NTIA SPECIAL PUBLICATION 98-39

IDENTIFICATION OF ALTERNATE BANDS

Response to Title III of The Balanced Budget Act Of 1997

Special Publication

U.S. DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration

IDENTIFICATION OF ALTERNATE BANDS

Response to Title III of The Balanced Budget Act Of 1997

Special Publication

U.S. DEPARTMENT OF COMMERCE ● National Telecommunications

NTIA Special Publication 98-39

Identification of Alternate Bands
In Response to The Balanced Budget Act Of 1997

Gerald Hurt
Ernesto Cerezo

U.S. DEPARTMENT OF COMMERCE
William Daley, Secretary

Larry Irving, Assistant Secretary
for Communications and Information, and
Administrator, National Telecommunications
and Information Administration

November 1998

EXECUTIVE SUMMARY

INTRODUCTION

Title III of the Balanced Budget Act of 1997 (Budget Act) requires the Federal Communications Commission (FCC) to identify 15 Megahertz (MHz) from the 1990-2110 MHz band for assignment by competitive bidding. This range includes the 2025-2110 MHz band used by the Federal Government and several foreign governments for critical space science services. In recognition of this critical use of the spectrum, the Budget Act mandates that the FCC coordinate with the Secretary of Commerce when its decision could impact Federal Government spectrum use and that it honor all international commitments concerning spectrum allocations. The Budget Act also provides a process for spectrum substitution to protect incumbent Federal systems from interference. The Budget Act authorizes the President to substitute an alternate 15 MHz for assignment by competitive bidding that would better serve the public interest, convenience and necessity and could reasonably be expected to produce comparable receipts.

The National Telecommunications and Information Administration (NTIA) within the Department of Commerce serves as the President's principal adviser on telecommunications policy and is responsible for management of the Federal Government's use of the radio spectrum. Through the required interagency coordination process, the FCC informed NTIA that it intends to identify the 15 MHz for competitive bidding within the 2025-2110 MHz portion of the 1990-2110 MHz band. This report documents the profoundly negative impact of such a decision on the $87 billion current and planned U.S. space program, provides a basis for the Presidential determination, and identifies alternative spectrum required by the Budget Act.

EFFECT OF REALLOCATING 15 MHz OF THE 2025-2110 MHz BAND FOR ASSIGNMENT BY COMPETITIVE BIDDING

The National Table of Frequency Allocations allocate the 2025-2110 MHz band to Federal space science services and the entire 1990-2110 MHz band to the non-Federal government fixed and mobile communication services. The Federal space science services provide the tracking, telemetry, and command (TT&C) functions for near-Earth and geostationary-satellite network operated by the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA). The transmissions made to these satellites both from the surface of the Earth and from NASA's Tracking and Data Relay Satellites (TDRS) in the 2025-2110 MHz band are essential to the success of the scientific and manned space programs.

Major U.S. scientific satellite systems using the band include Space Shuttle, Hubble Space Telescope, TDRS System, future International Space Station, GOES Weather Satellites, and Landsat. Other space agencies in Europe, Japan, and Russia, following international frequency allocations for the band, use it for the same functions. NASA has entered several agreements to provide back up

support for these foreign systems. Also, preliminary discussions have taken place within the Department of Defense regarding the possible consolidation of Federal, military and domestic-civilian TT&C satellite functions into the 2025-2110 MHz band, which would further increase the usage of the band.

The broadcast and cable industries use the entire 1990-2110 MHz band for electronic news gathering (ENG) equipment in the mobile service and studio-to-transmitter and inter-city relay links in the fixed service. The ENG equipment, which provides live video coverage of news, sports and entertainment events, has over the past thirty years, shared the 2025-2110 MHz band compatibly with the space science services. This is partly because ENG is a low density application with few transmitters distributed over the entire 120 MHz, so generally spectrum is available to satisfy both services. In addition, given the vagaries of news and sports, ENG transmitters are not used very often at any specific place, so, even if the spectrum is crowded, usage times can be coordinated. Moreover, the space science and broadcasting communities have worked together to develop coordination procedures to mitigate potential interference.

The Administrators of both NASA and NOAA are concerned that levels of radio interference to Federal space services would be unacceptable if the FCC were to assign any 15 MHz portion of the 2025-2110 MHz band by competitive bidding for a use different in character than the ENG service. National and international technical studies also have shown that space science services cannot share frequency bands with high density terrestrial services. One International Telecommunication Union (ITU) Recommendation concludes, for example, that only low density mobile systems like the U.S. ENG equipment should use the 2025-2110 MHz band. It states that neither high density nor conventional mobile systems should use the band and recognizes that specifying a maximum number of mobile stations to preclude interference may constitute a valid technical solution. The Recommendation affirms, however, that "the implementation of such a solution may not be practical."

Reallocation of 15 MHz in the 2025-2110 MHz band to a high density service could cause interference to NASA and NOAA scientific satellite systems and compromise the ability of the United States to honor its international obligations. Moreover, the private sector uses this band for the broadcast auxiliary services. The estimated cost of relocating NASA and NOAA satellites is about $13 billion and of relocating the broadcast auxiliary service is about $200 million. Given the $13.2 billion estimated relocation cost, OMB estimates that the auction receipts for this band would be negligible. Thus, pursuant to Section 3002(c)(4) of the Budget Act this report identifies alternative bands of frequencies for assignment by competitive bidding.

SUBSTITUTE BANDS

The Budget Act allows the President very wide latitude in selecting alternative bands. The substitutes must provide comparable revenues and be in the public interest, convenience and necessity. The Budget Act does not restrict the President to bands allocated to either Federal or non-

federal users. Thus, this report considers all frequency bands that have not been licensed by competitive bidding.

The following four bands are identified as candidates for substitution under the Budget Act. The Office of Management and Budget (OMB) has provided revenue and cost estimates.

944-960 MHz. FM broadcast stations use the 944-952 MHz portion of this band for studio-to-transmitter and inter-city relay links, while the power, petroleum, security and paging industries and point-to-point private operational fixed stations use the 952-960 MHz portion for the fixed service. Assignment by competitive bidding could require grandfathering the 20,000 existing licenses in the band. Given the likely constraints on the full use of these frequencies by auction winners, OMB estimates that the auction receipts for this band would be $900 million.

1390-1400, 1427-1432, and 1670-1675 MHz. The Federal Government uses these bands, which total 20 MHz, for radiolocation, fixed, mobile, and meteorological services. NTIA released these bands in 1995 for reallocation to the private sector under requirements of OBRA-93. The bands are available for reallocation in January 1999. Specific Federal sites in each of these three bands will require continued protection as defined in the 1995 NTIA *Spectrum Reallocation Final Report*. Assignment by competitive bidding would require reimbursement of some existing Federal users for relocation to other spectrum and sharing with others. Given the $106-143 million relocation costs and the minimal sharing constraints associated with these bands, OMB estimates that the auction receipts for this band would be $1.57 billion.

Unauctioned parts of the 2500-2690 MHz band. Wireless cable TV broadcasting (multipoint distribution service), instructional TV fixed service, private operational fixed, and narrowband audio response channels use these bands. Assignment by competitive bidding could require grandfathering the existing licenses in the band. Given the likely constraints on the full use of these frequencies by auction winners, OMB estimates that the auction receipts for this band would be $750 million.

3650-3700 MHz. The Federal Government uses this band for radiolocation service aboard ships, while the private sector uses it to a limited degree for the fixed-satellite service. NTIA identified this band in 1995 for reallocation to the private sector under requirements of OBRA-93 for reallocation in January 1999. Specific Federal sites in this band will require continued protection as defined in the 1995 NTIA *Spectrum Reallocation Final Report*. Assignment by competitive bidding would require reimbursement of some existing Federal users for relocation to other spectrum and sharing with others. Given the $8-30 million relocation costs and the potential sharing constraints associated with this band, OMB estimates that the auction receipts for this band would be $1.2 billion.

The public interest, convenience and necessity would be better served by identification for assignment by competitive bidding any of the four alternatives identified in this report. This would prevent the compromise of over $87 billion of current and planned investment in this band by the U.S. space program and preserve the possibility of greater consolidation and spectrum efficiency of U.S.

space operations in this band. Moreover, the OMB cost analysis makes clear that any of the four alternatives identified can reasonably be expected to produce comparable, if not significantly higher, auction receipts.

SECTION 1
INTRODUCTION

BACKGROUND

The National Telecommunications and Information Administration (NTIA), an agency of the U.S. Department of Commerce, is responsible for managing the Federal Government's use of the radio spectrum. NTIA establishes policies concerning frequency assignment, allocation and use, and provides the various Executive Branch agencies with guidance to ensure that their conduct of telecommunications activities is consistent with these policies.[1] Further, NTIA serves as the President's principal advisor on telecommunication policies pertaining to the nation's economic and technological advancements and to the regulation of the telecommunications industry. NTIA develops Executive Branch positions to ensure that policy is effectively presented to Federal agencies, the Federal Communications Commission (FCC), Congress, and the public.

On August 8, 1997, the President signed into law the Balanced Budget Act of 1997 (Budget Act).[2] The Budget Act requires, among other things, that the FCC reallocate a total of 15 Megahertz (MHz) from within the 1990-2110 MHz band for competitive bidding.[3] The Budget Act also includes a provision that permits the President to identify an alternative 15 MHz, if the President determines that 15 MHz from the 1990-2110 MHz band cannot be reallocated to protect incumbent Federal systems from interference, and that allocation of other spectrum (A) better serves the public inetrest, convenience, and necessity, and (B) can reasonably be expected to produce comparable receipts. If the President exercises this option, the President shall report to the Congress an identification of such alternative bands for assignment by competitive bidding no later than August 8, 1999.[4]

Through the interagency coordination process, the FCC informed NTIA that it would designate the 15 MHz for auction purposes as required in accordance with the Budget Act within the 2025-2110 MHz portion of the 1990-2110 MHz band. Following discussions among NTIA, NASA and NOAA, the Administrators of both NASA and NOAA expressed their concern that levels of radio interference to Federal space services would be unacceptable if the FCC were to assign any 15 MHz portion of the 2025-2110 MHz band by competitive bidding for a use different in character than the ENG service (see NASA and NOAA letters to NTIA in Appendices B and C, respectively).

---

1 The National Telecommunications and Information Administration Organization Act, Pub. L. No. 102-538, 106 Stat. 3353 (1992) (codified at 47 U.S.C. § 901 *et seq*.).

2 The Balanced Budget Act of 1997, Pub. L. 105-33, 111 Stat. 251-258 (1997) (Title III-Communications and Spectrum Allocation Provisions).

3 In accordance Section 3002 (c) (2) (D) and (E) of the Budget Act, the FCC, in making available bands of frequencies for competitive bidding, must, among other things, comply with the requirements of international agreements concerning spectrum allocations and coordinate with the Secretary of Commerce when there is any impact on Federal Government spectrum use. Budget Act, §§ 3002 (c) (2) (D), (E), *supra* note 2.

4 *See* Budget Act, § 3002 (c) (4), *supra* note 2.

The 1990-2110 MHz band includes both Federal and non-Federal uses. This report focuses on the Federal use, which is contained within the 2025-2110 MHz portion of the band. The Federal use in the 2025-2110 MHz frequency range is vital to the successful operation of numerous Federal satellite and spacecraft systems, as well as, foreign systems that the United States supports by virtue of international agreements. The services provided by these systems include a variety of manned, scientific research, and weather related space programs. Federal Government current and planned investment costs in these satellite and spacecraft systems, along with their associated earth stations, are estimated to exceed $87 billion.

The 2025-2110 MHz band is used in the United States as the primary command and control communications band for the National Space Programs administered by NASA and NOAA. NASA has relied upon this portion of the spectrum in support of virtually all of its mission spacecraft since the days of the Apollo Program. Major space systems that the band supports include the Mission to Planet Earth Programs, the Tracking and Data Relay Satellite System (TDRSS), Space Shuttle and Hubble Space Telescope Programs, and the soon-to-be launched International Space Station (ISS). NOAA has also relied on this band for the operation of Geostationary Operational Environmental Satellites (GOES), Polar Orbiting Environmental Satellites and the Landsat system, as well as, evolving commercial satellite systems.

This report examines the impact of reallocating 15 MHz of spectrum for competitive bidding from the 2025-2110 MHz band. Specific information includes: overview of current allocation rules and regulations; pertinent national and international footnotes; Federal Government spectrum usage; Federal agencies current and future space programs or systems operating in the 2025-2110 MHz band; and international agreements and national issues pertaining to the 2025-2110 MHz frequency span. Pursuant to exercising the Presidential option for substitution, alternative bands of frequencies that meet the requirements of the Budget Act are also identified and assessed.

OBJECTIVES

The objectives of this report are to examine the use of the 2025-2110 MHz band by Federal space systems and identify alternative spectrum for substitution that meet the requirements of the Budget Act.

APPROACH

This report draws extensively on previously completed reports describing Federal use of the radio spectrum as well as international documents addressing spectrum sharing issues in the 2025-2110 MHz band. These include:

1) *Reallocation Impact Study of the 1990-2110 MHz band*, a companion report prepared in conjunction with this report,[5]

2) *Spectrum Reallocation Final Report*, prepared in response to the *Omnibus Budget Reconciliation Act of 1993 (OBRA-93)*,[6]

3) *Spectrum Reallocation Report*, prepared in response to the Balanced Budget Act of 1997,[7]

4) Recommendations, Resolutions and Regulations adopted by the International Telecommunication Union pertaining to use of this band, and

5) Various information and literatures from affected Federal agencies.

---

5 National Telecommunications and Information Administration, U.S. Department of Commerce, *Reallocation Impact Study of the 1990-2110 MHz Band*, NTIA Special Publication 98-37 (November 1998).

6 National Telecommunications and Information Administration, U.S. Department of Commerce, *Spectrum Reallocation Final Report*, NTIA Special Publication 95-32 (February 1995).

7 National Telecommunications and Information Administration, U.S. Department of Commerce, *Spectrum Reallocation Report*, NTIA Special Publication 98-36 (February 1998).

SECTION 2
SPECTRUM USE OF THE 1990-2110 MHz BAND

FREQUENCY ALLOCATIONS

International frequency allocations, as established by the International Telecommunication Union (ITU), and domestic frequency allocations, as established by the FCC and NTIA, govern the overall use of the radio spectrum. The international and domestic frequency allocation tables along with the corresponding footnotes for the 1990-2110 MHz band are given in Appendix A. In the United States, three broad categories of current and planned uses are designated for the band. Across the entire 1990-2110 MHz band, the broadcast auxiliary service (BAS), local TV transmission service (LTTS) and cable television relay service (CARS) are allocated on a primary basis. The 2025-2110 MHz portion of the band is also allocated to three space services - the space research, space operation, and Earth exploration-satellite services, collectively called the space science services. These space science services are allocated internationally on a primary basis, and in the United States via a series of footnotes to the tables. In the 1990-2025 MHz portion of the band, the FCC has a pending proceeding to allocate this band segment to the mobile-satellite service, in agreement with international allocations adopted in 1992 and 1995. The following paragraphs describe in more detail the spectrum usage of these three categories of users. This report emphasizes the Federal usage of space science services.

SPACE SCIENCE SERVICES

Under the Space Act of 1958, NASA and NOAA operate spacecraft in the space science services for a variety of congressionally directed missions, all of which are dependent on radio spectrum access for satellite control and relay to Earth of telemetry and mission-derived data. There is extensive use of the 2025-2110 MHz band for tracking, telemetry, and command (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.

The United States civil space program is administered primarily by two Federal agencies, NASA and NOAA. Together, these two agencies perform a variety of Congressionally mandated space missions and functions that include: collecting satellite-derived weather data necessary for timely and accurate weather forecasts; satellite tracking/monitoring of forest fires, volcanic activity, ozone depletion and environmental pollution; scientific study of the properties of the Earth's upper and lower atmosphere, solar phenomena, and exploration of the moon; conduct planet Earth missions, surveys of the celestial sphere across the electromagnetic spectrum, and three-dimensional imaging techniques and others.

The major Federal programs and systems operating and planned for operation in the 2025-2110 MHz band are shown in Table 1, along with estimates of the total dollar investment for each. NTIA, in consultation with NASA and NOAA, has completed an extensive review and documentation of the Federal major space systems that have critical communication links in the 2025-2110 MHz band.[8] That report provides more detail description of the major space systems than the one provided here.

Major NOAA Space Programs/Systems in the 2025-2110 MHz Band

NOAA uses the 2025-2110 MHz band to support numerous space-related radio services, such as space telecommand, space operation, space research, and meteorological services. In particular, NOAA uses this band to fulfill a requirement to provide continuous photographic coverage of the western hemisphere for accurate weather prediction. Presently, this photographic coverage is provided by GOES 8 and 10. NOAA also uses this band to support the Landsat and the Polar-orbiting satellite systems. In addition, NOAA has a worldwide commitment through the World Meteorological Organization (WMO) to provide low resolution, direct readout weather imagery to 178 administrations, as well as, a national commitment to support space science directives in this band. These services, requirement and commitment, are provided for by NOAA's space systems which are described below.

Geostationary Operational Environmental Satellite (GOES) System

NOAA's GOES satellite system is a part of the International Geostationary Meteorological Satellite Data Collection System (IGMSDCS) which also include several satellites of other nations. GOES satellites' primary function is to provide timely, high resolution weather data over the Western Hemisphere, and the collection and dissemination of meteorological data. This function is vital not only to the citizens of the United States but also to those in other countries. Present budgetary plans identify the procurement of subsequent GOES satellites to use the same uplink frequency band at 2025-2035 MHz through the year 2015.

GOES satellites transmit imaging and sounding data at other frequency bands (*i. e.*, 1670-1694 MHz) to a command and data acquisition (CDA) facility complex at Wallops Island, VA. Command and processed data are subsequently uplinked to the satellites in the 2025-2035 MHz band from the CDA for further distribution to client weather facilities located throughout the United States and its Possessions. NOAA is developing a backup GOES CDA facility which will also use the 2025-2035 MHz band for command uplink transmissions. This CDA facility is at Goddard Space Flight Center (GSFC) in Greenbelt, Maryland and will consist of a single earth station with a 16.2-meter antenna. GOES functions likely to be carried out at GSFC are processed data relay, weather facsimile, command, ranging, and data collection platform interrogation.

---

[8] *Reallocation Impact Study*, *supra* note 5.

TABLE 1
MAJOR SPACE SYSTEMS/PROGRAMS IN THE 2025-2110 MHz BAND

Program/System	No. of Satellites	Launch Date	Min. Op. Life (Yrs)[a]	Current Investment (Billion)[b]	Total Investment (Billion)[c]
Geostationary Operational Environmental Satellite (GOES)	9	1990-2010	5	$2.0 [d]	$3.9
Landsat	1	1999	6	$0.8 [e]	$0.9
Polar Orbiting Environmental System (POES)	5 [f]	1998-2007	3	$2.0	$6.4
Tracking & Data Relay Satellite System (TDRSS)	9	1983-2000	15	$2.6	$4.4
National Space Transportation System (Space Shuttle)	4	On-going	10	$19.2	$36.0
Hubble Space Telescope System (HST)	1	1990	15	$3.9	$4.2
International Space Station (ISS)	1	1998	15-20	$10.4	$21.3
Earth Orbiting Scientific Satellites (EOS)	7	1999-2006	5	$2.6	$6.6
Spaceflight Tracking & Data Network (STDN)	Ground based		Indefinite	$1.8	$2.0
Deep Space Network (DSN)	Ground based		Indefinite	$1.6	$1.8
TOTAL				$46.9	$87.5 B

[a] Operational life expectancy of a space system in years. Most satellites can be expected to operate beyond their design or operational life.
[b] Mission investment to-date in FY1998 dollars.
[c] Total current and projected program investment over mission life.
[d] The cost is for the current five satellites only.
[e] This cost is for Landsat 7 only.
[f] There will be a total of 9 satellites (four future National POES satellite systems or NPOESS).

Landsat System

Currently, the Landsat system is composed of Landsats 5 and 7. Landsat 5 was launched in 1984 and continues to operate, acquiring multi-spectral image data for 16 ground stations around the world. The Remote Sensing Act of 1992 authorized the development of Landsat 7 as a follow-on mission. Landsat 7 is completing its final testing and a change in frequency would cause a multi-year launch delay and, hence, a financial burden that would cancel the mission and effectively end the Landsat Program. Landsat 7 is scheduled for launch in late March 1999, and is designed for a 6-year mission life.

Landsat 7 will continue systematic imaging of the Earth that began in 1972. It will collect a global archive of multi-spectral images by acquiring imagery of about one-quarter of the Earth's land surface every 16 days. These data will be available to the public at a greatly reduced price, compared to past Landsat data and current United States and foreign commercial systems. Data will be distributed from the U.S. Geological Survey/Earth Resource Observation System (USGS/EROS) Data Center of the Department of Interior (DOI). These data will be used for global monitoring of agriculture, forestry, and range resources, land use and mapping, geology, water resources, coastal resources, urban change and planning, environmental monitoring and assessment, and other uses.

Both Landsat satellites require the use of the 2025-2110 MHz band for uplink of commands for their normal operations. These command data are sent either by the ground stations or by NASA's TDRSS satellites.

Polar-orbiting Operational Environmental Satellites

NOAA and NASA have jointly developed a valuable series of polar-orbiting Earth environmental observation satellites since 1978. These satellites provide global data to NOAA's short and long-range weather forecasting systems. The system consist of two polar-orbiting satellites known as the Advanced Television Infrared Observation Satellites (TIROS-N). Operating as a pair, these satellites ensure that environmental data, for any region of the Earth, are no more than six hours old. These satellites have not only provided cost-effective data for every immediate and real needs but also for extensive climate and research programs. The weather data has afforded both convenience and safety to viewers throughout the world. The satellites also support the Search and Rescue Satellite Aided Tracking (SARSAT) part of the COSPAS-SARSAT constellation. The COSPAS is the Russian space system for the search of vessels in distress.[9]

NOAA-K, launched on May 13, 1998 and now called NOAA-15, is the latest in the Advanced TIROS-N series. The spacecraft will continue the provision, as a polar-orbiting platform, to support the environmental monitoring instruments for imaging, and measurements of the Earth's atmosphere, its surface, and cloud cover, including Earth radiation, atmospheric ozone, aerosol distribution, sea

[9] NOAA/NASA Publication, NOAA-K, NP-1997-12-052-GSFC, (1997).

surface temperature, vertical temperature and water profiles in the troposphere; measurement of proton and electron flux at orbit altitude, and for SARSAT. Additionally, NOAA-15 is the first in the series to support dedicated microwave instruments for the generation of temperature, moisture, surface and hydrological products in cloudy regions where visible and infrared instruments have decreased capability.[10] Construction of three new antenna systems have been completed at Fairbanks, AK to support the polar-orbiting environmental satellites.

Major NASA Space Programs/Systems in the 2025 -2110 MHz Band.

NASA is the largest Federal user of the 2025-2110 MHz band. Currently, NASA has 183 authorized frequency assignments within the 2025-2110 MHz portion of the band, supporting the operations of numerous United States and international space satellite systems. Common uses allow for "cross support" between NASA and other international space agencies and emergency operations, particularly where astronaut safety is concerned.

Since the early 1960's, NASA has successfully used this band to support the many missions that started from the Apollo Program. This band is currently used to support missions and programs including the Tracking and Data Relay Satellite, Hubble Space Telescope and the National Space Transportation System (Space Shuttle), International Space Station Program, and numerous scientific programs. A more complete description of these systems is given in the Reallocation Impact Study.[11]

Both the Land Remote Sensing Act of 1992 and the Commercial Space Act of 1997 strongly promote commercial space opportunities as a priority goal for the United States. NASA has stated, in the implementation of this goal, continued support for numerous commercial space endeavors in the 2025-2110 MHz band. In the future, NASA may provide uplink TT&C to commercial low-Earth orbit remote sensing systems that will operate in the 2025-2110 MHz band (*e.g.*, systems owned by the Space Imaging L.P. and Earthwatch Incorporated). Also, other future commercial entities may benefit from NASA for launch, early orbit, on-orbit, and/or recovery support.

Tracking and Data Relay Satellite System (TDRSS)

The TDRSS was developed to fulfill NASA's requirements to improve the efficiency of returning spacecraft-gathered scientific data to Earth and to provide real-time coverage of the low earth orbit (LEO) satellites on a more complete basis, as compared to the previous network of U.S. earth stations which could support a given space mission for only about 15 percent of the time due to visibility constraints. The TDRSS was principally designed to provide near continuous communication links between LEO spacecraft, including the Space Shuttle, and earth stations via

---

10 *Id.*

11 *Reallocation Impact Study*, *supra* note 5.

geostationary satellites. It is an integral part of NASA's Spaceflight Tracking and Data Network (STDN).

Currently, the TDRSS network is composed of six geostationary tracking and data relay satellites, five operational satellites and one in-orbit spare. At full operation, the TDRSS can track up to 26 satellites at a time. The first satellite, TDRS-1, was launched in 1983 and positioned at 41° West. A second satellite was lost with the Space Challenger disaster in 1986. In 1988, TDRS-3 was launched and placed at 171° West to work in tandem with TDRS-1. The TDRS-3 allows mission control to stay in near-continuous contact with the Space Shuttle crews and other low-orbit satellites. Because of the importance in improving communications with future Space Shuttle crews, NASA launched TDRS-4 in 1989, which is the most complex non-military communications satellite built to date. TDRS-4 has dramatically improved communications with LEO spacecraft, in particular, the Space Shuttle.

Another satellite, TDRS-5, was launched in 1991 as a possible replacement for either TDRS-1 or TDRS-3. NASA augmented the TDRSS network to enhance its capacity with the increase in the number of satellites and the addition of a second earth station at White Sands, NM. In 1992, NASA requested the Spectrum Planning Subcommittee (SPS) of the Interdepartment Radio Advisory Committee (IRAC) for two more additional geostationary orbit location for TDRSS as a response to the technical difficulties with the Gamma Ray Observatory (GRO) satellite. All of these added TDRSS and the earth station require access to the 2025-2110 MHz band.

A follow-on TDRSS, consisting of three satellites (TDRSS H, I, & J), is pending approval for operational use through the NTIA certification process. Eventually, the new TDRSS will be phased-in to replace all the original TDRSS satellites as their useful lifetimes are realized or as increases in capacity is needed for mission support. The follow-on TDRSS will continue to provide support to user spacecraft throughout the 2025-2110 MHz band.

National Space Transportation System (Space Shuttle)

The Space Shuttle is a NASA program designed to support a wide range of scientific, environmental, defense, commercial, and international interests. It is a manned re-usable space transportation system that can deliver satellites to low-Earth orbit where an upper stage rocket can be used to boost them into a higher energy orbit. In addition to this launch capability, the Space Shuttle also carries spacelab payloads, modules, and pallets used to conduct in-orbit experiments from the cargo bay. Four reusable orbital vehicles make-up the Space Shuttle fleet with flights that began in the early 1980's and will continue on the foreseeable future.

Hubble Space Telescope (HST) System

Launched by the Space Shuttle in 1990, the HST is the first complete observatory in space and has an expected orbiting lifetime of 15 years. It is an unmanned astronomical observatory consisting of a support system module, an optical telescope assembly and a complement of scientific instruments. It is used to probe the secrets of the universe and analyze light sources which cannot be detected by ground-based telescopes. The HST, although unmanned, can be serviced by astronauts during extra vehicular activity missions and can be returned to Earth for refurbishment. Command signals are transmitted to the Hubble in the 2025-2110 MHz band, whereas housekeeping and some research telemetry data are transmitted by the telescope in the 2200-2290 MHz band and wideband data also in the 2200-2290 MHz band. All communications to and from the HST are through the TDRSS.

International Space Station (ISS)

When fully operational, the ISS will be a multi-purpose facility which will provide the United States and a host of international partners with a permanent, manned orbital facility serving many functions including the following: a national laboratory in space for scientific research; a permanent observatory in space; a servicing facility for various free-flying spacecraft; a transportation node; a manufacturing facility; an assembly facility; and a staging base for space exploration. In addition to Government use, the ISS will also be available for non-government and foreign use.

When the various space station elements are fully assembled, the main platform, or core, will occupy a low-Earth orbit inclined at 51.6 degrees. The polar orbiting platform, containing payloads such as remote sensors that do not require frequent servicing from the core, will occupy a sun-synchronous orbit inclined about 98 degrees. Other elements include the free-flying spacecraft and various orbit transfer vehicles. Telecommunications for the ISS will be provided primarily by many existing NASA frequency resources including the TDRSS and its follow-on systems (*e.g.*, TDRS H, I and J). The Space Shuttle will provide primary logistics support. The Global Positioning System is the most likely system to be used in conjunction with the ISS traffic function.

Earth Observing System (EOS)

Part of NASA's Earth science enterprise is the EOS Program. This system will consist of a series of satellites for extended space-based studies of the Earth and its environments as an integrated system. The EOS AM, PM, CHEM and LAM spacecraft will observe how the Earth is changing both naturally and as a result of human activity by obtaining measurements of the atmosphere, oceans, land surfaces, polar regions and solid Earth. Separate EOS platforms will host a compliment of scientific and remote sensing instruments. These spacecraft utilize the 2025-2110 MHz band through TDRSS. The initial spacecraft (EOS AM-1) is scheduled for launch in June 1999.

Spaceflight Tracking and Data Network (STDN)

NASA operates and maintains a worldwide system of ground stations to provide TT&C to all authorized user spacecraft missions. The set of ground stations presently supporting the low-Earth orbit spacecraft, together with the communication links connecting NASA centers with the ground stations, is referred to as the STDN. In the 1980's, the TDRSS was added to the STDN. With this addition, the STDN provided the increased support required by user missions. A key benefit of the STDN in the TDRSS era is that data flow between mission spacecraft and user ground station facilities is in real time.

Presently, earth stations operating at seven locations around the world make up the Ground Spaceflight Tracking and Data Network (GSTDN). This network is used to track spacecraft during launch, suborbital, and in orbit mission phases. Three of the GSTDN ground stations are located at Goldstone, CA; Madrid, Spain; and Canberra, Australia and provide the primary support for high and synchronous orbit spacecraft, as well as, eccentric orbit spacecraft. A fourth GSTDN station is located at Fairbanks, AK, which supports existing Earth orbiting spacecraft that are not compatible with TDRSS. The other GSTDN facilities that provide launch support are located at Merrit Island, FL, Vandenberg Air Force Base, CA, and Wallops Island, VA.

Deep Space Network (DSN)

NASA's DSN facilities consist of earth stations located in Spain, Australia and in the United States. The only DSN earth station facility in the United States is at Goldstone, CA. One technical characteristic that makes these earth stations very different from other earth stations is that they employ very high-powered transmitters. Although, the DSN at Goldstone emits a power of up to 500 kW, the highly directive characteristics of the earth station antenna and remoteness of its location reduces the probability of harmful interference with terrestrial services. Normally, DSN uplink operations are conducted in the 2110-2120 MHz (uplink) but for some missions, especially during emergencies such as when contact with a mission spacecraft is lost, the 2025-2110 MHz can be utilized in order to command the errant spacecraft.[12] The DSN sites are also routinely used to support launch and early orbit operations in the band for national and international space science missions.

NASA, NOAA, and their international space partners operate major space programs throughout the 2025-2110 MHz band. Table 1 identifies representative Federal systems along with estimates of the current and total dollar investments for each.

---

[12] The Solar Heliospheric Observatory (SOHO) spacecraft, which was launched on December 2, 1995, spun out of control on June 24, 1998 and all communication links were lost. On September 16, 1998, NASA and European Space Administration controllers successfully regained control of SOHO via the 2025-2110 MHz band. For more information, *see* NASA's web site at http://sohowww.nascom.nasa.gov/operations/recovery.

The total Federal system replacement cost depends on many factors.[13] For those flight systems which are already in orbit and which cannot be retrieved, the mission becomes a total loss and must be replaced altogether. Retrievable flight hardware, including systems onboard the Space Shuttle and the pending Space Station, can undergo a retrofit. Associated ground systems, including the DSN or the STDN, can also be retrofitted. International cooperatives such as the Space Station could have additional cost implications as a result of the communications systems onboard the foreign modules.

The TDRSS represents a special case in that the system has radiocommunication capabilities at other frequencies.[14] However, the primary operational mode for the system is at 2025-2110 MHz band; more than 75 percent of its user spacecraft tracking support is provided at this frequency band. A key reason is the multiple access capability, which only exists at 2025-2110 MHz band. This capability allows the TDRSS to support a large number user spacecraft in a cost-effective manner since it allows simultaneous communications links. Loss of the multiple access capability would severely cripple the system.

Future Space Programs/Systems in the 2025-2110 MHz Band

The Reallocation Impact Study provides details of NASA's and NOAA's future space systems and programs. Since the majority of these systems are still in their early stages, the description and other information pertaining to these systems are not available at this time. Only the projected launch dates are known. Additionally, as agency funding is secured, new mission program offices will require communications support in the 2025-2110 MHz band. The GOES, specifically the continuation series, will still be operational in the year 2015.

A complete list of the current and planned worldwide civil space satellite systems utilizing the 2025-2110 MHz band is provided in the Reallocation Impact Study. The listing includes the space program or satellite nomenclature and the respective operating administration. In addition, preliminary discussions have taken place within the Department of Defense regarding the possible consolidation of Federal, military and domestic, TT&C satellite functions into the 2025-2110 MHz band.

In total, the United States' current and planned civil space programs represent a taxpayer supported investment of over $87 billion. Each of these systems could fail if interference-free operation in the 2025-2110 MHz band is not available.

---

[13] Defined as the total cost to modify or retrofit the current S-band (2025-2110 MHz) communications capability of that system.

[14] The TDRSS also operates at the Ku-band (13.775 GHz) and the Ka-band (22.55-23-55 GHz).

BROADCAST AUXILIARY, LOCAL TV TRANSMISSION and CABLE TV RELAY SERVICES

Currently the entire 1990-2110 MHz band is allocated on a primary basis for the broadcast auxiliary and cable TV relay services. Specific uses include a number of fixed point-to-point video links, typically for studio-to-transmitter links (STL) and intercity relay (ICR), and more extensive use of mobile links for electronic news gathering (ENG) equipment. ENG systems include both mobile point-of-view and transportable ENG systems that provide video from a variety of locations and activities. ENG systems are typically used for on-location coverage of news events or interviews and live-action video during sports or entertainment events. Because of the value of on-location video, most local televison stations in urban areas operate ENG systems. These transportable systems are generally mounted in vans and operate in a stationary mode transmitting video to a fixed receive site. These systems provide mobility for news coverage throughout a geographic region.

The 1990-2110 MHz band is divided into 7 channels, each 17- or 18- MHz wide. All ENG systems cannot operate simultaneously because of mutual interference, only one transmission per channel per receive site at a time is usually possible. Most television markets areas contain multiple receive sites that allow for simultaneous transmissions on a channel. In most large markets, however, only six simultaneous transmissions are possible on the busiest channel, and in most markets the number does not exceed two. More than two simultaneous transmissions on a single channel rarely occur. In fact, multiple ENG receive sites and systems exist only in the largest television markets, so most regions have little or no simultaneous ENG activity per channel. Transportable ENG transmitters are typically operated approximately twice per day. Broadcast engineers estimate that each ENG operation transmits an average of 15 minutes per operation.[15] Typical characteristics of the ENG systems include transmit power of 100 milliwatts to 12 watts of power using wideband frequency modulation (FM) spread over the 17 MHz channel.

MOBILE-SATELLITE SERVICE (MSS)

The MSS is a rapidly emerging new technology to provide cellular-like mobile communications to and from anywhere on the globe. The service may include satellites located in geostationary Earth orbit (GEO) or, increasingly, by a series of low Earth orbit (LEO) satellites. Because of the lower orbits of the LEOs, a constellation of satellites is required to provide continuous global coverage. Also, because of the global coverage requirement, common international frequency allocations worldwide are required.

The FCC released the Further Notice of Proposed Rule Making (FNPRM) to the public for comments on the proposed allocation of spectrum at 2 gigahertz (GHz) for use by the MSS, on

---

[15] ITU Recommendation 1154, Provisions To Protect the Space Research, Space Operations and Earth-Exploration Satellite Services and to Facilitate Sharing with the Mobile Service in the 2025-2110 MHz Band and 2200-2290 MHz Bands, Annex 3, Section 4, WRC-95.

March 14, 1997. The FCC plans to allocate 70 MHz of spectrum at 1990-2025 MHz and 2165-2200 MHz to the MSS, effective January 1, 2000. In the FNPRM, FCC proposes to modify the current broadcast auxiliary service (BAS), and cable television relay and local television transmission services allocation at 1990-2110 MHz by providing an allocation to these services in the 2025-2130 MHz band. In addition, the FCC proposes to re-channelize BAS at 2 GHz from seven channels with 17 and 18 MHz bandwidths to seven channels of 15 MHz bandwidth.

Spectrum has been made available to MSS internationally through World Radiocommunication Conferences in 1992, 1995, and 1997. Further discussion of these international allocations appear in Section III of this report.

SECTION 3
INTERNATIONAL OBLIGATIONS PERTAINING TO THE 1990-2110 MHz BAND

INTRODUCTION

This section deals with international agreements, to which the United States is a party, dealing with radio spectrum in the 1990-2110 MHz band. These include, but are not limited to, those agreements adopted by the International Telecommunication Union (ITU) and its Study Groups and those bilateral or multi-lateral treaties to which the United States is a signatory. International agreements, treaties and obligations must be considered, as required by the Balanced Budget Act of 1997, if spectrum auctions are to be viable because they affect the potential for new radio services in and outside the United States. The following paragraphs discuss these international agreements.

INTERNATIONAL AGREEMENTS

International agreements regarding the use of the radio frequency commence, culminate, and are agreed upon at World Radiocommunication Conferences sponsored by the ITU or in technical recommendations approved by the ITU-R Study Groups. An administration enters into an agreement when it becomes a signatory of the Final Acts of the World Radiocommunication Conferences or signs an agreement with other administrations. Agreed-upon documents at ITU conferences may come in the form of approved international radio regulations, recommendations, resolutions, appendices, and articles, as defined by the ITU, and thus become a part of the Final Acts of the Conference and part of the ITU Radio Regulations. There are also bilateral or multi-lateral agreements outside the domain of the ITU.

By virtue of these agreements and treaties, cooperation between the United States and other administrations or space agencies to provide support to each other's satellite systems and programs is common. NOAA, for instance, is fulfilling its ongoing international obligation in this band to support the French satellite Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS). On the other hand, METEOSAT-3 was borrowed from the European Meteorological Satellite (EUMETSAT) by NOAA and used as a temporary gap filler for GOES when earlier GOES satellites failed prematurely. Also, NOAA, under international agreement will provide orbital support to the Meteorological Operational (METOP) system, a European meteorological satellite that will become part of the future National Polar-orbiting Operational Environmental Satellite System (NPOESS). Another example is a space program called the Topography Ocean Experiment (TOPEX)/Poseidon which is a joint mission between NASA and the National Space Agency of France (CNES). NASA provides the satellite and the TOPEX sensors, while CNES provides the Ariene launch and the Poseidon sensors.

At times, agreements involve only the use of geographic sites for earth terminals. Cases like NASA's DSN and Upper Atmosphere Research Satellite (UARS) are examples, where some of the

earth stations are in foreign countries such as Spain, Australia, and England. The use of these earth stations, however, are locally coordinated with regards to NASA's frequency use. The preceding examples show the inherent international and cooperative nature of the NASA and NOAA space programs. Domestic regulatory changes will have international implications.

In previous world conferences, the United States always has been one of the more active administrations pursuing changes, introducing new documents relating to the efficient use of the radio spectrum, and recommending the type of radio services that would be appropriate in certain frequency bands. Some of the international issues regarding the 1990-2110 MHz band are summarized and discussed below.

1990-2025 MHz Band

The United States has a long-standing commitment to find sufficient spectrum for MSS in the 2 GHz band. International spectrum allocation decisions addressing this band were adopted at three ITU conferences, in 1992, 1995, and 1997.

At WARC-92, the frequency bands 1980-2010 MHz and 2170-2200 MHz were allocated to MSS for Earth-to-space and space-to-Earth transmissions, respectively, worldwide on a primary co-equal basis with fixed and mobile services with an effective date of January 1, 2005. However, in 1994, the FCC reallocated a 10 MHz portion of the 1980-2010 MHz band (*i.e.*, the 1980-1990 MHz) to the Personal Communications Service (PCS) in the United States. Consequently, this 10 MHz portion was no longer available to MSS in the United States.

At the WRC-95, the United States sought more spectrum for MSS and gained a primary Region 2 allocation for MSS (Earth-to-space) in the frequency bands 2010-2025 MHz and 2160-2170 MHz. Also, at WRC-95, recognizing that the MSS allocations at the 2 GHz needed to be adjusted in order to account for the different regional allocations and access dates, the United States, together with other Region 2 administrations, strongly supported for the adoption of Resolutions 716 and 717. Resolution 716 called for, among other things, the consideration of the MSS allocations to the above mentioned bands and the need to facilitate the introduction and future use of the 2 GHz bands by MSS. Resolution 717 called for WRC-97 to review the MSS allocations with a view to harmonize them, including the access dates in the 2 GHz band.

At the recent WRC-97 conference, the United States again introduced numerous proposals to amend, among other ITU documents, Resolutions 716 and 717, and Article 5 to complete the harmonization needed in the 2 GHz for MSS so that there would be compatible operations between MSS and other radio services. These proposals took into account the planned date to bring into use the IMT-2000 technology, and promote the goal of the World Telecommunications Policy Forum and the Global Mobile Personal Communications by Satellite. As a result of WRC-97, the MSS allocation in Region 2, including the United States, and the MSS allocation in the rest of the world have been harmonized in the years 2000 and 2007, respectively.

2025-2110 MHz Band

As a result of WARC-92, the international allocations for space services in the 2 GHz bands, specifically the 2025-2110 MHz band paired with the 2200-2290 MHz band, were elevated to primary status worldwide. However, in the U.S. Table of Frequency Allocations, although the 2200-2290 MHz band is now primary, the 2025-2110 MHz band is still designated to space science services on a secondary basis. In 1998, NTIA submitted a petition to the FCC requesting that the national allocation of the 2025-2110 MHz band be upgraded to primary status in order to bring the National Table of Frequency Allocation in line with that of the international allocation where the space science services are afforded primary status worldwide (see Appendix D).[16] NTIA's petition attempts to reconcile the differences between the domestic and international allocations. Specifically, the petition proposes to modify the U.S. Table of Frequency Allocations to add space research, space operations and Earth exploration-satellite services in the 2025-2110 MHz band for Earth-to-space and space-to-space transmissions on a primary basis.

The 2025-2110 MHz band has many international agreements associated with space sciences services negotiated by the United States. At WARC-92, the United States proposals were fundamental to the allocation of Earth-to-space and space-to-space transmissions in the 2025-2110 MHz band on a primary basis for the space operation, space research and Earth exploration-satellite services. Also, between WARC-92 and WRC-97, the technical body of the ITU Study Groups (ITU-R) addressed sharing studies between terrestrial systems and space science services in this band. The ITU Resolution 211 and two sharing recommendations (ITU-R SA.1154 and ITU-R F.1247) described briefly below resulted from these studies and were approved at the ITU conferences. Further, at the WRC-97, the United States proposed to modify the provisions of Article S5.391, which referenced Resolution 211, in order to take into account the results of Recommendation ITU-R SA.1154. As a result, the International Footnote S5.391, also described below, has been added to the International Table of Frequency Allocations addressing Resolve 1 of Resolution 211.

ITU Resolution 211

Resolve 1 of Resolution 211 (WARC-92), use by the mobile service of the frequency bands 2025-2110 MHz and 2200-2290 MHz, invites the ITU-R to develop appropriate provisions to protect the space services operating in the bands 2025-2110 MHz and 2200-2290 MHz from harmful interference from emissions by stations of the mobile service. The ITU-R has completed its task on this issue and, as a result, adopted Recommendation ITU-R SA.1154.

---

[16] Letter from William Hatch, Acting Associate Administrator, Office of Spectrum Management, NTIA, to Richard Smith, Chief, Office of Engineering and Technology, FCC, requesting primary status for Government operations in the 2025-2110 MHz band, (Feb. 11, 1998) (attached as Appendix D).

Recommendation ITU-R SA.1154

Recommendation ITU-R SA.1154 specifically addresses the provisions to protect the space science services and enables the mobile service to share the 2025-2110 MHz and 2200-2290 MHz bands with the space science services. This recommendation sets forth the levels of acceptable interference to the stations in the space science services from the emissions of mobile systems. Similarly, it provides the technical and operating characteristics of mobile systems that will not cause the aggregate interference to the stations of the space science services to exceed acceptable levels. Mobile electronic news gathering (ENG) systems are representative of compatible mobile systems. More importantly, Recommendation ITU-R SA.1154 determined and confirmed earlier study results that sharing between space sciences and high density, and even conventional, mobile systems is not feasible. Further, the introduction of such mobile systems in the above mentioned bands may preclude the continued operation of space science services.

Recommendation ITU-R F.1247

Recommendation ITU-R F.1247 addresses the technical and operational characteristics of systems in the fixed service (FS) to facilitate sharing with the space research, space operation, and Earth exploration-satellite services (collectively, space services) operating in the bands 2025-2110 MHz and 2200-2290 MHz bands. This recommendation considers, among other things, that the space services have operated satisfactorily for many years with the FS in these bands but, should large numbers of FS systems be introduced, it will be important to identify preferred FS technical characteristics to ensure long term compatibility.

International Footnote S5.391

In making assignments to the mobile service in the bands 2025-2110 MHz and 2200-2290 MHz, administrations shall not introduce high-density mobile systems, as described in Recommendation ITU-R SA.1154, and shall take this Recommendation into account for the introduction of any other type of mobile system

One of the studies indicated that the introduction of high density terrestrial transmitters would be a potential source of interference to space science service operations. Recent technical studies by NASA confirm the earlier conclusions that only low-density mobile or fixed systems similar both technically and operationally to the current ENG occupants could be introduced into the band.

Another issue negotiated by the United States at the WRC-97 was the suppression of Resolution 711. This resolution describe the possible reallocation of frequency assignments to certain space missions from the 2 GHz band to bands above 20.

OTHER INTERNATIONAL AGREEMENTS

In addition to the ITU, there are other international organizations in which the United States made agreements regarding this band. Some of these are: the World Meteorological Organization (WMO); the Interagency Tracking, Communications, Operations Panel (ITCOP); the Space Network Interoperability Panel (SNIP); the Space Frequency Coordination Group (SFCG); and the Consultative Committee on Space Data Systems (CCSDS). Numerous international agreements have evolved concerning world wide use of the 2025-2110 MHz band. For example, this band has been adopted by civil space agencies worldwide as the primary uplink communications band. Some of the more current and significant agreements are listed in Table 2.

TABLE 2: INTERNATIONAL AGREEMENTS RECOGNIZED BY THE UNITED STATES PERTAINING TO THE 2025-2110 MHz BAND

Document Identification	Int'l Group	Description
Resolution 211	ITU	Invites the ITU-R to develop appropriate provisions to protect the space services operating in the bands 2025-2110 MHz and 2200-2290 MHz from harmful interference from emissions by stations of the mobile service.
Rec. SA.1154	ITU	Addresses provisions to protect the space science services and enables mobile service to share the 2025-2110 MHz and 2200-2290 MHz bands with the space science services.
Rec. F.1247	ITU	Addresses the technical and operational characteristics of systems in the fixed service (FS) to facilitate sharing with the space research (SR), space operation (SO) and Earth exploration-satellite (EES) services operating in the bands 2025-2110 MHz and 2200-2290 MHz bands.
Rec. F.1248	ITU	Addresses the limiting interference to satellites in the space science services from the emissions of trans-horizon radio-relay systems in the 2025-2110 MHz and 2200-2290 MHz bands.
Article S5	ITU	Radio Regulations: Space Operation, Earth Exploration-Satellite, & Space Research, all have primary allocations for Earth-to-space and space-to-space transmissions.
Article S21	ITU	Power limits for terrestrial and earth stations, and limits of power flux-density from space stations.
Rec. SA.509-1	ITU	Preferred frequencies and bandwidths for manned and unmanned near-Earth research satellites.
Rec. SA.1019	ITU	Preferred frequency bands and transmission directions for data relay satellites.
Rec. SA.1024	ITU	Necessary bandwidths and preferred frequency bands for data transmission from earth exploration satellites, not including meteorological satellites.
Rec. SA.363-5	ITU	Frequencies, bandwidths and protection criteria for space operation systems.
Rec. 662 (WRC-97)	ITU	Use of the frequency bands 2025-2110 MHz and 2200-2290 MHz by the space research, space operations, Earth exploration-satellite, fixed and mobile services.
	SNIP	S-band communications services and requirements for interoperability.
Rec. 401(3.2.1) B-1	CCSDS	Limitations on Earth-space link power levels.
Rec. 4-3 R2	SFCG	Utilization of the 2 GHz bands for space operations.
Rec. 6-1R4	SFCG	Interference from space-to-space links between non-geostationary satellites to other space systems.
Rec. 6-2 R1	SFCG	Transponder turnaround frequency ratios for category A missions.
Rec. 7-1 R3	SFCG	Transponder turnaround frequency ratios for category A missions.
Rec. 12-5 R1	SFCG	Limitations on Earth-space link power levels.
Res.14-2 R1	SFCG	Protection of space science services from Fixed Service interference in the bands 2025-2110 and 2200-2290 MHz.

SECTION 4
IDENTIFICATION OF ALTERNATIVE BANDS

The 1997 Budget Act authorizes the President to substitute alternative spectrum for auction to 15 MHz in the 1990-2110 MHz band that would better serve the public interest, convenience and necessity and could reasonably be expected to produce comparable receipts. These criteria are discussed in the following paragraphs and are used to identify alternative bands that meet these criteria.

PUBLIC INTEREST, CONVENIENCE, AND NECESSITY

The first criterion is that any alternative "better serve the public interest, convenience, and necessity." This criterion is not defined and can only be addressed in a qualitative manner. Some guidance is provided on this point, however, in the Conference Committee report[17] prepared with the Budget Act. It states "the conferees expect that the President will carefully consider the taxpayers clear interest in continued government use of the 1990-2110 MHz band for space research and exploration activities." Based on the large taxpayer investment in space systems that utilize the 2 GHz band and the spectrum sharing difficulties described in Section 3, this Congressional guidance suggests that identifying alternatives to auctioning of 15 MHz of spectrum at 2 GHz would meet the public interest criterion.

As described in section 2, NOAA and NASA are the predominant Federal users of the 2025-2110 MHz band and collectively manage nearly $47 billion in existing investment in spacecraft and associated earth stations. Over forty billion dollars more are planned for investment in new generations of systems currently being developed to operate in this band. Moreover, there is also substantial investment in foreign space systems in which the federal government have joint ventures with other administrations.

NOAA's satellite programs, including the GOES, polar-orbiting, and Landsat operations described earlier, provide vital services to the public. The GOES system provides meteorological data that includes, inter alia, those that produce accurate weather forecasts and severe weather tracking. The polar-orbiting satellites track and monitor pollution, fires, and volcanoes in addition to their weather-related functions. The Landsat system collects a global archive of multi-spectral images data. These data are used for global monitoring of agriculture, forestry, and range resources, land use and mapping, geology, water resources, coastal resources, urban change and planning, and environmental monitoring and assessment. These programs also support other administrations' space programs through NOAA's commitment with the World Meteorological Organization and other international organizations.

---

[17] H.R. Conf. Rep. 217, 105th Cong., 1st Sess. 574 (1997) (accompanying H.R. 2015).

NASA is the leader in space research and exploration activities worldwide. The 2025-2110 MHz band was first used by NASA to support the Apollo Program in the 1960's. NASA's continuing commitments in this band support major space programs including: National Space Transportation System (Shuttle), Tracking and Data Relay Satellite System, Hubble Space Telescope, planned International Space Station, and space programs of foreign space agencies.

As discussed earlier, the 2025-2110 MHz band has been the subject of numerous negotiated international agreements by the United States, including treaty-level agreements with the International Telecommunication Union (ITU). At the recent ITU World Radiocommunication Conference in 1997, international regulations were adopted stating that in this band, ". . . administrations shall not introduce high-density mobile systems. . ." This regulation is supported by detailed technical analyses in Recommendation ITU-R SA.1154 indicating that space science services share spectrum well with low density communications systems similar to existing ENG operations; but implementation of high density systems or conventional mobile systems could seriously jeopardize operations of the space sciences services in this band. Through international negotiations and agreements, this band has been adopted as the primary spacecraft control band by civil space agencies worldwide that include the European Space Agency, Russian Federation, Japan, and China.

Both NASA and NOAA participate in numerous joint space ventures with other administrations involving meteorology, space research and exploration, and space commercialization. Interference-free access to the 2025-2110 MHz band is fundamental to the satellite tracking, telemetry and control for all of these activities. Any changes in the United States regarding the use of this band for these space functions should be compatible with the international community. This is especially important to those administrations whose space programs are being supported by the United States or those administrations that have joint space ventures with the United States in this band.

In summary, reallocating 15 MHz from this band would have a detrimental affect on: 1) numerous NASA and NOAA operations in the space science services, including manned flight operations, 2) the ability of the United States to comply with international agreements, including treaty agreements with the International Telecommunication Union, 3) Federal investment costs for future space research and exploration activities, and 4) current and future United States' participation in joint space ventures with other administrations. Therefore, it is in the public interest, convenience, and necessity to identify alternative bands.

COMPARABLE AUCTION RECEIPTS

The second criteria to be met in identifying alternative spectrum is expectation that auctions would generate comparable receipts. Based on the four-year history in spectrum auctions, a clear industry need for additional spectrum may be one of the most important factors in the amount of auction revenue generated. For example, for the highly successful auctions of the narrowband and wideband personal communications services (PCS), the need for additional spectrum, industry infrastructure, radio equipment, etc., were all well-defined prior to the auction, leading to active

demand for the identified spectrum and high auction receipts. On the other hand, the auction of the Wireless Communications Service (WCS) at 2.3 GHz drew little interest. In this case, prior to the auction there was no industry consensus on any of these issues, including the need for the additional spectrum, functions to be fulfilled, infrastructure, and equipment.

Methodology

Estimating the receipts that may be received when a given segment of spectrum is auctioned is, in reality, more art than science. For example, in the auction of the WCS spectrum at 2.3 GHz completed in 1997, actual auction receipts of $14 million fell far short of expectation.[18] This shortfall is generally attributed to the stringent technical standards applied and the short time available for prospective bidders to develop business plans. On the other hand, winning bids for the wideband PCS C-block spectrum far exceeded expectations, although subsequent bankruptcies and defaults have greatly reduced actual revenue.

The FCC summarized the net auction bids on the 16 FCC spectrum auctions completed through August 1998.[19] From that data, it is clear that the auction receipts depend on a number of factors including general frequency range, date of the auction, the nature of the incumbents, and technical or usage limitations placed on the bidders. The five PCS auctions generated the largest receipts.[20]

While the results of the 16 spectrum auctions completed by the FCC provide very useful "reality checks" on estimates, the baseline methodology used here follows the same procedures used by the Office of Management and Budget (OMB) in estimating receipts for the formal budget process. OMB estimates expected auction receipts through analysis of past auction results, prices paid for FCC licenses in private transfers, expectations of market demand, as well as opinions from experts. OMB continues to revise its estimates to reflect changes in the marketplace.

---

18 *The FCC Auctions and the Future of Radio Spectrum Management, Where Do We Go From Here?*, Congressional Budget Office (April 1997).

19 Information about each auction is available on the FCC's web site at http:\\www.fcc.gov/wtb/auctions.

20 Results from the 16 completed FCC auctions suggest that constraints on the spectrum due to sharing or other factors can significantly lower auction receipts. Spectrum sharing constraints typically result in reducing the maximum number of transmitters the band can accommodate. The PCS bands upon which the baseline auction revenue estimates are derived have been estimated to eventually accommodate tens of millions of transmitters within the authorized 120 MHz. This equates to several million transmitters in a given 15 MHz segment. If constraints on spectrum use result in a substantially lower number of transmitters , then a corresponding reduction in auction receipts is a reasonable assumption.

For this study, OMB considered three factors in estimating receipts that may be expected in auctioning 15 MHz of spectrum and in determining comparable value:

Factor 1 - Baseline Values. Initial values are based on preliminary estimates prepared by OMB for this report.

Factor 2 - Reimbursement Costs. The baseline value is adjusted for reimbursement costs. It is assumed that spectrum auction winners will fully reimburse the incumbent spectrum users for relocation from the band.[21] Where reimbursement is required, it is reasonable to assume that successful bidders will take these costs into account and bid accordingly. Therefore, from the initial value from factor 1 above, these estimated costs to reimburse incumbents will be deducted.

Factor 3 - Discount Factor. The baseline value is further adjusted by a "Spectrum Discount Factor" prepared by OMB. This factor takes into account constraints on use of the band due to sharing and other considerations.

Estimated Auction Receipts for 15 MHz from the 2025-2110 MHz Band

To determine whether comparable receipts could be produced, OMB first estimated potential receipts from auction of 15 MHz from 2025-2110 MHz utilizing the three factors as follows:

Factor 1. From the methodology described above, the initial OMB auction revenue estimate for this band is $1.5 billion. The figure was calculated using a base value determined from prior auctions adjusted for assumptions regarding demand.

Factor 2. Assuming that NASA and NOAA must shut down operations by fiscal year 2002, the year by which the FCC auctions must be completed, the estimated Federal system relocation cost exceeds $13 billion.[22] A factor in estimating Federal system relocation cost is the calendar year in which NASA or NOAA would be required to shut down operations. A rough estimate of lead-time prior to launch associated with state-of-the-art scientific spacecraft is 3-5 years. Changes well before this period can be minor; changes well afterwards can be prohibitively costly. Some programs, such as the Earth Observing System (EOS) suite of spacecraft, are based on commonality and inheritance from prior spacecraft

---

[21] In accordance with requirements of the newly enacted Defense Authorization Act of 1998, successful bidders in auctions of Federal spectrum must compensate the Federal incumbent user for the marginal costs associated with the relocation of Federal stations. *See* Section 1064 of the Defense Authorization Act of 1998, Pub. L. No. 105-261, (1998) (amending 47 U.S.C. § 923(g)).

[22] Letter from Wayne Whyte, Spectrum Program Manager, NASA, to Ernie Cerezo, NTIA (Nov. 2, 1998).

in the series. This estimate is very conservative and only considers those systems below that are operational at that time. It does not factor in the effects of changes to pending systems (those launched shortly thereafter) nor does it consider any international cost issues related to cross-support.

The reimbursement costs of removing the incumbent non-Federal operations from the 2025-2110 MHz band have been examined in detail in filings to the FCC on the 2 GHz MSS rule making. The Association for Maximum Service Television, Inc. commissioned a study to estimate the relocation and retrofit costs for the 2 GHz ENG band in order to accommodate MSS in the 1990-2025 MHz portion of the band.[23] That study identified the relocation costs for the approximate 7000 fixed and mobile equipments to be $171 million. The results of that study were subsequently endorsed by the Society of Broadcast Engineers.[24]

The total reimbursement costs are the sum of the above two values, or about $13.2 billion.

Factor 3. In evaluating the third factor, it is assumed that the United States will continue to comply with international treaty obligations limiting usage in the 2025-2110 MHz band to low density services similar, both operationally and technically, to the existing ENG operations. The approximate 7000 equipments in the band are assumed to be uniformly distributed across the band, equating to 875 transmitters per 15 MHz segment. While the number of ENG licenses in the band has grown in recent years, unbridled growth is not expected. For purposes of discussion herein, it is assumed that a fully mature ENG environment would never exceed a few thousand transmitters per 15 MHz segment. Thus, compliance with treaty obligations would require limiting the number of transmitters to a few thousand transmitters in the auctioned 15 MHz band, nationwide. Considering this limitation on use, for purposes of this report, OMB assumed a discount factor of 50 percent.

Given the significant Federal relocation costs, OMB concluded that auction receipts 15 MHz in the 2025-2110 MHz band would be negligible.

IDENTIFICATION OF ALTERNATIVE BANDS:

The Budget Act provides very broad criteria for selection of alternative bands subject to only the public interest and comparable receipts factors discussed earlier. No upper frequency limit is designated nor is it limited to Federal bands or non-Federal bands.

---

[23] Joint Reply Comments of the Association for Maximum Service Television, Inc. and Other Major Television Broadcasting Entities, ET Dkt. No. 95-18 (June 21, 1995).

[24] Reply Comments of the Society of Broadcast Engineers, Inc, ET Dkt. No. 95-18 (June 21, 1995).

With regard to possible identification of Federal spectrum, NTIA has released two comprehensive examinations of Federal spectrum below 5 GHz.[25] The *Spectrum Reallocation Final Report*, prepared in response with requirements of the *Omnibus Budget Reconciliation Act of 1993 (OBRA-93)*, identified 235 MHz of Federal spectrum for reallocation to commercial use. To date, only 5 MHz of the 235 MHz has been auctioned; although, the Budget Act identified an additional 45 MHz to be auctioned. Thus, the remaining bands from the 235 MHz (totaling185 MHz) were considered for identification as alternatives to the 15 MHz from the 2025-2110 MHz band.

Taken together, the two NTIA spectrum reallocation reports document the extensive use made in bands allocated for the Federal Government to provide the various services to the public. The 255 MHz of spectrum identified for reallocation in these reports will have an estimated cost of $1.5 billion to remove incumbent Federal operations. Furthermore, the reports clearly indicate that identification of additional Federal spectrum for reallocation would result in substantially higher costs, impact on Federal operations, and loss of services to the public. Consequently, identification of Federal spectrum was not considered a viable option.

Based on a review of both Federal and non-Federal frequency bands that have not as yet been subject to auction, the following four bands are identified that meet the comparable receipts criterion. A comparison between the potential auction receipts of each of these alternative bands and the auction of 15 MHz from the originally proposed 2025-2110 MHz band indicates that any of the alternative bands can reasonably be expected to produce comparable, if not significantly higher receipts.

944-960 MHz Band

The 944-960 MHz band is divided into two segments in the United States, 944-952 and 952-960 MHz bands and are addressed separately. The 944-952 MHz band is used by Frequency Modulation (FM) broadcasters for auxiliary broadcast services, specifically aural studio-to-transmitter (STL) and inter-city relay (ICR) links. The band is divided into 25 kilohertz (kHz) channels which can be stacked to give a user access to up to 500 kHz. Some of this bandwidth can be leased for other broadcasting or non-broadcasting purposes. Use of the band has grown substantially over the past year. The number of licenses, 5,658 in 1997, reflect an approximate 24 percent annual growth rate, due mostly to broadcasters switching from wireline to radio links. Most STL equipment in this band uses a 200-500 kHz bandwidth to carry two audio signals, for stereo, and additional transmitter control signals. Although most STL's are still analog FM, about 30 percent of new STL's use digital technology. Near-term technologies that are expected to be available to reduce the spectrum requirements of these auxiliary broadcast functions are the adoption of digital compression such as advanced audio coding and wideband wireline digital transport technologies such as asynchronous digital subscriber line (ADSL) or integrated services digital networks (ISDN).

---

[25] *See supra*, notes 6 and 7.

The 952-960 MHz band is designated by the FCC for the fixed microwave services with two major types of users, multiple access systems (MAS) and private operational point-to-point fixed systems. The MAS operations are authorized in three distinct segments of the band near 152, 156 and 159 MHz, encompassing a total of 1.2 MHz. These MAS stations are used in a master-interrogator/remote-reply mode of operation. FCC rules require at least four remote stations to be used for each master to qualify for this type of service. MAS is a relatively new type of service, with many innovative uses being developed. Representative uses include supervisory control and data acquisition for typical utility customers, alarm systems, point-of-sale applications (*e.g.*, credit card and checking account verifications), and various utility applications such as water, gas, electricity, petroleum and railroads. As of 1997, there were approximately 8000 MAS licenses. The FCC has a rule making proceeding that proposes to auction a portion of the 1.2 MHz designated for MAS operations.

The remaining 6.8 MHz portion of the band is designated for private operational fixed (POF) point-to-point microwave systems having bandwidths of 12.5 to 200 kHz for a variety of low capacity voice and data applications. As of 1997, there were approximately 6,200 POF licenses.

> **Comparable Receipts.** In assessing the comparable receipts criteria, OMB estimates that spectrum totaling 16 MHz in this band has an initial value of $1.5 billion. Because of the approximate 20,000 existing licencees in the band and lack of an identified future spectrum home for current applications, it seems likely for the FCC to consider grandfathering existing stations rather than mandatory removal and reimbursement. Given this likely approach, the auction value must be lowered to account for the significant constraint on full use of the these frequencies by the auction winners. OMB estimates that the baseline value should be reduced by roughly 40 percent for a total estimated auction receipt of $900 million.

1390-1400, 1427-1432 & 1670-1675 MHz Bands

These three bands, with an aggregate of 20 MHz, were identified for reallocation by NTIA in the Final *Spectrum Reallocation Report* prepared in response to OBRA-93. From that report, the following description was provided:

> **1390-1400 MHz.** This band is used by long-range air defense radars, military test range telemetry links, tactical radio relays, and radio astronomy. The band has potential for new non-Federal fixed, mobile, and radiolocation communications technologies and applications. However, high-powered FAA and DoD radars must continue to operate in the lower adjacent band and important radio astronomy observations must continue within the band. Thus, reallocating this band for exclusive non-Federal use would require that: 1) airborne transmissions be prohibited to protect radio astronomy; 2) the FAA and DoD must install filters on their high powered radar transmitters; and 3) new equipment designed for use in this band must be capable of tolerating adjacent band FAA and DoD high power radar signals. Satisfaction of

these three conditions and Federal Government reaccommodation efforts require this band to be reallocated in January 1999. Federal operations at 17 sites will be continued until 2009.

1427-1432 MHz. This band is used by military tactical radio relay communications and military test range aeronautical telemetry and telecommand. The band has potential for new non-Federal fixed and mobile communications technologies and applications. In order to protect sensitive radio astronomy observations in the adjacent band, reallocation for airborne or space-to-Earth communications should be avoided. Reallocation of this band was delayed until January 1999 to permit the orderly phase out of radio relay communications equipment, the procurement of replacement equipment, and the engineering of associated network systems. In addition, essential military airborne operations at 14 sites will be continued until 2004.

1670-1675 MHz. This band is used for meteorological services. Meteorological systems operating in this band will have to be redesigned or replaced. The band has potential for new non-Federal fixed or mobile communications. In order to protect sensitive radio astronomy observations in the adjacent band, reallocation for airborne or space-to-Earth communications should be avoided. Reallocation of this band was delayed until January 1999 to permit redesign and procurement of replacement equipment for meteorological radiosonde systems. Reallocation also requires protection of two important meteorological-satellite Earth stations at Wallops Island, Virginia and Fairbanks, Alaska.

Comparable Receipts. In assessing the comparable receipts criterion, OMB estimates an initial baseline value of $1.9 billion for these three bands totaling 20 MHz. Estimated Federal relocation costs total $106-143 million. Assuming the high end of the range, OMB adjusted the baseline value to $1.76 billion. Minimal sharing constraints would apply to the bands so that an additional discount of 10 percent is applied, for a total estimated auction receipt of $1.57 billion.

2500-2690 MHz Band (15 MHz from unauctioned portions)

This band is allocated for several types of services, including wireless cable TV broadcasting (multi point distribution service - MDS), instructional TV fixed service (ITFS), private operational fixed service (OFS), and narrowband audio response channels. MDS wireless cable was created in 1983 to provide a wireless alternative to cable TV. The 66 MHz of spectrum designated for MDS was auctioned by the FCC in 1996. The ITFS is typically used for TV classroom instruction, *e.g.*, when a local university brings in-house classroom instruction to the employees of a local corporation.

Comparable Receipts. In assessing the potential auction receipts for 15 MHz in this band, OMB estimates a baseline value of $1.5 billion. In a previous auction, the FCC auctioned 66 MHz within this band designated for the MDS. All existing licenses were grandfathered, thus requiring no relocation costs but imposing a significant constraint on full use of the these frequencies by the auction winners. It is expected that similar constraints may be imposed on this new spectrum, thus OMB applied a discount of 50 percent to the baseline value for a total estimated auction receipt of $750 million.

3650-3700 MHz Band

This 50 MHz band was identified for reallocation by NTIA in the *Spectrum Reallocation Final* Report prepared in response to OBRA-93. This band is used by Navy air traffic control radars on board aircraft carriers and is allocated to a number of different radio services around the world. Thus, the band could be used for new non-Federal technologies in the fixed, mobile (except aeronautical), fixed-satellite and radiolocation services. Reallocation of this band was delayed until 1999 to re-engineer the Navy radars operating in coastal waters. Adopting regulatory or industry receiver standards for the new equipment would enhance band sharing. Essential Federal radar operations will be continued at three sites.

Comparable Receipts. OMB estimates a baseline value of $4.9 billion for 50 MHz of spectrum in this band. However, because of expected restrictions for interference, accommodations for band sharing, and the higher frequency of this band, OMB applied a discount of 75 percent. Estimated Federal relocation costs total $8-30 million. Assuming the high end of the range, OMB adjusted the baseline to accommodate these relocation costs for total estimated auction receipt of $1.2 billion.

Table 3 summarizes the net expected auction receipts.

TABLE 3
COMPARISON OF EXPECTED AUCTION RECEIPTS

Band (MHz)	# MHz	OMB Baseline Value	OMB Discount Factor	Estimated Total Reimb. Costs	Net Expected Auction Receipts
2025-2110	15	$1.5 B	50%	$13.2 B	Negligible*
944-960	16	$1.5 B	40%	...	$0.9 B
1390-1400 1427-1432 1670-1675	20	$1.9 B	10%	$0.14 B	$1.57 B
2500-2690	15	$1.5 B	50%	...	$0.75 B
3650-3700	50	$4.9 B	75%	$0.03 B	$1.2 B

* $12.5 B in potential costs

APPENDIX A

TABLE A-1: NATIONAL AND INTERNATIONAL FREQUENCY ALLOCATIONS FOR THE 1990-2110 MHz FREQUENCY BAND [1]

INTERNATIONAL			UNITED STATES		
Region 1 (MHz)	**Region 2 (MHz)**	**Region 3 (MHz)**	**Frequency Band (MHz)**	**Government Allocation**	**Non-gov't. Allocation**
1980-2010 FIXED MOBILE MOBILE-SATELLITE (Earth-to-space) S5.388 S5.389A S5.389B			1980-1990		FIXED MOBILE
2010-2025 FIXED MOBILE S5.388	2010-2025 FIXED MOBILE MOBILE-SAT-ELLITE S5.388 [S5.389C] S5.389D S5.389E	2010-2025 FIXED MOBILE S5.388	1990-2025	 US111	MOBILE-SATELLITE (Earth-to-space) US111 ***NG156*** [2]
2025-2110 FIXED MOBILE SPACE RESEARCH (Earth-to-space) (space-to-space) SPACE OPERATION (Earth-to-space) (space-to-space) EARTH EXPLORATION-SATELLITE (Earth-to-space)(space-to-space) ***[S5.391]*** [3] S5.392			2025-2110	 US90 US111 US219 US222	FIXED MOBILE US90 US111 US219 US222 NG23 NG118 ***[S5.391]***

---

1 This table includes international changes to frequency allocations that resulted from WARC-92 and WRC-95 that have not as yet been reflected within the U.S. National Table of Frequency Allocations. Also included are domestic changes to the U.S. Table of Frequency Allocations that have been proposed by NTIA and forwarded to the FCC for consideration for national adoption.

2 This is a proposed footnote for the 1990-2025 MHz band. *See Amendment of Section 2.106 of the Commission's Rules to Allocate Spectrum at 2 GHz for Use by the Mobile-Satellite Service, ET Dkt. No. 95-18, First Report and Order and Further Notice Of Proposed Rule Making,* 12 FCC Rcd 7388 (1997).

3 This international footnote is a result of WRC-97.

TABLE A-2: APPLICABLE FOOTNOTES FOR THE 1990-2110 MHz BAND

U.S. FOOTNOTES

US90: In the band 2025-2110 MHz Earth-to-space and space-to-space transmissions may be authorized in the space research and Earth exploration-satellite services subject to such conditions as may be applied on a case-by-case basis. Such transmissions shall not cause harmful interference to non-government stations operating in accordance with the National Table of Frequency Allocations. All space-to-space transmission reaching the Earth's surface shall adhere to a power flux density of between -144 and -154 $dBW/m^2/4$ kHz depending on the angle of arrival per ITU Radio Regulation 2557 and shall not cause harmful interference to the other space services.

US111: In the band 1990-2120 MHz, Government space research earth stations may be authorized to use specific frequencies at specific locations for earth-to-space transmissions. Such authorizations shall be secondary to non-Government use of this band and subject to such other conditions as may be applied on a case-by-case basis.

Corpus Christi, Tex., 27° 39'N 097° 23'W.
Fairbanks, Alaska, 64° 59' N 147° 53' W.
Goldstone, Calif., 35° 18' N 116° 54' W.
Greenbelt, Md., 39° 00' N 076° 50' W.
Guam, Mariana Is., 13° 19' N 144° 44' E.
Kauai, Hawaii, 22° 08' N 159° 40' W.
Merritt Is., Fla., 28° 29' N 080° 35' W.
Roseman, N.C., 35° 12' N 082° 52' W.
Wallops Is., Va., 37° 57' N 075° 28' W.

US219: In the band 2025-2110 MHz Government earth resources satellite earth stations in the Earth exploration-satellite service may be authorized to use the frequency 2106.4 MHz for Earth-to-space transmissions for tracking, telemetry, and telecommand at the sites listed below. Such transmissions shall not cause harmful interference to non-government operations:

Sioux Falls, SD, 43^0 32' 03.1"N 096^0 45' 42.8"W;
Fairbanks, AK, 64^0 58' 36.6"N 147^0 30' 54.2"W.

US222: In the band 2025-2035 MHz Geostationary Operational Environmental Satellite Earth stations on the space research and Earth exploration-satellite services may be authorized on a co-equal basis to use the frequency band 2025-2035 MHz band for Earth-to-space transmissions for tracking, telemetry, and telecommand at the sites listed below:

Wallops Is., VA, 37^0 50' 48"N 075^0 27' 33"W;
Seattle, WA, 47^0 34' 15"N 122^0 33' 10"W;
Honolulu, HI, 21^0 21' 12"N 157^0 52' 36"W.

US252: The bands 2110-2120 and 7145-7190 MHz, and 34.2-34.7 GHz are also allocated for Earth-to-space transmissions in the space research service, limited to deep space communications at Goldstone, California.

TABLE A-2: APPLICABLE FOOTNOTES FOR THE 1990-2110 MHz BAND (Con't)

INTERNATIONAL

S5.388: The bands 1885-2025 MHz and 2110-2200 MHz are intended for use, on a worldwide basis, by administrations wishing to implement the future public land mobile telecommunication systems (FPLMTS). Such use does not preclude the use of these bands by other services to which these bands are allocated. The bands should be made available for FPLMTS in accordance with Resolution 212 (Rev. WRC-95).

S5.389A: The use of the bands 1980-2010 MHz and 2170-2200 MHz by the mobile-satellite service is subject to coordination under Resolution 46 (Rev.WRC-95)/No. S9.11A and to the provisions of Resolution 716 (WRC-95). The use of these bands shall not commence before 1 January 2000; however the use of the band 1980-1990 MHz in Region 2 shall not commence before 1 January 2005.

S5.389B: The use of the bands 1980-1990 MHz by the mobile-satellite service shall not cause harmful interference to or constrain the development of the fixed and mobile services in Argentina, Brazil, Canada, Chile, Ecuador, the United States, Honduras, Jamaica, Mexico, Peru, Suriname, Trinidad and Tobago, Uruguay and Venezuela.

[MOD S5.389C]: The use of the bands 2010-2025 MHz and 2160-2170 MHz in Region 2 by the mobile-satellite service shall commence before 1 January 2005 and is subject to coordination under Resolution 46 (Rev.WRC-95)/No. S9.11A and to the provisions of Resolution 716 (WRC-95).

S5.389D: In Canada and the United States the use of the bands 2010-2025 MHz and 2160-2170 MHz by the mobile-satellite service shall not commence before 1 January 2000.

S5.389E: The use of the bands 2010-2025 MHz and 2160-2170 MHz by the mobile-satellite service in Region 2 shall not cause harmful interference to or constrain the development of the fixed and mobile services in Regions 1 and 3.

[MOD S5.391]: In making assignments to the mobile service in the bands 2025-2110 MHz and 2200-2290 MHz, administrations shall not introduce high-density mobile systems, as described in Recommendation ITU-R SA.1154, and shall take this Recommendation into account for the introduction of any other type of mobile system.

S5.392: Administrations are urged to take all practicable measures to ensure that space-to-space transmissions between two or more non-geostationary satellites in the space research, space operation and Earth exploration-satellite services in the bands 2025-2110 MHz and 2200-2290 MHz, shall not impose any constraints on Earth-to-space, space-to-Earth and other space-to-space transmissions of those services and in those bands between geostationary and non-geostationary satellites.

Note: Bracketed footnotes are modified at the WRC-97.

National Aeronautics and
Space Administration
Office of the Administrator
Washington, DC 20546-0001

APPENDIX B

SEP 23 1998

The Honorable C. Larry Irving
Assistant Secretary for Communications
and Information
National Telecommunications and
Information Administration
Department of Commerce
Washington, DC 20230

Dear Mr. Irving:

The pending release of a proposed rule making[1] by the Federal Communications Commission (FCC) at 2 GHz raises serious concerns within NASA. As you know, the Agency uses the 2 GHz bands[2] in conjunction with its international partners for spacecraft command, control and telemetry. The FCC's proposal to reallocate any portion of the 2025-2110 MHz band segment will disrupt critically important NASA operations using this spectrum. National Civil Space use of this spectrum has been increasing rapidly since the Apollo program.

NASA's Space Network and Ground Network operations take place over the entire 2025-2110 MHz band including vital communications associated with the Space Shuttle and the upcoming International Space Station.

NASA presently operates in the 2025-2110 MHz band on a secondary allocation status within the United States. Although this status is less than desirable, two factors have served to mitigate our concerns in the past:

1. Space Science Services in this band operate on a primary basis internationally under the International Telecommunication Union (ITU) Radio Regulations; thus, it is only in the U.S. where the implications of secondary status must be addressed.

2. Within the U.S., the FCC has heretofore reserved the band principally for the Broadcast Auxiliary Service. Fortunately, the operational characteristics of this Service enable a minimum of interference to the Space Science Services and operational coordination has been successfully carried out for many years with the broadcasting industry.

---

[1] ET Docket No. 95-18, Memorandum Opinion and Order and Third Notice of Proposed Rule Making

[2] Unified S-Band, Uplink and Forward Link at 2025-2120 MHz, and Downlink and Return Link at 2200-2300 MHz.

APPENDIX B
(con't)

Introduction of additional services, such as Personal Communications Services or other high density users, will result in an unmanageable environment for civil space users. ITU studies confirm this conclusion.

In excess of 50 NASA Space Flight missions are reliant upon the 2025-2110 MHz band for telecommand operations. These missions include Space Shuttle, Hubble Space Telescope, Compton Gamma Ray Observatory, TOPEX/POSEIDON, and NASA's Tracking and Data Relay Satellite System. Future program use includes the International Space Station(ISS), the ISS Crew Return Vehicle and the Earth Observing System. These missions represent a significant investment of taxpayer dollars, estimated in excess of $36 billion. In light of the changing spectrum environment near 2 GHz, as evidenced by the FCC proposal, we have concluded that primary allocation status is essential for the long term protection of this major public investment.

In addition, NASA is concerned that the FCC's proposal does not adequately address the international implications of interference into the legitimate operations of the international space science community. These international operations will be impacted in the same manner as NASA's operations, but will require coordination with the U.S. regulatory authorities to comply with the treaty-based provisions of the ITU Radio Regulations. NASA has had and will continue to have extensive cooperative and cross-support agreements with the international space science community in meeting its obligations mandated by current National Space Policy directives.

For these reasons, I respectfully request the following actions be taken with respect to the FCC's proposed rule making:

1. Recommend alternative spectrum be identified in accordance with provisions of the 1997 Balanced Budget Amendment.

2. Continue to work with NASA in the pursuit of a primary allocation status in the 2025-2110 MHz band for Space Science Services within the U.S.

Sincerely,

Daniel S. Goldin
Administrator

APPENDIX C

UNITED STATES DEPARTMENT OF COMMERCE
The Under Secretary for
Oceans and Atmosphere
Washington, D.C. 20230

OCT -7 1993

MEMORANDUM FOR: Larry Irving
Assistant Secretary for
Communications and Information

FROM: D. James Baker

SUBJECT: NOAA Concerns with Proposed Spectrum Auction

I have been informed that the Federal Communications Commission (FCC) is proposing to auction 15 MHz from the 2025-2110 MHz band in conformance with the Balanced Budget Act of 1997 (BBA-97). The band segments, 2095-2110 MHz or alternatively 2025-2040 MHz, are used for critical control circuits associated with the National Oceanic and Atmospheric Administration (NOAA) satellites. The upper band is used to control the Landsat satellites from several ground stations in Alaska and the contiguous United States. The lower band is used to command NOAA's geostationary (GOES) and polar-orbiting (NOAA series) meteorological satellites from Wallops Island, Virginia, and Fairbanks, Alaska. As you know, the GOES operations at Wallops enjoy primary status. In light of the nature of NOAA operations in these bands, it is imperative that our investment of over $1 billion dollars for critical satellite services to both the public and Federal Government be protected now and in the future. It is particularly troublesome that no decision has been made as to the commercial uses to which the auctioned band will be put. While it is certainly possible to protect commercial terrestrial operations from interference by keeping them at some minimum distance from NOAA's ground stations, NOAA's own operations cannot be similarly protected. Use of the band for high-density radio communications and other than what is already sharing the spectrum (low density radio communications - electronic news gathering systems) may result in interference as shown in International Telecommunications Union (ITU) studies and recommendations to our satellite receivers.

The same interference concerns apply to foreign satellites. I note that space services in the 2025-2110 MHz band enjoy a primary allocation worldwide, except they are secondary in the United States. NTIA has requested the FCC to modify the U.S. allocation tables to conform to international usage, which the Commission has declined to do. There is also a potential for harmful interference to international satellite systems, including those which the United States may be required to operate under cooperative agreements.

THE ADMINISTRATOR

Given the present and planned use of the band by the Federal Government including NOAA satellite operations and those of foreign countries, I must respectfully urge that the President exercise his option as per BBA-97 to designate alternative spectrum tc remove the potential for harm to these critical satellite networks.

APPENDIX D

UNITED STATES DEPARTMENT OF COMMERCE
National Telecommunications and
Information Administration
Washington, D.C. 20230

February 11, 1998

Mr. Richard Smith
Chief, Office of Engineering and Technology
Federal Communications Commission
2000 M Street N.W.
Washington, D.C. 20554

Dear Mr. Smith:

In the OSM January 2, 1997 letter to you, the importance of the band 2025-2110 MHz to the Federal government was indicated, and we requested that the Federal government's requirements be taken into account in any proceedings that the Commission undertakes in this band. Of principle concern were the potential sharing problems which would arise if high-density mobile systems were introduced into the band. These concerns and certain changes in the international rules and regulations have now prompted OSM to request that the National Table of Frequency Allocations be modified to reflect primary status for space services by the Federal Government in the 2025-2110 MHz band. (Proposed changes to the National Table of Frequency Allocations are provided at Enclosure 1.)

As you know, this is the primary band used by the National Aeronautic and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and space agencies worldwide for Earth-to-space and space-to-space communications. The Federal government has been operating in this band for over 30 years and has a financial investment of over 30 billion dollars in the band. For a number of technical and policy reasons, NASA and NOAA cannot satisfy critical mission requirements in other allocated spectrum. NASA and NOAA use this band for over 60 U.S. satellites, including such programs as the Space Shuttle, the Tracking and Data Relay Satellite System (TDRSS), the Hubble Space Telescope, Geostationary Operational Environmental Satellite (GOES), and the International Space Station. Note that under existing Footnote US222 of the National Table certain Federal government sites already have co-equal status.

The U.S. also has long-standing international treaty obligations with respect to allocations to the space services in the International Table of Frequency Allocations. (A historical summary of the international space allocations for this band is shown in Enclosure 2.) NASA and NOAA have numerous obligations to support other administrations' space programs in this band. Among others, Brazil, Canada, France, Germany, India, Italy, Japan, Russia, Spain, Sweden, Ukraine, and the United Kingdom have launched satellites that use this band. Additionally, many administrations have indicated that the 2025-2110 MHz band will be used when they launch their first satellites. (A listing of existing and planned world wide satellite systems is shown in

Enclosure 3.)

Since OSM's earlier letter, there have been many developments concerning this band that support this request for modifying the National Table of Frequency Allocations. For example, auction of spectrum within the 1990-2110 MHz frequency range was identified as a potential source of revenue in the Balance Budget Act of 1997. The FCC has issued a rulemaking on mobile-satellite and terrestrial services (FCC 97-93). And finally, WRC-97 acted to prohibit the introduction of high-density mobile systems into this band.

NTIA believes now is the opportune time to modify the National Table of Frequency Allocations in the 2025-2110 MHz band. Such modification would conform with the International Table of Frequency Allocations and will implement nationally the results of WARC-92, WRC-95, and WRC-97. FCC should ensure that terrestrial systems in the band be limited to those that conform with the relevant ITU Radio Regulations and ITU-R Recommendations. Such assurance is needed to safeguard the ability of the Federal government space programs to continue to satisfy their requirements in this frequency band -- the backbone of the U.S. space program.

NTIA looks forward to working with the Commission to assure the protection of national and international space services. If you have any questions, please contact Mr. Edward M. Davison (phone (202)-482-1164; fax (202)-482-2830; email edavison@ntia.doc.gov).

Sincerely,

William T. Hatch
Acting Deputy Associate Administrator
Office of Spectrum Management

Enclosures

1 - Proposed Changes to the U.S. Table of Allocation
2 - Summary of the History of the International Allocation
3 - List of Worldwide Satellite Systems

cc: Daniel Phythyon, Chief, FCC Wireless Telecommunications Bureau
Regina Keeney, Chief, FCC International Bureau