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NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION (NTIA)

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An Assessment of the Viability of Accommodating Advanced Mobile Wireless (3G) Systems in the 1710-1770 MHz and 2110-2170 MHz Bands

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SUMMARY

Consideration for spectrum for advanced mobile wireless services started with the World Administrative Radio Conference (WARC) in 1992 and was further delineated at the World Radiocommunication Conference (WRC) in 2000. The quest for 3G spectrum in the U.S. began when the Federal Communications Commission (FCC) released their Spectrum Policy statement in 1999. In October 2000, the previous Administration directed that a plan be developed to select spectrum for 3G by October 20, 2000 that would result in the allocation of additional spectrum for 3G services by July 2001 and the auction for licensing 3G wireless providers by September 30, 2002. In December 2000, the FCC adopted a Notice of Proposed Rulemaking (ET Docket No. 00-258) to amend Part 2 of the Commission's rules to allocate spectrum below 3GHz for mobile and fixed services to support the introduction of new advanced wireless services including 3G based on the FCC's Spectrum Policy Statement and petitions from the Cellular Telecommunications and Internet Association (CTIA).

The Administration's and FCC's attempt to identify spectrum for 3G in 2000 and early 2001 timeframe was unsuccessful. Meanwhile, a number of countries in the rest of the world moved forward and allocated spectrum for 3G (e.g., Europe, where 155 MHz of spectrum was set aside for the 3G terrestrial component). According to the CTIA, wireless voice and data usage has grown from 16 million subscribers using 20 billion total minutes in 1993 to 130 million subscribers using 450 billion minutes in 2001. At the same time, the Department of Defense (DOD) has become much more spectrum intensive since they have had to participate in a number of defensive and offensive actions throughout the world, including Eastern Europe, Mideast, Afghanistan, and the U.S. (Homeland Defense).

Secretary Evans and FCC Chairman Powell established a task force to succeed where previous efforts had failed. The Commerce Department's National Telecommunications and Information Administration (NTIA), in conjunction with the FCC, DOD, and other federal government agencies, studied the viability of making all or a portion of the 1710-1770 MHz and 2110-2170 MHz bands available for advanced mobile wireless (3G) services. This study concluded that 90 MHz of this spectrum can be allocated for 3G services to meet increasing demand for new services without disrupting communications systems critical to national security. This 90 MHz would come from the 1710-1755 MHz band and a matching 45 MHz

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from the 2110-2170 MHz band.[1] Further information regarding the results of the viability assessment and the steps necessary to clear the identified spectrum is described below.

A. 1710-1755 MHz Band

The 1710-1755 MHz band can be used for the accommodation of advanced mobile wireless services, assuming certain actions are accomplished. Specifically, the 1710-1755 MHz band would be substantially cleared of federal systems. Except as provided below, federal users of this band would relocate or modify their operations accordingly not later than December, 2008, or sooner, depending on the nature of the radiocommunications. In order to achieve this time line, the following actions would be required:

1. **Reimbursement Funds**: As required by the Strom Thurmond National Defense Authorization Act for Fiscal Year 1999 ("NDAA 99"), funds would be made available by the private sector entity receiving the Government spectrum (1710-1755 MHz band) for the cost of relocating or modifying all Federal Government radiocommunications systems required to vacate or modify their operations in the 1710-1755 MHz band after the auction has taken place.

2. **Federal Non-Military Systems**: The NTIA would direct the relocation of federal non-military systems from the 1710-1755 MHz band to other federal bands. Federal agencies that operate systems that are required to relocate under OBRA-93 are entitled to reimbursement, and would submit planning assignments to the Frequency Assignment Subcommittee (FAS) in a timely manner. Federal agencies with protected assignments have agreed voluntarily to relocate such assignments, if reimbursed, and would also submit planning assignments to the FAS. All such systems would be relocated two years after availability of reimbursed funds, or sooner if practicable.

3. **Department of Defense (DOD) Fixed Microwave Systems**: The DOD would relocate its conventional fixed microwave systems from the 1710-1755 MHz band to other bands within two years after reimbursement, but no later than December 2008, depending on the complexity of the relocated systems.

4. **DOD's 16 Protected Sites**:

   a. **DOD Airborne Telemetry & Video Systems**: Subject to the availability of reimbursement funds, DOD would relocate their airborne operations by December 2008 to other frequency bands, such as the 1755-1850 MHz band, 2360-2385 MHz or other telemetry bands; or the 2385-2395 MHz band under

[1] This 90 MHz would be in addition to the existing cellular/specialized mobile radio spectrum (806-821, 824-849, 861-866, 869-894, 896-901, 935-940 MHz), 120 MHz of personal communications service spectrum (1850-1910 and 1930-1990 MHz which can also be used for 3G services as market and technology develop), and other bands currently under consideration (for example, licenses for the 746-764 MHz and 776-794 MHz bands (36 MHz) will be auctioned.) In addition, the FCC also recently added a mobile allocation to the 2500-2690 MHz band (190 MHz).

primary status provided as a result of FCC rulemaking for government mobile use. The NTIA will work with DOD to facilitate the introduction of new and relocated systems into the bands identified above.

b. **DOD Ground Systems**: The FCC would accomplish the necessary rulemaking so that DOD ground systems in the 1710-1755 MHz band can remain on a secondary, coordinated basis at all sites, but on a primary basis at the Cherry Point, NC, and Yuma, AZ sites for operations used in a manner similar to current operations at these protected sites. DOD ground systems, other than Digital Wideband Transmission System (DWTS) operations at Cherry Point and Yuma, that cannot adjust their operations to prevent interference to commercial users in the 1710-1755 MHz band will operate in the 1755-1850 MHz band or on a non-interference, coordinated basis in the 1350-2690 MHz band. DOD ground systems may operate in the 2025-2110 MHz band on a secondary, coordinated basis in the Southwestern region[2] of the U.S.

c. **Future DOD Requirements in 1755-1850 MHz Band**: Considering that DOD has future requirements to satisfy in the 1755-1850 MHz band plus the absorption of certain operations from the 1710-1755 MHz band, the FCC would conclude the necessary rulemaking by September, 2004 to permanently modify footnote US346 of the U.S. Table of Allocations to allow DOD the use of the 2025-2110 MHz band on a co-equal primary basis for DOD ground stations at selected sites[3] that support DOD space operations. The relocation of satellite control frequencies would make more spectrum available in the 1755-1850 MHz band to satisfy future DOD spectrum requirements.

d. **DOD Precision Guided Munitions (PGM) Operations**: PGM operations may continue in the 1710-1720 MHz band on a primary basis until inventory is exhausted or until December 31, 2008, whichever is earlier.

e. **Other DOD Systems**: Other DOD systems[4] would relocate to the 1755-1850 MHz band, or other bands as available.

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[2] The Southwestern region includes operations in mostly remote areas and ranges, including China Lake, CA; Pacific Missile Test Range, Pt. Mugu, CA; Ft. Irwin, CA; Holloman AFB, NB; and Yuma, AZ.

[3] These satellite control stations are: New Hampshire Tracking Station, New Boston AFS, NH; Vandenberg Tracking Station, Vandenberg AFB, CA; Eastern Vehicle Check-out Facility & GPS Ground Antenna & Monitoring Station, Cape Canaveral, FL; Buckley AFB, CO; Guam Tracking Station, Anderson AFB, Guam; Hawaii Tracking Station, Kaena Ptl, Oahu, HI; Kwajalein Atoll (GPS ground antenna); Camp Parks Communications Annex, Pleasanton, CA; Colorado Tracking Station, Schriever AFB, CO; Naval Satellite Control Network, Laguna Peak, CA; Naval Satellite Control Network, Prospect Harbor, ME; and Kirtland AFB, NM

[4] Other systems include unmanned ground robotic systems, range timing distribution systems, and target scoring devices.

5. **Implementing Coordination**: The NTIA, the FCC, and industry will establish a continuing process to facilitate sharing in the 1710-1755 MHz band. It is anticipated that the FCC will complete the necessary rulemakings to address the above conditions for making the band essentially clear of DOD operations at the protected sites, as well as, reallocation of the band from government exclusive only to both government and non-government use on a mixed-use basis. It is expected that the early rollout of 3G will occur in the urban areas. Assuming reimbursed funds are available, every effort will be made to clear these areas first.

B. **1755-1770 MHz Band**

The 1755-1770 MHz band is not viable for use by 3G for three reasons. First, the impact to or constraints on DOD mobile radiocommunication system operations would be significant and unacceptable in light of DOD's extensive and critical operations in this band. Second, the sharing between 3G and DOD terrestrial systems in this band would not be possible in light of the large geographical separation distances required. Third, the DOD satellite ground control stations would interfere with 3G base stations at large geographical distances. In addition, it was determined that no suitable alternate federal and/or commercial spectrum could be identified for satisfactory relocation of DOD systems. A leap forward in technology may permit extensive sharing in all bands below 3 GHz in the future. Until that time, however, use of the 1755-1770 MHz band for advanced wireless applications is not considered viable.

C. **2110-2170 MHz Band**

According to FCC's 3G working group[5], 45 MHz in the 2110-2170 MHz band appears to be feasible for 3G use. It is anticipated that the FCC will initiate a rulemaking for allocation and service rules that will make 45 MHz available for advanced wireless services.

VIABILITY ASSESSMENT

This NTIA document summarizes the findings of NTIA, the FCC's 3G Working Group, the DOD, and other members of the Intra-Government 3G Planning Group (IG3GPG).[6] The IG3GPG assessed the 1710-1770 MHz and the 2110-2170 MHz bands to determine if those bands present viable options for accommodating advanced mobile wireless systems. The 1710-1770 MHz band is used by a number of Federal agencies for fixed microwave systems, airborne and land mobile systems, satellite command and control operations, radio astronomy, weapon

[5] The views expressed by the FCC staff while participating in the IG3GPG are those of the Commission staff's 3G Working Group and do not necessarily represent the views of the Federal Communications Commission, any Commissioners, or other FCC staff.

6 This planning group consists of representatives of NTIA, the FCC, the Department of Defense, the Office of Management and Budget, the Office of Science and Technology Policy, and the Department of State.

control systems, and video surveillance systems. The 2110-2170 MHz band includes common carrier, multi-point distribution, paging, radiotelephone, local TV transmission, and private point-to-point service licensees. The 2110-2170 MHz band is also allocated to the mobile satellite service downlink. During earlier efforts, these particular bands had been identified as offering the greatest potential for additional spectrum for advanced mobile wireless services.[7]

As of December 2001, according to CTIA, the wireless industry employed approximately 203,000 employees, generated revenues of $65 billion for CY 2001, and served approximately 128 million wireless subscribers. Wireless subscribers are expected to grow to 237 million in the next 3 years. The commercial wireless industry has forecast the need for significant increases in spectrum to support growing use of mobile phones as well as new mobile data and Internet applications (such as 3G) that will require more bandwidth than is currently available for first and second generation cellular wireless systems.

The successful implementation of 3G is expected to enhance U.S. economic security by providing opportunities for telecommunications manufacturers, service providers, and businesses and consumers across the country. 3G holds the potential to make U.S. business management more efficient and effective and to expand economic opportunities available to all Americans. Based on models used by the International Telecommunication Union (ITU), the FCC estimated that approximately 300 MHz to 420 MHz of spectrum would be required within the United States for 3G services. In addition to current national allocations available for commercial mobile services, at least 120 MHz to 240 MHz of spectrum has been projected by industry as needed to meet future needs. These estimates were based on busy hour traffic in high-population-density urban areas.

While the industry's case for additional spectrum for advanced wireless services is documented nationally and internationally, the spectrum needs of DOD are also increasing rapidly. The U.S. defense forces have greatly increased their wireless use in support of the war fighter and homeland defense. Telecommunications, including mobile, aeronautical mobile, and rapidly deployable fixed systems, are essential to the success of U.S. military operations around

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7 A Presidential executive memorandum dated October 13, 2000, stated the need and urgency for the United States to select radio frequency spectrum to satisfy the future needs of citizens and businesses for mobile voice, high-speed data, and Internet-accessible wireless capability; the guiding principles to be used for the development of 3G wireless systems; and direction to the federal agencies to carry out the selection of spectrum. The executive memorandum 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 ITU 2000 World Radiocommunication Conference (WRC-2000) that could be used for 3G systems. The executive memorandum also set forth a goal of completing the 3G spectrum decision by July 2001 to allow licenses to be auctioned by September 30, 2002. However, a 3G spectrum decision was not reached by July 2001, because of the difficulties associated with sharing the bands. As a result, the IG3GPG was established, and a new plan to select spectrum for 3G systems was developed that would require the examination of several additional spectrum options. After a thorough examination of many options for accommodating advanced mobile systems, the most viable option for further study was determined to be the 1710-1770 MHz band, paired with the 2110-2170 MHz band. The FCC agreed to study the viability of the 2110-2170 MHz band to accommodate advanced wireless systems, and the Federal Government would study the 1710-1770 MHz band.

the world. At the same time, U.S. forces need to train as they expect to fight, including the use of spectrum resources at home and abroad. Further, military forces could be called on to provide security anywhere within the country during crisis. Because of international agreements and long-term development and acquisition projects, DOD needs spectrum that offers long-term use and security from future encroachment. Furthermore, DOD needs operational flexibility as its mission responds to changing threats. Accordingly, any sharing arrangements would need to protect DOD missions without creating conflicts with commercial mobile systems. If DOD systems are to be relocated, alternate, comparable spectrum must be identified, as required by statute.[8]

THE BANDS ASSESSED

Commerce Secretary Evans and FCC Chairman Powell mutually agreed in July 2001 that a final decision on allocation of spectrum for 3G should be extended to ensure that any decision on additional spectrum for 3G be the best one possible. As a result of this agreement, the Secretary directed the NTIA to work with the FCC in coordination with the Executive Branch agencies to develop a plan to assess spectrum for 3G. A plan was developed to assess the 1710-1770 MHz and 2110-2170 MHz bands because they appeared to hold the greatest potential for possible use by 3G without significantly conflicting with Federal government operations. The 1710-1770 MHz band is currently used by the Federal government while the 2110-2170 MHz band is currently used by the private sector. It was envisioned that the 2110-2170 MHz band could be use for the base station part of 3G and the 1710-1770 MHz band for the hand-held units. It was then determined that NTIA would assess the 1710-1770 MHz band and the FCC would assess the 2110-2170 MHz band.

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8 The term "comparable spectrum" used in this assessment is specified in Title X, Subpart G, Section 1062 of the National Defense Authorization Act for Fiscal Year 2000 and the NTIA Manual of Regulations and Procedures For Federal Radio Frequency Management, Section 2.3.13, paragraph 1. "the Department of Defense shall not surrender use of any band of frequencies in which the Department of Defense is a primary user for non-federal use, unless the following conditions are met.

A. NTIA, in consultation with the FCC, has identified and made available to the Department of Defense for its primary use, if necessary, an alternative band or bands of frequencies with comparable technical characteristics as a replacement; and

B. The Secretary of Commerce, the Secretary of Defense, and the Chairman of the Joint Chiefs of Staff have jointly certified 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 the replacement band or bands of frequencies identified in (A.) above provides comparable technical characteristics to restore essential military capability that will be lost when the band of frequencies is surrendered."

The essential components of this definition are that the *comparable spectrum* offers primary access, if necessary, and comparable technical characteristics (i.e., adequate bandwidth, signal propagation characteristics) to restore essential military capability. Furthermore, the evaluation of comparability would require certification of the Secretaries of Commerce and Defense as well as the Chairman of the Joint Chiefs of Staff.

NTIA and the DOD assessed the 1710-1770 MHz band by splitting the assessment into two key parts - the 1710-1755 MHz band and the 1755-1770 MHz band. The split was based upon previous decisions resulting from the Omnibus Budget Reconciliation Act of 1993 (OBRA-93) [9], in which the Federal Government had identified *inter alia* the 1710-1755 MHz band for transfer to the FCC on a "mixed-use" basis (included the maintenance of federal spectrum use at 16 specific DOD sites and of certain critical federal fixed microwave links around the country). Spectrum use in the 1755-1770 MHz band is currently exclusive to the Federal Government. Therefore, a key difference in assessing these bands is that there is already a presumed federal limitation to the use of the 1710-1755 MHz band, while no such limitation exists for the 1755-1770 MHz portion.

Despite the limitation on federal use in the 1710-1755 MHz band, this band contained substantial challenges to accommodate 3G use. Because current law[10] guarantees the continued operation of protected Federal Power Administration systems in the 1710-1755 MHz band, unless they voluntarily agree to relocate, any future 3G operations would have to operate to protect them, thus limiting access. These, and other federal protected fixed links are distributed around the country; many supporting electrical power transmission or safety-of-life services. The Federal Government frequency assignment distribution is shown in Figure 1. The 16 DOD sites represent critical training and test facilities for Army, Navy, Air Force and Marine Corps. Many of those 16 sites are used for aeronautical mobile systems, and the potential impact of those operations extends to points within line-of-sight from high altitude aircraft. The potential for interference to 3G systems extends into high population areas in southern California, most of Nevada, Seattle, much of the Gulf Coast, and major portions of the Eastern seaboard. The protected site areas of operation and required distances to prevent interference to 3G are shown in Figure 2.

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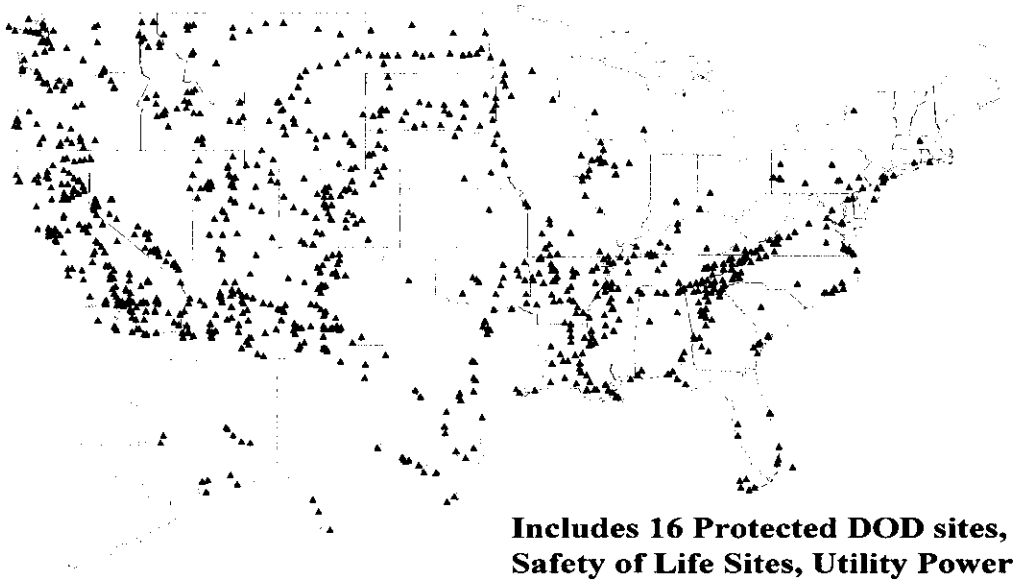
9 Pub. L. No. 103-66, 107 Stat. 312 (1993)

10 *Id.*

Figure 1

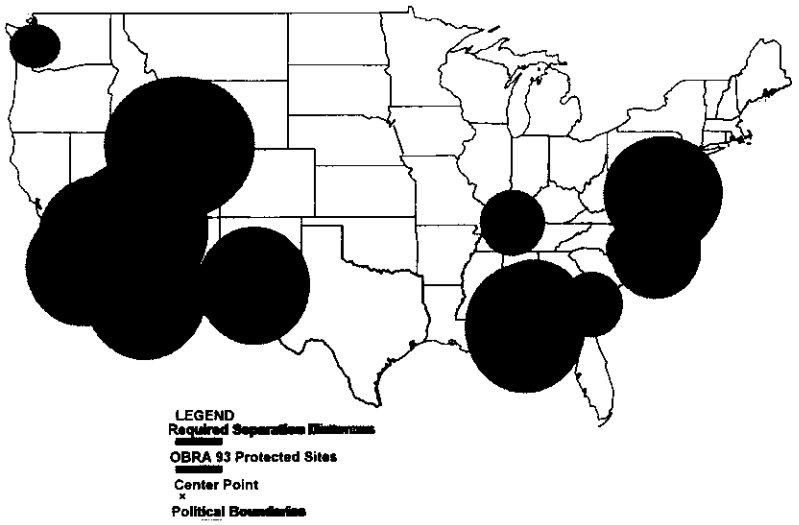
Federal Government Assignments In the 1710-1755 MHz Band



Includes 16 Protected DOD sites, Safety of Life Sites, Utility Power Sites, and other Federal Agency Microwave Sites

Figure 2

16 DOD Protected Sites



3G Separation Distances at Sites where DoD fixed microwave, tactical radio relay, and aeronautical mobile stations in the 1710-1755 MHz band will continue operations indefinitely under OBRA '93

Many federal operations use the spectrum for short periods of time at specific locations. Such uses may be able to share with private and commercial services if prioritization mechanisms or signal response and frequency flexibility capabilities can be incorporated in future systems.

CONSIDERATIONS FOR ASSESSING THE VIABILITY OF ACCOMMODATING 3G USE

To determine the viability of accommodating the use of advanced commercial mobile services, the IG3GPG identified the spectrum requirements of the incumbent users, analyzed the possibility of relocating incumbent users to other bands (including associated costs), and, where relocation of federal systems was not possible, analyzed methods of sharing spectrum. During the period of the assessment, NTIA and the FCC considered comments that were filed during the FCC's 3G rulemaking.[11]

NTIA first determined that it could relocate all non-military operations in the 1710-1770 MHz band to frequency assignments in other federal bands. The DOD determined that it could relocate most conventional fixed links (assuming that all systems relocated would be fully reimbursed) to other federal bands, thereby clearing DOD fixed operations from the band. However, the DOD could not relocate the remaining systems without comparable spectrum that offered the spectrum characteristics needed to support other DOD system requirements. Therefore, NTIA and DOD hosted information exchanges with industry service provider/vendor engineers who analyzed each of the 16 sites on an assignment-by-assignment basis, considering the operational characteristics of the DOD systems.[12] As a result of this analysis, the industry experts concluded that all aeronautical mobile systems and all ground-based TRR systems must be cleared from the 1710-1755 MHz band if the band is to be used for advanced wireless services. The industry team noted that further analysis might conclude that a few of the more remote areas might require less spectrum, particularly in the earlier years of advanced services deployment. However, the industry team expressed its desire that the entire 1710-1755 MHz band would need to be cleared eventually.[13]

With respect to the 1755-1770 MHz band, DOD operations are more varied in location and function than in the 1710-1755 MHz band. Also, DOD and other federal agencies currently have exclusive use of the band and have looked to this band to accommodate their growing and evolving missions. Once again, NTIA found that it could relocate federal non-military conventional fixed links to other bands. However, in order to move DOD systems, comparable

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11 Federal Communications Commission, Notice of Proposed Rulemaking, *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.

12 FCC staff did not participate in the DOD/NTIA/industry sharing analysis of the 16 grandfathered sites and, hence, express no view as to the results set forth in the Appendix.

13 See Appendix for the details of the Industry analysis.

spectrum that maintained flexibility of use and comparable room for future growth was required. Moving to other Federal Government exclusive bands below 3 GHz would merely serve to decrease operational flexibility and growth potential. Similarly, none of the non-Federal Government bands proposed by the FCC possessed the needed propagation characteristics, tuning range, growth potential and conflict-free operations needed by DOD.

Incumbent User Spectrum Requirements

1710-1770 MHz Band.

The federal requirements for the 1710-1755 MHz band are defined by the set of frequency assignments existing in the government master file (GMF) for that band. This includes military and non-military fixed systems, and military and non-military mobile systems, some of which are airborne. As a result of the OBRA-93 mandates, systems in unprotected areas have to vacate the band. Users of protected fixed links and systems in protected areas may voluntarily accept reimbursement and relocate. The 1755-1770 MHz band is available to federal agencies nationwide on an exclusive basis.

NTIA researched federal operations via its GMF, the master list of authorized federal frequency assignments (The GMF lists the assignments, but does not specify the amount of equipment associated with each assignment.). As of January 2002, there were 1,371 federal non-military assignments in the 1710-1770 MHz band listed in GMF. The majority (99 percent) of non-military assignments are for fixed service, followed by mobile, aeronautical-mobile, land mobile, and space services. There are 1,016 military assignments in the 1710-1770 MHz band. Of those assignments, approximately 76 percent are for fixed or transportable use. The GMF does not contain all the classified federal assignments.

The 1710-1850 MHz portion of the frequency spectrum possesses specific attributes that make it a prime operating region for many DOD mobile and aeronautical systems. These attributes include wide beamwidth antennas, low transmit powers, large channel throughputs, high link reliability, and extended link distances. No other band region to which DOD has access can simultaneously support this unique set of attributes in combination.

The DOD identified its incumbent systems operating in the 1710-1755 MHz band at 16 protected sites, and DOD systems operating in the 1755-1770 MHz band across the United States. The major incumbent systems include tactical radio relay (TRR), air combat training systems (ACTS), the satellite control Space Ground Link System (SGLS), precision guided munitions (PGMs), fixed point-to–point links, unmanned aerial vehicles (UAVs), combat identification, and other military systems. According to NTIA's reimbursement rules, reimbursed assignments in the 1710-1755 MHz band are limited to those in existence up to and including 1998.

The DOD has in recent years experienced an increase in spectrum requirements, especially for the 1710-1850 MHz band. The increase in DOD spectrum needs within this band is driven both by the need to increase the capabilities of existing systems as well as by the

introduction of newer advanced technology wireless systems. The characteristics of this portion of the spectrum lends itself to the development and operation of such systems as unmanned aerial vehicles, new identification systems to prevent "friendly fire" situations, and individual wireless links to soldiers to provide state-of-the-art data exchange to enhance battlefield situational awareness. In addition, increased information is being collected on the battlefield and must be rapidly transmitted to higher decision-making levels. This increased information transmission required improvements in existing system capability, primarily by expanding capacity or throughput to support the information exchange requirements of battlefield networks and expanding capacity on telemetry links to support growing test range data requirements. In many cases this increase in capacity requires wider transmission bandwidths.

2110-2170 MHz Band.

The 2110-2130 MHz portion of the 2110-2170 MHz band supports 3,454 common carrier (Part 101) licenses, 56 paging and radiotelephone service (Part 22) licenses, 47 local television transmission service (Part 101) licenses, and one general aviation (Part 22) license. The 2130-2150 MHz band supports 2,448 private point-to-point (Part 101) licenses, and two common carrier (Part 101) licenses. Channels in the 2130-2150 MHz band are paired with spectrum in the 2180-2200 MHz band. The 2160-2165 MHz band supports 890 common carrier (Part 101) licenses, 13 paging and radiotelephone service (Part 22) licenses, and 40 local television transmission service (Part 101) licenses.

NASA uses the 2110-2120 MHz band for high power up-link transmissions at its Deep Space Network (DSN) facility at Goldstone, California in order to ensure link availability to deep space satellites.

Potential for Relocation

Funding and comparable spectrum are two key factors in examining the possibility of relocating certain DOD systems. Because the participants in the IG3GPG estimated that revenues to be obtained from auction of 3G spectrum would be far greater than the costs of relocating incumbent systems, costs were not considered critical to the viability of each band. While current law does not mandate that all federal agencies have to be provided comparable spectrum, it does require that comparable spectrum be provided if DOD systems are relocated.

Certain DOD operations in the 1755–1770 MHz band are part of integrated systems that operate throughout much of 1755–1850 MHz band. Therefore, if the 1755-1770 MHz band were no longer available, DOD would need more than 15 MHz to relocate existing systems because of the links with other systems in the 1755-1850 MHz would be severed and would have to be re-accommodated elsewhere. DOD also needs spectrum that offers comparable opportunity to develop and deploy systems to meet international and homeland defense missions. Because of international agreements and long-term development and acquisition projects, comparable spectrum must also provide predictability and certainty for long-term availability. Furthermore, DOD needs operational flexibility as its mission responds to changing threats. Therefore, to

obtain joint certification of comparability, any spectrum for relocation of DOD uses would have to possess those characteristics.

The following bands were identified as potential candidate bands for relocation of incumbents in the 1710-1770 MHz band: 930-950, 1910-1930, 1990-2025, 2025-2110, 2200-2290, 2360-2385, 2385-2390, 2390-2400, 2500-2690, 3650-3700, 4400-4940, 7125-8500, and 14500-15400 MHz. The primary focus was on the 1770-1850, 2200-2290, 4400-4940, 7125-8500, and 14500-15400 MHz bands as these were Federal Government bands. The vast majority of the fixed microwave systems could be accommodated in the 7125-8500, and 14500-15400 MHz bands using off-the-shelf commercial equipment. However, bands above 3 GHz do not provide spectral characteristics to accommodate DOD mobile capabilities. Individual bands such as 930-950 MHz, 1910-1930 MHz, 2390-2400 MHz either do not offer sufficient spectrum, or would create new interference issues with regard to incumbent users, but may be useful when coupled with adjacent bands, such as coupling the 2360-2385 MHz and 2385-2390 MHz bands. The 1990-2025 MHz and the 2025-2110 MHz bands offers the spectral characteristics that could support many DOD requirements, but the bands also have incumbents with no readily apparent band(s) to which they could be relocated.

Potential for Sharing

To accommodate 3G sharing with incumbent DOD users, the IG3GPG needed to establish first whether 3G use was generally compatible with the incumbent users. If not, it would consider whether spectrum could be shared through frequency, location or time separation and provide a viable 3G service without diminishing the capabilities of the incumbent users. To support an analysis of sharing, the FCC provided the most recent technical parameters for the 3G systems.

Relocation Costs

In its report, "The Potential for Accommodating Third Generation Mobile Systems in the 1710-1850 MHz Band",[14] released in March 2001, NTIA estimated the costs associated with the various segmentation options that would allow the 1710-1755 MHz and 1755-1850 MHz bands to be used for 3G accommodation. For the 1710-1755 MHz band, NTIA is required to submit estimates to the FCC regarding the relocation costs for federal systems that must be relocated as a result of OBRA-93. NTIA is currently preparing a separate report for future release on this subject, but has previously estimated costs for this band, which appeared in the *NTIA 3G Report*. The final costs for the 1710-1755 MHz band may be different from the costs shown herein due to additional data received subsequent to this assessment.

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14 National Telecommunications and Information Administration, U.S. Department of Commerce, NTIA Special Publication 01–46, 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), (hereinafter referred to as the *NTIA 3G Report*)

VIABILITY OF THE 1710-1755 MHz BAND

Potential Relocation of Fixed Systems

To assess the viability of relocating federal non-military fixed systems from the 1710-1755 MHz band, NTIA ran a computer program, Spectrum XXI, which nominates frequencies for assignment based on the technical parameters of the subject system. Many federal agencies use this program, developed by NTIA and the DOD, to plan frequency assignments. Spectrum XXI uses GMF assignments to create an electromagnetic environment. Where spectrum was found in other frequency bands for the systems currently assigned in the 1710-1755 MHz band using Spectrum XXI, then relocation was deemed possible. Moving fixed links to other government bands does not significantly limit the use of the bands to which the fixed systems would be moved. Via this process, NTIA found that it could relocate all conventional non-military fixed links from the 1710-1755 MHz band to other federal bands. Although the Federal Power Administration links and certain other links identified in the NTIA Final Reallocation Report, are safety-of-life systems exempt from relocation by statute, the user agencies have agreed to relocate these systems pending reimbursement. Most of the fixed assignments in the 1710-1755 MHz and the 1755-1770 MHz bands have return links in the 1770-1850 MHz band. Accordingly, an added efficiency of the move to 3G will be the relocation of virtually all federal non-military conventional fixed links to other federal bands, freeing up spectrum in the 1755-1850 MHz band for more efficient uses. The DOD determined that it could relocate most of its conventional fixed microwave systems to other bands.

Potential Relocation of Mobile Systems

Relocation of mobile assignments presents a more difficult situation because potential interference is far greater from mobile systems to incumbent operations in the bands to which systems might be relocated. NTIA identified several non-military mobile systems for relocation. These non-military mobile systems are not protected, and due to the limited operations associated with these assignments, NTIA concluded that relocation is possible.

National Aeronautics and Space Administration (NASA): NASA has the following frequency assignments that require relocating:

(1) Aeronautical mobile operation in Virginia on 1720 MHz supporting remotely piloted vehicle research. Relocation of operations to the 1770-1850 MHz band is possible since equipment tunes between 1710-1850 MHz.

(2) Aeronautical mobile operation at Edwards AFB, California on 1727 MHz supporting data transfer from high performance aircraft. Relocation of operations to the 1770-1850 MHz band is possible since equipment tunes between 1710-1850 MHz.

(3) Aeronautical mobile operation at Pierre, South Dakota on 1735 MHz supports lighter-than-air aircraft research. Relocation of operations to the 1770-1850 MHz band is possible since equipment tunes between 1710-1850 MHz.

Departments of Justice, Treasury and the U.S. Postal Service: These three agencies have United States & Possessions video surveillance operations in the 1710-1755 MHz and 1755-1770 MHz bands. Ongoing discussions have addressed moving their operations to the 1770-1850 MHz band or another authorized band for this type of operation. These federal users have requested that selection of a new band and/or new equipment be made jointly due to the similarity of operations. Discussions on a specific band and commonality of equipment are ongoing.

Department of Transportation (DOT): The DOT has a land mobile operation at Pueblo, Colorado in support of testing and developing railroad vehicles and related railway systems. NTIA has asked the DOT to identify an alternate band to continue their operations.

Department of Defense (DOD):

NTIA identified the 1770-1850 MHz and 2200-2290 MHz bands as potential alternate government bands for the relocation of DOD mobile assignments. The 2200-2290 MHz band supports 1629 aeronautical mobile frequency assignments encompassing telemetry and telecommand. The band is the consolidated downlink and crosslink band for Space Ground Link Subsystem (SGLS) and NASA's Telemetry and Data Relay Satellite System (TDRSS) and NASA's Ground Network (GN). The TDRSS is critical to the control of commercial and government launches. It also supports communications with space research and earth exploration satellites, and the Hubble telescope. Given the ongoing difficulty in providing adequate spectrum for satellite command and control and telemetry applications and the fact that it would not be possible to find open channels in other bands for these uses, no further consideration could be given to this band. Other possible bands included the 2360-2385 MHz band, and the 2385-2390 MHz band identified for transfer to the FCC in 2005. The 2360-2385 MHz band contains 229 federal aeronautical mobile assignments, one fixed and one radar; the 2385-2390 MHz band contains 23 aeronautical telemetry assignments.

In general, relocating all DOD systems from the 1710-1755 MHz band of the 16 protected sites into the remaining 1770-1850 MHz band was not feasible, given the existing and growing operations in the 1770-1850 MHz band. Moving mobile, including aeronautical mobile operations into the dense electromagnetic environment of the 1770-1850 MHz band will restrict other potential deployments. The 1770-1850 MHz band currently supports additional systems (such as the satellite control earth stations and the air combat training systems) and must absorb the DOD frequency assignments that will be displaced from the 1710-1755 MHz band that are outside of the 16 protected areas. Although non-military conventional fixed systems may be relocated from this band, they are not generally located at or near military facilities and therefore do not significantly relieve the frequency congestion at DOD sites. The limited geographical areas of military facilities and the number of radio systems currently operating in these areas produce highly dense electromagnetic environments that are incapable of supporting the additional assignments that would need to be relocated from the protected areas, including the

other systems currently operating in the 1755-1770 MHz band that would need to be relocated to these same facilities. The tuning ranges of this equipment generally do not operate beyond 1850 MHz. Therefore, the potential identification of comparable spectrum outside this range or in small increments would require redesign of the equipment in some cases.

Therefore, systems such as the tactical radio relay (TRR), precision guided munitions, aeronautical mobile systems, and certain other systems will require comparable spectrum for relocation, in addition to reimbursement to maintain their current capabilities. However, no comparable spectrum has been identified. These systems are operational in many of the 16 protected areas as described in the NTIA Final Reallocation Report. Technical analyses have indicated that operation of these systems could cause interference to 3G base stations.

Tactical Radio Relay:

TRR systems mostly consist of the AN/GRC-103, AN/GRC-226 and AN/GRC-245 (mobile subscriber equipment) systems for Army use, and the AN/MRC-142 and AN/SRC-57 for Navy/Marine Corps use. These systems tune from 1350-1850 MHz (the AN/GRC-245 tunes to 2690 MHz) and requires 50 MHz (Army), 60 MHz (Marine Corp), and 88 MHz (Navy) for ship-to-shore links. Much of the tuning range of these systems is not available in the United States during peacetime.

TRR systems often have a large number of frequency assignments at military facilities to give the local frequency manager adequate spectrum resources to balance the requirements of TRR, mobile systems, and other DOD equipment that all use the 1710-1850 MHz band. During large exercises, the 1710-1850 MHz and other government bands are at times insufficient to satisfy the requirements for these exercises. For those exercises, no additional assignments can be made, and no additional equipment can be supported in this spectrum. The DOD examined relocating 1710-1755 MHz assignments to the 1770-1850 MHz band, but found that sufficient channels would not be available for large operations and that other operations in that band would be constrained. These systems have been designed with a broad tuning range to support large networks of multiple links that require significant co-site and transmit/receive frequency separations. The full tuning range is not able to be used in the United States because of limitations of suitable federal frequency allocations in the tuning range. Therefore, other comparable spectrum is necessary to accommodate the TRR systems if relocated from the band.

The TRR equipment also cannot be redesigned to operate outside the 1710-1850 MHz band on a site-by-site basis, since the equipment operates as part of a larger system. TRR equipment is transportable and is often deployed to multiple locations to interoperate with other systems for training exercises or operational missions. For example, TRR equipment used by the Army National Guard in New York State may need to move with the Guard unit to other geographical locations for training or deployment, and must interoperate with other TRR equipment.

However, DOD ground systems in the 1710-1755 MHz band could operate on a secondary, coordinated basis at the 16 protected sites with the exception of Cherry Point, NC, and

Yuma, AZ, where they would require primary status because they cannot adjust their operations to prevent interference to commercial users. Cherry Point and Yuma are critical for conducting realistic Marine Corps training in amphibious operations and aviation training, respectively. It may also be possible for DOD to operate on a non-interference, coordinated basis in the 1350-2690 MHz band at all locations and on a secondary, coordinated basis in the 2025-2110 MHz band in Southwestern region. DOD is already from time-to-time coordinating frequencies on a temporary basis at the local level in the 1350-2690 MHz band. The 2025-2110 MHz band is used primarily by the electronic news gather services, space operations, earth exploration-satellite operations and space research. NASA has very effectively coordinated with other users of the band. The DOD coordination would be similar in nature and since the ground operations are usually in remote areas, it would appear to be feasible for DOD to operate on a coordinated basis in this band. Use of the 2025-2110 MHz band in support of DOD space operations at selected DOD ground station sites would also be helpful to take the pressure off use of the 1755-1850 MHz band due to continued space operations use and absorption of certain operations in the 1710-1755 MHz band. The coordination in this band would be similar to that currently being done by NASA for its space operations. The FCC would have to perform a rulemaking to modify footnote US346 of the U.S. Table of Allocations to allow DOD the use of the 2025-2110 MHz band on a co-equal primary basis for DOD ground stations at selected sites that support DOD space operations.

Aeronautical Telemetry:

Airborne telemetry operations take place in 10 of the 16 protected sites. Telemetry downlinks operate from manned aircraft, unmanned aerial vehicles (UAV), and missiles or other ordnance devices. Flight characteristic data and video are transmitted to the ground for analysis. Aircraft operations are expensive, and data lost from live missile firings are irreplaceable, so telemetry signals are designed to be robust to completely capture the downlink data. Because of the operating altitude (up to 30,000 ft above mean sea level) of some of the aircraft, a wide area may be illuminated by telemetry signals. These systems were the least compatible with 3G systems.

Aeronautical telemetry assignments are often interleaved between ground-based assignments, and scheduled so as not to interfere. Because of the tight packing of frequency assignments and the complex scheduling required for flight operations, the DOD has stated that relocation of these assignments to the 1770-1850 MHz band, which is already heavily used, may be difficult. If other spectrum such as the 2385-2395 MHz band (adjacent to the existing telemetry band 2360-2385 MHz) could be made available, DOD airborne operations could be relocated from the 1710-1755 MHz band at the 16 protected sites. The 2385-2390 MHz band was identified by NTIA to be provided to the FCC under the Balanced Budget Act of 1997. The FCC is in process of reallocating this spectrum. The 2390-2395 MHz band is currently used for amateur service on a primary basis. FCC will have to perform a rulemaking to reallocate this spectrum to include airborne telemetry.

Precision Guided Munitions:

Both the Air Force and the Navy operate precision guided munitions (PGMs) in the 1710-1850 MHz band. Although the technical characteristics of these systems are classified, DOD has stated that their characteristics prevent limiting full PGM operations to the 1770-1850 MHz band. Therefore, operations within the 1710-1755 MHz band cannot be moved to the 1770-1850 MHz band. Because of the operational and physical constraints involved in launching and guiding a missile to its target, spectrum below 3 GHz is required for satisfactory operation of the guidance system. Higher frequencies pose problems with respect to antenna coverage, electrical (prime power) requirements, and transmitter power output. No studies exist that show practical implementation above 3 GHz. Relocation of PGMs to the 2200-2290 MHz band has been examined, but this band is heavily used by numerous RF systems critical to the national defense and operation of the PGMs at desired test sites would be problematic. There are no international frequency bands allocated for military uses, so the use of any alternate frequency band would likely conflict with commercial applications in bands allocated internationally. No other comparable spectrum suitable for PGMs has been identified. Although the bands cannot be stated in this assessment, it should be noted that PGMs could not be operated in any band where threat emitters are known to operate. Navy PGMs have slightly different frequency plans, and could still operate with the loss of the 1710-1755 MHz band, with reduced capability.

Impact to DOD PGM systems will be minimized by allowing them to operate on a primary basis in the 1710-1720 MHz band until the current inventory of PGMs is exhausted or until December 2008, whichever occurs first.

Relocation Costs

Based on information provided by the federal agencies, costs associated with the relocation of non-military systems from the 1710-1755 MHz are estimated at $410 million. The cost to relocate military systems (non-protected) from the 1710-1755 MHz is estimated to be between $38-138 million, an amount currently being reassessed by DOD. The cost to relocate and/or modify DOD radiocommunications at the 16 protected sites will be determined at a later date, but not exceed the date established by the NTIA reimbursement rules relative to the auction date. As indicated above, these values are estimates and subject to change.

Potential Sharing

Technical analyses of the potential for frequency sharing between incumbent systems and 3G systems in the 1710-1755 MHz were made. Previous analyses had shown that if operated on the same frequency, in the same geographic area, at the same time, DOD operations in the 1710-1755 MHz band would interfere with 3G base stations. Protected DOD operations are conducted within a circular area (operations area) drawn around the designated 16 sites. Interference to 3G base stations is possible outside these areas at distances that are a function of the location of the transmitter within the given operations area, the system altitude, power, and antenna gain. The results of the analyses indicate that large separation distances would be required to prevent interference between incumbent and 3G systems. However, while TRR systems occupy most of the band during large-scale training operations, these systems are located on the ground and, though portable, operate as fixed microwave systems with the associated narrow beamwidths.

Aeronautical links, though having the widest potential reach, are limited to periodic flights during a day, are limited in the number of channels, and move rapidly across the operation area (which constantly changes the potential zone of interference to the 3G base stations as the aircraft move). Signals associated with guidance of PGMs are short in duration during live firings; interference is only possible during the time of flight of the munition. Captive carry PGM training flights involving two or more aircraft will have a longer duration. In these cases, 3G operators could take measures to overcome interference coming from the known direction of the DOD operations.[15]

The analysis of the industry experts concludes that all aeronautical mobile systems and all terrestrial TRR systems must be cleared from the 1710-1755 MHz band if the band is to be used for advanced wireless services. The industry team noted that further analysis might conclude that a few of the more remote areas might require less 3G spectrum, particularly in the earlier years of advanced services deployment. However, industry noted that the entire 1710-1755 MHz band would need to be cleared eventually.

VIABILITY OF THE 1755-1770 MHz BAND

Potential Relocation of Fixed Systems

The Spectrum XXI mechanism was again used to assess the viability of relocating fixed systems from the 1755-1770 MHz band. Via this process, NTIA found again that all conventional non-military fixed links in the 1755-1770 MHz bands could be relocated to other federal bands. The DOD found relocation frequencies for most of its conventional fixed point-to-point assignments.

Potential Relocation of Mobile Systems

National Aeronautics and Space Administration (NASA): NASA requires relocation of space-to-space non-geostationary operations supporting communications between the space shuttle and its payload. Relocation of operations to the 1770-1850 MHz band is possible since the current NASA frequency assignment allows for continuous selection of frequency between 1763 and 1840 MHz.

Department of Defense:

DOD Mobile Systems: Some of the DOD mobile systems (e.g., unmanned aerial vehicles, combat identification systems, etc.) operating in the 1755-1850 MHz range have recently been elevated in importance due the war on terrorism, homeland defense, and possible requirements for ballistic missile defense. The DOD also anticipates that the 1755-1850 MHz band will experience increased use due to growth in military spectrum requirements to support mobile wireless applications. The current tuning ranges of this equipment do not go beyond 1850 MHz.

15 The FCC staff indicated that mitigation techniques resulting from terrain shielding, deployment of base station antennas that avoid main-beam coupling with interfering stations, and use of advanced (adaptive) antenna systems, would significantly lessen the distance over which a given DOD system would interfere with a given 3G system.

Therefore, the potential identification of *comparable spectrum* outside this range or in small increments, would require redesign of the equipment.

Tactical Radio Relay: The potential for the relocation of tactical radio relay is the same as for the 1710-1755 MHz band.

Aeronautical Telemetry: The potential for the relocation of aeronautical telemetry is the same as for the 1710-1755 MHz band.

Precision Guided Munitions: The relocation discussion on PGMs provided for the 1710-1755 MHz band also applies for the 1755-1770 MHz band. In addition, the loss of this 1755-1770 MHz band would severely constrain Navy PGM systems to the point of reducing training effectiveness.

Air Combat Training Systems: The Air Combat Training Systems (ACTS) use two ground-to-air and two air-to-ground frequencies above 1770 MHz. The ground-to-ground component of the system uses fixed links in the 1764-1770 MHz range. The DOD has tentatively identified alternate spectrum for the ground links in another federal band, but relocation of these links to higher bands will require a significantly increased infrastructure complexity.

Land Warrior and ICIDS: These relatively new DOD systems operate in the 1755-1850 MHz range. The Land Warrior system is a wireless local area network enabling soldiers to send and receive voice, video, map overlay information, operation plan diagrams, etc. It tunes between 1772 MHz and 1822 MHz, with a bandwidth of 20 MHz with 5 MHz channel increments for transmission. This overlaps the 1755-1770 MHz band. Loss of the 1755-1770 MHz band would mean the loss of 2 (center frequencies 1772 and 1777 MHz) out of 11 channels, or a loss of 18 per cent of possible channels. The Individual Combat Identification System (ICIDS) is an interrogate and response system designed to provide identification of friendly force by individual and automatic weapons users to a range of 1000 meters or more. ICIDS operates in the 1755-1850 MHz range. The loss of the 1755-1770 MHz band would mean the loss of 150 channels out of 950, or a loss of about 16 per cent of all possible operating channels. Furthermore, moving all operations within a smaller set of operating channels increases the likelihood of co-site interference. Inter-system interference reduces the ability of ICIDS to accurately identify friendly soldier, potentially leading to friendly fire casualties. No acceptable alternate bands have been identified for relocation of either Land Warrior or ICIDS.

Potential Relocation of Satellite Systems

The 1761-1842 MHz band segment supports the telemetry, tracking, and command (TT&C) functions for the DOD satellites. It also supports North Atlantic Treaty Organization (NATO) and British 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 main system operating in this band segment that supports the TT&C functions is the Air Force Space Ground Link Subsystem (SGLS). The band plan for SGLS comprises 20 discrete frequencies beginning at 1763.721 MHz and ending with 1839.795 MHz. Each channel is 4.004 MHz wide. Satellites generally are able to receive only on one pre-set channel, and this channel cannot be changed once the satellite is launched. 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.

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.

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 1755–1850 MHz band would have implications for U.S. allies as well, since both NATO and the UK specifically depend on satellite control stations operating in the 1755–1850 MHz band to provide military spacecraft TT&C support for the NATO SATCOM IV and the UK SKYNET satellites, respectively.

The Air Force Satellite Control Network (AFSCN) consists of satellite control centers, tracking stations and test facilities located around the world. Satellite Operations Centers are located at Schriever Air Force Base near Colorado Springs, Colorado and Onizuka Air Force Base, Sunnyvale, California. These centers are manned around the clock and are responsible for the command and control of their assigned satellite systems. The operations centers are linked to remote tracking stations (RTS's) around the world. The RTS's provide the link between the satellite being controlled and the operations center. RTS's around the world are needed to maintain frequent communications with the satellite. The TRS's are required by the operations centers to contact a supported satellite as needed while it's within the particular TRS's view. Some satellites, especially those in geostationary orbit, are limited in which TRS's can support them due to visibility constraints. Space vehicle checkout facilities are used to test launch vehicles and satellite platforms to ensure that the onboard systems operate within specifications.

No comparable available spectrum has been identified for relocation of the satellite control function. The physical relocation of a control station is a major undertaking, involving acquisition of real estate in the appropriate locations, funding, equipment procuring, and legal implications regarding the Base Relocation and Closure Act. Relocation of satellite remote tracking stations to minimize interference cannot be accomplished in the near-term, if at all. Spectrum relocation for satellite operations to the 2025-2110 MHz band has been considered, and could free up frequencies in the 1755-1850 MHz band for other DOD usage. New satellites to be

launched could be set to operate in the 2025-2110 MHz band, but any major transition to this band could not be completed within a decade. NTIA, in its Final Reallocation Report, noted that it is not possible to change the frequencies for satellites which have already been launched, and while it may be possible to change the frequency of satellites which have yet to be launched, in the near term this would be extremely expensive.[16]

Relocation Costs

NTIA identified current assignments via the GMF. However, given the expanding and evolving DOD missions, flexibility and long-term growth opportunity represented an essential characteristic of this band. The cost to relocate non-military systems from the 1755-1770 MHz band is estimated at $210 million. The estimate to relocate military assignments from the 1755-1770 MHz band has not been determined at this time.

Potential Sharing

Technical analyses of the potential for frequency sharing between incumbent systems and 3G systems in the 1755-1770 MHz bands were made. The results of the analyses indicate that large separation distances would be required to prevent interference between incumbent and 3G systems. The FCC staff indicated that mitigation techniques resulting from terrain shielding, deployment of base station antennas that avoid main-beam coupling with interfering stations, and use of advanced (adaptive) antenna systems, would significantly lessen the distance over which a given DOD system would interfere with a given 3G system. However, NTIA concluded that general frequency sharing is not feasible in the 1755-1770 MHz band, given the hundreds of geographically dispersed incumbent systems operating in that band, national coverage requirements for 3G, and the separation distances required to prevent interference. Further, implementation and protection of 3G in areas where the 3G systems would not receive interference will only further restrict DOD growth in the band. Additional system modifications may be required, such as RF filtering, to limit adjacent band interference due to the inherent disparity between Federal and 3G systems.

Satellite systems requiring access to any of SGLS channels 1 through 4 would be impacted by 3G operations in the 1755-1770 MHz band. While the mobile component of 3G systems that 1710-1770 MHz band would not pose a significant interference threat to satellites, the uplink transmissions of the satellite control stations may interfere with the 3G base stations receivers in the band for distances in excess of 200 km depending on terrain. Satellite receiver frequencies are pre-set, and cannot be changed from the ground. Both geostationary and non-geostationary satellites are controlled in the 1755-1770 MHz band. Satellites are scheduled for commanding, in advance, from those remote tracking stations that will have the satellite in view during the scheduled time. It is imperative that all remote tracking stations be able to command every satellite, as operational requirements dictate.

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

VIABILITY OF THE 2110-2170 MHz BAND

Fixed microwave incumbents in the 2110-2150 MHz and 2160-2165 MHz bands are entitled to compensation for relocation to other frequency bands under the policies adopted in the FCC's *Emerging Technologies* proceeding for incumbent fixed users in the frequency bands reallocated for broadband PCS. These incumbents are entitled to compensation for relocation of any links that may pose an interference threat to new fixed or mobile systems licensees, including compensation for all engineering, equipment, site, and FCC fees.

The 2150-2162 MHz band supports Multi-point Distribution Service (MDS) licensees as a return channel for transmissions in the 2500-2690 MHz band. Channel (1) is 2150-2156 MHz, channel (2) is 2156-2162 MHz, and channel (2a) is 2156-2160 MHz. Licenses are issued for geographic areas, either on a protected basis within an area defined as a circle with a 35 mile radius, or within a Basic Trading Area (BTA) not including the protected MDS areas (circles).

The FCC indicated that there may be viable replacement spectrum available for the licensees to continue to offer two-way services.

Potential Relocation of Fixed Systems

The FCC has already established relocation procedures for fixed service users in the 2110-2150 MHz and 2160/62-2165 MHz bands. For the 2165-2170 MHz band, the FCC has also established procedures for mobile-satellite service providers to relocate incumbent fixed services. Because it has not been determined whether this spectrum should be reallocated for 3G wireless systems, the FCC has not addressed whether there is a need for additional relocation procedures for incumbent mobile-satellite service providers. In addition, because the FCC has not decided whether to reallocate the 2150-2160/62 MHz band for 3G wireless systems, there are no relocation procedures for this portion of the band. The 2110-2130 MHz band is paired with the 2160-2180 MHz band, and the 2130-2150 MHz band is paired with the 2180-2200 MHz band. As a result, the FCC may also need to identify relocation spectrum for the bands paired with any spectrum ultimately allocated for 3G wireless systems.

For the bands under consideration, the FCC study reviewed various options for relocation spectrum. Several years ago, in the *Emerging Technologies* proceeding, the FCC reallocated certain bands to fixed services for the purposes of relocating incumbents in the bands designated for *Emerging Technologies* use, including spectrum at 4 GHz, 6 GHz, 10 GHz, and 11 GHz. Generally, it is believed that all of the existing non-multi-point distribution system (MDS) operations in the 2110-2150 MHz and the 2160/62-2200 MHz bands can be accommodated utilizing these relocation bands. For the 2150-2160/62 MHz band, the current record in the FCC's ongoing rulemaking proceeding regarding several options for relocation spectrum, including: unlicenced personal communications systems (PCS) spectrum (1910-1930 MHz); amateur radio service and unlicenced asynchronous voice (unlicenced PCS) device spectrum

(2390-2400 MHz); mobile-satellite service spectrum (1990-2025 MHz); and the upper multi-channel, multipoint distribution system/instructional television fixed service (MMDS/ITFS) band (2500-2690 MHz) appears to provide several viable alternatives for relocation spectrum, and as such, adequacy of relocation spectrum should not present an insurmountable challenge. For the 2110-2170 MHz band, and any relevant paired spectrum, the FCC's report provides information that will be helpful in determining the magnitude of the relocation issues.

The FCC plans to relocate fixed microwave incumbent licenses in the 4 GHz, 6 GHz, 10 GHz, and 11 GHz bands. Available data shows that it may be possible for many incumbent operations to be relocated to frequencies as high as 11 GHz, and technically, could be generally accommodated in the lower bands due to the relatively short path lengths of the links.

Relocation issues, including identifying appropriate relocation spectrum, will be addressed by the FCC in developing polices to facilitate implementation of 3G services. Based on the current information available, while acknowledging that some difficult tradeoffs may need to be made, there is sufficient spectrum available for relocation. Accordingly, should the FCC decide, based on the record in the 3G proceeding, that such reallocation and re-licensing is in the public interest, the entire 2110-2170 MHz band could be made available for 3G wireless systems in an acceptable timeframe.

Potential Relocation of Space Research

The frequency associated with the NASA Goldstone facility cannot be altered because space probes will continue to be commanded by Goldstone for years to come.

Potential Sharing with Fixed Systems

Third Generation wireless systems cannot generally share spectrum with nation-wide fixed service systems.

Potential Sharing with Space Research

Third generation mobile receivers will probably experience service disruption in the 2110-2120 MHz band when attempting to operate in areas surrounding the Goldstone site during uplink transmissions. The severity and duration of such disruption will depend upon the frequency/channel assigned to the mobile unit, as well as, time, power, and orientation of the transmitting antenna, distance, terrain, and weather between Goldstone and the affected mobile unit.[17]

17 *See* the *NTIA 3G Report*, Appendix A for more detailed information on possible interference from Goldstone to 3G systems.

APPENDIX

INDUSTRY ANALYSIS OF SHARING BETWEEN ADVANCED WIRELESS SYSTEMS AND DOD OPERATIONS IN THE 16 PROTECTED SITES

Introduction

This appendix was prepared by the Cellular Telecommunications & Internet Association ("CTIA") in conjunction with NTIA's ongoing study of "The Potential for Accommodating Third Generation Mobile Systems in the 1710-1850 MHz Band." On October 5, 2001, NTIA announced a new plan to identify spectrum for advanced mobile services that examines the potential use of the 1710-1770 MHz and 2110-2170 MHz bands. This plan includes the 1710-1755 MHz band, which was reallocated in 1995 in accordance with the Omnibus Budget Reconciliation Act of 1993 ("OBRA-93"). At the request of NTIA, technical experts from various companies[1] met with NTIA and DoD representatives on June 24-25, 2002 to discuss the potential for accommodating advanced wireless services in the 1710-1755 MHz band including in areas identified by DoD as "protected areas."[2]

Technical Analysis

NTIA advised the industry experts that all conventional fixed systems that were previously exempt from relocation would be cleared from the 1710-1755 MHz band including those systems operating in the 16 "protected areas." However, DoD intended to continue to operate aeronautical mobile and tactical radio relay ("TRR") systems operating in these areas. As a result, the industry's analysis focused only on the aeronautical mobile and TRR systems.

Industry studied the potential impact of the DoD systems on the future operations of advanced wireless systems. Operation of these systems on the same frequencies at the same time and over the same geographic area would result in harmful interference to commercial systems. It was noted that the DoD systems are operated for a significant portion of the day and/or over a significant number of days per week. Consequently, we concluded that the band could not be shared based on operational criteria and that continued operations of the DoD systems would create large interference contours ("exclusion zones") within which acceptable commercial service would not be possible.

The aeronautical mobiles presented the worse case scenario. Aircraft employing these systems fly within the identified "protected areas" at altitudes up to 50,000 feet. The analysis

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1 Representatives from AT&T Wireless, Cingular Wireless, Ericsson, Lucent, Motorola, Nortel Networks, Verizon Wireless, VoiceStream, and CTIA participated in the June 24-25, 2002 meeting.

2 These "protected areas" include China Lake, CA, Eglin AFB, FL, Yuma, AZ, Cherry Point, NC, Pacific Missile Test Range, CA, Nellis AFB, NV, Hill AFB, UT, Patuxent River, MD, Holloman AFB, NM, Ft. Irwin, CA, Ft. Rucker, AL, Ft. Bragg, NC, Ft. Campbell, KY, Ft. Lewis, WA, Ft. Benning, GA, and Ft. Stewart, GA. However, DOD noted that there are no aeronautical mobile or tactical radio relay systems operating in the 1710-1755 MHz band at Ft. Rucker or Ft. Benning.

showed that interference from the airborne stations would occur over all areas that are line of sight to the aircraft. The line of sight exclusion zone depends on altitude. For a typical operation at an altitude of 25,000 ft, the line of sight distance is approximately 300 km. At the maximum operational altitude of 50,000 ft, interference could occur over a distance of more than 400 km. As a result, the exclusion zones created by the operation of these systems may extend 300-400 km beyond the operational "protected area," blocking off large portions of the country from commercial service. For example, aeronautical mobiles operating in and around the Patuxent River, MD facility would create an exclusion zone that extends from Baltimore, MD, through Washington, DC, and as far south as Norfolk and Newport News, VA.

Interference from terrestrial TRR systems is also significant. Terrain-based propagation models were used to analyze the potential interference from the TRR fixed link systems. The results showed that the exclusion zones are generally comparable to the identified "protected areas" which range from 100 km to 240 km in diameter. Many of these "protected areas" include, or are in close proximity to, cities, major interstate highways, or other areas where wireless services would be anticipated. The propagation analysis showed that continued operation of the TRR systems in these areas would make commercial service inaccessible in those areas.

Conclusions

The analysis of the industry experts concludes that all aeronautical mobile systems and all terrestrial TRR systems must be cleared from the 1710-1755 MHz band if the band is to be used for advanced wireless services. It was noted that further analysis might conclude that a few of the more remote areas might require less spectrum, particularly in the earlier years of advanced services deployment. However, it is expected that the entire 1710-1755 MHz band would need to be cleared eventually.