NTIA SPECIAL PUBLICATION 98-37

# REALLOCATION IMPACT STUDY OF THE 1990 - 2110 MHz BAND

## Response to Title III of The Balanced Budget Act Of 1997


*Special Publication*

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

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## Response to Title III of The Balanced Budget Act Of 1997

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### KEY WORDS

1990-2025 MHz Band
2025-2110 MHz Band
Spectrum Usage
Space Programs/Systems
National Issues
International Agreements

# EXECUTIVE SUMMARY

## OVERVIEW

The National Telecommunications and Information Administration (NTIA) serves as the President's principal advisor on telecommunications policies pertaining to the Nation's economic and technological advancement and to the regulation of the telecommunications industry. It also serves as manager to the Federal Government's use of the radio frequency spectrum. NTIA's responsibilities include establishing policies concerning spectrum assignment, allocation and use, and providing the various departments and agencies with guidance to ensure that their conduct of telecommunications activities is consistent with policies as mandated in the NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management. As part of these responsibilities, NTIA conducted a reallocation impact study of the 1990-2110 megahertz (MHz) band to the Federal users.

The Balanced Budget Act of 1997 (Act) was signed by the President on August 8, 1997. The Act requires the Federal Communications Commission (FCC), among other things, to reallocate the 2110-2150 MHz band, a total of 40 MHz of spectrum, and another 15 MHz of spectrum from the 1990-2110 MHz band for assignment by competitive bidding. With regards to the reallocation of the 15 MHz from the 1990-2110 MHz band, if the President determines that such spectrum cannot be reallocated due to the need to protect incumbent Federal systems from interference, Title III of the Act permits him to identify alternative bands of frequencies totaling 15 MHz and report to the Congress no later than August 8, 1999.

This report presents information that could be used to evaluate the impact, on Federal systems, of reallocating the 15 MHz from the 1990-2110 MHz band for competitive bidding. Specific information includes: overview of current allocation rules and regulations, as well as, pertinent national and international footnotes governing the use of the entire radio frequency spectrum; Federal Government spectrum usage; Federal Government current and future space programs/systems operating in the 1990-2110 MHz band; and international agreements and national issues pertaining to the 1990-2110 MHz frequency spectrum. In addition, the report addresses the impact on the closely related 2200-2290 MHz band if 15 MHz of spectrum is reallocated from the 1990-2110 MHz band.

This report also identifies operational requirements for the National Aeronautics and Space Administration's (NASA's) space research operations at Goldstone, California and the National Oceanic and Atmospheric Administration's (NOAA's) space research and Earth exploration-satellite services at Wallops Island, Virginia, Fairbanks, Alaska, and the soon to be developed back-up station at Goddard Space Flight Center in Maryland.

# EXECUTIVE SUMMARY

Aspects of frequency sharing between Government and non-government operations in the 2025-2110 MHz band have not been considered in this report. However, technical analyses of sharing potential have been addressed within the domain of the International Telecommunications Union (ITU). Two specific ITU Recommendations, SA.1154 and F.1247, present provisions to facilitate sharing between space and terrestrial services in the 2025-2110 MHz band. Both of these Recommendations recognize the susceptibility of space science services to interference from terrestrial services, especially in the space-to-space direction. Specifically, Recommendation SA.1154 stipulates that, implementation of mobile systems in the band be limited to "low-density" services. Recommendation F.1247 describes the characteristics of the fixed service which will facilitate frequency sharing with space science services in the band.

## REALLOCATION IMPACT ASSESSMENT OF THE 15 MHz TO FEDERAL USERS

The impact assessment for reallocating 15 MHz of spectrum from the 1990-2110 MHz band is predicated on the following five key factors: 1) Federal Government band usage; 2) the major systems, including their critical functions or missions, supported in each of the band segments; 3) international agreements, as well as, national issues relating to the 1990-2110 MHz band or portions thereof; 4) the reallocation impact to other bands; and 5) Federal Government investment/relocation costs. A summary of the findings by band segment is presented below.

### 1990-2025 MHz Band

Reallocation of 15 MHz of spectrum from this band segment would have little or no impact to the Federal users. This band is practically unused by the Federal Government. As such, there are no major systems operating in the band and the Federal investment is minimal.

### 2025-2110 MHz Band

Reallocating 15 MHz from this band for competitive bidding would:

1. Affect numerous NASA and NOAA operations in the space science services, including safety-of-life operations;

2. Create uncertainty as to the type of services that will be employed by future FCC licensees but, more likely generate bidding from high-density wireless communications services which are not compatible with space sciences services in this band;

3. Severely impact the space operations in the companion downlink band (2200-2300 MHz);

4. Impact NASA's and NOAA's abilities to support national space science directives and fulfill international agreements;

5. Dramatically increase the current investment cost, which is in the tens of billions of dollars, because of detailed new studies and designs, inflation and systems' costs, and extra expenditures including monetary support to joint space ventures with other administrations;

6. Create an immeasurable problem for NASA and NOAA as to what band would their space science operations move to, as well as, what will be the corresponding companion or downlink band, and, more importantly, who will pay for the reallocation costs; and

7. Potentially compromise the United States' abilities to honor and fulfill its international obligations with respect to space science services.

Furthermore, any changes regarding space operations in the United States, because of the reallocation of 15 MHz from the 2025-2110 MHz band, have to be coordinated with the international community for compatibility. Especially, 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. Enforcing these changes, however, with foreign space agencies would be very difficult, specifically if the United States would require them to undergo modifications commensurate to any changes in United States space systems' operations to maintain compatibility.

## GOVERNMENT SPECTRUM USAGE AND MAJOR SYSTEMS

### 1990-2025 MHz Band

Based on the retrieved data from the Government Master File, the band segment 1990-2025 MHz is unused by the Federal agencies. There are only two Federal Government frequency assignments in this band and both are experimental in nature. As such, these assignments may not be afforded electromagnetic interference protection.

### 2025-2110 MHz Band

The 2025-2110 MHz band is extensively used by NOAA and NASA. There are more than 200 Federal Government frequency assignments in this band, as of September 1998. The 2025-2110 MHz band is used in the United States as the primary backbone communications link for the National Space Programs within NOAA and NASA to support their respective national space directives. Specifically, NOAA has 30 frequency assignments in this band, as of September 1998 and, all, virtually support the Geostationary Operational Environmental Satellite (GOES), Landsat and the Polar-orbiting Environmental Satellite Systems. These assignments also support other

administrations' space programs through NOAA's commitment with the World Meteorological Organization and other international space organizations. The GOES satellite system provides timely, high-resolution weather data that includes, inter alia, input into the Numerical Weather Prediction (NWP) models resulting in accurate weather forecasts over the continental United States, and the collection and dissemination of meteorological data. The Landsat 7 system scheduled for launch in Spring 1999, will collect a global archive of multi-spectral images. 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. The polar orbiters track and/or monitor environmental pollution, forest fires and volcanic activities to name just a few applications.

NASA is the largest Federal user in the 2025-2110 MHz band. Common uses allow for "cross support" between NASA and other international space agencies; emergency operations, particularly where astronaut safety is concerned; and the ability to control and de-orbit errant spacecraft. NASA has over 180 frequency assignments, as of September 1998, in this band supporting the operations of numerous United States and international satellite systems. This band is of very critical importance to NASA's space tracking; space telecommand; space operation; space telemetering; space research; satellite emergency position-indicating radio beacon; and other services in support to national space science directives. This band also supports NASA's numerous and complex space-related experiments.

NASA has used the 2025-2110 MHz portion of the spectrum in support of virtually all of its mission spacecraft since the days of the Apollo Program and, continuing to this date, in support of more complex programs: such as the National Space Transportation System (Space Shuttle), Tracking and Data Relay Satellite, Hubble Telescope; Spaceflight Tracking & Data Network; Deep Space Network to name just a few and, in the very near future, the International Space Station Program. The missions of these space systems are summarized below.

In addition, the 2025-2110 MHz band is currently used and is expected to be more fully used in the future for commercial space endeavors. Both, the Land Remote Sensing Act of 1992 and the Commercial Space Act of 1997 strongly promote commercial space opportunities as a priority goal of the United States. Many new and innovative commercial space projects have been initiated by such companies as Boeing, Kistler Aerospace, Earthwatch, and Space Imaging L.P. These efforts in a large part are supported by communications in the 2025-2110 MHz band. Also, NASA, when requested, provides S-band (2 GHz) support to commercial users as required for launch orbit insertion and for emergency situations.

## MISSIONS AND FUNCTIONS OF UNITED STATES SPACE SYSTEMS

- Collect meteorological data and some of which are used as input into the NWP models which provide timely and accurate weather forecasts.

- Provide environmental data used to track/monitor forests fires and depletions, volcanic activities, ozone depletion and environmental pollution.

- Study other planets and celestial bodies, the properties of the Earth's upper and lower atmosphere, and various solar phenomena (*e.g.*, X-ray and gamma ray sources, Ultraviolet, X-ray and gamma radiation, diffuse radiation of cosmic origin, charged and neutral particles, element and isotropic composition of several distinct samples of matter, the universe age and size, etc.);

- Conduct measurements on high resolution plasma, magnetic and electric field, the motion of local inertial space with respect to distant inertial space, temperature difference in cosmic microwaves, nitric oxide in terrestrial lower atmosphere and inputs from the Sun and magnetosphere, visible and near-infrared radiation reflected by Earth, etc.

- Conduct interplanetary and planet Earth missions, space sciences experiments using scientific payloads, and three-dimensional imaging techniques to study the global responses of the Earth's magnetosphere to variation of solar winds.

- Surveys the entire celestial sphere in extreme ultraviolet spectrum.

## NATIONAL ISSUES AND INTERNATIONAL AGREEMENTS (1990-2110 MHz BAND)

National issues encompass those emanating from the Office of the President, the Congress, the FCC and, by in large, the public. International agreements or treaties include, but not limited to, those that were adopted by the ITU and its study groups, and those bilateral or multi-lateral treaties in which an administration is a signatory. International agreements, treaties and obligations are usually tied to domestic policy matters. As such, they must be considered if spectrum auctions are to be viable because they affect the potential for new radio services in and outside the United States. Some of the national issues and international agreements germane to the 1990-2025 MHz and 2025-2110 MHz bands are presented in this report.

## INVESTMENT/REALLOCATION COSTS

- NASA's total current investment on space programs that utilize the 2025-2110 MHz band is over $42 billion.

- NASA's total current and projected investment on space programs that utilize the 2025-2110 MHz band is over $76 billion.

- NOAA's current investment on space programs that utilize the 2025-2110 MHz band is almost $5 billion.

- NOAA's total current and projected investment on space programs that utilize the 2025-2110 MHz band is over $11 billion.

Relocation costs of Federal users of the 2025-2110 MHz band have not been specifically assessed in this report since the overall economic impact of such a relocation is directly a function of the following factors: 1) which 15 MHz portion of the band is selected for reallocation; 2) when the Federal Government operations in this portion of the spectrum must cease; and 3) where in the spectrum are the services, which were formerly conducted in this 15 MHz, to be relocated. NASA, however, provided a Federal system replacement cost of about $13 billion.

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AF | Air Force |
| ATDRSS | Advanced Tracking and Data Relay Satellite System |
| BAS | Broadcast Auxiliary Service |
| CCSDS | Consultative Committee on Space Data Systems |
| CDA | Command and Data Acquisition |
| CNES | National Space Agency of France |
| COSPAS | Cosmicheskaya Systyema Poiska Avariynich Sudov |
| CTRS | Cable Television Relay Service |
| DARA | German Space agency |
| DOI | Department of Interior |
| DoD | Department of Defense |
| DORIS | Doppler Orbitography and Radiopositioning Integrated by Satellite |
| EES | Earth Exploration Satellite |
| EESS | Earth Exploration Satellite Service |
| EIRP | Equivalent Isotropically Radiated Power |
| EMI | Electromagnetic Interference |
| ENG | Electronic News Gathering |
| EPIRB | Emergency Position-Indicating Radiobeacon |
| EROS | Earth Resource Observation System |
| ESA | European Space Agency |
| EUMETSAT | European Meteorological Satellite |
| EUTELSAT | European telecommunication Satellite |
| FAS | Frequency Assignment Subcommittee |
| FCC | Federal Communications Commission |
| FNPRM | Further Notice of Proposed Rule Making |
| FPLMTS | Future Public Land Mobile Telecommunications Systems |
| FS | Fixed Service |
| GMF | Government Master File |
| GOES | Geostationary Operational Environmental Satellite |
| GPS | Global Positioning System |
| GRO | Gamma Ray Observatory |
| GSFC | Goddard Space Flight Center |
| GSTDN | Ground Spaceflight Tracking and Data Network |
| HST | Hubble Space Telescope |
| IGMSDCS | International Geostationary Meteorological Satellite Data Collection System |
| IRAC | Interdepartment Radio Advisory Committee |
| ISEE | International Sun Earth Explorer |
| ISS | International Space Station |
| ITCOP | Interagency Tracking, Communications, Operations Panel |
| ITU | International Telecommunication Union |
| LEO | Low Earth Orbit |
| LTTS | Local Television Transmission Service |

## LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

| | |
|---|---|
| METEOSAT | Meteorological Satellite |
| METOP | Meteorological Operational |
| MSS | Mobile Satellite Service |
| NASA | National Aeronautics and Space Administration |
| NASDA | Japanese Space Agency |
| NOAA | National Oceanic and Atmospheric Administration |
| NPOESS | National Polar-orbiting Environmental Satellite System |
| NTIA | National Telecommunications and Information Administration |
| NWP | Numerical Weather Prediction |
| OMB | Office of Management and Budget |
| PCS | Personal Communications Services. |
| PEACESAT | Pacific Education and Communications Experiments by Satellite |
| POESS | Polar-orbiting Environmental Satellite System |
| RFI | Radio Frequency Interference |
| SARSAT | Search and Rescue Satellite |
| SFCG | Space Frequency Coordination Group |
| SGLS | Space Ground Link Subsystem |
| SNIP | Space Network Interoperability Panel |
| SOS | Space Operation Service |
| SRS | Space Radiocommunications Station |
| SRS | Space Research Service |
| SRV | Systems Review File |
| STDN | Spaceflight Tracking and Data Network |
| TDRSS | Tracking and Data Relay Satellite System |
| TOPEX | Topography Ocean Experiment |
| TT&C | Tracking, Telemetry, and Command |
| UARS | Upper Atmosphere Research Satellite |
| USGS | United States Geological Survey |
| WARC | World Administrative Radio Conference |
| WEFAX | Weather Facsimile |
| WMO | World Meteorological Organization |
| WRC | World Radiocommunication Conference |

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## 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 U.S. Departments and 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 nations 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 the Balanced Budget Act of 1997 (Act). The Act requires the FCC, among other things, to reallocate from the 2110-2150 MHz band, a total of 40 MHz of spectrum, for assignment by competitive bidding. If, however, the FCC determines that auction of other spectrum better serves the public interest, convenience, and necessity, and can reasonably be expected to produce greater receipts, then the Commission shall identify an alternative 40 MHz of spectrum and report to Congress no later than August 8, 1999.[2]

The Act also requires the FCC to reallocate and auction a total of 15 MHz from the 1990-2110 MHz band for assignment by competitive bidding, unless the President determines that such spectrum cannot be reallocated due to the need to protect incumbent Federal systems from interference.[3] In addition, if the President determines that the allocation of other spectrum better serves the public interest, convenience, and necessity, and can reasonably be expected to produce comparable receipts, then the President, after making such determination, shall identify alternative bands of frequencies totaling 15 MHz and report to the Congress an identification of such alternative bands for assignment by competitive bidding no later than August 8, 1999.[4]

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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 (1997) Title III-Communications and Spectrum Allocation Provisions, (1997).

3 In accordance with 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 FCC, in making available bands of frequencies for competitive bidding, shall: 1) seek to promote the most efficient use of the electromagnetic spectrum; 2) consider the cost of relocating existing uses to other bands of frequencies or other means of communication; 3) consider the needs of existing public safety radio services; 4) comply with the requirements of international agreements concerning spectrum allocations; and 5) coordinate with the Secretary of Commerce when there is any impact on Federal Government spectrum use.[5]

As a result of the NTIA Ad Hoc 206 tasking, Implementation of the Results of the World Administrative Radio Conference of 1992 (WARC-92) and the World Radiocommunication Conference of 1995 (WRC-95), the national allocation of the 1990-2110 MHz frequency span has been amended, as shown in Table 2-1. The 1990-2025 MHz and 2025-2110 MHz frequency bands are allocated exclusively to the non-government on a primary basis for mobile-satellite, and fixed and mobile services, respectively. Although the 2025-2110 MHz band has been allocated exclusively to the non-government, there are footnotes in this frequency range that accommodate Federal Government use, as indicated in Table 2-2. However, the National Aeronautics and Space Administration (NASA) through NTIA has proposed to the FCC that the 2025-2110 MHz band be upgraded to primary status in the United States in order to bring the National Table of Frequency Allocations in line with that of the international allocation where the space science services are afforded primary allocation status worldwide (*see* Annexes C and D).

The majority of 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, but are not limited to: accurate weather forecasts, ozone measurements, scientific research on the Sun-Earth interaction, atmospheric surveillance and mapping, oceanography research, monitoring of volcanoes, forest fires, pollution and rain forest depletion, probing the secrets of the universe and analyzing light sources, delivering satellites to low-Earth orbit, conducting in-orbit scientific experiments, detecting visible and near infrared radiation, exchanging social environmental, health, and educational information between countries of the Pacific Basin, and, in the near future, servicing facility for various free-flying spacecraft and staging base for space exploration just to name a few. Federal Government investment costs in these satellite and spacecraft systems, along with their associated earth stations, are in the tens of billions of dollars.

Specifically, the 2025-2110 MHz band is used in the United States as the primary backbone communications band for the National Space Programs within NASA and the National Oceanic and Atmospheric Administration (NOAA). NASA has used this portion of the spectrum in support of virtually all of its mission spacecraft since the days of the Apollo Program. The band supports the Tracking and Data Relay Satellite System (TDRSS), the Mission to Planet Earth Program, Space Shuttle and Hubble Telescope Programs, and is slated to provide baseline service to the International Space Station (ISS). It also supports NOAA's Geostationary Operational Environmental Satellite

[5] *Id*.

(GOES), Landsat 5 and 7 systems, and the polar orbiters, as well as, evolving commercial systems and other various space systems.

The physics of this frequency range allow for ***all weather communications links through the atmosphere*** and provide the capability to establish communications with a satellite which has lost its ability to orient itself. This band was used in re-establishing control of the first TDRSS satellite (TDRSS-1), the Solar Heliospheric Observatory (SOHO) spacecraft, and the Olympus satellite which is owned by the European Space Agency (ESA). Other frequency bands, specifically higher bands, would not have provided this very crucial capability.

In a related matter, the FCC, on March 14, 1997, released the First Report and Order and Further Notice of Proposed Rule Making (FNPRM) regarding the allocation of the 1990-2025 MHz to the mobile-satellite service (MSS).[6] Specifically, the Commission plans to allocate 70 MHz of spectrum at 1990-2025 MHz and 2165-2200 MHz to the MSS, effective January 1, 2000. In the plan, FCC proposed to modify the current Broadcast Auxiliary Service (BAS), Cable Television Relay Service (CARS), and Local Television Transmission Service (LTTS) allocation at 1990-2110 MHz by providing an allocation to these services at 2025-2130 MHz band. In addition, the FCC proposes to re-channelize BAS at 2 GHz from seven channels of 17 and 18 MHz of bandwidths to seven channels of 15 MHz bandwidth.

This report presents information that could be used to evaluate the impact of reallocating the 15 MHz of spectrum for competitive bidding from the 1990-2110 MHz band. Specific information includes: overview of current allocation rules and regulations, as well as, pertinent national and international footnotes governing the use of the entire frequency range; Federal Government spectrum usage; Federal agencies' current and future space programs or systems operating in the 1990-2110 MHz band; international agreements and national issues pertaining to the 1990-2110 MHz frequency span; and reallocation impact of the 15 MHz to the 2200-2290 MHz band. In addition, it identifies the operational requirements for NASA's space research service at Goldstone, California and NOAA's space research and Earth exploration-satellite services at Wallops Island, Virginia, Fairbanks, Alaska and the soon to be built backup earth station at Goddard Space Flight Center (GSFC) in Greenbelt, Maryland. It should be noted that these transmitting earth stations can operate at a maximum range of 500 watts to 500 kilowatts of power.

Further, this report focuses only on the 1990-2110 MHz frequency span because of Federal Government's extensive investment and vital interest in this portion of the band. Section II presents discussion on allocation rules that include applicable footnotes for each segment of the 1990-2110 MHz band. It also includes discussion on the unclassified information on Federal Government's spectrum usage, and description of major systems and their functions. Section II,

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[6] FCC, First Report and Order and Further Notice of Proposed Rule Making, Amendments of Section 2.106 of the Commission's Rules to Allocate Spectrum at 2 GHz for Use by the Mobile-Satellite Service, ET Docket No. 95-18, (March 14, 1997).

however, does not include discussion on non-government spectrum usage. Section III presents the discussion on international agreements and national issues relating to the 1990-2110 MHz band or portion thereof, and the 15 MHz reallocation impact to the 2200-2290 MHz band, as well as, NASA's and NOAA's investment/relocation costs. Section IV presents the summary on the 15 MHz reallocation impact assessment.

## OBJECTIVE

The objective of this task was to research, examine and present current data that could be used to evaluate the impact, on Federal systems or users, of reallocating 15 MHz of spectrum from the 1990-2110 MHz band, for assignment by competitive bidding.

## APPROACH

To accomplish the objective of the task, the following approach was undertaken:

1. Coordinate with major Federal Government users of the 1990-2110 MHz band;

2. Examine the Government Master File (GMF) and the Systems Review File (SRF) records, the Space Radiocommunications Station (SRS) and the Space Frequency Coordination Group (SFCG) data, along with governing rules, applicable footnotes, spectrum usage and channeling plans in the 1990-2110 MHz band;

3. Examine international agreements and outstanding national issues regarding the 1990-2110 MHz band or portion thereof;

4. Investigate the 15 MHz reallocation impact on the 2200-2290 MHz band; and

5. Estimate overall current and projected economic investment on Federal systems in the 1990-2110 MHz band.

The major sources from which the information on Federal Governments's spectrum usage, system's description and functions, and estimate overall economic investment were derived from either one of the following sources: the GMF, SRV, agencies' input documents and literature, and other government documents. As far as the international agreements and national issues relating to the 1990-2110 MHz band, the following texts were used: the International Telecommunication Union's (ITU) Radio Regulations, the Final Acts of the World Radiocommunication Conferences (i.e., WARC-92, WRC-95 and WRC-97), other ITU documents, and relevant FCC rule making documentation.

# SECTION II
# SUMMARY OF FEDERAL GOVERNMENT SPECTRUM USAGE IN THE 1990-2110 MHz BAND

## ALLOCATION RULES

The international and national allocations, along with the corresponding footnotes, for the 1990-2110 MHz span are shown in Table 2-1.[7] 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. Footnotes that were approved or modified at the WRC-97 are shown with brackets. Note that only international footnotes relevant to the United States are included in the Table. Nationally, the entire frequency span is composed of two major bands, the 1990-2025 MHz and the 2025-2110 MHz bands. These bands are exclusively allocated to the non-government for mobile-satellite, and fixed and mobile services on a primary basis, respectively. However, there are footnotes in this entire span of spectrum that accommodate Federal Government use. These footnotes are enumerated and described in Table 2-2.

Government use of these bands ranges from secondary use or non-interference basis, in some cases, to primary co-equal use, in one case. Specifically, in the entire 1990-2110 MHz span, Government space research earth stations may be authorized to use specific frequencies at specific sites for Earth-to-space transmissions. These authorization shall be secondary to non-government operations in the band. In the 2025-2110 MHz band segment, Earth-to-space and space-to-space transmissions may be authorized in the space research and Earth exploration-satellite services, however, such transmissions shall not cause harmful interference to non-government stations operating in accordance with the National Table of Frequency Allocations. Also, in the 2025-2110 MHz band segment, 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 certain sites. Such transmissions, however, shall not cause harmful interference to non-government operations. On the other hand, the GOES 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 certain sites. These sites are included on the list in Table 2-7.

[7] The National Allocation of the 1990-2110 MHz frequency range presented here is a result of the NTIA Ad Hoc 206 Report, AH 206-388/8, Implementation of the Results of WARC-92 and WRC-95, (April 1998).

# SECTION II
# SUMMARY OF FEDERAL GOVERNMENT SPECTRUM USAGE IN THE 1990-2110 MHz BAND

## TABLE 2-1: INTERNATIONAL AND NATIONAL ALLOCATIONS AND FOOTNOTES ATTRIBUTED TO THE 1990-2110 MHz FREQUENCY SPAN [a]

| INTERNATIONAL | | | UNITED STATES | | |
|---|---|---|---|---|---|
| **Region1 (MHz)** | **Region 2 (MHz)** | **Region 3 (MHz)** | **Frequency Band (MHz)** | **Government Allocation** | **Non-gov't. Allocation** |
| 1980-2010<br>FIXED<br>MOBILE<br>MOBILE-SATELLITE<br>(Earth-to-space)<br>S5.388 S5.389A S5.389B | | | 1980-1990 | | FIXED<br>MOBILE |
| 2010-2025<br>FIXED<br>MOBILE<br><br><br><br><br>S5.388 | 2010-2025<br>FIXED<br>MOBILE<br>MOBILE-SATELLITE<br>S5.388<br>[S5.389C]<br>S5.389D<br>S5.389E | 2010-2025<br>FIXED<br>MOBILE<br><br><br><br><br>S5.388 | 1990-2025 | <br><br><br><br><br><br>US111 | MOBILE-SATELLITE<br>(Earth-to-space)<br><br><br><br>US111<br>***NG156*** [b] |
| 2025-2110<br>FIXED<br>MOBILE<br>SPACE RESEARCH (Earth-to-space)<br>(space-to-space)<br>SPACE OPERATION (Earth-to-space)<br>(space-to-space)<br>EARTH EXPLORATION-SATELLITE<br>(Earth-to-space)(space-to-space)<br><br>***[S5.391]*** [c] S5.392 | | | 2025-2110 | <br><br><br><br><br><br>US90<br>US111<br>US219<br>US222 | FIXED<br>MOBILE<br><br>US90<br>US111<br>US219<br>US222<br>NG23<br>NG118<br>***[S5.391]*** |

[a] 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.

[b] 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).

[c] This international footnote is a result of WRC-97.

# SECTION II
# SUMMARY OF FEDERAL GOVERNMENT SPECTRUM USAGE IN THE 1990-2110 MHz BAND

## SUMMARY OF FEDERAL SPECTRUM USAGE

The information on spectrum usage is based entirely on the frequency assignment records in the GMF, as of September 1998, and supplemental data provided by the Federal agencies. A summary of the current total number of Federal Government frequency assignments, as per the GMF, is shown in Table 2-3.

A graphical representation of these assignments in the entire 1990-2120 MHz frequency span is shown in Figure 2-1. Note, however, that Figure 2-1 only includes Federal Government and non-government authorized frequency assignments that are in the GMF and not those authorized for the private sector, such as for electronic news gathering. Figure 2-2 represents the graphical representation of the current plus future frequency assignments in the entire 1990-2120 MHz band. In this study, future frequency assignments only include those of NASA and NOAA that were planned for submission to the Frequency Assignment Subcommittee (FAS) of the Interdepartment Radio Advisory Committee (IRAC) for approval. Again, Figure 2-2, does not include private sector's current and future frequency assignments for electronic news gathering. The majority of the frequency assignments or listings represented in Figures 2-1 and 2-2 are for the space science services (i.e., space research, space operation, and Earth exploration-satellite services). It can be seen from both figures that the 2025-2120 MHz band segment is or will be heavily used by the Federal Government.

A graphical representation of the current, and current plus future international frequency assignments in the 1990-2120 MHz band is depicted in Figures 2-3 and 2-4, respectively. Current international frequency assignments refer to those listed, as of September 1998, in the Space Radiocommunications Station (SRS) of the ITU. Future international frequency assignments refer to those that are unpublished in the ITU register, but have already been received in the SRS and are either under coordination or notification process, as of September 1998. It is noteworthy that in Figure 2-3, the band segment 2010-2025 MHz presently has no registered international frequency assignments. Again, in the same band segment in Figure 2-4, it appears that there are very few pending request for frequency assignments before the ITU. Figures 2-3 and 2-4 only represent space science and mobile satellite services assignments. All figures use a 0.5 MHz resolution and were derived by plotting the carrier frequency and the emission bandwidth (i.e., carrier frequency $\pm$ ½ bandwidth).

For practical purposes and convenience, discussion regarding Federal Government spectrum usage, and description and functions of major systems in the entire frequency span, including the portrayal of total number of authorized frequency assignments, is divided into two sub-bands, namely 1990-2025 MHz and 2025-2110 MHz sub-bands.

# SECTION II
# SUMMARY OF FEDERAL GOVERNMENT SPECTRUM USAGE IN THE 1990-2110 MHz BAND

## TABLE 2-2: 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, Texas, 27° 39'N 097° 23'W. Fairbanks, Alaska, 64° 59' N 147° 53' W.
Goldstone, California, 35° 18' N 116° 54' W. Greenbelt, Maryland, 39° 00' N 076° 50' W.
Guam, Mariana Island, 13° 19' N 144° 44' E. Kauai, Hawaii, 22° 08' N 159° 40' W.
Merritt Is., Florida, 28° 29' N 080° 35' W. Roseman, North Carolina, 35° 12' N 082° 52' W.
Wallops Is., Virginia, 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, South Dakota, $43^0$ 32' 03.1"N $096^0$ 45' 42.8"W;
Fairbanks, Alaska, $64^0$ 58' 36.6"N $147^0$ 30' 54.2"W.

**US222:** In the band 2025-2035 MHz Geostationary Operational Environmental Satellite Earth stations of 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 Island, Virginia, $37^0$ 50' 48"N $075^0$ 27' 33"W;
Seattle, Washington, $47^0$ 34' 15"N $122^0$ 33' 10"W;
Honolulu, Hawaii, $21^0$ 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.

**NON-GOVERNMENT**

**NG23:** Frequencies in the band 2100-2200 MHz may also be assigned to stations in the international fixed public radio service located south of $25^0$ 30' north latitude in the State of Florida and in U.S. Possessions in the Carribean area, provided, however, no new assignments in the band 2150-2162 MHz will be made to such stations after February 25, 1974.

**NG118:** Television translator relay stations may be authorized to use frequencies in this band on a secondary basis to stations operating in accordance with the Table of Frequency Allocations.

**NG156:** In the 1990-2025 MHz band, incumbent fixed and mobile service operations (Television Broadcast Auxiliary and Cable Television Relay) may continue to use the band on a primary basis until a mobile satellite service applicant(s) relocates all affected operations according to the transition plan- found at 47 C.F.R. Sections 74.690 and 101.69. ***[This is a proposed footnote for this band***].

## TABLE 2-2: 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.

## 1990-2025 MHz Band Federal Usage

Based on the retrieved data from the GMF, the band segment 1990-2025 MHz is unused by the Federal agencies, as shown in Figure 2-1. Essentially, the two Federal Government assignments are both experimental in nature and may not be afforded electromagnetic interference (EMI) protection. This minimal Federal usage follows from the lack of any Federal allocations in this band segment.

## 2025-2110 MHz Band Federal Usage

In contrast, the 2025-2110 MHz band is ***extensively used***. The two major Federal Government users of the band are NASA and NOAA of the Department of Commerce. Under the Space Act of 1958, NASA and NOAA operate mission spacecraft that are totally dependent on radio spectrum access. Thus, as expected, there is an extensive use of this 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. Currently, all Federal Government uses in this band are shared with the non-government's use of low-density terrestrial communication; such as, the electronic news gathering. Such government and non-government shared-use in this band has been proven successful for over three decades through coordination. WARC-92 concluded that sharing between high density and conventional land mobile systems on the one hand and space services on the other hand is not feasible.[8]

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. NOAA has an ongoing requirement to provide continuous coverage of the Western Hemisphere for accurate weather prediction. This service being provided by NOAA is vital not only to the citizens of the United States but also to other countries. Presently, this image coverage is provided by the GOES satellites. In addition, NOAA has a worldwide commitment through the World Meteorological Organization (WMO), a part of the United Nations, 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.

NASA is the largest Federal user of this band. Common uses allow for "cross support" between NASA and other international space agencies; emergency operations, particularly where astronaut safety is concerned; and the ability to control and de-orbit errant spacecraft. Currently, it has approximately 160 authorized frequency assignments, as of September 1998, supporting the operations of numerous United States and international satellite systems. The 2025-2110 MHz band is of very critical importance to NASA's space tracking, space telecommand, space operation, space telemetering, space research, satellite emergency position-indicating radiobeacon (EPIRB), and other services in support of national space science directives. This band also supports NASA's numerous and complex space-related experiments.

[8] Recommendation ITU-R SA. 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.

## SECTION II
## SUMMARY OF FEDERAL GOVERNMENT SPECTRUM USAGE IN THE 1990-2110 MHz BAND

### TABLE 2-3: NUMBER OF FREQUENCY ASSIGNMENTS FOR FEDERAL GOVERNMENT IN THE 1990-2110 MHz BAND, AS PER THE GMF (SEPT.1998)

| Freq. Band (MHz) | Agency | No. of Freq. Assignments Per Station Class |
|---|---|---|
| 1990-2025 | Air Force | 1/XT |
| | Army | 1/XT |
| 2025-2110 | Air Force | 7/XT |
| | Commerce | 5/TD, 5/TW, 6/TH, 1/TF, 1/TC, 3/TT, 17/TM |
| | Interior | 2/TC |
| | NASA | 16/EK, 16/ED, 9/ET, 67/TH, 38/TD, 26/TW, 1/TF, 1/TE, 9/XT, 2/XC, 2/XD, 2/XR |

LEGEND:

ED = Space Telecommand Space
EK = Space Tracking Space
ET = Space Operation Space
MOEC = Surface Telemetering Mobile
TC = Fixed-Satellite Earth
TD = Space Telecommand Earth
TE = Mobile-Satellite Sat. EPIRB
TH = Space Research Earth
TF = Radiodetermination Satellite Earth
TM = Meteorological-Satellite Earth
TT = Space Operation Earth
TW = Earth Exploration-Satellite Earth
XC = Experimental Contract
XD = Experimental Developmental
XR = Experimental Research
XT = Experimental Testing

Since the early 1960's, NASA has successfully used this band to support the many missions that started from the Apollo Program and, continuing to this date, supports more complex missions, such as; TDRSS, Hubble Space Telescope and the National Space Transportation System (Shuttle) Programs to name a few and, in the near future, the International Space Station Program. Some of the other space programs that are supported in this band are: Magellan, Mars Global Surveyor, International Comet Explorer, Cosmic Background Explorer, Earth Radiation Budget, International Solar Physics, Upper Atmosphere Research Satellite, Galileo, Ulysses, Cassini, Gamma Ray Observatory, Extreme Ultraviolet Explorer, Laser Geodynamic Satellite, Ocean Topography Experiment, Mars Pathfinder, GOES, Landsat and other NOAA series. A more complete listing of these programs/systems is shown in Table 2-5. Included in Table 2-5 is a brief description of the functions of these space programs/systems.

In addition, the 2025-2110 MHz band is used currently and is expected to be more fully used in the future, for commercial space endeavors. Both the Land Remote Sensing Policy Act of 1992 and the Commercial Space Act of 1997 strongly promote commercial space opportunities as a priority goal of the United States. Many new and innovative commercial space projects have been initiated by such companies as Boeing, Kistler Aerospace, Earthwatch and Space Imaging L.P. These

efforts are in a large part supported by communications in the 2025-2110 MHz band. Also, NASA, when requested, provides S-band (2 GHz) support to commercial users as required for launch, orbit insertion and for emergency situations.

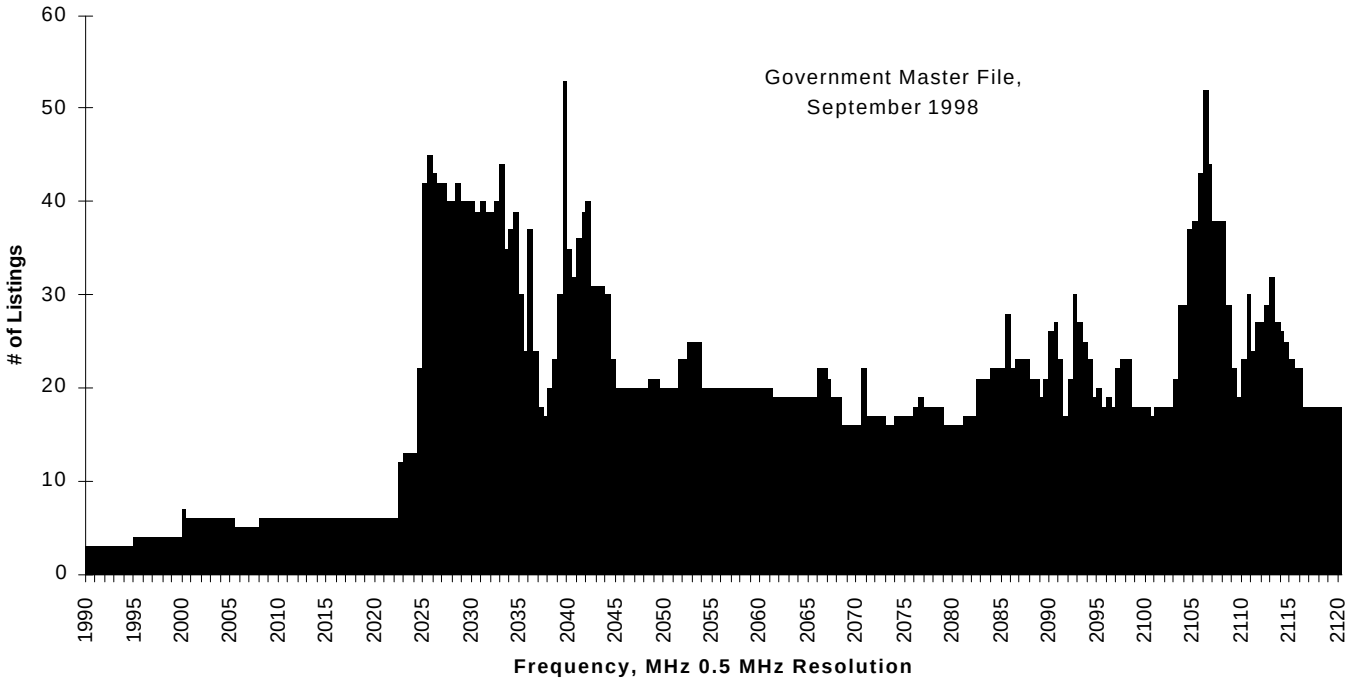
The other users of the bands are the Air Force (AF), with seven assignments, and the Department of Interior (DOI) with two assignments. Use of this band by the Air Force is confined to its test ranges in the East Coast for pre-launch check of missiles and satellites. In addition, the AF uses this band to support the pre-launch check of the NOAA Polar-orbiting satellites and the testing of the Space Shuttle's antenna systems. Although the DOI has only two assignments in this band, these frequency assignments support international agreements with Pacific Rim countries. Particularly, the DOI, in conjunction with NOAA, uses this band to promote community educational developments in the Pacific region through communications experiments with the use of the Pacific Education and Communications Experiments by Satellite (PEACESAT) network.

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

The GMF and the SRV are the primary sources of data used to identify the major systems operating in this band. The Federal agencies' input and other Federal Government documents, as well as literature, were used to augment the information taken from the GMF and the SRF. As indicated earlier, the 1990-2025 MHz band segment is essentially unused by the Federal Government and, as expected, there are no major systems found to be operating in the band. Therefore, only the major systems operating in the 2025-2110 MHz band are discussed in this Section. Table 2-4 provides a lists of these major systems and their respective operational uplink and downlink frequency bands. A short description of their functions and technical characteristics (as available) is presented in subsequent paragraphs. Figure 2-5 illustrates the data transfer and some of the benefits from space systems to the public or end-users.

Space programs/systems that were not discussed in detail are listed in Table 2-5. Basically, these are dependent on or receive communication link support from some of the major systems. Furthermore, the United States supports space programs of other administrations or space agencies or has joint space ventures with these. A list of these joint venture space programs is shown in Table 2-6. Table 2-6 only includes current foreign space programs.

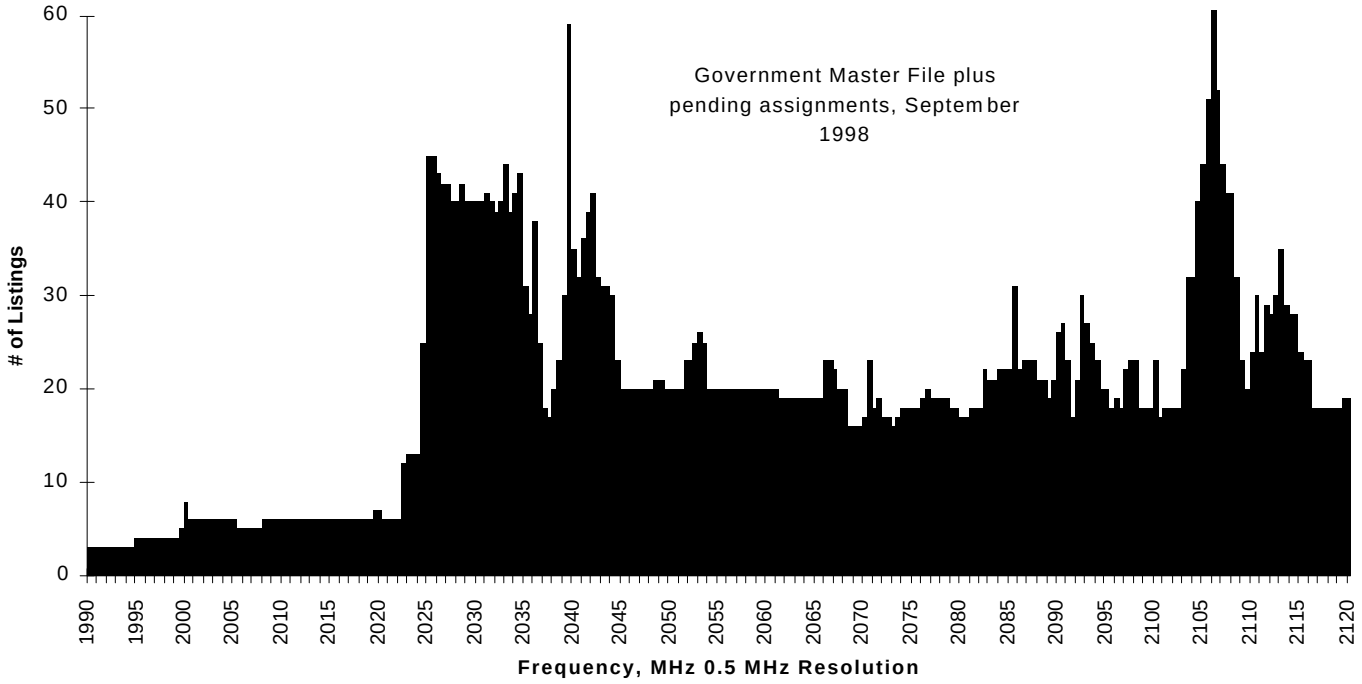
## SECTION II
## SUMMARY OF FEDERAL GOVERNMENT SPECTRUM USAGE IN THE 1990-2110 MHz BAND




Note: 1) The figure represents authorized frequency assignments or listings in the GMF, as of September 1998, and does not include the private sector's authorized frequency assignments such as for electronic news gathering.

2) The majority of the authorized frequency assignments are for space science services.

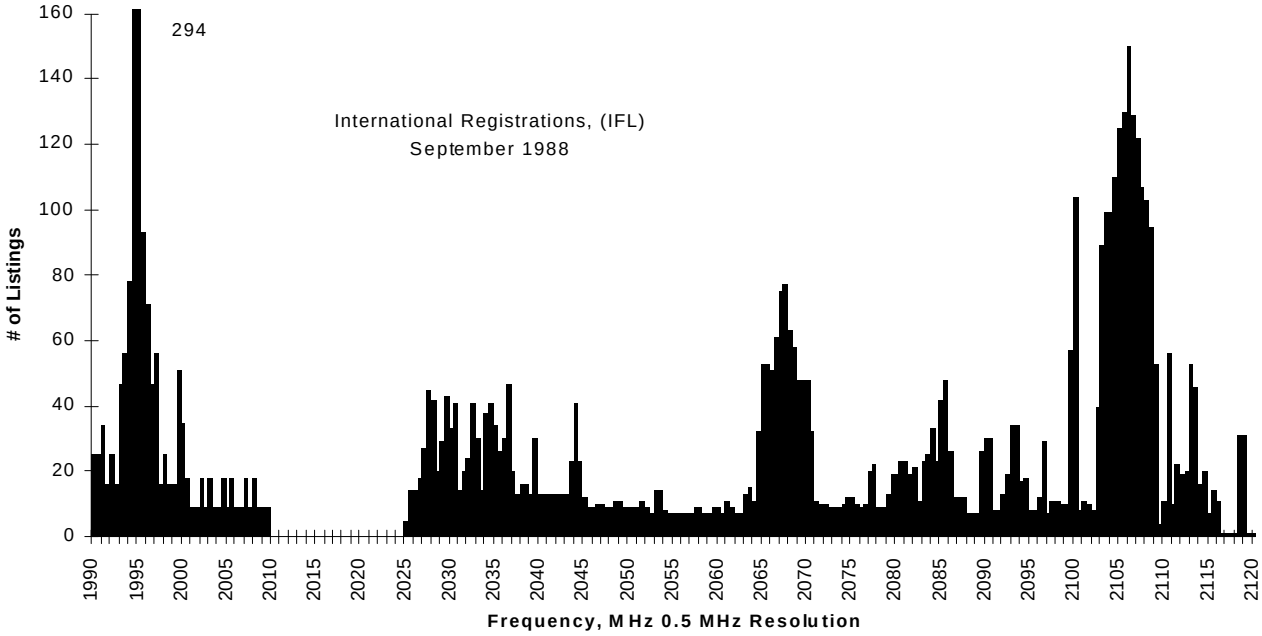
**Figure 2-1.**
**A graphical representation of the frequency assignments or listings in the 1990-2120 MHz band, as per the GMF (September 1998).**




Note: 1) The figure does not include the private sector's current and future frequency assignments or listings such as for electronic news gathering.

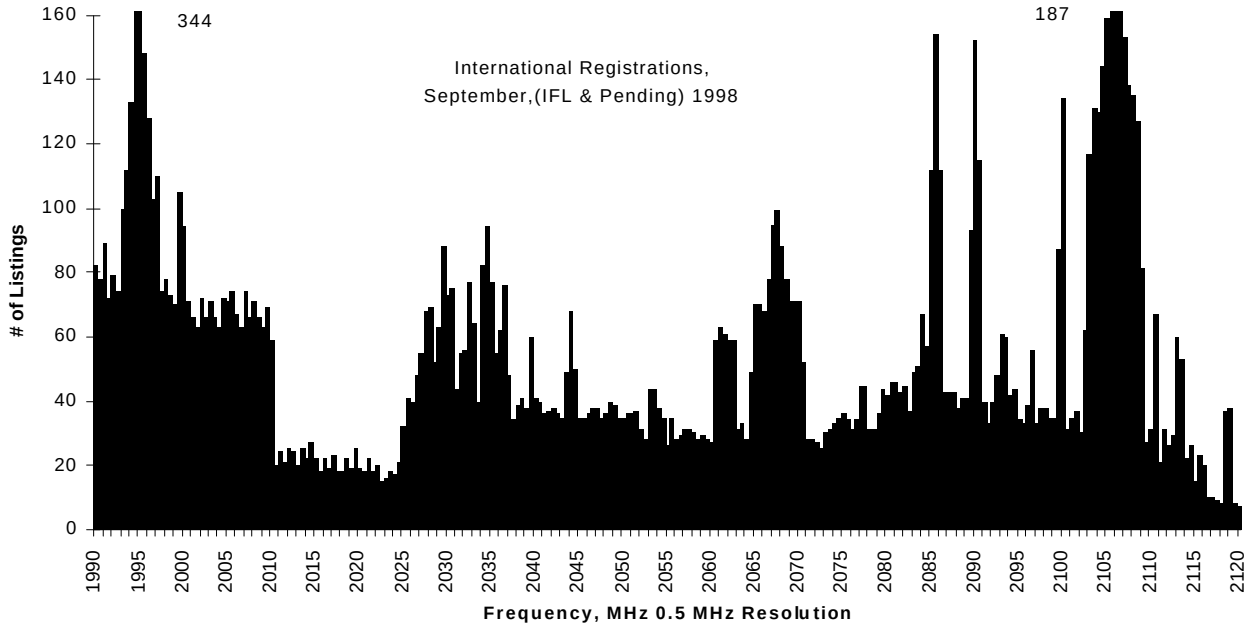
2) The majority of the frequency assignments are for space science services.

**Figure 2-2.**
**A graphical representation of the current frequency assignments or listings in the GMF, as of September 1998, plus NASA's and NOAA's future frequency assignments planned for submission to the SPS in the1990-2120 MHz band**.




Note: The figure only represents international space science and mobile-satellite services listings.

**Figure 2-3.**
**A graphical representation of the current international frequency listings in the 1990-2120 MHz band, as per the SRS of the ITU (September 1998).**




Note: The figure only represents international space science and mobile-satellite services listings.

**Figure 2-4.**
**A graphical representation of the current and future international frequency listings in the1990-2120 MHz band, as per the SRS of the ITU (September 1998).**

## SECTION II
## SUMMARY OF FEDERAL GOVERNMENT SPECTRUM USAGE IN THE 1990-2110 MHz BAND

### TABLE 2-4: MAJOR SPACE PROGRAMS/SYSTEMS IN THE 1990-2110 MHz AND 2200-2290 MHz BANDS

| Program/System | Uplink Freq. (MHz) | Dnlink Freq. (MHz) | Launch Date | Opn. Life (Yrs) [a] | Current Investment (Billions) [b] | Planned Investment (Billions) [c] |
|---|---|---|---|---|---|---|
| Geostationary Operational Environmental Satellite | 2025-2035 | 2200-2290 | 1990-2010 | 5 | 2.0 [d] | 3.9 |
| Landsat | 2106.4 | 2287.5 | 1999 | 6 | 0.8 [f] | 0.9 [f] |
| Polar-orbiting Environmental System | 2026 | 2247.5 | 1998-2007 | 3 | 2.0 | 6.4 |
| Tracking & Data Relay Satellite System | 2025-2120 | 2200-2300 | 1983-2000 | 15 | 2.6 | 4.4 |
| National Space Transportation System | 2025-2120 | 2200-2300 | On-going | 10 | 19.2 | 36.0 |
| Hubble Space Telescope System | 2106.4 | 2255.5 & 2297.5 | 1990 | 15 | 3.9 | 4.2 |
| International Space Station | 2025-2118.7 | 2200-2290 | 1998 | 15-20 | 10.4 | 21.3 |
| Earth Orbiting Scientific Satellites | Not Available | Not Available | 1999-2006 | 5 | 2.6 | 6.6 |
| Spaceflight Tracking & Data Network | 2025-2120 | 2200-2300 | Ground based | Indef.[e] | 1.8 | 2.0 |
| Deep Space Network | 2025-2120 | 2200-2300 | Ground based | Indef. | 1.6 | 1.8 |
| TOTAL | | | | | 46.35 | 87.5 |

[a] Operational life expectancy of a space system, in years. Most satellites can be expected to operate beyond their design or operational life.
[b] Investment to-date in FY 1998 dollars.
[c] Total current and projected investment over mission life.
[d] Cost is for the current 5 GOES satellites only.
[e] Indefinite
[f] This is the cost for Landsat 7 only.

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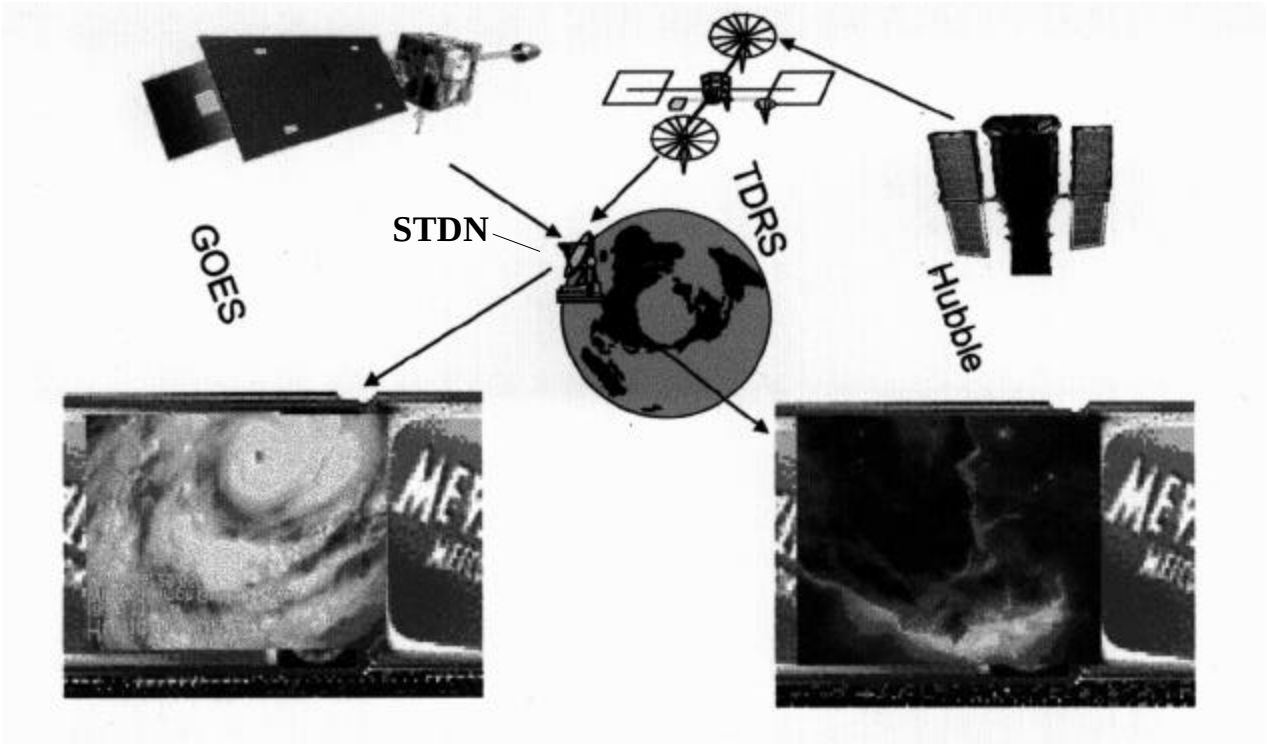
Weather Images

Scientific Data




The NOAA GOES system provided opportunity for scientists to examine data and follow-up on hurricanes and other natural disasters.

The NASA Hubble Telescope system provided scientist with valuable data on the Super Nova.

Note: 1) Communications links are in the 2025-2110 MHz and 2200-2200 MHz bands.

2) For simplicity, the figure does not depict interaction between major and other space systems.

**Figure 2-5.**
**Benefits and data transfer from space systems to the end users**.

It is important to note that these earth stations transmit to NASA and NOAA satellites at quite a high equivalent isotropically radiated power (EIRP). Typically, the transmitter power levels employed exceed the multi-kilowatt levels and, in the case of the Goldstone, California site, can be as high as 500 kilowatts. As a result, the areas around the earth stations within which interference can be caused to other shared services is quite large as seen in Annexes A-1 through A-15. Thus, any sharing situation proposed for this band must consider this radio frequency interference (RFI) potential.

## 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 provide timely, high resolution weather data over North and South America, and the collection and dissemination of meteorological data. At present NOAA operates GOES-8 and GOES-10 located at the orbital positions $75^0$ West and $135^0$ West longitudes, respectively. NOAA recently replaced the faulting GOES-9 with GOES-10, an orbiting spare, moving it from its stored location at $105^0$ West longitude.

GOES satellites receive command and processed data uplinks from the NOAA command and data acquisition (CDA) facility at Wallops Island, Virginia using frequencies in the 2025-2035 MHz band. The processed data are distributed to client weather facilities located throughout the United States and possessions. Present budgetary plans identify GOES-L and GOES-M, and subsequent series, GOES-N, -O, -P, and -Q, to use the same uplink frequency band at 2025-2035 MHz ***through the year 2015.*** In addition, NOAA to is developing a backup GOES CDA facility which will also use the 2025-2035 MHz band for command uplink transmissions. This CDA facility will be at Goddard Space Flight Center (GSFC) in Greenbelt, Maryland and will consists 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.

## Landsat System

Currently, the Landsat system is composed of Landsat 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[9]. Landsat 7 is scheduled for launch in late March 1999, and is designed for a six year mission life.

[9] Facsimile form Jim Ellickson, NOAA Landsat 7 Manager, NASA, to Ernie Cerezo, NTIA, Subject Landsat 5/7 Mission, (September 10, 1998).

## TABLE 2-5: OTHER FEDERAL GOVERNMENT SPACE PROGRAMS IN THE 2025-2110 MHz BAND

| Space System/Agency | Uplink Freq. (MHz) | Dnlink Freq. (MHz) | Launch Date | Opn. Life (Yrs) [a] | Description/Function |
|---|---|---|---|---|---|
| PIONEER/NASA [b, c] | 2110-2120 | 2290-2300 | 1965-1978 | Indef. | Provide data from planetary encounters and comet observation. |
| VOYAGER/NASA [c] | 2110-2120 | 2290-2300 | 1977 | Indef. | Provide data from planetary encounters. |
| Earth Radiation Budget/NASA | 2106.4 | 2287.5 | 1984 | 14+ | Study processes related to Earth's climate. |
| ISEE/NASA | 2040 | N/A | 1985 | N/A | This is a high Earth-orbit system that studies solar physics. |
| San Marco D/L/NASA | 2025-2110 | 2200-2290 | 1988 | N/A | Investigate charged and neutral particles. |
| Galileo/NASA | 2025-2110 | 2290-2300 | 1989 | 10+ | Study atmosphere, magnetosphere and satellites of Jupiter. |
| Cosmic Background Explorer/NASA | 2106.4 | 2287.5 | 1989 | N/A | Explore and study diffuse radiation of cosmic origin. |
| Gamma Ray Observatory/NASA | 2106.4 | 2287.5 | 1990 | 6+ | Study various sources of gamma rays (Leo System). |
| Upper Atmosphere Research/NASA | 2106.4 | 2287.5 | 1991 | N/A | Perform extensive studies of the properties of the Earth's upper atmosphere between 20 km and 120 km. |
| Extreme Ultraviolet Explorer/NASA | 2106.4 | 2287.5 | 1994 | 2+ | Surveys the entire celestial sphere in extreme ultraviolet spectrum. |
| MICROLAB /NASA | 2092.59 | 2272.5 | 1994 | 4+ | Circular orbit-optical transient detector. University Corporation for Atmospheric Research |

[a] Operational life expectancy of a space system, in years. It should be noted that most satellites can be expected to operate well beyond their design or operational life if proper and sufficient station keeping is accomplished. Where there is a plus sign next to the number of years, this implies that the operation is still continuing or could be activated in the future.

[b] NASA is still communicating with PIONEER

[c] This system has the capability to operate at the edge of the band and uses a wide bandwidth which goes below 2110 MHz.

## TABLE 2-5: OTHER FEDERAL GOVERNMENT SPACE PROGRAMS IN THE 2025-2110 MHz BAND (Con't)

| Space System/Agency | Uplink Freq. (MHz) | Dnlink Freq. (MHz) | Launch Date | Opn. Life (Yrs) [a] | Description/Function |
|---|---|---|---|---|---|
| SEA WIFS (SeaStar)/NASA | 2025, 2093.054 2090.59 | 2287.5 | 1994 | 10 | Provide measurable data to enable calculations of the viability of ocean chlorophyll. |
| X-Ray Timing Explorer/NASA | 2106.4 | 2287.5 | 1995 | 5 | Study X-ray sources. |
| HETE/NASA | 2092.133 | 2272.5 | 1995 | 3+ | Measures Ultraviolet, X-ray and Gamma radiation. |
| Mars Pathfinder/NASA | N/A | N/A | 1996 | 2+ | Study Mars surface and launch support. |
| Mars Global Surveyor/NASA | N/A | N/A | 1996 | 2+ | Surveys the planet Mars. |
| TOMS - EP/NASA | 2087.5-2095 | N/A | 1996 | 4 | Free flying spacecraft and the total ozone mapping spectrometer instrument |
| CRAF - Cassini/NASA | 2040-2097 | 2298.33-2299.074 | 1997 | 11 | Interplanetary mission. |
| TRMM/NASA-NASDA | 2076.94 | 2255.5 | 1997 | 3 | Integral part of the mission to Planet Earth Program under Earth probe series. |
| SNOE (STEDI)/NASA | 2092.96 | 2272.9 | 1997 | 2+ | Measure Nitric Oxide in terrestrial lower atmosphere and inputs from Sun and magnetosphere. |

[a] Operational life expectancy of a space system, in years. It should be noted that most satellites can be expected to operate well beyond their design or operational life if proper and sufficient station keeping is accomplished. Where there is a plus sign next to the number of years, this implies that the operation is still continuing or could be activated in the future.

## TABLE 2-5: OTHER FEDERAL GOVERNMENT SPACE PROGRAMS IN THE 2025-2110 MHz BAND (Con't)

| Space System/Agency | Uplink Freq. (MHz) | Dnlink Freq. (MHz) | Launch Date | Opn. Life (Yrs) [a] | Description/Function |
|---|---|---|---|---|---|
| ACE/NASA | 2097.9806 | 2278.35 | 1997 | 5 | Determine and compare the element and isotropic composition of several distinct samples of matter. |
| EQUATOR - 2/NASA-DARA * | 2284.5 | 2103.6 | 1997 | 2+ | High resolution plasma, magnetic and electric field measurements. |
| AXAF - 1/NASA | 2071.875 | 2250 | 1998 | 10 | Study the universe age and size. |
| FUSE/NASA | 2065-2072.5 | 2249 | 1998 | 5 | Obtain high resolution spectrum in far ultraviolet wavelength |
| Polar-Orbiting Satellite/NOAA | 2026.0 | 2247.5 | 1998 | 3 | Collecting weather information and climatology. |
| HELIOS-1A & 1B/NASA-ESA* | 2022-2040 | 2200-2220 | 1994/1A<br>1999/1B | 5<br>5 | Polar-orbiting remote sensing data. |
| MAP-MIDEX/NASA | 2035-2042.5 | N/A | 1999 | 2 | Conduct space sciences investigation in Explorer Program using scientific payloads. |
| Medium-Class Explorer (MIDEX)/NASA | N/A | N/A | 1999 | N/A | Three-dimensional imaging techniques to study the global responses of the Earth's magnetosphere to variation in solar winds. |
| Microwave Anisotropy Program (MAP)/NASA | 2090.66 | 2270.42 | 2000 | N/A | Probe conditions in the early universe measuring temperature difference in cosmic microwaves. |
| CLUSTER/NASA | 2077.4 | 2256 | 2000 | N/A | N/A |
| Gravity Probe-B/NASA | 2102.5-2110 | 2287.5 | 2000 | 1.5 | Directly measures the motion of local inertial space with respect to distant inertial space. |

*** Legend:** **ESA- European Space Agency** **NASDA- Japanese Space Agency** **DARA- German Space Agency**

[a] Operational life expectancy of a space system, in years. It should be noted that most satellites can be expected to operate well beyond their design or operational life if proper and sufficient station keeping is accomplished. Where there is a plus sign next to the number of years, this implies that the operation is still continuing or could be activated in the future.

Landsat 7 will continue a 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 operated by 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 2106.4 MHz for uplink 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.[10]

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 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.[11] Construction of three new antenna systems have been completed at Fairbanks, AK to support the polar-orbiting environmental satellites.

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

[11] *Id.*

## Tracking and Data Relay Satellite System (TDRSS)

The TDRSS is a NASA system developed to reduce the cost and improve the efficiency of returning spacecraft-gathered scientific data to Earth. In addition, real-time coverage low earth-orbit (LEO) satellites can be provided on a more complete basis, as compared to the previous network of U.S. earth stations which can support a given space mission for about 15 percent of the time due to visibility constraints. The TDRSS was principally designed to provide communication links between LEO spacecraft, including the Space Shuttle, and earth stations via geostationary satellites. It is an integral part of NASA's Spaceflight Tracking and Data Network (STDN).

The TDRSS at full operation can track up to 26 satellites at a time and will consist of six geostationary tracking and data relay satellites (TDRS); five operational satellites located at $41^0$ West, $62^0$ West, $79^0$ West, and $171^0$ West longitudes and one in-orbit spare; and an earth station at White Sands, New Mexico. The first satellite, TDRS-East or TDRS-1, was launched in 1983 and positioned at $41^0$ West longitude. A second satellite was lost with the Space Shuttle Challenger in 1986, but was replaced. In 1988, TDRS-3 was launched and placed at $171^0$ West longitude to work in tandem with TDRS-1. The TDRS-3 allows mission control to stay in near-continuous contact with the Shuttle crews and other low-orbit satellites. Because of the importance in improving communications with future Shuttle crews, NASA launched another satellite (TDRS-4) in 1989. Described as the most complex non-military communications satellite, the 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 to enhance its capacity with the increase in the number of satellites ($46^0$ West and $174^0$ West) and the addition of a second earth station at White Sands, NM. Again, in 1992, NASA requested the Spectrum Planning Subcommittee (SPS) of the IRAC for two more additional geostationary orbit location for TDRSS ($107^0$ West and $85^0$ East) as a response to the technical difficulties with the Gamma Ray Observatory (GRO) satellite regarding data transfer and planned to move one of the earth stations at White Sands, New Mexico to Guam. All of these added TDRSS and earth station will use the 2025-2120 MHz and 2200-2300 MHz bands. A follow-on TDRSS, consisting of TDRS-H, I and J, is pending approval for operational use by 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. All follow-on TDRSS satellites will require access to the 2025-2110 MHz band for their orbital lifetimes.

## TABLE 2-6: CURRENT FOREIGN SPACE PROGRAMS BEING SUPPORTED BY THE UNITED STATES

| Space Programs/ Administration or Space Agency | Uplink Freq. (MHz) | Dnlink Freq. (MHz) | Launch Date | Opn. Life (Yrs)[a] | Description/Function |
|---|---|---|---|---|---|
| ROSAT/DARA | 2096.27 | 2276.5 | 1990 | N/A | Study individual X-ray & perform general X-ray survey. |
| TOPEX-Ocean Topography Experiment-Poseidon/CNES | 2040.943 | 2215.922 | 2000 | 5 | Joint U.S./France mission for oceanographic data collection. JASON is a follow-on to TOPEX. |
| ADEOS-2/NASDA-NASA | 2027.5-2102.5 | N/A | 1996 | 6 | N/A |
| SPOT (SPOT 4&5)/CNES | 2027.5-2080 | N/A | 1998 | 5 | Earth observation and development qualification of a multi- mission platform. |
| COMETS/NASDA | 2075 | 2295.5 | 1995 | 5 | Commercial experiment transporter. |
| METOP/EUMETSAT | 2050-2057.5 | 2230 | 2003 | 3-5 | Polar-orbiting meteorological system that will function with future NOAA NPOESS system. |
| RADARSAT -1A/Canada | 2053 | 2130 | 1995 | 6 | Radar survey of Antarctica. |
| International Solar Terrestrial Physics-SOHO/ESA, Japan | 2065-2095 | N/A | 1995 | 2.5+ | Collaborative solar-terrestrial research. |

**Legend:**

**EUTELSAT- European Telecommunication Satellite**
**EUMETSAT- European Meteorological Satellite**
**DARA - German Space Agency**
**ESA - European Satellite Agency**
**CNES - National Space Agency of France**
**NASDA - Japanese Space Agency**

[a] Operational life expectancy of a space system, in years. It should be noted that most satellites can be expected to operate well beyond their design or operational life if proper and sufficient station keeping is accomplished. Where there is a plus sign next to the number of years, this implies that the operation is still continuing or could be activated in the future.

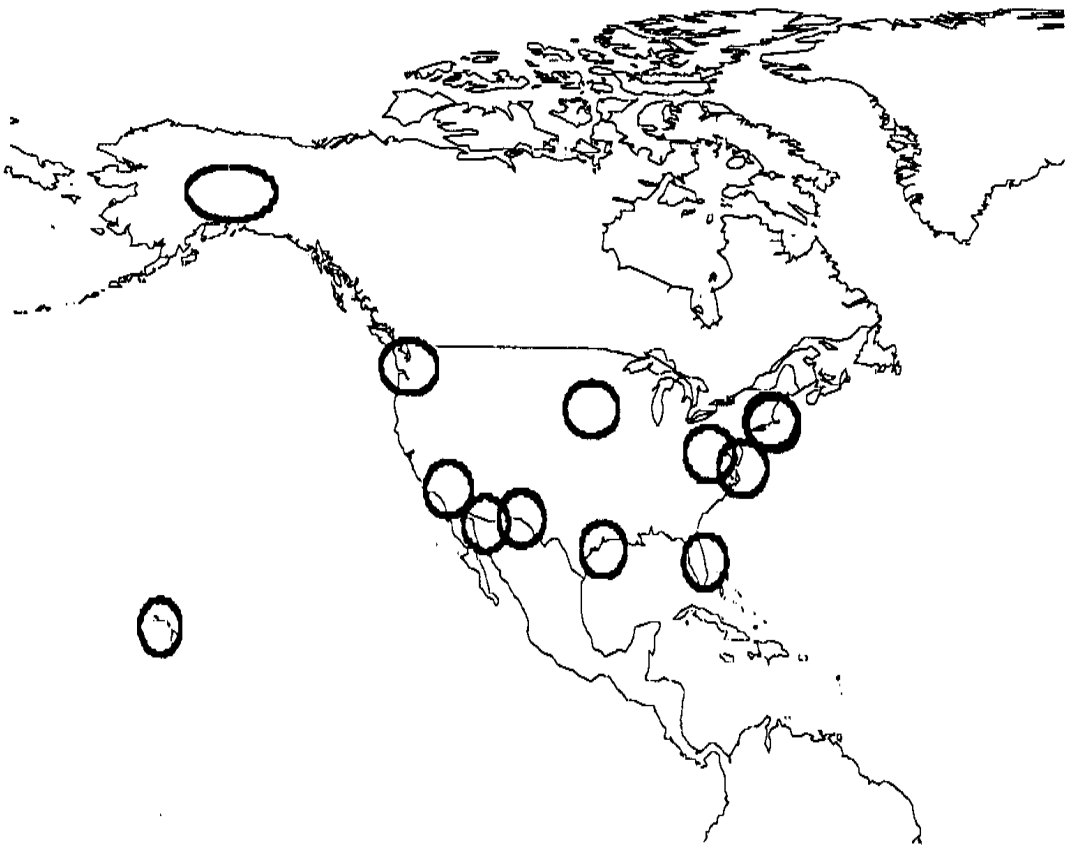
## TABLE 2-6: CURRENT FOREIGN SPACE PROGRAMS BEING SUPPORTED BY THE UNITED STATES (Con't)

| Space Programs/ Administration or Space Agency | Uplink Freq. (MHz) | Dnlink Freq. (MHz) | Launch Date | Opn. Life (Yrs)[a] | Description/Function |
|---|---|---|---|---|---|
| SAC-B/Argentina-CNES | 2076.9 | 2255.5 | 1996 | 3+ | Observe solar flares with instrument to measure the X-ray time profile of gamma ray burst. |
| HOTBIRD3,4,&5/ EUTELSAT | 2090.51 | 2270.58 | 1998 | 12 | N/A |
| ISO/ESA | 2087.6 | 2266.5 | 1995 | 2+ | Provide spectroscopic, photometric imaging and polarimetric observations. |
| LUNAR -A/NASDA | 2081.1 | 2059.91 | 1999 | 1+ | Launch and early orbit-trans lunar. |
| STRV-1A &1B/ United Kingdom | 2093.75 | 2273 | N/A | N/A | N/A |
| ULYSSES/ESA | 2111.6072 | 2293.1481 | 1990 | N/A | Formal ISPM sun and polar orbit (EOL still working). |
| DORIS/CNES | 2036.25 | 401.25 | N/A | N/A | Beacon earthquake-tracking polar orbit. |
| PEACESAT/Pacific Countries | 2025-2033 | 1683-1691 | N/A | N/A | Uses GOES-3 Satellite. Department of Commerce experiment on cultural and educational ventures. |

**Legend:**

**EUTELSAT - European Telecommunication Satellite**
**EUMETSAT- European Meteorological Satellite**
**NASDA - Japanese Space Agency**
**ESA - European Satellite Agency**
**CNES - National Space Agency of France**

[a] Operational life expectancy of a space system, in years. It should be noted that most satellites can be expected to operate well beyond their design or operational life if proper and sufficient station keeping is accomplished. Where there is a plus sign next to the number of years, this implies that the operation is still continuing or could be activated in the future.



Note: 1) The figure only illustrates the general sites of the earth stations in the United States.

2) The circles do not represent the interference areas, an interference coordination contour is provided for each of the earth station in annexes A-1 through A-15.

**Figure 2-6.**
**A pictorial representation of existing NASA and NOAA earth stations in the United States.**

## Spaceflight Tracking and Data Network (STDN)

NASA operates and maintains a worldwide system of ground stations to provide tracking, telemetry, and command 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.

### TABLE 2-7: NASA AND NOAA EARTH STATION SITES

| Site | Agen. | Lat.º (North) | Long.º (West) | Site | Agen. | Lat.º (North) | Long.º (West) |
|---|---|---|---|---|---|---|---|
| Goldstone, CA | NASA | 35.34 | 116.92 | Wallops Is. VA | NOAA | 37.95 | 075.46 |
| Merritt Is., FL | NASA | 28.51 | 080.69 | Fairbanks, AK | NOAA | 64.97 | 147.52 |
| STGT, NM | NASA | 32.54 | 106.61 | Honolulu, HI | NOAA | 21.35 | 157.88 |
| WSGT, NM | NASA | 32.50 | 106.61 | Sioux Falls, SD | NOAA/ DOI | 43.53 | 096.76 |
| Houston, TX | NASA | 29.54 | 095.06 | Seattle, WA | NOAA | 47.57 | 122.55 |
| Kitt Peak, AZ | NASA | 31.95 | 111.62 | Greenbelt, MD* | NOAA | 39.00 | 076.84 |
| Westford, MA | NASA | 42.62 | 071.49 | | | | |
| Fairmont, WV | NASA | 39.26 | 080.11 | | | | |
| Boston, MA | NASA | 42.35 | 071.11 | | | | |
| Chantilly, VA | NASA | 38.89 | 080.69 | | | | |
| Poker Flats, AK | NASA | 63.13 | 147.51 | | | | |

**Legend:**
**Agen. - Agency**
**Lat. - Latitude**
**Long. - Longitude**
**STGT - Second TDRSS Ground Terminal**
**WSGT - White Sands Ground Terminal**
*** - Future GOES earth station**

The earth stations operating at eight locations around the world comprise the Ground Spaceflight Tracking and Data Network (GSTDN). These earth stations usually track spacecraft during launch, sub-orbital phases, and in-orbit. Three of the GSTDN ground stations located at

Goldstone, California; Madrid, Spain; and Canberra, Australia, provide primary support for high and synchronous orbit spacecraft and for the eccentric orbit spacecraft. A fourth GSTDN ground station at Fairbanks, Alaska, supports existing Earth-orbiting spacecraft which are not compatible with TDRSS. Launch support facilities are located at Merritt Island, Florida. The Vandenberg facility is operated by the AF for West Coast launches, while Wallop Island, Virginia, will continue to support a limited number of orbiting research satellites.

## Deep Space Network (DSN)

NASA's DSN facilities consist of earth stations located in Spain, Australia and in the United States at Goldstone, California. One technical characteristic that makes these earth stations very different from other earth stations is that they employ very high-powered transmitters (see Annex A-1 for the coordination contour for Goldstone).

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 to terrestrial services. Normally, DSN uplink operations are conducted in the 2110-2120 MHz but for some missions, especially during emergencies such as when contact with a mission spacecraft is lost, the 2025-2110 MHz band can be utilized in order to command the errant spacecraft.

These DSN facilities support deep space missions using 26-, 34-, 64-, and 70-meter antennas and augment NASA's GSTDN and the Air Force's Space Ground Link Subsystem (SGLS) for certain other missions. In addition, the DSN supports a wide variety of exploration spacecraft and research missions.

## National Space Transportation System (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 could deliver satellites to low-Earth orbit where an upper stage rocket could be used to boost them into a higher-energy orbit. In addition to this launch capability, the Shuttle also carries spacelab payloads, modules, and pallets used to conduct in-orbit experiments from the cargo bay. Five reusable orbital vehicles comprise the Shuttle fleet with flights beginning in the early 1980's.

The 2 GHz communication links for the Shuttle are shown in Figure 2-7. The primary links of interest are the ones emanating to and from the NASA payload, STDN earth station, the TDRSS and the Space Shuttle. Note that the bands 2025-2120 MHz and 2200-2300 MHz are always paired

in these links. Not shown in the link diagram is the NASA payload communicating with STDN and TDRSS and vice-versa also at 2025-2120 MHz and 2200-2300 MHz bands.

## Hubble Space Telescope (HST) System

Launched by the Space Shuttle in 1990, the HST is the first complete observatory in space and will have 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 at 2106.4 MHz, whereas housekeeping and some research telemetry data are transmitted by the telescope on 2287.5 MHz and wideband data near 2255.5 MHz on several discrete frequencies. All communications to and from the HST will be through the TDRSS.

## International Space Station (ISS)

When fully operational, the ISS will be a multi-purpose facility which will provide the United States 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 Federal Government use, the ISS will also be available for non-government and foreign activities.

When the various space station elements are finally assembled, the main platform, or core, will occupy a low-Earth orbit inclined at $51.6^0$. 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 $98^0$ . 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. The 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.

## FUTURE SPACE PROGRAMS/SYSTEMS in the 2025-2110 MHz BAND

Enumerated in Table 2-8 are NASA's and NOAA's future space programs/systems. 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. As discussed earlier, NASA's TDRSS H, I, and J will soon be operational and, in the near future, the ISS or at least the first few components of the ISS will be launched. In addition, NOAA's Landsat 7 and GOES series will soon be also launched. Note that, NOAA has indicated that the GOES, specifically the continuation series, will still be operational by the year 2015.

There are over 260 existing and planned worldwide satellite systems in the 2025-2110 MHz band. A complete listing of these worldwide space satellite systems is shown in Annex B. The annex was derived from NASA's data base, as of 1997, which is a compendium of data from the ITU and other sources. Some of the space systems listed in Annex B are still being coordinated or under notification process within ITU (e.g., NASA's TDRSS H, I, and J, EOS Systems) The listing includes the space program or satellite nomenclature and the respective operating administration. Included in this listing are existing and future United States space systems.

## TABLE 2-8: FUTURE NASA AND NOAA SPACE PROGRAMS/SYSTEMS IN THE 2025-2110 MHz BAND [a]

| SPACE PROGRAMS/SYSTEMS | # of Satellites | Launch Date |
|---|---|---|
| ASTRONOMY (ASTRO) | 2 | 2000 & 2003 |
| CLUSTER | 2 | 2000 |
| EARTH OBSERVING SYSTEM (EOS) | 7 | 1999-2006 |
| ENGINEERING TEST SATELLITES VIII (ETS-VIII) | 1 | 2001 |
| INTEGRAL | 1 | 2001 |
| LONG DURATION BALLOON PROGRAM (LDBP) | 1 | on-going |
| MEDIUM CLASS EXPLORER MISSIONS (MIDEX-03) | 8 | 2000-2008 |
| NPOESS [b] | 4 | 2007-2025 |
| SATELITE de APLICACIONES CIENTIFICAS (SAC-C) [c] | 1 | 1999 |
| SMALL EXPLORER MULTI-MISSION PROJECT (SMEX) | 7 | 2004-2010 |
| STARLINK | 1 | on-going |
| X-RAY MEASURING MISSION (XMM) | 1 | 1999 |
| INTERNATIONAL SPACE STATION | 1 | 1999 |
| TDRSS H, I, & J | 3 | 1999 |
| LANDSAT 7 | 1 | 1999 |

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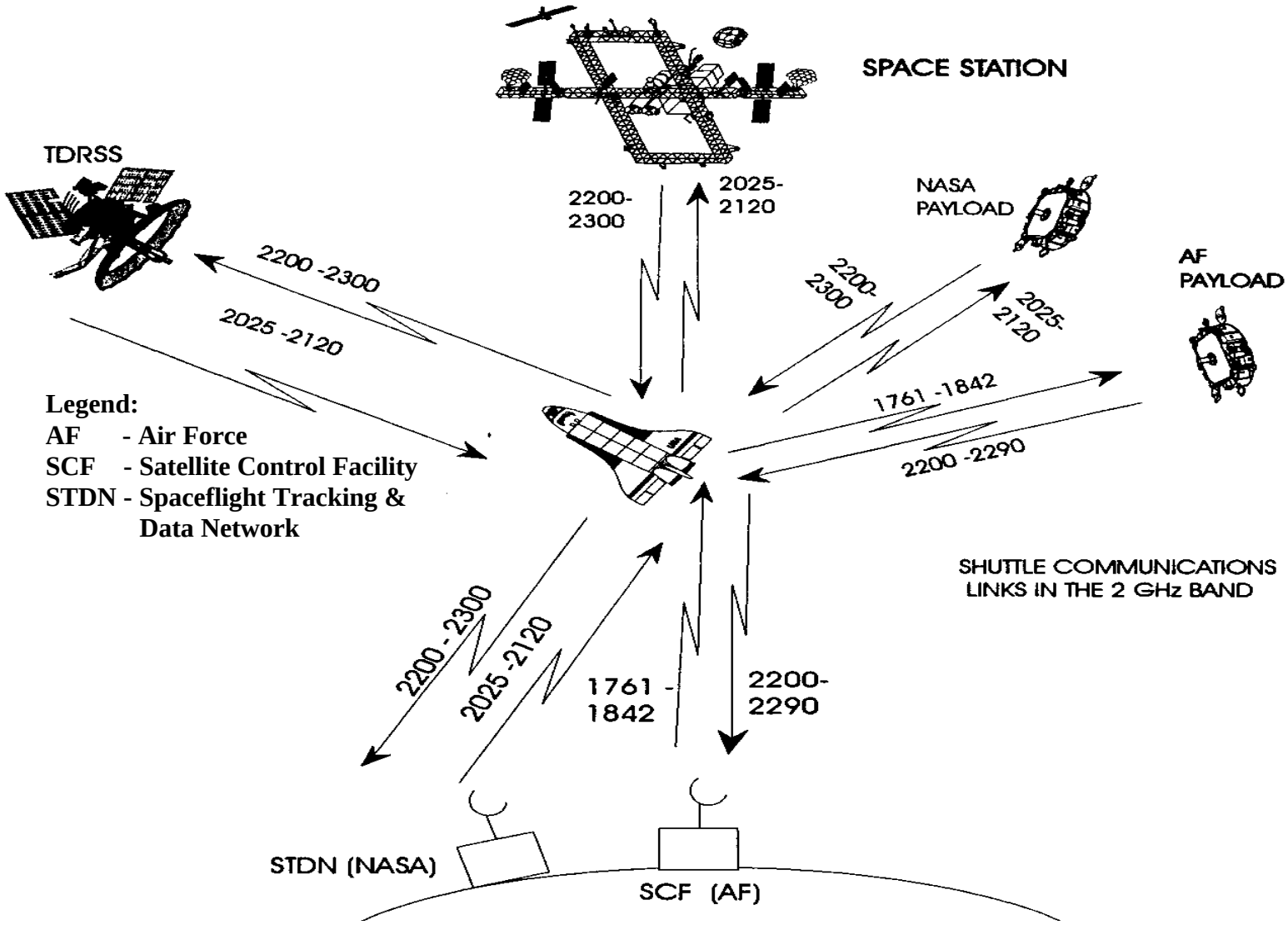
[a] The downlink frequency band for these systems will be in the 2200-2290 MHz band
[b] National Polar-orbiting Operational Environmental Satellite System
[c] This will be a space joint venture between NASA and Argentina




Note: NASA payloads also communicate with STDN and TDRSS at 2025-2110 MHz and 2200-2300 MHz bands.

**Figure 2-7: Communication links between the Space Shuttle and some of the space systems.**

# SECTION III
# RADIO SPECTRUM ISSUES IN THE 1990-2110 MHz BAND

## INTRODUCTION

This section discusses domestic issues and international agreements dealing with radio spectrum in the 1990-2110 MHz band. Investment costs, as they relate to spectrum issues, are also discussed. Domestic issues encompass those emanating from the Office of the President, the Congress, the FCC, and, by in large, the public. Examples would be those spectrum issues contained in the Balanced Budget Act of 97, which was signed into law by the President and adopted by Congress on August 8, 1997, that are currently being address by both the FCC and NTIA. Other examples are issues introduced in the Commission's published FNPRM regarding the allocation of the 1990-2025 MHz to the MSS. In part, the FCC initiated and acted on the FNPRM because of the private sector's requests for MSS spectrum in the 2 GHz band.

International agreements or treaties include, but not limited to, those that were adopted by the ITU and its study groups and those bilateral or multi-lateral treaties in the United States is a signatory. International agreements, treaties and obligations are usually tied to domestic policy matters. As such, they must be considered if spectrum auctions are to be viable because they affect the potential for new radio services in and outside the United States.

## NATIONAL ISSUES

The FCC released the FNPRM to the public for comments on the proposed allocation of spectrum at 2 GHz for use by the MSS, on 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 plan, FCC proposed to modify the current BAS, CARS, and LTTS 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.

Another domestic issue in this band is NASA's petition to the Commission. NASA through 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 U.S. Table of Frequency Allocation in line with that of the international allocation where the space science services are afforded primary status worldwide[12,13] (*see* Annexes C, D, and E).

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[12] Letter from David Struba, IRAC Representative, NASA, to William Gamble, IRAC Chairman, NTIA, (July 19, 1996).

[13] 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 Annex E).

# SECTION III
# RADIO SPECTRUM ISSUES IN THE 1990-2110 MHz BAND

## 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 world radiocommunication conferences or signed a bilateral or multi-lateral 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 define 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 in regard to providing support to each other's satellite programs/systems 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 the GOES project when earlier GOES satellites failed prematurely. Also, NOAA, under international agreement will provide orbital support to the Meteorological Operational (METOP) system, a European satellite that will become part of the future National Polar-orbiting Operational Environmental Satellite Systems (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 (dual-frequency altimeter, microwave radiometer, laser retro reflector array, and Global Positioning System (GPS) receiver), while CNES provides the Ariene launch and the Poseidon sensors (solid-state altimeter and DORIS tracking system receiver).

At times, agreements only involve the use of geographic areas 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.

In previous world conferences, the United States 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 in which the United States played a key role in the negotiation processes 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. 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 a date of entry into force on January 1, 2005. Prior to the WRC-95, however, a 10 MHz portion of the 1980-2010 MHz band (i.e., the 1980-1990 MHz band) was reallocated to the Personal Communications Services (PCS) in the United States. As a consequence, 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 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. These resolutions were adopted.

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. These proposals ensure that there would be compatible operations between MSS and other radio services. Further, the 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 allocations 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* Annex E).[14] NTIA's petition attempts

[14] *Id.*

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. For example, the United States has negotiated NASA's rights of use in the 2 GHz band for over 35 years at five international conferences. 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 three sharing recommendations (ITU-R SA.1154, ITU-R F.1247, and ITU-R F. 1248) 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.

### Recommendation ITU-R SA.1154

Recommendation ITU-R SA.1154 specifically addresses the 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. This recommendation sets forth the levels of acceptable interference to the stations in the space science services from the emissions of mobile system. 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 (SR), space operation (SO) and Earth exploration-satellite (EES) services (collectively, space science services) operating in the bands 2025-2110 MHz and 2200-2290 MHz bands. This recommendation considers, among other things, that space science 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.

### Recommendation ITU-R F.1248

This recommendation 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. It considers some issues that include the difficult sharing conditions with trans-horizon radio-relay systems and urges administrations to keep to a minimum the number of trans-horizon systems in certain bands, including the bands 2025-2110 MHz and 2200-2290 MHz, and that limits on the emissions of trans-horizon radio relay systems are required to prevent harmful interference to space science services operating in these bands.

### 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 supported by the United States at the WRC-97 was the suppression of Resolution 711. This resolution describes the possible reallocation of frequency assignments to certain space missions from the 2 GHz band to bands above 20 GHz. This is because of the wealth of study that has taken place since WARC-92 which indicated that the spectrum around 2 GHz, including the 2025-2110 MHz band, is required for satellite use.

## OTHER INTERNATIONAL AGREEMENTS

In addition to 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 worldwide use of the 2025-2110 MHz band. For example, this band has been adopted by civil space agencies worldwide as the primary space uplink communications band. Some of the more current and significant agreements are listed in Table 3-1. Table 3-1 includes a brief description of each.

## TABLE 3-1: 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 the 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: SO, EES, & SR, 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. 622 (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 | SFCG | Limitations on Earth-space link power levels. |
| Res.14-2 R1 | SFCG | Protection of space science services from FS interference in the bands 2025-2110 and 2200-2290 MHz. |

## 15 MHz REALLOCATION IMPACT ON THE 2200-2290 MHz BAND

The 2200-2290 MHz band is the companion downlink band for the 2025-2110 MHz band. Virtually, all the space systems that use the 2025-2110 MHz uplink band also use the 2200-2290 MHz downlink band. NASA specifically uses this band to downlink spacecraft telemetry, and engineering and scientific data to earth stations all over the globe.

There exists a very critical relationship between the uplink and downlink frequency bands used in the 2 GHz bands by NASA and NOAA. In order to acquire and accurately track orbiting spacecraft NASA uses a specific ratio between the up and down links that allows precision doppler tracking of mission range and range-rate information. The frequency band corresponding to the 2025-2110 MHz uplink band is the 2200-2290 MHz downlink band. Almost all mission transponders are designed with this "turn-around ratio" as and integral part of its operation.[15] These transponders, known as Unified S-band (2GHz) transponders, are used on virtually all space science missions because of their low cost, proven reliability, and space qualified nature. The reallocation of 15 MHz in the 2025-2110 MHz band will result in an associated loss of more than 15 MHz of spectrum in the 2200-2290 MHz band for space science use. Figure 3-1 illustrates the bandwidth-use ratio. The figure also shows examples of some frequency pairings between the 2025-2110 MHz and 2200-2290 MHz bands. ***Note that the missions listed and frequency pairings depicted in Figure 3-1 are only a partial indication of frequency use in both bands.***

Moreover, NASA has indicated that, finding new spectrum at the 2200-2290 MHz band to be paired with new frequencies is more difficult than at other bands. This is because of existing congestion in the 2200-2290 MHz band and, more importantly, the complex and sensitive use by the DoD, in particular, the channeling plan of the Air Force's Space Groundlink Subsystem (SGLS). NASA's current spectrum uses in this band have been negotiated with practically all the Federal agencies; especially, the DoD, over the last few decades and has proven to be compatible.

## INVESTMENT/REALLOCATION COSTS

NASA stated that its total current space program investment cost to-date in the 2025-2110 MHz band is about $42 billion and the total current and projected space program investment is about $76 billion.[16] These values only include the cost of the major systems that are listed in Table 2-4 and do not take into account all of the other space programs/systems, both current

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[15] NASA's Working Papers on S-Band Workshop, 2025-2110 MHz and 2200-2290 MHz Bands, Goddard Space Flight Center, July 14-15, 1997.

[16] Facsimile from Wayne Whyte, Spectrum Manager, NASA, to William Hatch, Associate Administrator, Office of Spectrum Management, NTIA, Subject: Replacement and Investment Costs (October 16, 1998).

and future, that are listed in Tables 2-5 and 2-8. The values also do not include the U. S. expenditures associated with joint space ventures with other space agencies. NOAA's total current space program investment in the 2025-2110 MHz band is about $5 billion and about $11 billion in total current and projected space program investment.

NASA provided a Federal system replacement cost estimate of $13 billion for relocation purposes.[17] This estimate, however, could only be a portion to the total Federal relocation costs. Reallocation costs of Federal users of the 2025-2110 MHz band have not been specifically assessed in this report since the over all economic impact of such a relocation is directly a function of the following factors: 1) which 15 MHz portion the band is selected for reallocation; 2) when government operations in this portion of the spectrum must cease; and 3) where in the spectrum, the services which were formerly conducted in this 15 MHz, are to be relocated.

To relocate Federal Government operations from the 2025-2110 MHz band to another band would require at least 15-20 years to implement if one is to consider the following: the impact on existing systems; replacement of systems; and other systems awaiting to be implemented. To try to gauge this overall relocation cost, NOAA, which is dwarfed by comparison to NASA's use of the 2025-2110 MHz and the number of spacecraft systems, provided an estimate of $50-$100 million for ***extra expenditures only*** that are not presently envisioned. This cost does not include the value of existing satellites and CDA facilities, and future systems that are being constructed to operate in the band. NOAA also stated that 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. Further, NASA indicated that, a redesign of the command uplink (2025-2110 MHz band) would be prohibitively expensive at this late date.[18]

Therefore, it is safe to assume that the cost to reallocate 15 MHz from the 2025-2110 MHz band could dramatically increase the current Federal Government investment cost in this band segment. A large portion of the cost will be attributed to: research and development, including detailed design and studies needed to identify alternative uplink band; inflation; and systems' cost. The overall cost for such relocation, which is estimated to be in the billions of dollars, would need to be reimbursed to affected Federal agencies.

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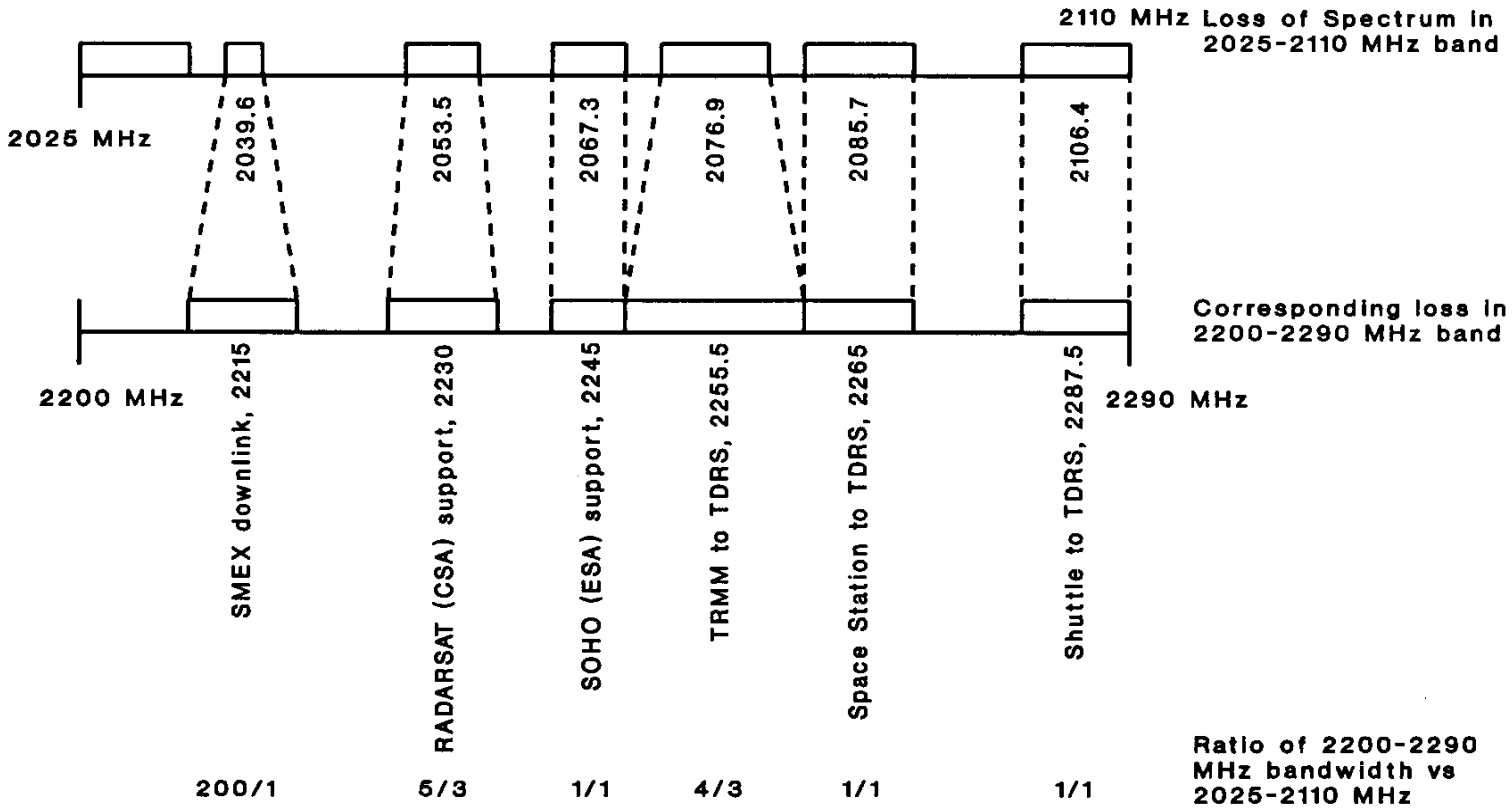
[17] Letter from Wayne Whyte, Spectrum Manager, NASA, to Ernie Cerezo, NTIA. Subject: Federal System Replacement Cost, (November 2, 1998).

[18] NASA/NOAA Briefing Material to OMB on Use of the Spectrum in the 1990-2110 MHz Band, September 30, 1997.




Note: Missions listed and frequency pairings are only a partial indication of actual frequency use in both bands.

**Figure 3-1: An example of frequency pairings in the 2025-2110 MHz and 2200-2290 MHz bands.**

# SECTION IV
# SUMMARY OF THE 15 MHz REALLOCATION IMPACT ASSESSMENT

## INTRODUCTION

The impact assessment for reallocating 15 MHz of spectrum from the 1990-2110 MHz band is predicated on the following five key factors: 1) Federal Government band usage; 2) the major systems, including their critical functions or missions, supported in each of the band segments; 3) international agreements, as well as, national issues relating to the 1990-2110 MHz band or portions thereof; 4) the reallocation impact to other bands; and 5) Federal Government investment/relocation costs. A summary of findings by band segment is presented below.

## SUMMARY OF FINDINGS

### 1990-2025 MHz Band

Nationally, the band segment 1990-2025 MHz is essentially unused by the Federal Government. All the Federal Government authorized frequency assignments in the band are experimental in nature and, therefore, are not afforded EMI protection. There are also no major systems operating in this band segment. As such, the Federal Government's investment in this band is minimal. Reallocation of 15 MHz from this band may not have a direct impact on other bands, but, it could impact the FCC's plan for this band. The FCC, as per ET Docket No. 95-18, wanted this band available for MSS. This plan was set in motion when FCC released the First Report and Order and FNPRM to the public for comments, on 14 March 1997, regarding the allocation of the 1990-2025 MHz to MSS.

Internationally, extensive effort has been expended by the United States negotiating for this band to be allocated for MSS for Earth-to-space transmissions. This effort started before the WARC-92 conference and, finally, at the WARC-92 conference, the frequency bands 1980-2010 MHz and 2170-2200 MHz were allocated to MSS for Earth-to-space transmissions worldwide on a co-equal basis with fixed and mobile services with a date of entry into force on January 1, 2005. Again, at WRC-95, the United States sought for more MSS spectrum because a portion of the 1980-2010 MHz band (i.e., 1980-1990 MHz band) was reallocated to the PCS nationally. As a result, the frequency bands 2010-2025 MHz and 2160-2170 MHz were allocated for MSS in Region 2 on a primary basis.

Also, at WRC-95, the United States supported the adoption of Resolutions 716 and 717. Resolution 716 considers, among other things, that the use of the frequency bands 1980-2010 MHz and 2170-2200 MHz in all three regions and 2010-2025 MHz and 2160-2170 MHz in Region 2 is subject to a date of entry into force of 1 January 2000 or 1 January 2005. In addition, Resolution 716

also considers the MSS allocations to these bands and resolves to facilitate the introduction and future use of the 2 GHz bands by the MSS. Resolution 717 resolves to review the MSS allocations at the 2 GHz bands with a view to harmonize them. Consequently, at the WRC-95, Resolutions 716 and 717 were adopted.

At the recent WRC-97, the United States again introduced proposals to amend Resolutions 716 and 717, and Article S5 with the purpose of finally harmonizing the MSS (Earth-to-space) allocations and the date of entry into force worldwide so that there would be compatible operations between MSS and other radio services. 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.

The United States, being a signatory to previous ITU conferences and other bilateral and multi-lateral treaties with other space agencies, has an obligation to honor adopted international agreements. If the 15 MHz will be reallocated from this band, the future use of this band cannot be guaranteed to be in harmony with the intent of previously adopted international agreements. As such, it could disrupt the implementation of previously adopted international agreements, as well as, those currently being negotiated. Further, it will certainly disrupt FCC's planned activities regarding this band.

## 2025-2110 MHz Band

Of the two band segments discussed, the 2025-2110 MHz band is the most heavily used by the Federal Government, especially for space sciences services. There are more than 200 Federal Government authorized frequency assignments in this band, as of September 1998. The Federal agencies have indicated that this band will even be more populated in the future for space sciences services. NOAA and NASA are the predominant users of the band. NOAA has about 30 frequency assignments, as of September 1998 and, all, virtually support the GOES, Landsat and Polar-orbiting environmental satellites. These assignments also support other administrations' space programs through NOAA's commitment with the WMO and other international organizations.

NOAA's GOES system has primary allocations, via Footnote US222, and operates in the 2025-2035 MHz portion of this band. This system provides vital services to the public. GOES provides meteorological data information that includes, inter alia, various input parameters that are derived from satellite sensor data for numerical weather prediction models. 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 planing, environmental monitoring and assessment. The polar orbiting satellites provide global data to NOAA's short and long-range weather forecasting systems. Specifically, these support the environmental monitoring instruments for imaging, and measurements of Earth's atmosphere, its surface, and cloud cover, including Earth radiation, atmosphere ozone, aerosol distribution and others.

NASA has the most frequency assignments (180 assignments as of September 1998) in this band. NASA is one of the prominent leaders in space research activities worldwide and it is common that it share space research ventures with other foreign space agencies. Hence, some of NASA's frequency assignments are used in support of foreign space missions. Although the U. S. footnotes applicable in this band (except for US 222 granting GOES allocation as co-equal with non-government fixed and mobile services) suggest secondary use by Federal Government, NASA's rights of use has been negotiated by the United States at five international conferences over 35 years and its international allocation, which is primary worldwide, holds treaty status.

The 2025-2110 MHz band was first used by NASA to support the Apollo Program in the 1960's. NASA's frequency assignments in this band support major space programs including, but not limited to the following: Space Shuttle; TDRSS; Hubble Space Telescope; MARS Pathfinder; and, in the near future, the ISS; and others, including GOES and international space programs of foreign space agencies.

The 2025-2110 MHz band has many negotiated international agreements by the United States. Some of the most recent ones are discussed in Section III and listed in Table 3-1. One of the negotiated agreements (ITU-R SA. 1154) concerning this band indicates that space sciences services ***share well with low density communications systems; whereas, high density systems could render this band useless for the space sciences services.*** At the recent WRC-97 conference, the international Footnote S5.391 was modified to state that high-density mobile systems shall not be introduced in this band. Through international negotiations and agreements, this band has been adopted as the primary spacecraft communications band by civil space agencies worldwide that include; Russia, France, United Kingdom, Japan, Germany, Canada, Mexico, ESA, Italy, China, and more than 100 other countries. Thus, the use of this band is coordinated through international organizations like the ITU, SFCG, SNIP, CCSDS, and WMO.

The 2025-2110 MHz uplink band, which is used basically for command and control of spacecraft, has a companion downlink band (i.e., 2200-2290 MHz band). This downlink band is used mainly for telemetry of engineering and scientific data to Earth, and NASA shared this band with virtually all the Federal agencies, particularly with the DoD. NASA has negotiated its current frequency uses in the 2200-2290 MHz band with the DoD over the last few decades. The current frequency pairings between both bands are vital to the successful operations of NASA and other international space systems and have to be maintained because of flexibility constraints in the 2200-2290 MHz band. That is, if portions of the 2025-2110 MHz band will be reallocated, the paired frequencies in the 2200-2290 MHz band will be unusable and finding another set of frequencies in the 2200-2290 MHz band to accommodate NASA's space requirements is essentially next to impossible because of the existing congestion in the band. Further, it could ensue a massive relocation of numerous DoD, as well as other agencies, operations to other bands in order to accommodate NASA in the band.

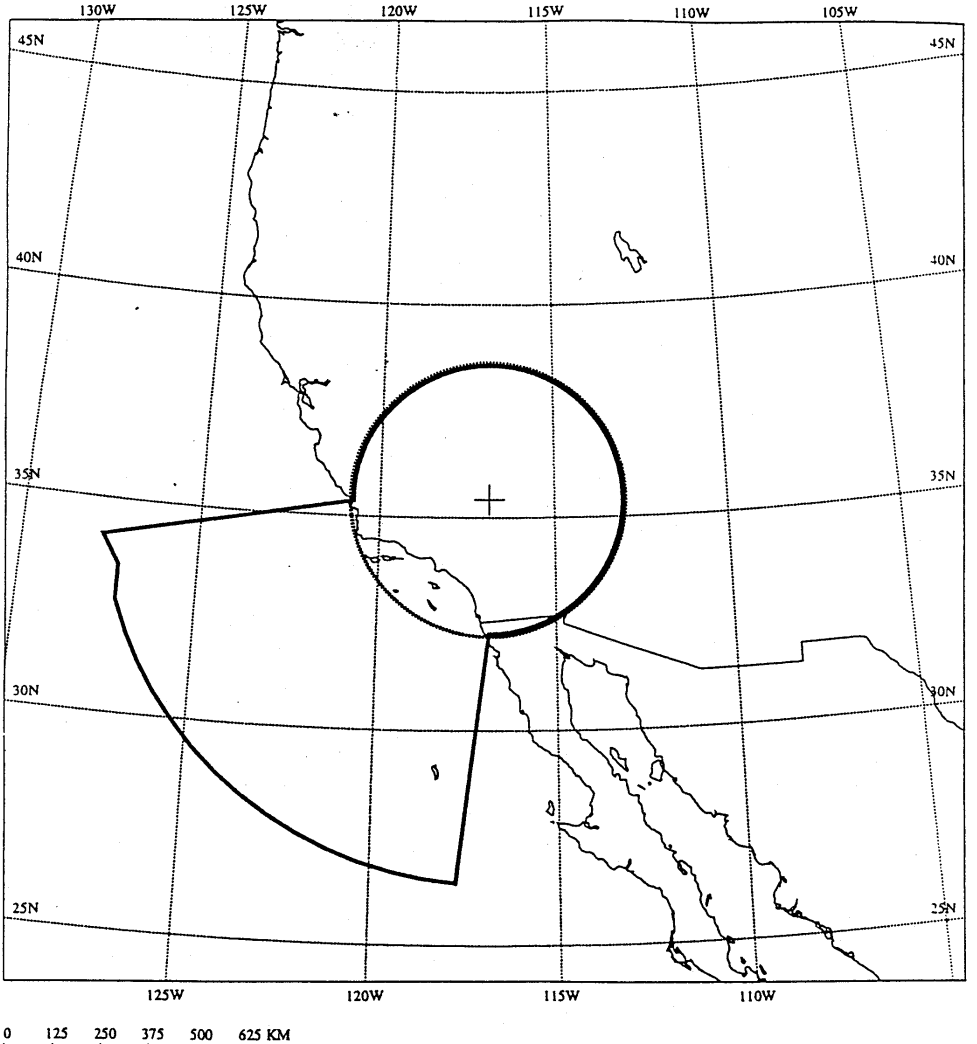
## SECTION IV
## SUMMARY OF THE 15 MHz REALLOCATION IMPACT ASSESSMENT

NOAA and NASA have a combined total current investment of about $46 billion in the 2025-2110 MHz band for their existing spacecraft and satellite systems, along with their respective earth stations. Another $40 billion is invested in new generations of systems currently being developed to operate in this band. Moreover, there could be also substantial investment in foreign space systems because of joint ventures with other administrations.

Reallocating 15 MHz from this band for competitive bidding would: 1) affect numerous NASA and NOAA operations in the space science services, including safety-of-life operations; 2) create uncertainty as to the type of services that will be employed by future FCC licensees but, more likely generate bidding from high-density wireless communications services which are not compatible with space sciences services in this band. Further, convincing the international community to adopt to future United States uses of this band would entail a very laborious and difficult negotiations; 3) severely impact the space operations in the 2200-2300 MHz band; 4) impact NASA's and NOAA's abilities to support national space science directives and fulfill international agreements; 5) dramatically increase the current investment costs in this band because of detailed new studies and designs, inflation and systems' costs, and extra expenditures, including support to joint space ventures with other administrations; 6) create an immeasurable problem for NASA and NOAA as to what band would their space science operations move to, as well as, what will be the corresponding companion or downlink band, and, more importantly, who will pay for the reallocation costs; and 7) potentially compromise the United States abilities to honor and fulfill its international obligations with respect to space science services.

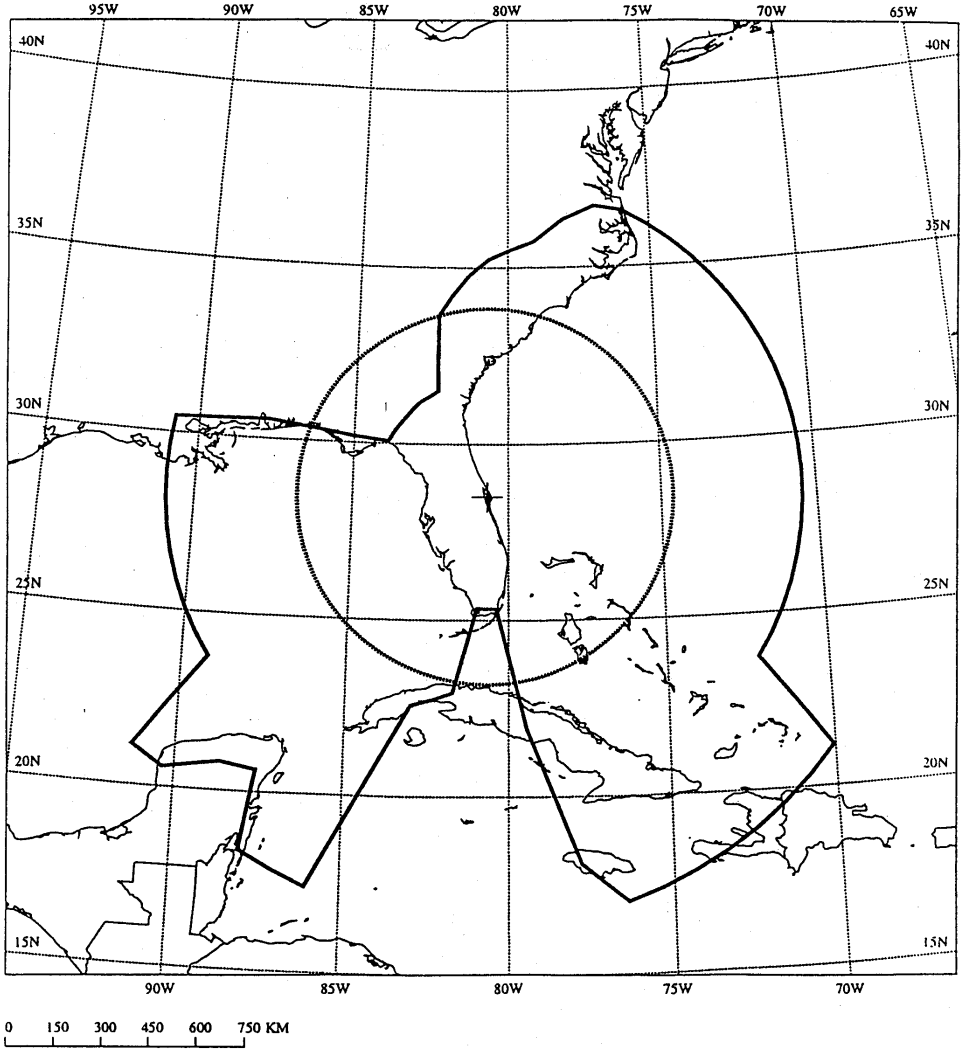
Furthermore, any changes regarding to space operations in the United States because of the reallocation of 15 MHz from the 2025-2110 MHz band have to be coordinated with the international community for compatibility. Especially, to those administrations whose space programs are being supported by the United States or those administrations that have joint space ventures with the United States in this band. Enforcing these changes, however, with foreign space agencies would be very difficult, specifically if the United States would require them to undergo modifications commensurate to any changes in U.S. space systems' operations to maintain compatibility.

# ANNEXES A-1 THROUGH A-15
# COORDINATION CONTOUR OF THE EARTH STATIONS LISTED IN TABLE 2-7

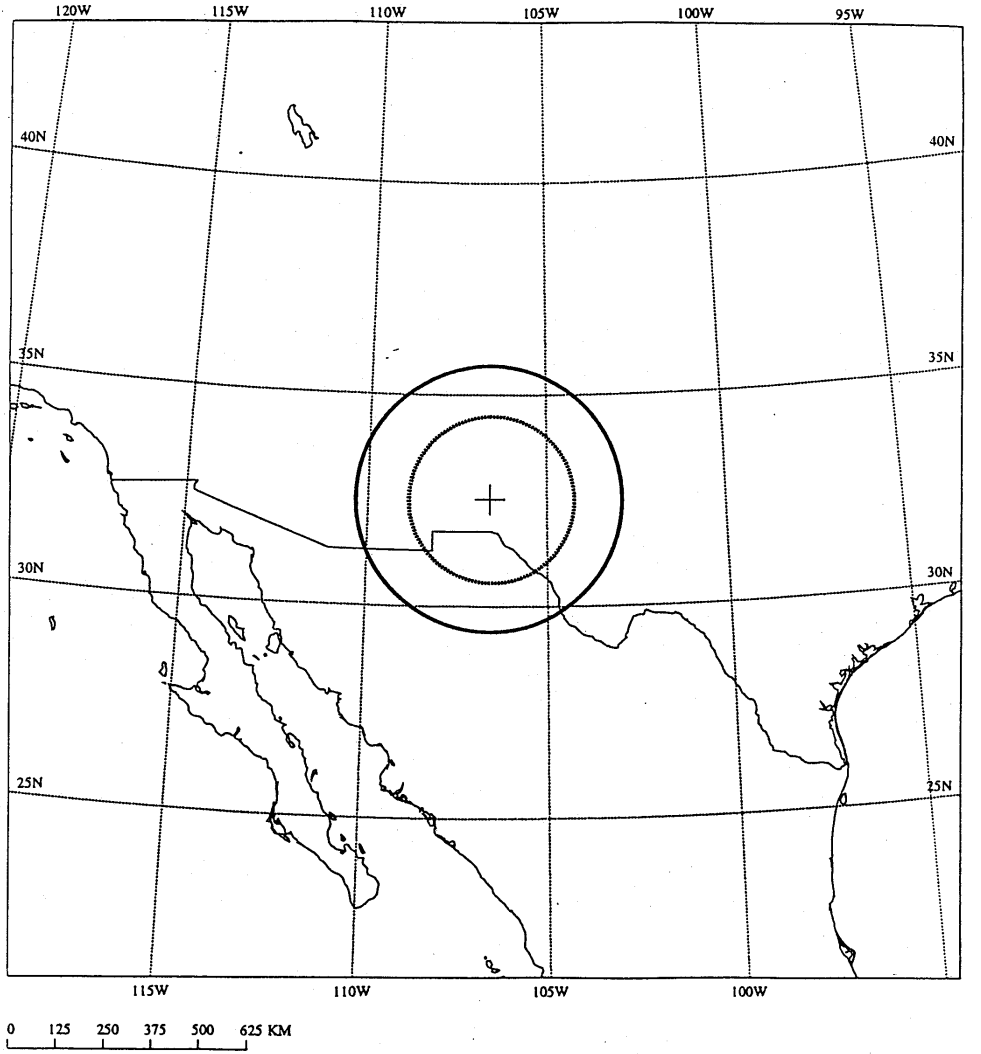



Coordination contour of the earth station in Goldstone, CA.

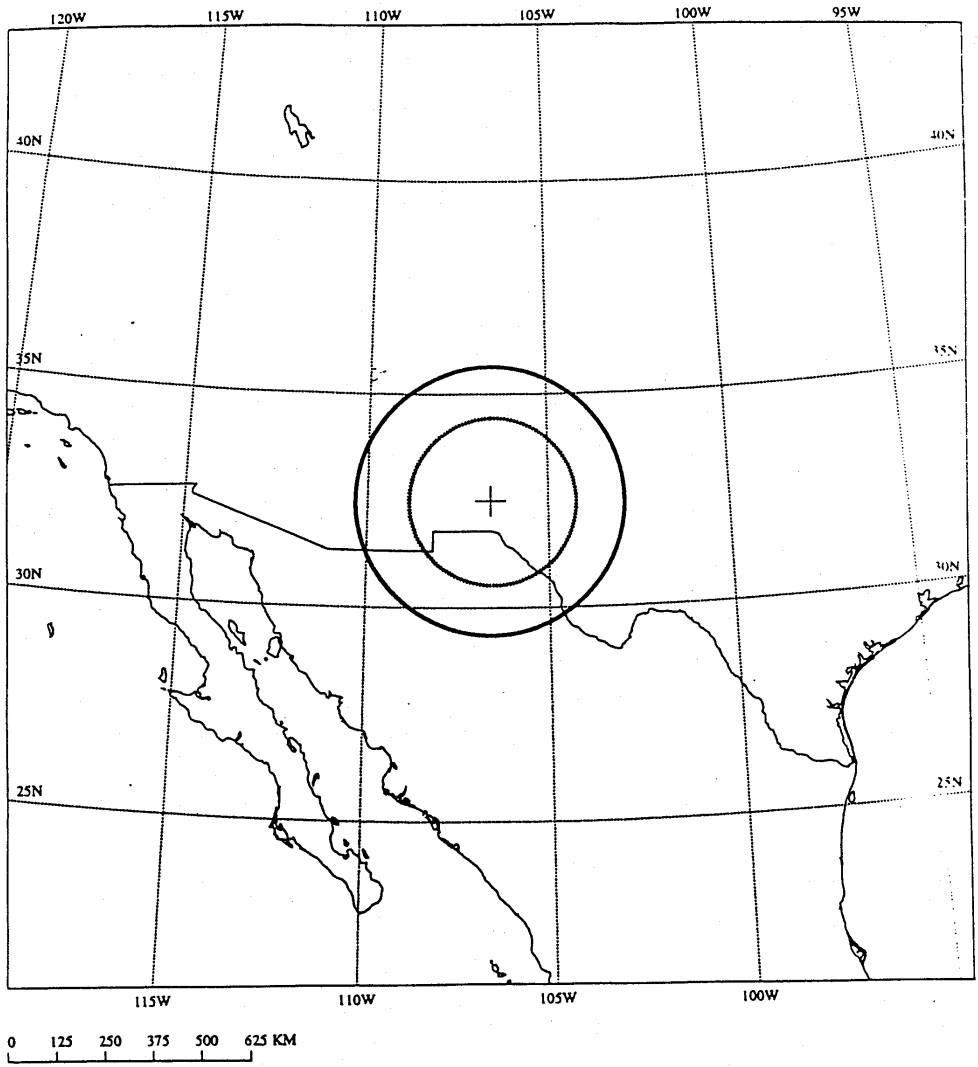
Note: There are two other earth stations (2025-2110 MHz and 2110-2120 MHz bands) within proximity to this station. The contours are similar as above.



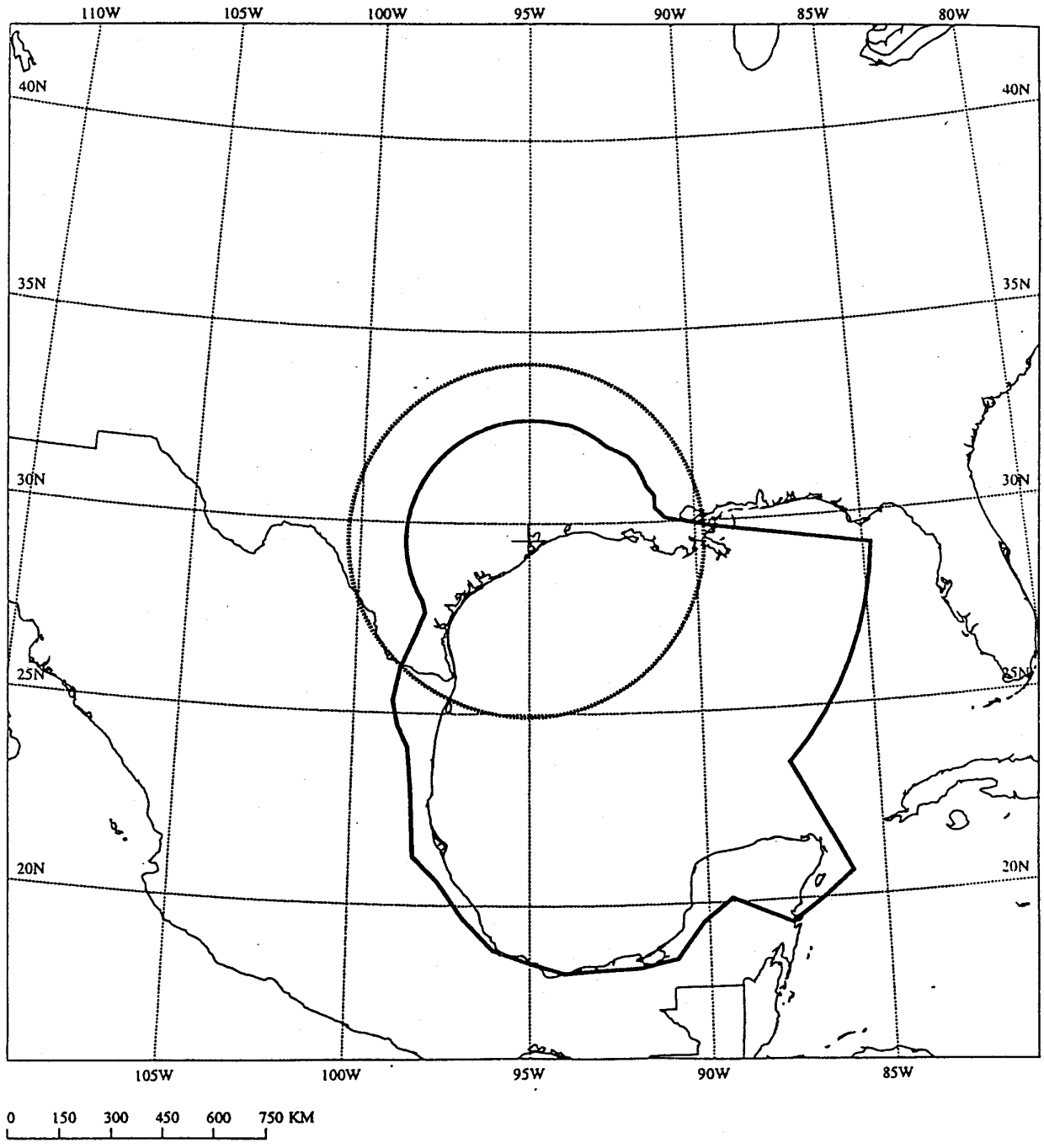

Coordination contour of the earth station in Merrit Is., Florida



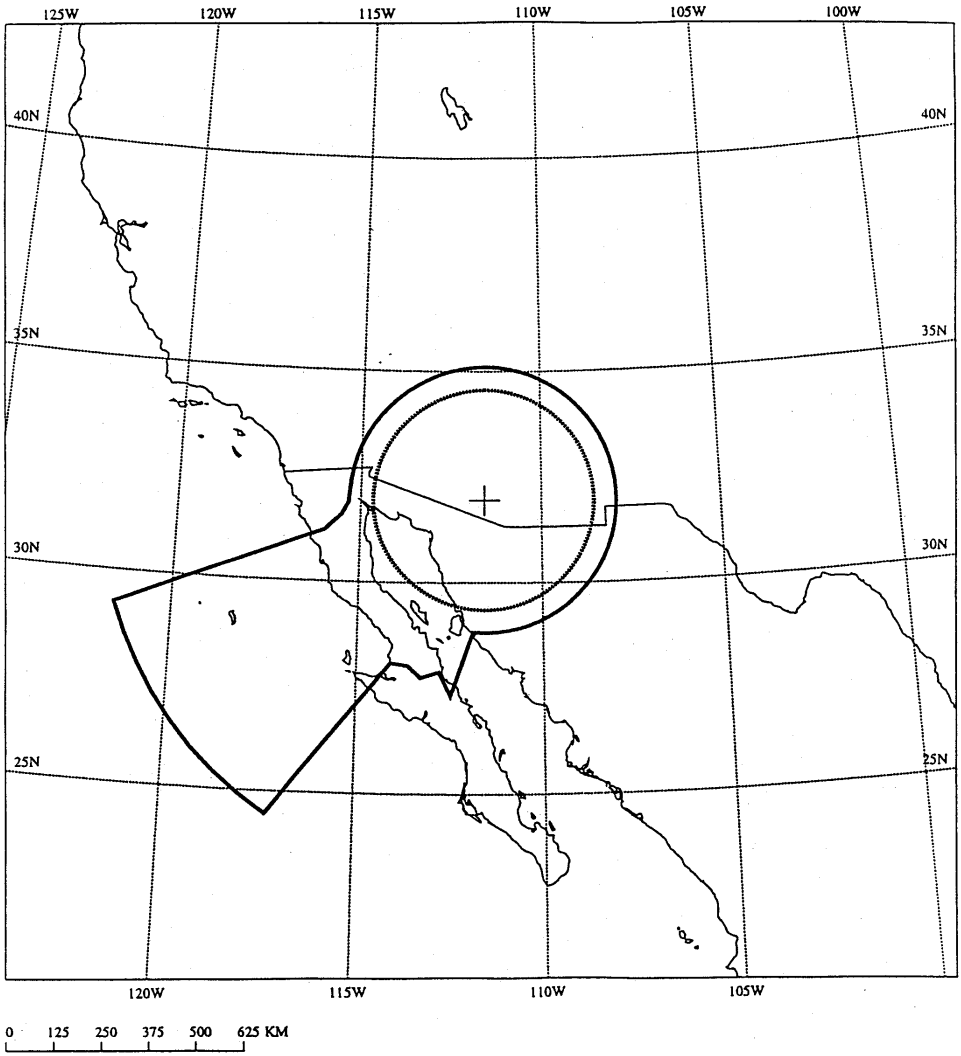

Coordination contour of the second TDRSS ground terminal in White Sands, New Mexico



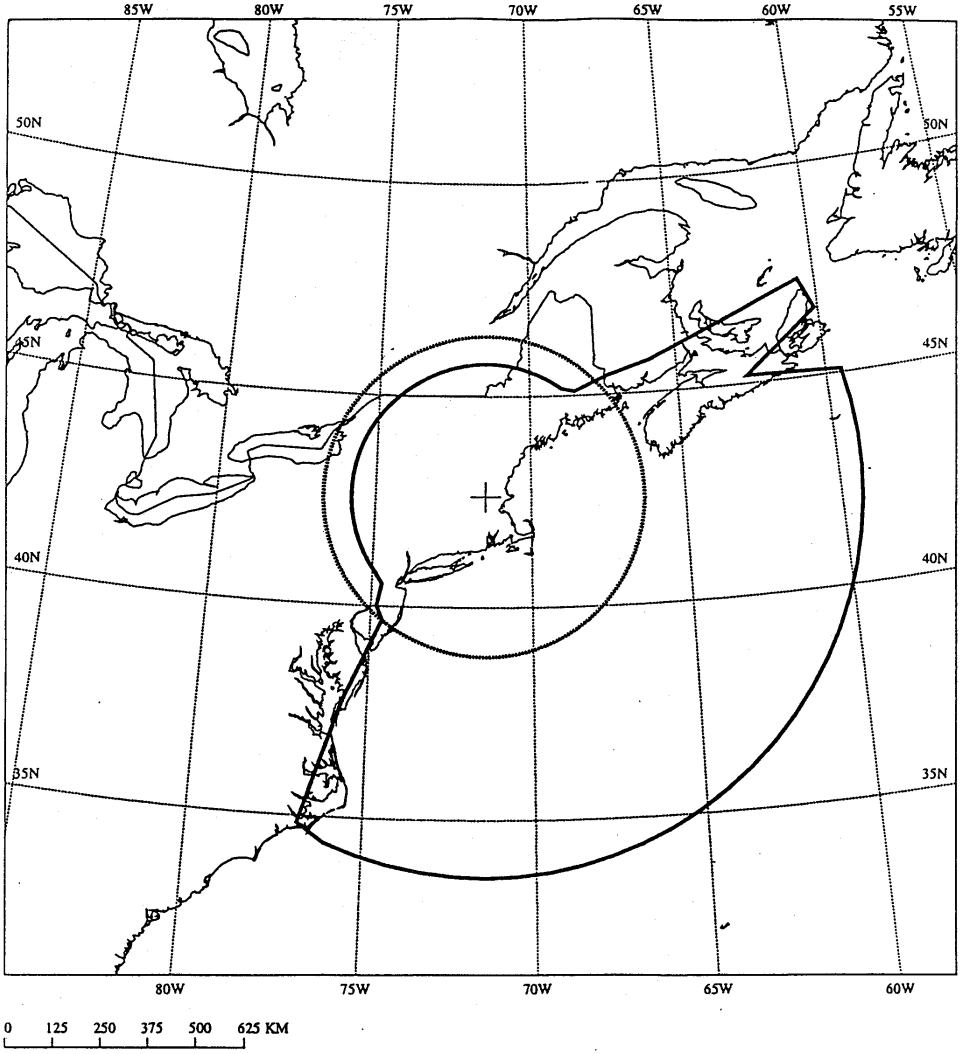

Coordination contour of the ground terminal in White Sands, New Mexico



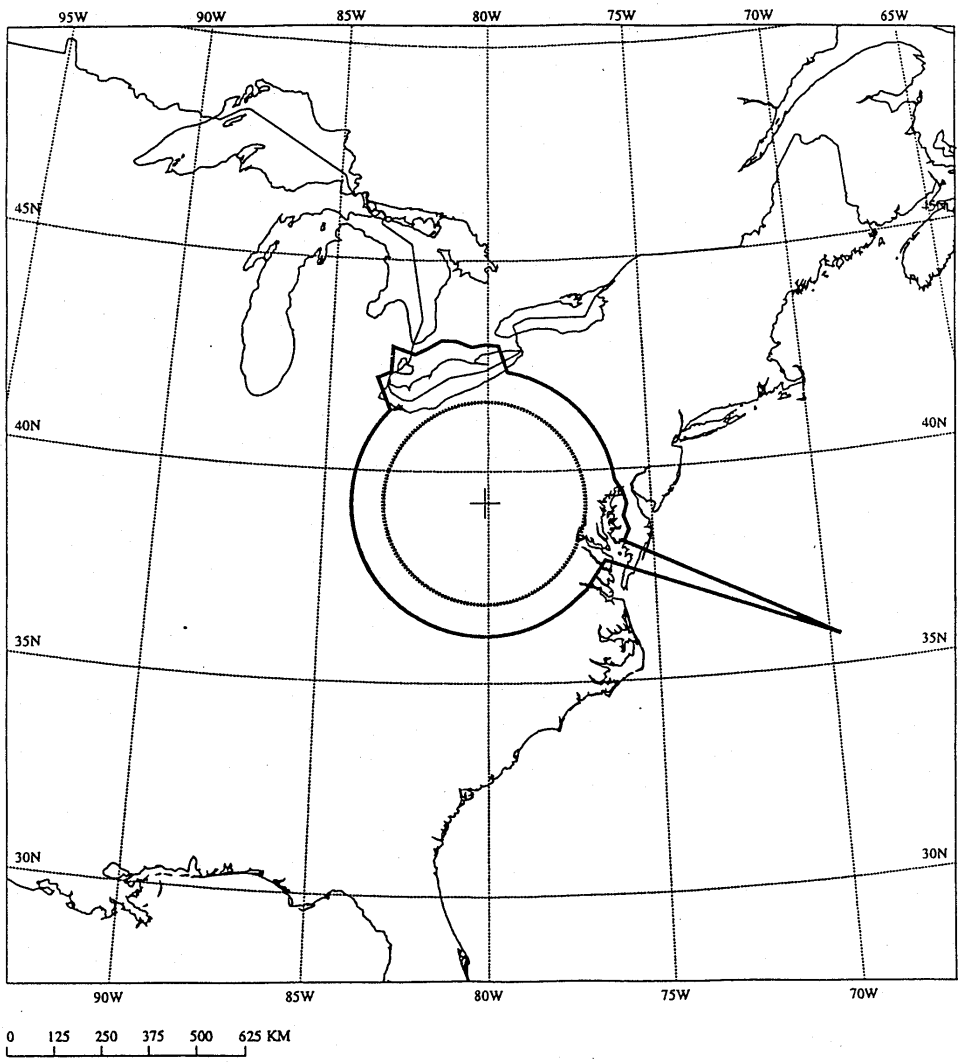

Coordination contour of the earth station in Houston, Texas



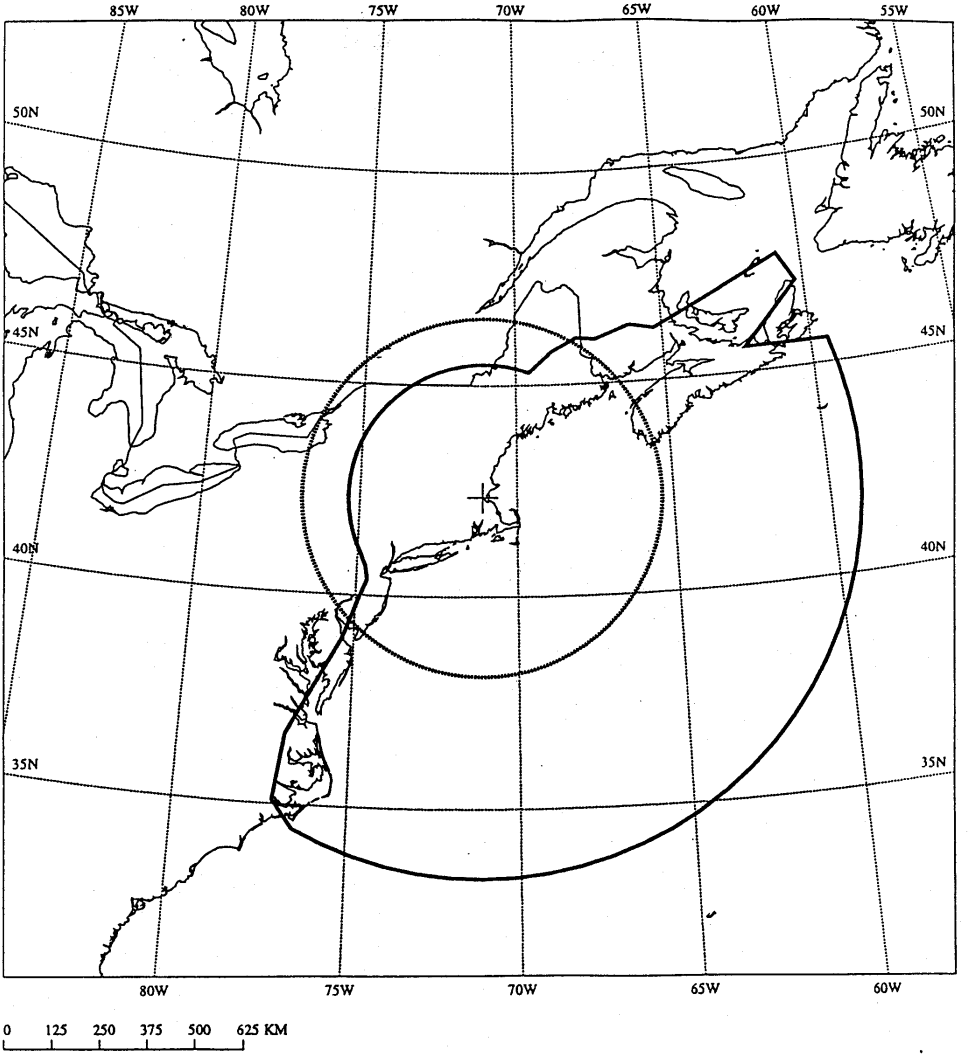

Coordination contour of the earth station in Kitt Peak, Arizona



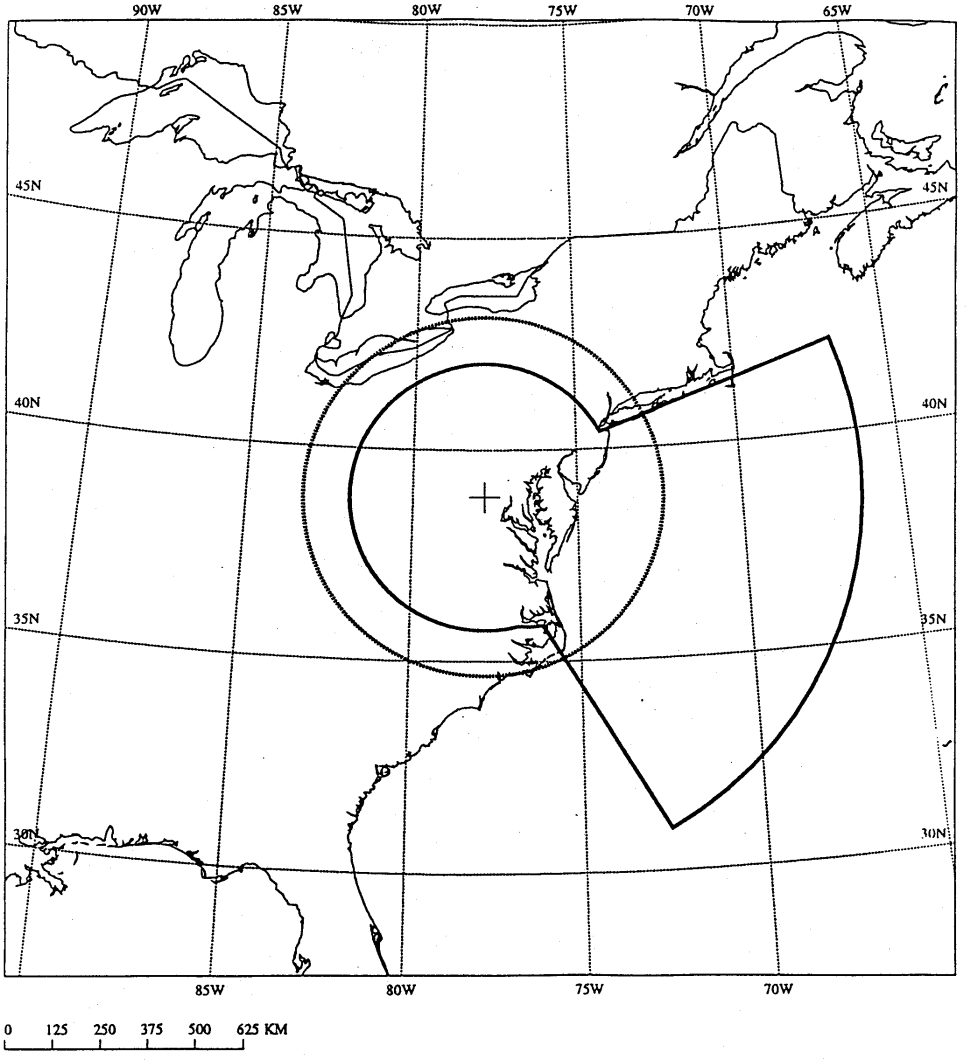

Coordination contour of the earth station in Westford, Massachusetts



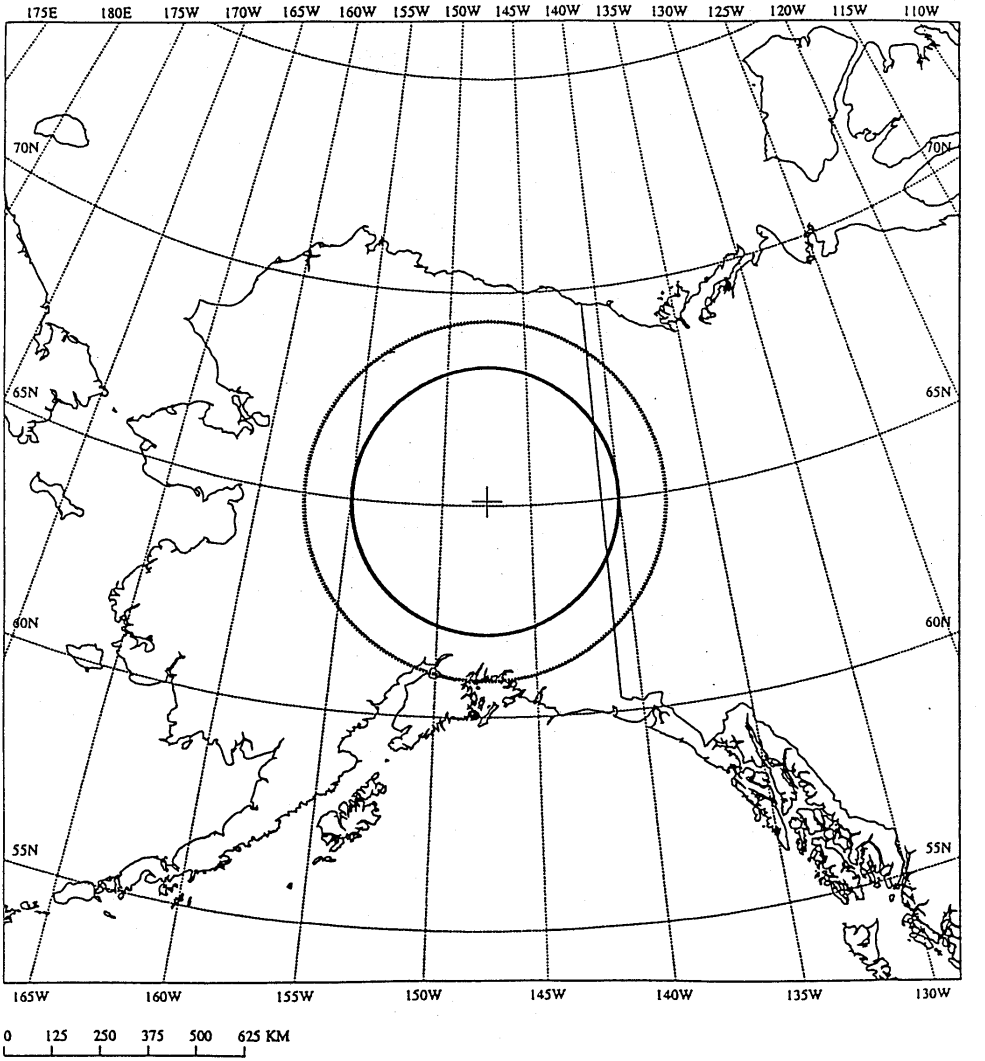

Coordination contour of the earth station in Fairmont, West Virginia



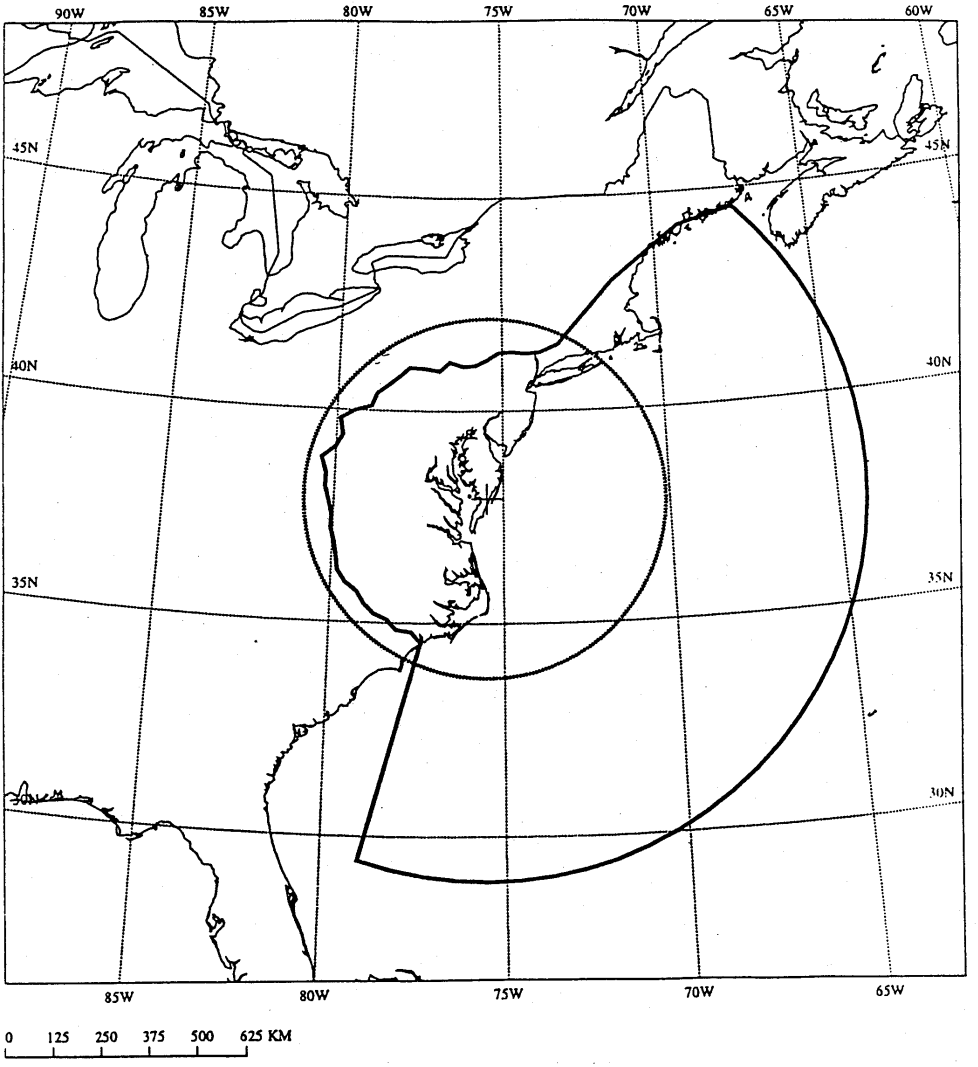

Coordination contour of the earth station in Boston, Massachusetts



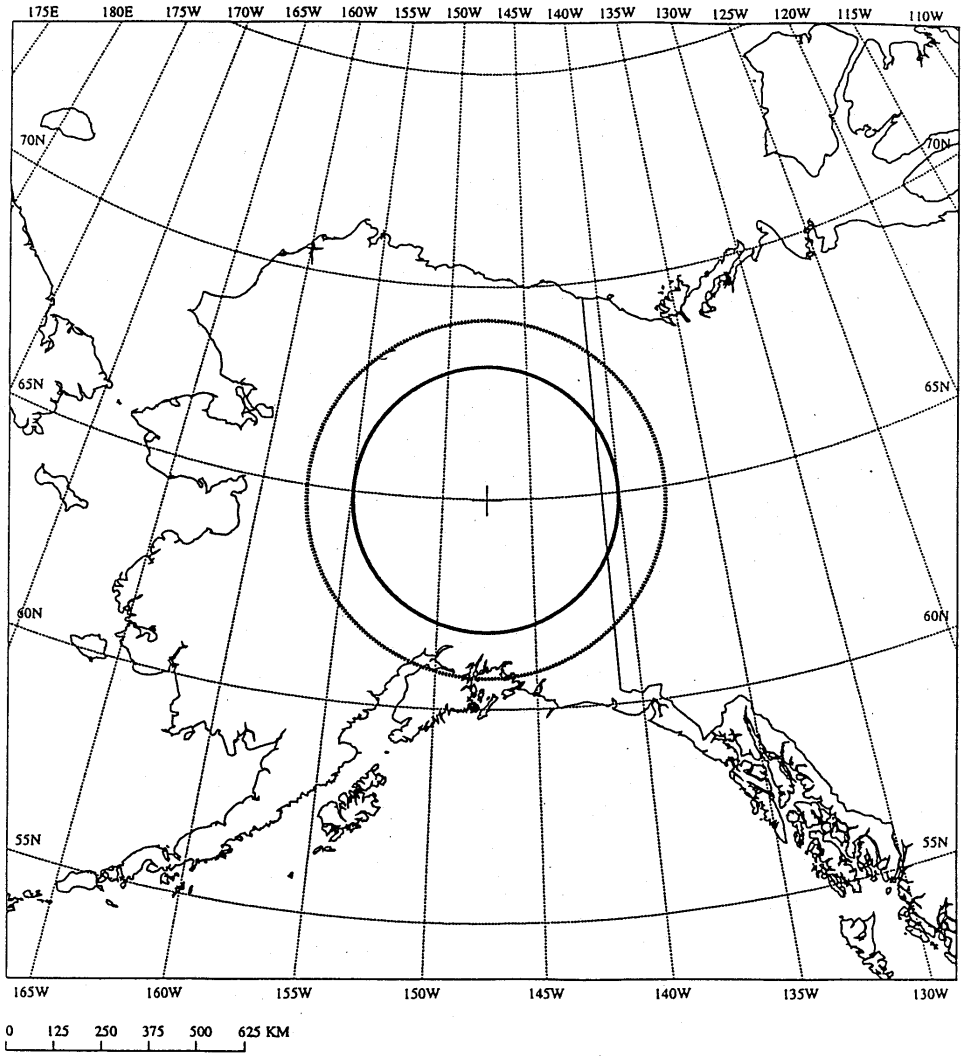

Coordination contour of the earth station in Chantilly, Virginia



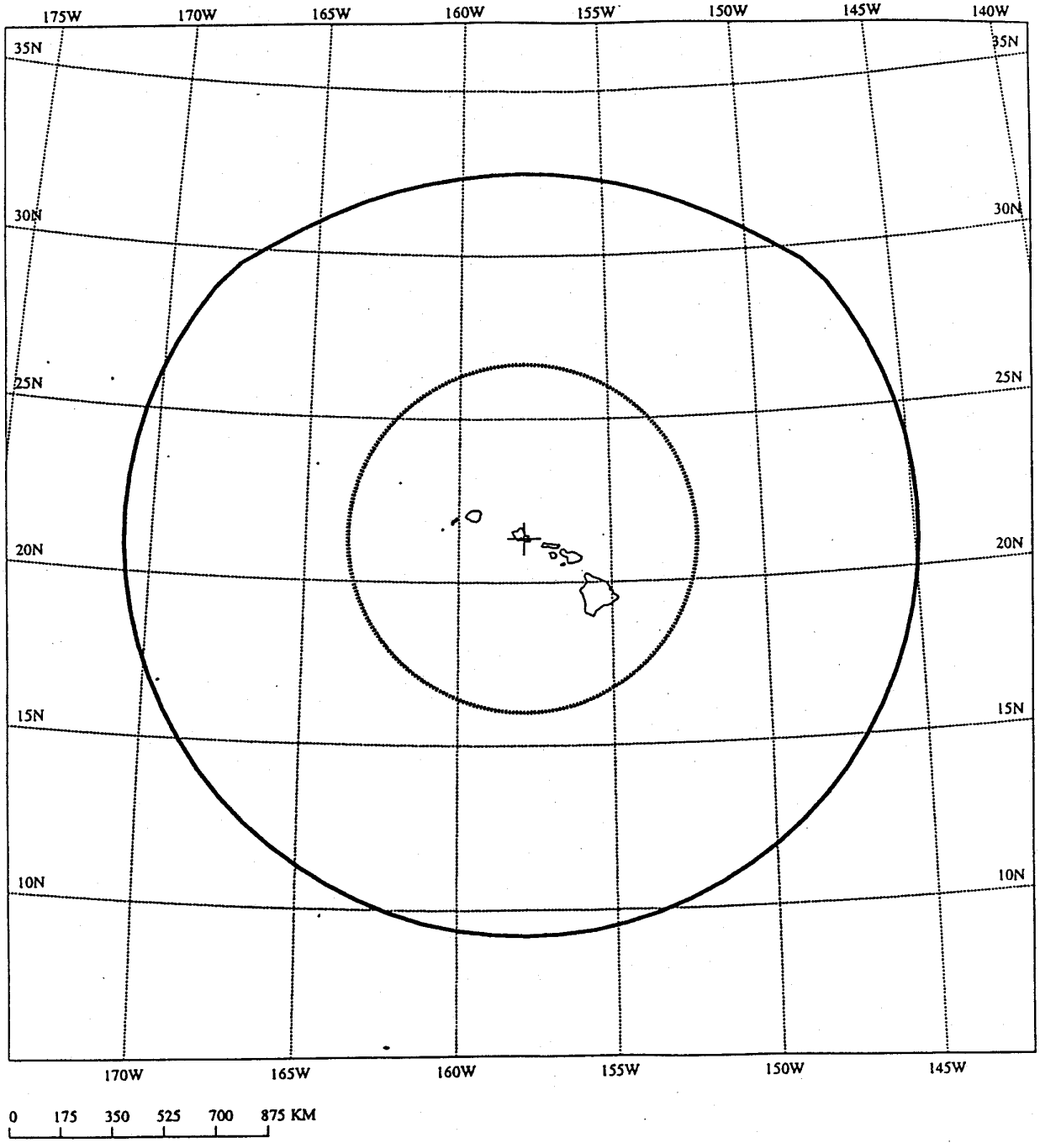

Coordination contour of the earth station in Poker Flats, Alaska



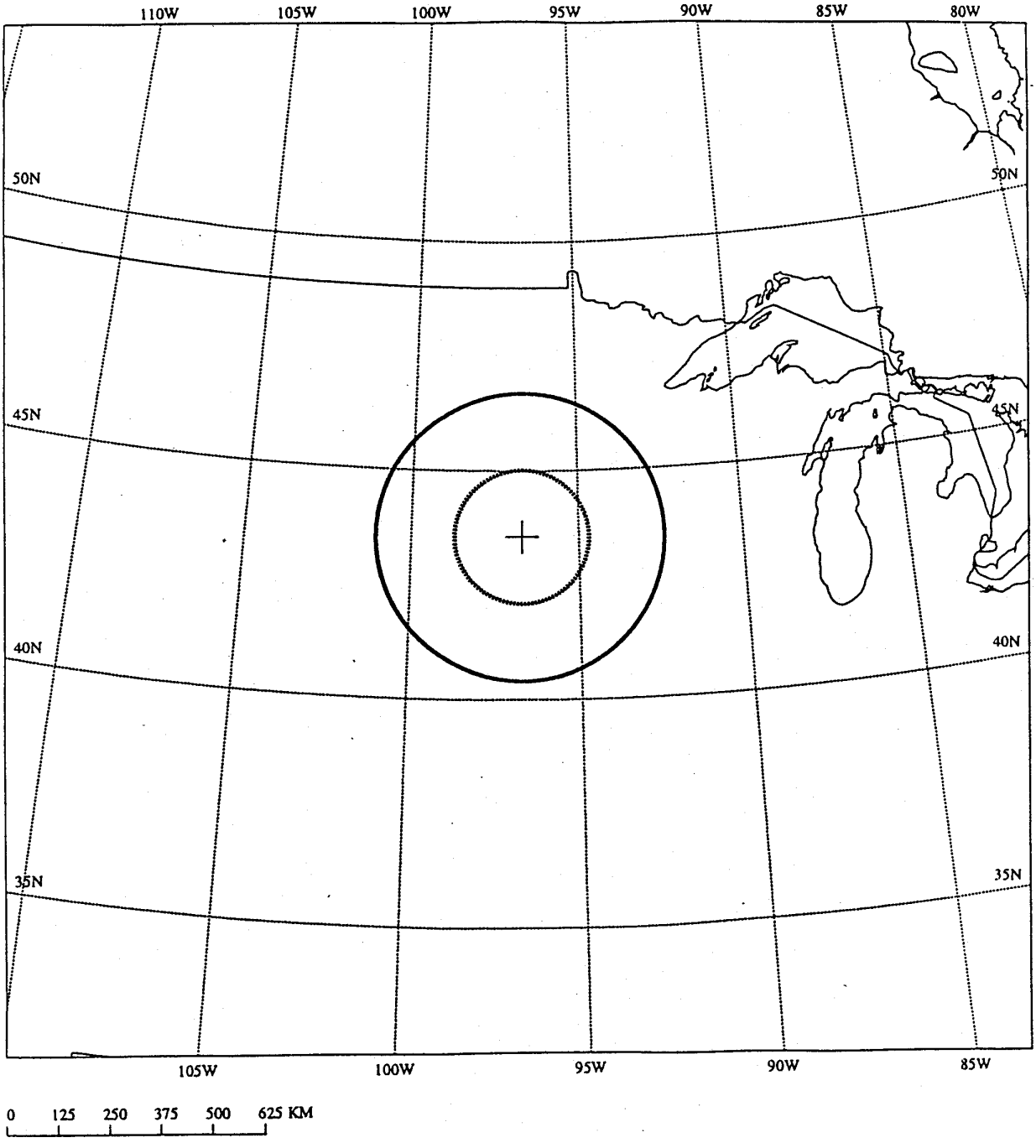

Coordination contour of the earth station in Wallops Is., Virginia




Coordination contour of the earth station in Fairbanks, Alaska




Coordination contour of the earth station in Honolulu, Hawaii




Coordination contour of the earth station in Sioux, South Dakota

List of Worldwide Satellite Systems
2025-2110 MHz

| | Satellite name | Country/Agency |
|---|---|---|
| 1 | SAC-A | ARGENTINA |
| 2 | SAC-B | ARGENTINA |
| 3 | SAC-C | ARGENTINA |
| 4 | MLMS | BELGIUM |
| 5 | CBERS | BRAZIL |
| 6 | MECB/S1 | BRAZIL |
| 7 | RADARSAT 1A | CANADA |
| 8 | CHINASAT-41 | CHINA |
| 9 | CHINASAT-42 | CHINA |
| 10 | CHINASAT-43 | CHINA |
| 11 | CHINASAT-44 | CHINA |
| 12 | CHINASAT-45 | CHINA |
| 13 | CHINASAT-46 | CHINA |
| 14 | CHINASAT-47 | CHINA |
| 15 | FY-2A | CHINA |
| 16 | ORSTED | DENMARK |
| 17 | ERS-1 | ESA |
| 18 | ERS-2 | ESA |
| 19 | ISO | ESA |
| 20 | METEOSAT | ESA |
| 21 | METEOSAT 4 | ESA |
| 22 | METEOSAT 5 | ESA |
| 23 | METEOSAT S1 | ESA |
| 24 | METEOSAT S2 | ESA |
| 25 | SOHO | ESA |
| 26 | ARTEMIS 16.4E-DR | ESA |
| 27 | ARTEMIS 21.5E-DR | ESA |
| 28 | ENVISAT-1 | ESA |
| 29 | INTEGRAL | ESA |
| 30 | XMM | ESA |
| 31 | ABRIXAS | F.R. GERMANY |
| 32 | EUTELSAT 2 7E | FRANCE |
| 33 | EUTELSAT 2 13E | FRANCE |
| 34 | EUTELSAT 2 16E | FRANCE |
| 35 | EUTELSAT 2 21.5E | FRANCE |
| 36 | EUTELSAT 2 36E | FRANCE |
| 37 | SIRIO 2 | FRANCE |
| 38 | SPOT 1 | FRANCE |
| 39 | SPOT 2 | FRANCE |
| 40 | SPOT 3 | FRANCE |
| 41 | TDF-2 | FRANCE |
| 42 | TELECOM 2A | FRANCE |
| 43 | TELECOM 2B | FRANCE |
| 44 | TELECOM 2C | FRANCE |
| 45 | TELECOM 2C | FRANCE |
| 46 | DORIS 1 | FRANCE |

**List of Worldwide Satellite Systems**
**2025-2110 MHz**

| | | |
|---|---|---|
| 47 | DORIS 2 | FRANCE |
| 48 | EDRSS-E | FRANCE |
| 49 | EDRSS-EC | FRANCE |
| 50 | EDRSS-W | FRANCE |
| 51 | EDRSS-WC | FRANCE |
| 52 | EUTELSAT 2 4E | FRANCE |
| 53 | EUTELSAT 2 33E | FRANCE |
| 54 | EUTELSAT 3 4E | FRANCE |
| 55 | EUTELSAT 3 7E | FRANCE |
| 56 | EUTELSAT 3 10E | FRANCE |
| 57 | EUTELSAT 3 12.5W | FRANCE |
| 58 | EUTELSAT 3 13E | FRANCE |
| 59 | EUTELSAT 3 14.8W | FRANCE |
| 60 | EUTELSAT 3 16E | FRANCE |
| 61 | EUTELSAT 3 21.5E | FRANCE |
| 62 | EUTELSAT 3 33E | FRANCE |
| 63 | EUTELSAT 3 36E | FRANCE |
| 64 | EUTELSAT 3 44E | FRANCE |
| 65 | EUTELSAT 3 48E | FRANCE |
| 66 | EUTELSAT 3 70.5E | FRANCE |
| 67 | EUTELSAT 3 76E | FRANCE |
| 68 | EUTELSAT 3 80.5E | FRANCE |
| 69 | EUTELSAT 3 83.5E | FRANCE |
| 70 | EUTELSAT 3 88.5E | FRANCE |
| 71 | EUTELSAT-E-44E | FRANCE |
| 72 | EUTELSAT-E-48E | FRANCE |
| 73 | EUTELSAT-E-70.5E | FRANCE |
| 74 | LOCSTAR CENTRAL | FRANCE |
| 75 | LOCSTAR EAST | FRANCE |
| 76 | LOCSTAR WEST | FRANCE |
| 77 | MSG | FRANCE |
| 78 | MSG-S1 | FRANCE |
| 79 | MSG-S2 | FRANCE |
| 80 | OPS-1 | FRANCE |
| 81 | OPS-1.1 | FRANCE |
| 82 | OPS-2 | FRANCE |
| 83 | OPS-3 | FRANCE |
| 84 | PROTEUS-OBS | FRANCE |
| 85 | PROTEUS-SCI | FRANCE |
| 86 | PROTEUS-TPFO | FRANCE |
| 87 | SPOT 4 | FRANCE |
| 88 | SPOT 4-ESBT | FRANCE |
| 89 | SPOT 5 | FRANCE |
| 90 | SPOT 6 | FRANCE |
| 91 | SYRACUSE-3A | FRANCE |
| 92 | SYRACUSE-3B | FRANCE |
| 93 | SYRACUSE-3C | FRANCE |

**List of Worldwide Satellite Systems**
**2025-2110 MHz**

| | | |
|---|---|---|
| 94 | SYRACUSE-3D | FRANCE |
| 95 | SYRACUSE-3E | FRANCE |
| 96 | SYRACUSE-3F | FRANCE |
| 97 | SYRACUSE-3G | FRANCE |
| 98 | SYRACUSE-3H | FRANCE |
| 99 | SYRACUSE-3I | FRANCE |
| 100 | VIDEOSAT-6 | FRANCE |
| 101 | VIDEOSAT-7 | FRANCE |
| 102 | DFS-2 | GERMANY |
| 103 | DFS-5 | GERMANY |
| 104 | EQUATOR-S | GERMANY |
| 105 | EXPRESS | GERMANY |
| 106 | ROSAT | GERMANY |
| 107 | TV-SAT 2 | GERMANY |
| 108 | DFS-6 | GERMANY |
| 109 | KEPLER 1 | GERMANY |
| 110 | ASLV | INDIA |
| 111 | IRS-1A | INDIA |
| 112 | IRS-1B | INDIA |
| 113 | IRS-1C | INDIA |
| 114 | IRS-P3 | INDIA |
| 115 | PSLV | INDIA |
| 116 | SROSS-1 | INDIA |
| 117 | SROSS-C2 | INDIA |
| 118 | IRS-P4 | INDIA |
| 119 | SSR-1 | INDIA |
| 120 | SAX | ITALY |
| 121 | SICRAL 1A | ITALY |
| 122 | SICRAL 1B | ITALY |
| 123 | EUROSKYWAY- 5E | ITALY |
| 124 | EUROSKYWAY-10.2E | ITALY |
| 125 | EUROSKYWAY-13.2E | ITALY |
| 126 | EUROSKYWAY-16.4E | ITALY |
| 127 | EUROSKYWAY-22E | ITALY |
| 128 | EUROSKYWAY-30E | ITALY |
| 129 | EUROSKYWAY-39E | ITALY |
| 130 | ITALSAT 10.2E | ITALY |
| 131 | ITALSAT 13.2E | ITALY |
| 132 | ITALSAT 16.4E | ITALY |
| 133 | SARIT | ITALY |
| 134 | SICRAL 2A | ITALY |
| 135 | SICRAL 2B | ITALY |
| 136 | ASTRO-D | JAPAN |
| 137 | BS-3 | JAPAN |
| 138 | CS-3B | JAPAN |
| 139 | ETS-5 | JAPAN |
| 140 | ETS-7 | JAPAN |

List of Worldwide Satellite Systems
2025-2110 MHz

| | | |
|---|---|---|
| 141 | EXOS-C | JAPAN |
| 142 | EXOS-D | JAPAN |
| 143 | GEOTAIL | JAPAN |
| 144 | GMS-4 | JAPAN |
| 145 | GMS-5 | JAPAN |
| 146 | HAGAROMO | JAPAN |
| 147 | JERS-1 | JAPAN |
| 148 | LUNAR ORBITER | JAPAN |
| 149 | SFU | JAPAN |
| 150 | SOLAR-A | JAPAN |
| 151 | ADEOS-II | JAPAN |
| 152 | COMETS | JAPAN |
| 153 | DRTS-113E | JAPAN |
| 154 | DRTS-160E | JAPAN |
| 155 | DRTS-177E | JAPAN |
| 156 | DRTS-E | JAPAN |
| 157 | DRTS-W | JAPAN |
| 158 | ETS-8-129E | JAPAN |
| 159 | ETS-8-135E | JAPAN |
| 160 | ETS-8-146E | JAPAN |
| 161 | GMS 120E | JAPAN |
| 162 | GMS 140E | JAPAN |
| 163 | GMS 160E | JAPAN |
| 164 | LUNAR-A | JAPAN |
| 165 | MTSAT-135E | JAPAN |
| 166 | MTSAT-140E | JAPAN |
| 167 | MTSAT-145E | JAPAN |
| 168 | MUSES-B | JAPAN |
| 169 | OICETS | JAPAN |
| 170 | TAIKI-109.65 | JAPAN |
| 171 | KITSAT-3 | KOREA |
| 172 | KOMPSAT-1 | KOREA |
| 173 | KOMPSAT-2 | KOREA |
| 174 | MALTASAT-1A | MALTA |
| 175 | MALTASAT-1B | MALTA |
| 176 | MALTASAT-1C | MALTA |
| 177 | MALTASAT-1D | MALTA |
| 178 | ACE | NASA |
| 179 | CASSINI | NASA |
| 180 | COBE | NASA |
| 181 | ERBS | NASA |
| 182 | EUVE | NASA |
| 183 | FAST | NASA |
| 184 | GRO | NASA |
| 185 | HST | NASA |
| 186 | ISTP POLAR | NASA |
| 187 | LANDSAT-4 | NASA |

**List of Worldwide Satellite Systems**
**2025-2110 MHz**

| | | |
|---|---|---|
| 188 | LANDSAT-5 | NASA |
| 189 | LUNAR PROSPECTOR | NASA |
| 190 | MICROLAB-1 | NASA |
| 191 | SAMPEX | NASA |
| 192 | SPACE SHUTTLE | NASA |
| 193 | TDRS-1 | NASA |
| 194 | TDRS-3 | NASA |
| 195 | TDRS-4 | NASA |
| 196 | TDRS-5 | NASA |
| 197 | TDRS-6 | NASA |
| 198 | TDRS-7 | NASA |
| 199 | TOMS-EP | NASA |
| 200 | TOPEX/POSEIDON | NASA |
| 201 | TRMM | NASA |
| 202 | UARS | NASA |
| 203 | WIND | NASA |
| 204 | WSF | NASA |
| 205 | XTE | NASA |
| 206 | AXAF-I | NASA |
| 207 | COMET | NASA |
| 208 | EOS AM 1 | NASA |
| 209 | EOS AM 2 | NASA |
| 210 | EOS CHEM | NASA |
| 211 | EOS LAM | NASA |
| 212 | EOS PM | NASA |
| 213 | FUSE | NASA |
| 214 | GRAVITY PROBE-B | NASA |
| 215 | HETE | NASA |
| 216 | IMAGE | NASA |
| 217 | INT'L SPACE STATION ACS | NASA |
| 218 | NMP/EO-1 | NASA |
| 219 | QUIKSCAT | NASA |
| 220 | SNOE | NASA |
| 221 | SWAS | NASA |
| 222 | TDRS H | NASA |
| 223 | TDRS I | NASA |
| 224 | TDRS J | NASA |
| 225 | TERRIERS | NASA |
| 226 | TIMED | NASA |
| 227 | TRACE | NASA |
| 228 | WIRE | NASA |
| 229 | GOES 10 | NOAA |
| 230 | GOES 7 | NOAA |
| 231 | GOES 8 | NOAA |
| 232 | GOES 9 | NOAA |
| 233 | GOES EAST 1 | NOAA |
| 234 | GOES WEST 1 | NOAA |

List of Worldwide Satellite Systems
2025-2110 MHz

| | | |
|---|---|---|
| 235 | GOES L | NOAA |
| 236 | GOES M | NOAA |
| 237 | NOAA-K | NOAA |
| 238 | NOAA-L | NOAA |
| 239 | NOAA-M | NOAA |
| 240 | NOAA-N | NOAA |
| 241 | NOAA-N' | NOAA |
| 242 | BADR-B | PAKISTAN |
| 243 | GOMS-1M | RUSSIA |
| 244 | GOMS-2M | RUSSIA |
| 245 | GOMS-M | RUSSIA |
| 246 | GONETS | RUSSIA |
| 247 | KOSKON | RUSSIA |
| 248 | GREENSENSE-1 | SOUTH AFRICA |
| 249 | GROENSAT-TP1 | SOUTH AFRICA |
| 250 | HISPASAT-1 | SPAIN |
| 251 | MINISAT 1 | SPAIN |
| 252 | SIRIUS-2 | SWEDEN |
| 253 | TELE-X | SWEDEN |
| 254 | ASTRID-2 | SWEDEN |
| 255 | ODIN | SWEDEN |
| 256 | ROCSAT-1 | TAIWAN |
| 257 | STRV-1 | UK |
| 258 | CRSS-1 | USACommercial |
| 259 | EARTHWATCH-1A | USA-Commercial |
| 260 | EARTHWATCH-1B | USA-Commercial |
| 261 | ORBVIEW-2 | USA-Commercial |

**FOR AGENDA**

Doc. 29872/1-4.9.2/2.4.2/6.15

ANNEX - C

National Aeronautics and
Space Administration

**Headquarters**
Washington, DC 20546-0001

Reply to Attn of: OI

JUL 19 1996

Mr. William Gamble
Chairman, IRAC
NTIA/Department of Commerce
Room 4099A
14th and Constitution Avenue, NW
Washington, DC 20230

Dear Mr. Gamble:

As you know, NASA makes use of frequency allocations to the Space Research, Space Operations and Earth Exploration Satellite services in the 2 GHz spectrum region for support of all of the Agency's spacecraft missions. This includes such major Programs as the Space Shuttle, the Tracking and Data Relay Satellite System (TDRSS) and the Hubble Space Telescope. In the future, the same bands will provide a major portion of the communications support for the International Space Station.

Until 1992 at the World Administrative Radio Conference (WARC-92) in Geneva, the use of these frequency allocations was per Article 14 of the Radio Regulations and required a great deal of "coordination with Administrations concerned." As a result of NASA and U.S. efforts at that Conference, allocations in the 2 GHz bands (specifically 2025-2110 and 2200-2290 MHz) were elevated in status to Primary worldwide. However, in the U.S. Table of Allocations, although the 2200-2290 MHz band is now Primary, the 2025-2110 MHz band is still designated Secondary status via U.S. Footnote 90.

NASA believes that the time has come to recognize such major economic and scientific programs as the Space Shuttle, the Hubble Space Telescope, the TDRSS and the International Space Station as national resources, requiring more explicit documentation of it's Secondary status in the U.S: Table. It has become evident after nearly 30 years of use, that the space services can continue to successfully share the band with other allocated users and in fact, Enclosure 2 presents good evidence of this. As a result, NASA is submitting a proposal to IRAC to bring the U.S. Table of Allocations more nearly in line with the International Table in the 2025-2110 MHz band.

Enclosures 1 through 4 present background and support information for this proposal.

Sincerely,

David Struba
NASA Representative, IRAC
Office of Space Communications

4 Enclosures

FOR AGENDA

ANNEX - D

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

Doc. 30063/1-2.8.2.1/4.22/6.15
Ref. Doc. 29872/1-4.9.2/2.4.2/6.15
30032/1-2.8.2.1/4.22/6.15

January 2, 1997

Mr. Richard Smith
Chief, Office of Engineering
and Technology
Federal Communications Commission
Washington, D.C. 20554

Dear Mr. Smith:

I am writing on behalf of NASA and the Department of Commerce to request that the Federal Communications Commission (FCC) take into account the Government requirements for the use of the band 2025-2110 MHz in any reallocation of this band. The Government use includes such programs as the Hubble Space Telescope, the Space Shuttle, and the Tracking and Data Relay Satellite System (TDRSS).

Early in the national space programs the band 2025-2110 MHz was chosen as the uplink for NASA and other Government agency's space programs for the space research and earth exploration-satellite services. This Government use was recognized in the National Table of Frequency Allocations through footnotes US90, US111, US219 and US222. Internationally this type of use in the band is recognized as it is allocated worldwide on a primary basis to these services.

The Government agencies have been able to operate in the band on a secondary basis to the current FCC licensees since there has been good coordination and cooperation among the parties.

We understand that the FCC is considering reallocating this band to mobile services and may then use competitive bidding. We request that the FCC recognize the Government use when considering such uses of the band and provide adequate protection for these national systems.

It is noted that the potential problem from the introduction of high density mobile users in this band has been recognized in the International Telecommunication Union. The ITU-R has adopted Recommendation SA. 1154, "Provisions to Protect the Space Research (SR), Space Operations (SO) and Earth Exploration Satellite Services (EES) and to Facilitate Sharing with the Mobile Service in the 2025-2110 MHz and 2200-2290 MHz Bands," which is enclosed. That document recommends specific limits to protect the SR, SO, and EES services from aggregate interference from emissions of mobile systems in the 2025-2110 MHZ band.

Staff from this office will work with the Commission staff to determine any sharing agreements or transition plans to protect these Government services. Thank you for your attention to this matter. Please contact either Richard Parlow or Edward Davison of this office at 202-482-1850 with any questions.

Sincerely,

William Gamble
Deputy Associate Administrator
Office of Spectrum Management

cc: Michele Farquhar
Donald Gips

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

## REFERENCES


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. (1997) Title III-Communications and Spectrum Allocation Provisions, (July 26, 1997).

3. FCC, First Report and Order and Further Notice of Proposed Rule Making, Amendments of Section 2.106 of the Commission's Rules to Allocate Spectrum at 2 GHz for use by the Mobile-Satellite Service, ET Docket No. 95-18, Released on March 14, 1997.

4. Draft NTIA Ad Hoc 206 Report, AH 206-388/8, Implementation of the Results of WARC-92 and WRC-95, April 1998.

5. Facsimile form Jim Ellickson, NOAA Landsat 7 Program Manager, NASA, to Ernie Cerezo, NTIA, Subject: Landsat 5/7 Mission, (Sept. 10, 1998).

6. NOAA/NASA Publication, NOAA-K, NP-1997-12-052-GSFC, (1997)

7. Letter form David Struba, IRAC Representative, NASA, to William Gamble, IRAC Chairman, NTIA, Subject: Request to Upgrade the Allocation of the 2025-2110 MHz Band to Primary Status, (July 19, 1996).

8. 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, (February 11, 1998) (Attached as Annex E).

9. NASA's Working Papers on S-Band Workshop, 2025-2110 MHz and 2200-2290 MHz Bands, Goddard Space Flight Center, (July 14-15, 1997).

10. Facsimile from Wayne Whyte, Spectrum Manager, NASA, to William Hatch, Associate Administrator, Office of Spectrum Management, NTIA, Subject: Replacement and investment costs (October 16, 1998).

11. Letter from Wayne Whyte, Spectrum Manager, NASA, Ernie Cerezo, NTIA, Subject: Federal system replacement costs, (November 2, 1998).

12. NASA/NOAA Briefing Material to OMB on Use of the Spectrum in the 1990-2120 MHz Band, (September 30, 1997).