FAA	FX
NJ	1	N	MA
TOTAL	8		
NM	65	A	FX
NM	2	AF	MAD
NM	7	AR	FLE
NM	7	AR	FX
NM	1	AR	FX
NM	4	DOE	FX
NM	4	FAA	FX
NM	3	I	FX
NM	7	J	FX
NM	2	N	MOEB
NM	1	T	MOEB
TOTAL	103		
NV	5	A	FX
NV	6	AF	FX
NV	2	AF	FXD
NV	3	AR	FX
NV	8	DOE	FX
NV	2	DOE	MA
NV	1	DOE	ML
NV	1	DOE	MOD
NV	6	FAA	FX
NV	3	I	FX

STATE/ LOCATION	No.	AGENCY	STATION CLASS
NV	3	J	FX
NV	3	N	MAD
TOTAL	43		
NY	8	AR	FX
NY	3	N	FX
TOTAL	11		
OH	1	AF	MOEA
OH	1	N	FX
TOTAL	2		
OK	5	AR	FX
OK	2	C	FX
OK	15	DOE	FX
OK	1	FAA	FX
TOTAL	23		
OR	31	A	FX
OR	4	AR	FX
OR	1	C	FX
OR	3	CG	FX
OR	14	DOE	FX
OR	2	FAA	FX
TOTAL	55		
PA	2	AR	FX
PA	11	J	FX
TOTAL	13		
PR	5	AR	FX
PR	4	CG	FX
PR	9	FAA	FX
PR	3	J	FX
PR	1	N	FXE
PR	1	N	MOEA
TOTAL	23		
RI	1	N	MOEA
RI	1	N	XT
TOTAL	2		
SC	11	AR	FX
SC	1	N	FX
SC	3	N	MAD
TOTAL	15		

1710-1755 MHz

STATE/ LOCATION	No.	AGENCY	STATION CLASS
SD	1	A	FX
SD	42	DOE	FX
TOTAL	43		
SMA	2	FAA	FX
SMA	3	I	FX
TOTAL	5		
TN	16	A	FX
TN	3	AR	FX
TN	1	DOE	ML
TN	1	I	FX
TN	21	TVA	FX
TOTAL	42		
TX	1	AF	FX
TX	1	AR	FLEC
TX	26	AR	FX
TX	5	AR	XT
TX	1	CG	FX
TX	3	DOE	FX
TX	2	FAA	FX
TX	1	FEMA	FX
TX	27	J	FX
TX	1	NASA	FX
TX	1	T	FX
TOTAL	69		
USA	45	AR	FX
USA	10	FEMA	FX
USA	1	HUD	FX
USA	1	NASA	MOEB
TOTAL	57		
USP	3	J	FX
USP	1	J	FX
USP	8	T	FX
USP	1	T	MA
USP	1	USPS	FX
TOTAL	14		
UT	30	A	FX
UT	6	AF	FX
UT	1	AF	FXD
UT	1	AF	MAD
UT	6	AR	FX
UT	1	I	FX
TOTAL	45		

STATE/ LOCATION	No.	AGENCY	STATION CLASS
VA	17	A	FX
VA	3	AR	FX
VA	3	FAA	FX
VA	4	FEMA	FX
VA	6	I	FX
VA	3	N	FX
VA	3	N	MAD
VA	3	N	MOEA
VA	2	NASA	MOEA
TOTAL	44		
VI	10	FAA	FX
TOTAL	10		
WA	31	AR	FX
WA	14	CG	FX
WA	11	DOE	FX
WA	3	FAA	FX
WA	3	N	FX
TOTAL	62		
WI	15	AR	FX
WI	1	J	FX
TOTAL	16		
WY	9	A	FX
WY	18	DOE	FX
WY	9	I	FX
TOTAL	36		

1755-1850 MHz

STATE/ LOCATION	No.	AGENCY	STATION CLASS
AK	31	AF	FLEB
AK	71	AF	FX
AK	5	AF	MOEB
AK	99	AR	FX
AK	1	AR	FXD
AK	1	C	TD
AK	15	CG	FX
AK	1	DOE	TC
AK	13	FAA	FX
TOTAL	237		
AL	34	AR	FX
AL	1	AR	MA
AL	1	AR	MOEA
AL	4	AR	XT
AL	1	J	ML
AL	9	TVA	FX
TOTAL	50		
AR	18	A	FX
AR	1	AF	ML
AR	43	AR	FX
AR	26	DOE	FX
AR	1	N	MOEA
TOTAL	89		
AZ	60	A	FX
AZ	1	AF	FA
AZ	8	AF	FLEB
AZ	21	AF	FX
AZ	1	AF	ML
AZ	1	AF	MOEA
AZ	1	AF	MOEB
AZ	18	AR	FX
AZ	1	AR	MA
AZ	1	AR	ML
AZ	1	AR	MOEB
AZ	30	DOE	FX
AZ	1	FAA	FX
AZ	26	I	FX
AZ	14	J	FX
AZ	13	N	FLEB
AZ	4	N	FX
AZ	32	N	FXE
AZ	2	N	MAD
AZ	5	N	MOEB
AZ	1	SI	FX
TOTAL	242		
BAH	1	FAA	FX
TOTAL	1		
CA	194	A	FX
CA	20	AF	FLEB
CA	64	AF	FX
CA	1	AF	FXD
CA	2	AF	ML
CA	10	AF	MOEA
CA	5	AF	MOEB
CA	41	AF	TD
CA	2	AF	TK
CA	8	AF	XD
CA	40	AF	XT
CA	5	AR	FLEB
CA	101	AR	FX
CA	4	AR	ML
CA	2	AR	XT
CA	4	C	FX
CA	5	CG	FX
CA	13	DOE	FX
CA	4	DOE	ML
CA	33	FAA	FX
CA	34	I	FX
CA	1	I	FXE
CA	43	J	FX
CA	1	N	FLEB
CA	50	N	FX
CA	4	N	FXE
CA	6	N	MAD
CA	3	N	ML
CA	1	N	MO
CA	1	N	MOE
CA	35	N	MOEA
CA	15	N	MOEB
CA	1	N	MOEC
CA	2	N	MS
CA	2	NASA	FAT
CA	3	NASA	FX
CA	3	NASA	MOEA
CA	4	T	FX
TOTAL	767		
CAN	1	N	FX
TOTAL	1		
CO	38	A	FX
CO	18	AF	TD
CO	1	AF	TK
CO	40	AR	FX
CO	1	C	FX
CO	19	DOE	FX
CO	1	DOE	ML
CO	15	FAA	FX
CO	7	I	FX
CO	2	NSF	FXE
TOTAL	142		
CT	2	AR	FX
TOTAL	2		

1755-1850 MHz

STATE/ LOCATION		No.	AGENCY	STATION CLASS
DC		1	AR	FX
DC		1	J	FX
DC		1	USCP	FX
	TOTAL	3		
DE		1	AF	MOEC
DE		1	AR	FX
	TOTAL	2		
DGA		20	AF	TD
	TOTAL	20		
FL		9	AF	FLEB
FL		2	AF	FLEC
FL		9	AF	FX
FL		1	AF	FXE
FL		4	AF	MA
FL		1	AF	MAD
FL		4	AF	ML
FL		5	AF	MLD
FL		3	AF	MO
FL		5	AF	MOEB
FL		6	AF	MOEC
FL		18	AF	TD
FL		10	AF	XD
FL		2	AF	XT
FL		1	AR	MR
FL		8	FAA	FX
FL		4	J	FX
FL		6	N	FLEA
FL		18	N	FXE
FL		5	N	MOEA
FL		8	N	MOEB
FL		1	NASA	FL
FL		1	NASA	ML
	TOTAL	131		
G		20	AF	TD
	TOTAL	20		
GA		25	A	FX
GA		1	AF	FX
GA		29	AR	FX
GA		1	AR	XT
GA		6	FAA	FX
GA		20	J	FX
GA		1	N	FX
GA		1	T	FX
GA		1	TVA	FX
	TOTAL	85		
GLM		2	AF	FA
GLM		11	AF	FLEB
GLM		37	AF	FX
GLM		2	AF	MOEB
	TOTAL	52		
GUM		1	AF	MO
GUM		21	AF	TD
GUM		4	FAA	FX
	TOTAL	26		
HI		2	AF	FX
HI		20	AF	TD
HI		1	AR	FX
HI		1	AR	MOEB
HI		2	C	FX
HI		1	CG	FX
HI		24	FAA	FX
HI		6	N	FX
HI		1	N	ML
HI		1	N	MO
HI		7	T	FX
	TOTAL	66		
IA		25	AR	FX
IA		5	DOE	FX
	TOTAL	30		
ID		55	A	FX
ID		1	AF	ML
ID		3	AR	FX
ID		15	DOE	FX
ID		3	DOE	ML
ID		2	FAA	FX
	TOTAL	79		
IL		1	AF	MOEC
IL		26	AR	FX
IL		2	FAA	FX
	TOTAL	29		
IN		1	N	ML
	TOTAL	1		
KS		1	AF	MO
	TOTAL	1		
KY		55	AR	FX
KY		9	TVA	FX
	TOTAL	64		
LA		1	AF	ML
LA		103	AR	FX
LA		9	CG	FX
LA		1	J	FX
LA		2	N	MOEA
	TOTAL	116		

1755-1850 MHz

STATE/ LOCATION	No.	AGENCY	STATION CLASS
LANT	4	N	FLEA
LANT	19	N	FLEB
LANT	1	N	FX
LANT	31	N	FXE
TOTAL	55		
MA	2	AF	XT
MA	3	AR	FX
MA	2	FAA	FX
MA	9	J	FX
TOTAL	16		
MD	1	AF	XD
MD	2	AR	FX
MD	3	AR	ML
MD	2	C	ML
MD	1	HHS	FX
MD	1	N	FLEA
MD	5	N	FX
MD	3	N	MOEA
MD	2	N	MOEB
MD	20	N	TD
TOTAL	40		
ME	10	J	FX
ME	1	N	FX
TOTAL	11		
MHL	1	AF	TD
TOTAL	1		
MI	1	AF	MOEA
TOTAL	1		
MN	20	AR	FX
MN	13	DOE	FX
MN	1	FAA	FX
TOTAL	34		
MO	1	AF	XD
MO	32	AR	FX
MO	3	AR	XT
MO	17	DOE	FX
MO	8	FAA	FX
TOTAL	61		
MT	9	A	FX
MT	1	AF	ML
MT	5	AR	FX
MT	2	C	FX
MT	50	DOE	FX
MT	3	FAA	FX
TOTAL	70		
NC	29	A	FX
NC	2	AF	ML
NC	1	AR	XT
NC	4	FEMA	FX
NC	3	I	FX
NC	7	N	FLEA
NC	26	N	FLEB
NC	22	N	FX
NC	65	N	FXE
NC	2	N	MAD
NC	18	N	ML
NC	35	N	MO
NC	1	N	MOEA
NC	12	N	MOEB
TOTAL	227		
ND	1	AF	ML
ND	39	DOE	FX
TOTAL	40		
NE	20	AR	FX
NE	15	DOE	FX
TOTAL	35		
NH	22	AF	TD
NH	74	AR	FX
NH	2	J	FX
TOTAL	98		
NJ	1	AF	MOEC
NJ	4	AR	FX
NJ	1	C	FX
NJ	5	FAA	FX
NJ	1	J	FX
NJ	1	N	MOEB
TOTAL	13		
MS	7	AF	FLEB
MS	9	AF	FX
MS	19	AR	FX
MS	3	FAA	FX
MS	12	I	FX
MS	11	TVA	FX
TOTAL	61		

1755-1850 MHz

STATE/ LOCATION	No.	AGENCY	STATION CLASS
NM	66	A	FX
NM	2	AF	MA
NM	3	AF	MAD
NM	1	AF	MOEB
NM	20	AF	TD
NM	1	AF	XD
NM	1	AF	XT
NM	3	AR	FLE
NM	12	AR	FX
NM	1	AR	MA
NM	2	AR	MOEA
NM	3	AR	MR
NM	6	DOE	FX
NM	1	DOE	ML
NM	1	DOE	XT
NM	12	FAA	FX
NM	18	I	FX
NM	16	J	FX
NM	2	N	MOEB
NM	2	T	FAD
NM	1	T	FX
TOTAL	174		
NV	6	A	FX
NV	2	AF	FA
NV	27	AF	FLEB
NV	146	AF	FX
NV	3	AF	FXD
NV	1	AF	FXE
NV	1	AF	ML
NV	4	AF	MOEB
NV	2	AF	XD
NV	6	AF	XT
NV	3	AR	FX
NV	17	DOE	FX
NV	2	DOE	FXE
NV	1	DOE	ML
NV	18	FAA	FX
NV	1	I	FX
NV	5	J	FX
NV	26	N	FLEA
NV	23	N	FLEB
NV	87	N	FXE
NV	2	N	MAD
NV	3	N	MOEB
TOTAL	386		
OK	1	AR	FLD
OK	32	AR	FX
OK	3	C	FX
OK	22	DOE	FX
OK	3	FAA	FX
TOTAL	61		

STATE/ LOCATION	No.	AGENCY	STATION CLASS
OR	47	A	FX
OR	10	AR	FX
OR	2	C	FX
OR	6	CG	FX
OR	33	DOE	FX
OR	4	FAA	FX
TOTAL	102		
PA	3	AR	FX
PA	2	FEMA	FX
PA	25	J	FX
TOTAL	30		
PR	13	AR	FX
PR	2	CG	FX
PR	20	FAA	FX
PR	5	J	FX
PR	3	N	MOEA
TOTAL	43		
RI	1	J	FX
TOTAL	1		
SC	1	AF	MOEC
SC	19	AR	FX
SC	2	DOE	MA
SC	1	DOE	ML
SC	2	N	FLEB
SC	2	N	FX
SC	2	N	MAD
SC	1	N	MO
SC	1	N	MOD
SC	2	N	MOEB
TOTAL	33		
SD	2	A	FX
SD	75	DOE	FX
TOTAL	77		
SMA	2	FAA	FX
SMA	4	I	FX
TOTAL	6		
SPCE	1	NASA	ED
TOTAL	1		
NY	35	AR	FX
NY	6	CG	FX
NY	9	N	FX
TOTAL	50		
OH	1	N	FX
TOTAL	1		

1755-1850 MHz

STATE/ LOCATION	No.	AGENCY	STATION CLASS
TN	21	A	FX
TN	4	AR	FX
TN	2	DOE	FX
TN	5	DOE	ML
TN	4	I	FX
TN	34	TVA	FX
TOTAL	70		
TX	1	AF	FX
TX	2	AF	ML
TX	20	AF	TD
TX	8	AF	XT
TX	2	AR	FLD
TX	49	AR	FX
TX	9	AR	XT
TX	1	CG	FX
TX	5	DOE	FX
TX	2	FAA	FX
TX	1	FEMA	FX
TX	62	J	FX
TX	3	T	FX
TOTAL	165		
USA	3	A	FX
USA	1	AID	FX
USA	93	AR	FX
USA	2	DOE	FX
USA	1	EPA	FX
USA	1	HHS	MLP
USA	5	HUD	FX
USA	1	L	FX
USA	3	NASA	MOEB
USA	1	NRC	FX
TOTAL	111		
VA	24	A	FX
VA	1	AR	MOEA
VA	3	FAA	FX
VA	4	FEMA	FX
VA	3	I	FX
VA	3	J	FX
VA	5	N	FC
VA	8	N	FX
VA	2	N	MAD
VA	1	N	MO
VA	3	N	MOEA
VA	1	N	MOEB
VA	20	N	TD
VA	5	NASA	FAD
VA	1	NASA	MOEA
TOTAL	84		
VI	1	CG	FX
VI	14	FAA	FX
TOTAL	15		

STATE/ LOCATION	No.	AGENCY	STATION CLASS
WA	4	A	FX
WA	1	AF	MO
WA	1	AF	MOEC
WA	63	AR	FX
WA	25	CG	FX
WA	42	DOE	FX
WA	3	DOE	ML
WA	3	FAA	FX
WA	2	J	FX
WA	5	N	FX
WA	1	N	MAD
TOTAL	150		
WI	1	AF	FLEB
WI	1	AF	FXE
WI	17	AR	FX
WI	1	J	FX
TOTAL	20		
WV	2	FEMA	FX
TOTAL	2		
USP	1	HUD	FX
USP	10	J	FX
USP	5	J	ML
USP	15	T	FX
USP	1	T	MA
USP	2	USPS	FX
TOTAL	34		
UT	57	A	FX
UT	10	AF	FX
UT	1	AF	MAD
UT	1	AF	ML
UT	2	AF	MOEA
UT	10	AR	FX
UT	1	AR	MR
UT	1	DOE	FX
UT	7	I	FX
TOTAL	90		
WY	13	A	FX
WY	31	DOE	FX
WY	13	I	FX
TOTAL	57		

Station Class Definitions

FA--Aeronautical Station: A land station in the aeronautical mobile service. In certain instances, an aeronautical station may be located, for example on board ship or on a platform at sea. (RR)

FAD--Telecommand Aeronautical Station: A land station in the aeronautical mobile service the emissions of which are used for terrestrial telecommand.

FAT--Flight Test Station: An aeronautical station used for the transmission of essential communications in connection with the testing of aircraft or major components of aircraft.

FC--Coast Station: A land station in the maritime mobile service. (RR)

FL--Land Station: A station in the mobile service not intended to be used while in motion. (RR)

FLD--Telecommand Land Station: A land station in the mobile service the emissions of which are used for terrestrial telecommand.

FLE--Telemetering Land Station: A land station the emissions of which are used for telemetering.

FLEA--Aeronautical Telemetering Land Station: A telemetering land station used in the flight testing of manned or unmanned aircraft, missiles, or major components thereof.

FLEB--Flight Telemetering Land Station: A telemetering land station the emissions of which are used for telemetering to a balloon; to a booster or rocket, excluding a booster or rocket in orbit about the Earth or in deep space; or to an aircraft, excluding a station used in the flight testing of an aircraft.

FLEC--Surface Telemetering Land Station: A telemetering land station the emissions of which are intended to be received on the surface of the Earth.

FX--Fixed Station: A station in the fixed service. (RR)

FXE--Telemetering Fixed Station: A fixed station the emissions of which are used for telemetering.

LR--Radiolocation Land Station: A station in the radiolocation service not intended to be used while in motion. (RR)

MA--Aircraft Station: A mobile station in the aeronautical mobile service other than a survival craft station, located on board an aircraft. (RR)

MAD--Telecommand Aircraft Station: A mobile station in the aeronautical mobile service the emissions of which are used for terrestrial telecommand.

ML--Land Mobile Station: A mobile station in the land mobile service capable of surface movement within the geographical limits of a country or continent. (RR)

MLD--Telecommand Land Mobile Station: A mobile station in the land mobile service the emissions of which are used for terrestrial telecommand.

MLP--Portable Land Mobile Station: A portable station operating in the land mobile service.

MO--Mobile Station: A station in the mobile service intended to be used while in motion or during halts at unspecified points. (RR)

MOD--Telecommand Mobile Station: A mobile station in the mobile service the emissions of which are used for terrestrial telecommand.

MOE--Telemetering Mobile Station: A mobile station the emissions of which are used for telemetering.

MOEA--Aeronautical Telemetering Mobile Station: A telemetering mobile station used for transmitting data directly related to the airborne testing of the vehicle, (or major components), on which the station is installed.

MOEB--Flight Telemetering Mobile Station: A telemetering mobile station used for transmitting data from an airborne vehicle, excluding data related to airborne testing of the vehicle itself, (or major components thereof).

MOEC--Surface Telemetering Mobile Station: A telemetering mobile station located on the surface of the Earth and the emissions of which are intended to be received on the surface of the Earth.

MR--Radiolocation Mobile Station: A station in the radiolocation service intended to be used while in motion or during halts at unspecified points. (RR)

MS--Ship Station: A mobile station in the maritime mobile service located on board a vessel which is not permanently moored, other than a survival craft station. (RR)

TC--Fixed-Satellite Earth Station: An earth station in the fixed-satellite service. (RR)

TD--Space Telecommand Earth Station: An earth station the emissions of which are used for space telecommand.

TK--Space Tracking Earth Station: An earth station which transmits or receives emissions used for space tracking.

XD--Experimental Developmental Station: An experimental station used for evaluation or testing of electronics equipment or systems in a design or development stage.

XT--Experimental Testing Station: An experimental station used for the evaluation or testing of electronics equipment or systems, including site selection and transmission path surveys, which have been developed for operational use.

Geographical Abbreviations

AK	Alaska
AL	Alabama
AR	Arkansas
AZ	Arizona
BAH	Bahamas (Commonwealth of the)
CA	California
CAN	Canada
CO	Colorado
CT	Connecticut
DC	District of Columbia
DE	Delaware
DGA	Diego Garcia
FL	Florida
GA	Georgia
GLM	Gulf of Mexico
GUM	Guam
HI	Hawaii
IA	Iowa
ID	Idaho
IL	Illinois
IN	Indiana
KS	Kansas
KY	Kentucky
LA	Louisiana
LANT	Atlantic Ocean
MA	Massachusetts
MD	Maryland
ME	Maine
MHL	Marshall Islands
MI	Michigan
MN	Minnesota
MO	Missouri
MS	Mississippi
MT	Montana
NC	North Carolina
ND	North Dakota
NE	Nebraska
NH	New Hampshire
NJ	New Jersey
NM	New Mexico
NV	Nevada
NY	New York
OH	Ohio
OK	Oklahoma
OR	Oregon
PR	Puerto Rico (including Culebra, Mona, and Vieques)
PA	Pennsylvania
RI	Rhode Island
SC	South Carolina
SD	South Dakota
SMA	American Samoa
SPCE	Space
TN	Tennessee
TX	Texas
UT	Utah
USA	For use only when transmitting and/or receiving in the 48 Contiguous States of the United States and the District of Columbia (This excludes Alaska and Hawaii)
USP	For use only when transmitting and/or receiving throughout the US (50 States and District of Columbia), the Commonwealth of Puerto Rico, and the Territories and Possessions. (does not include the former Trust Territory of the Pacific Islands)
VA	Virginia
VT	Vermont
WA	Washington
WI	Wisconsin
WV	West Virginia
WY	Wyoming

Abbreviations for the Federal Entities as used in this Appendix

A	Department of Agriculture
AID	Agency for International Development
AF	Department of the Air Force
AR	Department of the Army
FAA	Federal Aviation Administration
C	Department of Commerce
CG	United States Coast Guard
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
HHS	Department of Health and Human Services
HUD	Department of Housing and Urban Development
I	Department of the Interior
J	Department of Justice
L	Department of Labor
N	Department of the Navy
NASA	National Aeronautics and Space Administration
NRC	Nuclear Regulatory Commission (Now DOE)
NSF	National Science Foundation
T	Department of the Treasury
TVA	Tennessee Valley Authority
USPS	United States Postal Service
VA	Department of Veterans Affairs

Appendix D

DOD Final Report

Department of Defense
Investigation of the Feasibility of Accommodating the
International Mobile Telecommunications (IMT) 2000
Within the 1755-1850 MHz Band

This report is printed separately as Appendix D (less Attachment 1) to this report. This DOD report can be viewed in its entirety on the NTIA homepage at: www.ntia.doc.gov.

DEPARTMENT OF COMMERCE ★ UNITED STATES OF AMERICA ★