NTIA REPORT 85-179

SPECTRUM RESOURCE ASSESSMENT OF THE FIXED AND MOBILE SERVICES IN THE 947-17,700 MHz BAND, PHASE II

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ABSTRACT

A Phase I spectrum resource assessment based upon use of the bands containing fixed and mobile services in the 947-17,700 MHz portion of the radio frequency spectrum was completed in 1984. From the total number of fixed and mobile bands, four bands (1350-1400 MHz, 2310-2390 MHz, 8400-8500 MHz, 14.5-15.35 GHz) were selected for further analysis of their potential for sharing.

This is the Phase II report that includes actual system and equipment counts (where available) and projected future use by the various Government agencies who have, or plan, future services in the fixed and mobile bands from 947-17,700 MHz. It also provides an evaluation of the potential for sharing between Government and non-Government users in those bands selected during Phase I. Sharing is recommended for the 1350-1400 MHz and 8400-8500 MHz bands.

KEY WORDS

Fixed and Mobile Services
Geographic Sharing
Government Exclusive Bands
Government/Non-Government Shared Bands
Long-Range Plan
Spectrum Management
Spectrum Sharing
947-17,700 MHz

SECTION 1

INTRODUCTION

BACKGROUND

The National Telecommunications and Information Administration (NTIA) is responsible for managing the Federal Government's use of the radio spectrum. Part of NTIA's responsibility is to "...establish policies concerning spectrum assignment, allocation and use, and provide the various departments and agencies with guidance to ensure that their conduct of telecommunications activities is consistent with these policies" [NTIA, 1985]. In support of these requirements, NTIA has undertaken a number of spectrum resource assessments. The objectives of these studies are to assess spectrum utilization, identify existing and/or potential compatibility problems among the telecommunications systems that belong to various departments and agencies, provide recommendations for resolving any compatibility conflicts that may exist in the use of the frequency spectrum, recommend changes to promote spectrum efficiency and improve spectrum management procedures, and help establish a long-range plan for spectrum use.

In order to ensure efficient and effective use of the spectrum, Executive Order 12046 [E.O., 1978] and Department of Commerce (DOC) Order 10-10 [DOC, 1978] direct NTIA to develop, in cooperation with the Federal Communications Commission (FCC), a long-range plan for spectrum use. As part of this planning effort, several tasks have been initiated.

1. Spectrum resource assessments (SRAs) of the bands 947-17,700 MHz and 17.7-40.5 GHz. These SRAs are proceeding concurrent to the FCC Docket 82-334 [FCC, 1982] that addresses identification of suitable spectrum for licenses displaced under Docket 80-603 [FCC, 1980] by the broadcasting satellite service (BSS) in the 12.2-12.7 GHz band.

2. A spectrum resource assessment of the 2900-3100 MHz band.

3. A spectrum resource assessment evaluating the use of narrowband communications techniques.

4. A method for determining spectrum efficiency. The Interdepartment Radio Advisory Committee (IRAC) Technical Subcommittee (TSC) has

been tasked under IRAC Documents 23191/1, 23199/2 and 23748/1 to complete this work. TSC has defined a technical spectrum efficiency factor (TSEF) and is proceeding with development of a related computer model. This efficiency factor concept will be applied, where feasible, to fixed and mobile systems in selected bands within the overall 947-40,500 MHz range.

Pertinent portions of these SRAs will be incorporated into the joint NTIA/FCC Long-Range Plan (LRP).

The SRA covering the 947-17,700 MHz frequency bands was undertaken in two phases.

Phase I. [NTIA Report 84-161, 1984] This first phase involved the gathering of all information on assignments, uses, major systems, etc. in the bands of concern from the Government Master File (GMF), Non-Government Master File (NGMF), past SRA reports, other NTIA and Government agency reports, equipment manufacturers' systems descriptions and reports, and any other readily accessible sources with information pertinent to the study. This led to the completion of the Phase I report and the generation of preliminary recommendations for the bands' sharing potential. The report documents Government current spectrum use and, based upon the data obtained, recommends four bands (1350-1400 MHz, 2310-2390 MHz, 8400-8500 MHz, 14.5-15.35 GHz) be considered within the Phase II effort for geographic sharing. It was concluded that sharing in other bands was not feasible. The geographic concept would allow sharing in specifically defined geographic areas. In the Phase I report, it was pointed out that many assignments in some Government exclusive bands are concentrated in specific geographic locations because they support missile test ranges, military bases, electronic proving grounds, and the like. This may leave 10, 20, or more states without assignments in a certain band.

Phase II. This phase presents detailed information from each of the agencies represented in the IRAC by giving system/equipment counts, mission requirements, and plans for future use in all bands containing fixed and mobile services from 947-17,700 MHz and projects assignment and equipment quantities through 1990. Based on Phase I recommendations, certain bands are explored in more detail to assess the impact of band sharing. The concept of geographical sharing, as recommended in the Phase I report, is discussed in more detail in this Phase II report.

OBJECTIVES

To assist in the development of long-range spectrum management plans and policies, the following objectives were identified for this spectrum resource assessment:

1. document the planned requirements for Government use of the fixed and mobile frequency bands from 947-17,700 MHz and project the growth of assignment and equipment quantities

2. assess the nature and scope of future potential compatibility problems between Government and non-Government planned uses of this spectrum, based on the latest input on proposed systems and future-use data

3. evaluate the feasibility of increased sharing between Government and non-Government services with specific attention given to 1350-1400 MHz, 2310-2390 MHz, 8400-8500 MHz, and 14.5-15.35 GHz

4. recommend specific changes to the existing rules, regulations, and frequency management practices to improve overall management of the bands

5. identify and outline specific problem areas requiring additional analysis, if any.

APPROACH

In order to accomplish the objectives of this Phase II, 947-17,700 MHz spectrum resource assessment, the following approach was taken.

1. Data pertaining to the spectrum plans of each agency within the IRAC was requested from the agency representatives.

2. Agency responses were compiled and documented, by agency and then by band.

3. Assignment quantities were compiled back to 1982 and then estimated through 1990.

4. Data from agency submissions and the GMF, on equipment quantities, was correlated with assignment quantities.

5. Additional Government plans were identified through the NTIA Systems Review File and the Electromagnetic Compatibility Analysis Center (ECAC) Frequency Allocation List (FAL).

6. Agency plans and assignment and equipment estimates were analyzed for their impact on each of the fixed and mobile bands.

7. The 1350-1400 MHz, 2310-2390 MHz, 8400-8500 MHz, and 14.5-15.35 GHz bands were specifically analyzed for their potential for sharing with non-Government users on a geographical basis. The following criteria were used to evaluate bands for sharing potential:

   a. specific locations with concentrated assignments or a wide distribution of few assignments

   b. low growth predictions

   c. no predicted impact on adjacent Government bands if sharing with the private sector is approved.

SECTION 2

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

During the collection of the data and the completion of the analyses for the two phases, the question frequently arose, "In light of the great amount of planning and coordination that preceded and followed the World Administrative Radio Conference (WARC) in 1979, what criteria should dictate the reconsideration of Government and non-Government spectrum allocations?" Decisions pertaining to spectrum allocation must continue to be reached through the coordinated efforts of NTIA and the FCC. Shifts in allocations, even for unused spectrum, will ultimately have some impact on the agencies' missions and costs. Both the Government and non-Government must be able to plan, allowing room for growth, without the fear of having future availability of the spectrum withdrawn. The Government already has a significant and growing interest in equipment operating in these fixed and mobile bands between 947-17,700 MHz. Its ability to plan for national exigencies and the National Security and Emergency Preparedness Programs may be hampered by the loss of spectrum to the private sector. Lack of use by Government or non-Government entities is not sufficient to justify changes without considering long-term costs and benefits to both parties. Therefore, identification of bands for possible sharing should not be taken as recommendations for sharing, per se, but as identification of bands available for increased use if specific requirements are identified.

Though this analysis was primarily directed toward the possible increased sharing between Government and non-Government users for fixed and mobile services, bands identified as having little use are clearly available for increased use by the Government. This report should in fact assist Government agencies in selecting bands for planned systems. The lesser used bands also hold the potential for sharing with other services. Changes in the services, however, would require further analysis on a case by case basis.

CONCLUSIONS

The following conclusions are the result of the analysis of the fixed and mobile bands from 947-17,700 MHz.

1. With respect to future potential for sharing, the 13 fixed and mobile bands between 947 and 17,700 MHz fall into a number of distinct groupings

   a. The 1710-1850 MHz, 7125-8400 MHz and 14.5-15.35 GHz bands are, or are expected to be, (due to high growth rates) heavily used.

   b. The 1427-1535 MHz, 4500-4800 MHz, and 14.4-14.5 GHz bands are moderate, with respect to current use and are all experiencing slight growth.

   c. The 2200-2290 MHz band is moderate, with respect to its use. More recent growth trends may indicate the possibility of it becoming a high growth band.

   d. The 1700-1710 MHz and 2290-2390 MHz bands have had little use and little growth; however, changes in the use of these bands are expected.

   e. The 1350-1400 MHz and 8400-8500 MHz bands have had little use and low growth is expected.

   f. High equipment-to-assignment ratios and short term trends create the appearance of heavy use and high growth in the 4400-4500 and 4800-4990 MHz bands. Conclusions pertaining to these bands are held in abeyance pending further confirmation of equipment quantities and assignment trends.

2. Accurate estimates of equipment quantities associated with assignments are an essential element in the discussion of spectrum congestion and sharing potential.

3. Accurate projections of future use depend upon the availability of complete agency plans. However, various methods of making estimates need to be studied to identify the best substitute for actual agency plans when such plans are not available. The straight-line estimates of future assignment levels, based upon past GMF trends, were the methods used in this report. This straight-line methodology must be read, "If current trends continue" not "These projections are based on current trends."

4. The GMF does not reflect Government passive use of the spectrum, such as radio astronomy.

RECOMMENDATIONS

The following are NTIA staff recommendations based on the technical findings contained in the Phase I report and this Phase II report on the 947-17,700 MHz bands. Any action to implement these recommendations will be accomplished under separate correspondence by modifications of established rules, regulations, or procedures.

1. The 1350-1400 MHz and 8400-8500 MHz bands should be considered for increased use by currently allocated services or for modification of allocations, if specific requirements are identified by Government or non-Government users (within the 1350-1400 MHz band, non-Government users could have uncoordinated access, if limited to geographic areas as described in Section 5).

2. The allocation of other fixed and mobile bands in the 947-17,700 MHz frequency range should remain unchanged.

3. A study should be conducted to determine the data requirements for analysis of spectrum congestion and sharing potential and the GMF expanded to support those requirements.

4. A method of projecting spectrum use trends should be developed for instances where Government plans are not available. This method may need to take into account factors such as band-saturation limits, technological advances, and allocated services.

5. NTIA should establish a working group to determine the best means for protecting the use of passive systems.

SECTION 3

COLLECTION OF DATA

GENERAL

On October 6, 1983, the Chairman of the IRAC requested support from each of the IRAC agencies in compiling information on the agencies' plans from 947-17,700 MHz. The agencies were requested to do the following.

1. Verify that the information in the Government Master File (GMF) accurately and completely reflects their access to the spectrum.

2. Make data available that could be used for correlating the number of transmitting and receiving devices associated with a given frequency assignment.

3. Designate the type of spectrum access required (i.e., instantaneous, random, or scheduled) for each frequency assignment identified.

4. Identify future requirements for spectrum access in this band.

5. Summarize the mandated missions that relate to the respective assignments submitted.

A summary of the agency responses is presented in this section. A complete presentation of all Government plans was not possible because some of the IRAC agencies did not provide a response and, of the responses provided, some were incomplete.

GOVERNMENT MASTER FILE (GMF) ACCURACY

The effort by IRAC agencies to review the status of their assignments every five years appears to be helping to keep the GMF up to date. The following US agencies confirmed that the GMF accurately represents their assignments.

1. Department of Agriculture (USDA)
2. US Coast Guard (USCG)/Department of Transportation (DOT)
3. Department of Commerce (DOC)
4. Department of Energy (DOE)
5. Federal Aviation Administration (FAA)
6. Federal Emergency Management Agency (FEMA)
7. Department of Health and Human Services (HHS)
8. Department of Justice (Justice)
9. National Aeronautics and Space Administration (NASA)
10. US Postal Service (USPS)
11. Department of State (State)
12. Department of the Treasury (Treasury)
13. Veterans' Administration (VA)

The National Science Foundation (NSF) pointed out that the GMF does not account for passive systems or receivers. Due to the number of passive radio astronomy systems that NSF operates, a major portion of its activity is not represented within the GMF. These systems, as well other receivers, have no status within the assignment process, although they frequently perform valuable missions and require certain levels of protection.

EQUIPMENT QUANTITIES

The second item, correlating equipment quantities with assignments (in this context, equipment refers to transmitters), was requested because the GMF is a listing of assignments. However, each of these assignments may possibly be for a thousand transmitters leading to an erroneous impression of total spectrum use. Section 9.8.2 of the NTIA Manual [DOC, 1985], which pertains to the submission of frequency assignment applications, describes the manner in which this data is indicated in a record.

The figure recorded for the number of stations represents either the exact number or a range of numbers determined as follows:

Within the range	Record the number
1 - 10	10
11 - 30	30
31 - 100	100
101 - 1000	1000
1001 - 3000	3000
3001 - 10,000	10,000
Above 10,000	Nearest 10,000

The use of these ranges increases the difficulty in determining the equipment-to-assignment correlation.

An agency that only has a few assignments can easily contact the users for clarification. For those with a large number of assignments, this task becomes more difficult. For example, none of the Department of Defense (DOD) agencies responded to this portion of the request.

The following agencies indicated that their equipment-to-assignment ratios in these bands were one-to-one.

1. USDA
2. DOC
3. General Services Administration (GSA)
4. HHS
5. Justice

The following agencies indicated that the equipment-to-assignment ratios in these bands were greater than one-to-one.

1. USCG/DOT
2. DOE
3. FAA

ACCESS

The type of access required by an agency varied for each assignment. Access required on an infrequent, scheduled, constant, or random basis was usually mentioned within each agency's response. The system mission, related to each assignment, has the greatest impact on the access requirement. Many Government systems perform emergency functions that require guaranteed instantaneous access.

The responses for this item were similar to equipment quantities in that agencies with a limited number of assignments were able to make an evaluation for each. Agencies with a large number of assignments gave their access requirements in more general terms.

The following agencies indicated continuous or instantaneous operation for each assignment.

1. USDA
2. FEMA
3. GSA
4. HHS
5. Justice
6. Treasury

The following agencies indicated varied access requirements for their assignments.

1. USCG/DOT
2. DOE
3. NASA

PLANS

Most of the IRAC agencies provided documentation of their plans. Many of their systems have also been documented through the system review process and in the Phase I report. Detailed systems' plans are presented in Sections 4 and 5 of this report. The following agencies provided their plans for future spectrum use.

1. USDA
2. US Air Force (USAF)
3. US Army (Army)
4. DOC
5. DOE
6. FAA
7. FEMA
8. GSA
9. HHS
10. Justice
11. NSF
12. USPS
13. State
14. Veterans' Administration (VA)

The following agencies provided some planning information; however, specific requirements for systems or frequency bands were not identified.

1. NASA
2. Treasury

MISSION PERFORMED

The agencies responded to the question concerning mission in a couple of ways. Some gave a two- or three-word description of each assignment, while others gave a generalized statement of their mission. The former could not be presented in this document without providing a full listing of assignments, but the latter is included as APPENDIX D in the Phase I report.

SECTION 4

GOVERNMENT PLANNED USE BY AGENCY OF THE 947-17,700 MHz BANDS

GENERAL

The unclassified present and planned spectrum requirements, as described by each of the IRAC agencies, are presented in this section. (The agencies' response letters are listed in APPENDIX A.) In cases where an agency didn't supply the information requested, a general mission statement was extracted from information in reference 13 and is given as a minimum representation of agency requirements. Section 5 summarizes the information by frequency band, as well as providing information from additional sources. Tables and figures represent information compiled and provided by the agencies. An in-depth discussion of frequency assignments is contained in the Phase I report.

US DEPARTMENT OF AGRICULTURE (USDA)

USDA spectrum use is predominately land mobile FM radio. However, within the 947-17,000 MHz bands, fixed microwave links located within the National Forests' boundaries are the greatest in number. The rural location of most USDA equipment allows operation on lower frequencies that may be congested in metropolitan areas. These lower frequencies also allow greater distances between point-to-point sites. For these reasons, frequency use above 2 GHz has been limited.

In general, USDA favors sharing these bands between Government and non-Government communities because non-Government use would increase the availability of less expensive off-the-shelf equipment.

Assignments

The USDA has verified that the information contained in the GMF on its assignments is correct (they currently have 417 assignments in the 1710-1850 MHz band). Most of USDA's assignments in these bands are in the fixed service and require instantaneous access as they operate 24 hours a day.

Future Plans

The USDA has one assignment used for transmitting images from airborne infrared-photography equipment. They anticipate using three additional systems of this type by 1990.

The primary user agency within USDA is the United States Forest Service (USFS), which plans to operate microwave systems on about 90 percent of the land in the National Forest System. Most of the systems will have a six- to 12-channel capacity, with a few having major trunks of up to 72 channels. The primary system use will be for support of land mobile radio, fire-dispatch hotlines, fire weather telemetry, interoffice voice telephone, and interoffice computer data communications. The 1710-1850 MHz band is used by low-density-microwave equipment replacements for existing UHF point-to-point links within the National Forest System. Based on current trends and plans, USDA is expected to increase their number of assignments in the 1710-1850 MHz band to 3,000 within the next 10 years. In the future, the 7 GHz band may be used for fixed microwave when 1710-1850 MHz is either unsuitable or too congested.

US AIR FORCE (USAF)

The USAF and its subordinate commands maintain the nation's strategic alert system, provide for prompt and sustained tactical operations, and carry out routine training and support activities for forces tasked with the air defense of the US. Satellites, airborne radios, ground radios, intrabase radios, radars, transponders, beacons, electronic warfare equipment, electronic countermeasures equipment, enemy threat simulators, homing devices, and navigational aids are radiating devices used by the USAF.

Future Plans

The USAF's future plans in the fixed and mobile bands from 947-17,7000 MHz include the following unclassified activities.

1215-1400 MHz - Minimally Attended Radar (MAR)
1761-1842 MHz - Tracking, Telemetry, Command and Control
2200-2290 MHz - Tracking, Telemetry, Command and Control
6.8-12.0 GHz - Experimental Radar Cross Section Measurement System
7125-8400 MHz - Microwave and Communications Links
7250-8400 MHz - Sure Comm (Part of the Jam Resistant Secure Communications [JRSC] Program)
8290-8390 MHz - Philco LC 8D
14.4-15.35 GHz - Microwave Data and Communications Links

US ARMY (ARMY)

The Army's use of the electromagnetic spectrum is growing significantly, particularly by noncommunications emitters. Significant new noncommunications uses include a laser individual training system, ground and airborne radars, sensors, and navigational devices. This equipment is used in many diverse fields, from training to air traffic control, intelligence gathering, surveillance, early warning, target acquisition, guidance of munitions, and meteorological predictions. Mobile satellite terminals will be placed worldwide to provide additional means of command and control and pass critical communications to support Army missions.

Army aviation activities utilize the electromagnetic spectrum for communications, data links, air navigation, and related radar systems. The aviation-related communications-electronics (C-E) equipment is operated from ground stations and from fixed- and rotary-wing aircraft as appropriate.

The US Army Corps of Engineers (Civil Works Directorate) uses radio frequencies from 2-9400 MHz for voice communications, data collection, relay systems, Raydist surveying, radar, TV monitoring, and telemetry. Radio is the only communications link to many remote areas, as well as areas where land

lines are destroyed during catastrophic conditions. It is also used for communications between the widely separated division and district offices and flood-control dams. Radar and TV are used as an aid in scheduling and controlling canal traffic. Telemetry is used in the collection of hydrological and meteorological data. Relay systems are used to extend line-of-sight communications in remote areas. Certain frequencies are retained exclusively throughout the US for the Corps so that, in emergencies, equipment may be shifted and immediately operational on arrival.

Future Plans

The Army's decentralized structure in the areas of basic, exploratory, and conceptual research invites flexible investigation of the bands in the 947-17,700 MHz frequency range for Army applications. Under the Army's decentralization policy of delegating these research functions to various commands and laboratories, flexibility in the selection of frequency assignments is encouraged in the scientific investigation of supporting weapons, data exchange, communications, and electronic warfare systems. Little effort is made to direct long-range research to specific frequency bands before the conceptual stage evolves into a specific equipment approach that is submitted to the IRAC Spectrum Planning Subcommittee (SPS).

The Army's keen interest in the 947-17,700 MHz frequency range is partly due to the increasing congestion of the lower bands occupied by non-Government users. Other reasons for their interest in this frequency range are their improved directivity and wideband transmission capabilities, and the improved performance possible with state-of-the-art technology.

DEPARTMENT OF COMMERCE (DOC)

The DOC, in its mission to promote full development of the economic resources of the US, requires radio frequency spectrum to provide essential services to the public and other agencies of the Government. Within the DOC, the largest user of the radio spectrum is the National Oceanic and Atmospheric Administration (NOAA) that has the mission of managing, conserving, and

monitoring marine resources, and predicting atmospheric and marine conditions for the protection of life and property.

Assignments

Some of the most critical uses of the spectrum (radiosondes and meteorological radars and satellites) are outside the fixed and mobile service allocations and are not included in this report. There are 4579 total DOC assignments in the GMF. TABLE 4-1 lists the 72 assignments in the bands covered by this report. It should be noted that the table includes those areas of the spectrum available for Government, non-Government, and shared use for fixed or mobile service allocations.

Each of the fixed links in TABLE 4-1 has one transmitter and one receiver, and requires continuous 24-hour-per-day access.

Future Plans

NOAA's Meteorological Satellite Program objective is to maintain two geostationary satellites (GOES-East, GOES-West) and two polar orbiting satellites (the TIROS-N series). Because of a recent orbiting satellite failure, only one GOES satellite is fully operational. While the number and location of fixed-link operations may vary in future years, no major changes are expected, and the total number of meteorological satellites is expected to remain about the same. Future requirements will no doubt include additional terrestrial data links.

TABLE 4-1

DOC FIXED AND MOBILE ASSIGNMENTS IN THE 947-17,700 MHz BANDS

(Page 1 of 2)

Frequency (MHz)	Number of Assignments	Function
1700-1710	2	TIROS-N METSAT Downlinks - provide pictures of the earth to multiple receive points, receive earth stations operated by both private sector and Government; total number unknown
1710-1850	8	Fixed - 4 environmental research radar remoting; 2 data links for remoting of HF coast station; 2 Tsunami warning links
2200-2290	1	Space Telemetering - space station alternate downlink channel; from two GOES; METSATS; infrequent use
2200-2290	2	Flight Telemetering Mobile Stations - Telemetry of atmospheric data from high altitude balloons; not in use
7125-7190	2	Fixed - Full-time meteorological (MET) radar remoting data link
7190-7235	8	Fixed - Full-time MET radar remoting data link

METSAT = Meteorological Satellite

TABLE 4-1

(Page 2 of 2)

Frequency (MHz)	Number of Assignments	Function
7190-7235	8	Fixed - Full-time MET radar remoting data link
7300-7450	3	Fixed - 2 full-time MET radar remoting data links and 1 full-time GOES METSAT terrestrial data link
7550-7750	13	Fixed - 12 earthquake research data links and 1 GOES METSAT terrestrial data link
7750-7900	7	Fixed - 6 MET radar remoting data links and 1 GOES METSAT terrestrial data link
7900-8025	7	Fixed - 6 earthquake research data links and 1 administrative communications link
8025-8175	7	Fixed - 2 MET radar remoting data links, 1 earthquake research data link, and 1 GOES METSAT terrestrial data link
8175-8215	3	Fixed - 2 MET radar remoting data links and 1 GOES METSAT terrestrial data link
8215-8400	10	Fixed - 1 administrative communications link, 1 GOES METSAT terrestrial data link, 6 earthquake research data links, and 2 MET radars remoting data links

US COAST GUARD (USCG)/DEPARTMENT OF TRANSPORTATION (DOT)

US Coast Guard missions include maritime and recreational boating safety, search and rescue services, maritime law enforcement, marine environmental protection, port safety and security, aids to navigation, marine science activities, enforcement of offshore fishery laws, suppression of smuggling and illicit drug trafficking, icebreaking operations (both domestic and in the polar regions), maintaining a state of military readiness, and operating vessel traffic systems.

Radio frequencies are assigned for a variety of USCG operations including for a network of about 563 ship-to-shore radio stations for safety and distress communications with the general maritime community and for command and control of its own fleet of about 255 vessels and 2,100 smaller, radio-equipped rescue craft. Also, a network of 26 aeronautical radio stations for operational control of its fleet of about 200 aircraft, a national network of about 200 radiobeacon stations used primarily by small recreational and commercial vessels operating in coastal waters, and an international network of 40 LORAN and 2 Omega radionavigation stations used primarily by larger vessels at sea and by air and surface units of the armed forces.

Additional Department of Transportation components fulfill, through the use of telecommunications, mission requirements to promote safety related to highways, railroads, mass transit, the St. Lawrence Seaway and other programs.

Assignments

The USCG/DOT verified that the assignments listed in the GMF accurately reflect their access to the spectrum. The number of equipments in each band and the access they require are listed in TABLE 4-2.

TABLE 4-2

USCG/DOT FIXED FREQUENCY ASSIGNMENTS

Frequency (MHz)	Station Class	Equipments	Access Required
1710-1850	Fixed	88	Instantaneous
2200-2290	Fixed	28	Instantaneous
7125-8500	Fixed	61	Instantaneous

Future Plans

The USCG/DOT projects an annual growth of 20 percent in support of vessel traffic systems and fixed backbone operations.

DEPARTMENT OF ENERGY (DOE)

The DOE uses approximately 6000 radio frequency assignments from the low frequency range (76.5 kHz) through the laser frequency range (585 THz) to support its functions of electrical power transmission and marketing, nuclear and national security programs, and petroleum reserves. In addition, DOE is responsible for the operation of more than 1300 power-line-carrier circuits.

The DOE, through its power marketing administrations, markets electrical energy generated at 123 Federal hydroelectrical projects from Alaska to the east coast. To protect, control, and maintain these extensive networks, DOE uses more than 1300 power-line-carrier circuits from 8 through 496 kHz and 2190 assignments in the HF, VHF, UHF, and SHF bands for fixed, land mobile, aeronautical mobile, mobile, and METSAT services. The transportation of electrical energy from the generating plants to the load centers and the interconnection of bulk electrical power supply systems for reliability and adequacy have resulted in the development of extremely complex national networks aimed at the optimum economic configuration. These systems have, as integral and critical parts, extensive telecommunications for voice and

data. They are the nerve systems between control centers and many hundreds of generating stations, switching stations, and substations required to operate harmoniously as an interrelated and interconnected whole. These telecommunications facilities must be of the highest level of reliability, economically and technically feasible, and must be instantly available for the successful operation of the nation's electrical power systems.

The DOE uses over 3700 assignments for voice, data, and video in the MF, HF, VHF, UHF, and SHF bands to support nuclear and national security efforts. Five national laboratories, eight production plants, and the Nevada Test Site play significant roles in the design, development, engineering, production, surveillance and testing of nuclear weapons. Supporting these facilities are radio systems in the radionavigation, fixed, mobile, land mobile, aeronautical mobile, maritime mobile, radiolocation, and experimental services.

The Strategic Petroleum Reserves Program provides storage and retrieval facilities for imported crude oil. It is controlled from New Orleans, LA, and has terminal and storage facilities located at six sites along the Gulf Coast in Louisiana and Texas. The complex has five VHF/FM radio networks that cover the local area around each of the sites. Each site also has a radio paging system, and there is a microwave link for pipeline control. The program uses 53 assignments in the VHF and UHF bands in the fixed, land mobile, and maritime mobile services.

Assignments

All listings in the GMF for the DOE in the 947-17,700 MHz bands are accurate and reflect spectrum use in support of weapons and test programs for the DOD as mandated by the Atomic Energy Act of 1954 and the electrical power programs dictated by Public Law 95-91 of October 1977. A listing, by band, of the number of assignments and number of equipments is shown in TABLE 4-3.

TABLE 4-3

DOE FREQUENCY ASSIGNMENTS IN THE 947-17,700 MHz BANDS

Frequency Band (MHz)	Assignment Use	Number of Assignments	Number of Equipments[a]
947-1680	Power Marketing	1	20
	Nuclear Programs[b]	49	1078
	Subtotal----------	50	1098
1710-1850	Power Marketing	217	776
	Nuclear Programs[b]	60	228
	Strategic Petroleum Reserves	1	2
	Subtotal----------	278	1006
2200-2400	Nuclear Programs[b]	266	2173
7130-8900	Power Marketing	796	1622
	Nuclear Programs[b]	108	1306
	Subtotal----------	904	2928
9200-17700	Power Marketing	1	8
	Nuclear Programs[b]	57	312
	Subtotal----------	58	320
	TOTAL----------	1681	7991

a. Transmitters and receivers.
b. The number of equipments in this band may vary as they are tuneable and/or expendable and are dependent upon the exigencies of scientific missions involved.

Future Plans

The FCC deregulation actions and the divestiture of AT&T assets are influencing DOE's planning for its future requirements in this band. DOE is studying the replacement of existing, leased telecommunications services at field offices with contractor-installed and -operated microwave systems. At this time, it is not possible to complete the study under the provisions of the Office of Management and Budget (OMB) Circular No. A-76 (revised) to determine whether the spectrum support requirements will be in Government or non-Government bands.

FEDERAL AVIATION ADMINISTRATION (FAA)

The mission of the FAA is to provide for the safe and expedient movement of aircraft, both civilian and military. In so doing, it uses radio frequencies for communications, radionavigation, and radar. Radio frequencies are assigned for use at approximately 3,808 air/ground communications sites, 817 instrument landing system (ILS) facilities, 940 en-route and terminal VHF omnidirectional ranges, and 321 radar stations.

Assignments

FAA use of the 947-17,700 MHz portion of the spectrum is accurately recorded in the GMF and is summarized in TABLE 4-4.

In addition to the existing systems listed in the GMF, there are several other serious contenders for future spectrum usage. FAA is using three RF systems in the bands of concern. These are point-to-point microwave (PT-to-PT MW) links between 1710-1850 MHz, radar microwave links (RML) between 7125-8400 MHz, and the television microwave links (TML) between 14.4-15.35 GHz.

The point-to-point links are used for the transfer of voice and data between major facilities and from remote facilities to major facilities. The RMLs are used to send en route radar information to appropriate air route

TABLE 4-4

FAA FREQUENCY ASSIGNMENTS IN THE 947-17,700 MHz BANDS

Frequency	System	Spectrum Access	No. of Transmitters/ Receivers[a]	No. Planned Transmitters/ Receivers[a]
1710-1850 MHz	PT-to-PT MW	Instantaneous	228	2280
7125-8400 MHz	RML	Instantaneous	3633	4000
14.4-15.35 GHz	TML	Instantaneous	147	1470

a. The numbers shown in the transmitter/receiver columns reflect the number of combinations involved; e.g., the figure 3633 shown for existing RML means 3633 ground transmitters and 3633 ground receivers.

traffic control centers. These systems currently span about 26,000 km. The TMLs are used to transmit remote radar information to tower displays at one or more satellite airports.

Future Plans

Future plans include the expansion of the RMLs. A number of bands are being considered for airport telecommunications networks and extensions of the RML "backbone" system including 2.2-2.29 GHz, 4.4-4.99 GHz, and 14.4-15.35 GHz. The 750 existing RMLs will be replaced and an additional 250 installed.

Two new systems are in the early planning stages, and though they do not have designated frequency bands, it is probable that they will end up between 947 and 17,700 MHz. The application of packet radio technology is being considered to help eliminate cables at low activity airports. These may number up to approximately 400 systems. Also, a remote maintenance monitoring system is being considered for monitoring equipment at air facilities.

TABLE 4-4 shows FAA's existing and planned spectrum use in the fixed and mobile bands of the 947-17,700 MHz portion of the radio frequency spectrum. Future use is based on the FAA's National Airspace System Plan that covers up to the year 2000.

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

FEMA was created to provide a single point of accountability for all Federal emergency preparedness, mitigation, and response activities. The agency is chartered to enhance the multiple use of emergency preparedness and response resources at the federal, state, and local levels of government in preparing for, and responding to, the full range of emergencies (natural, manmade, and nuclear) and to integrate into a comprehensive framework activities concerned with hazard mitigation, preparedness planning, relief operations, and recovery assistance.

The National Emergency Management System (NEMS) consists of the total telecommunications and data processing resources necessary for FEMA to accomplish its assigned peacetime and wartime responsibilities and meet all established operations requirements.

Assignments

The information in the GMF accurately and completely reflects FEMA's current access to the spectrum in the 947-17,700 MHz bands. Due to security restrictions, only a limited amount of data is available on a case-by-case basis on the number of operating, transmitting, and receiving devices associated with a given frequency assignment.

Future Plans

Future requirements include operations in the 1710-1850 and 7125-8400 MHz bands for the line-of-site radio and satellite communications subsystems of the Direction, Control, and Warning Communications System (DCWCS).

GENERAL SERVICES ADMINISTRATION (GSA)

GSA's mandated mission performed in the areas of telecommunications, information resources management, and protection of life and property is to direct and coordinate a comprehensive Governmentwide program for managing, using, and procuring automatic data processing (ADP), office information/security systems, and telecommunications equipment and services to meet GSA's Federal information processing and protection needs.

GSA establishes policy and provides the Government with an economical and efficient system for the management of its property and records, including construction and operation of buildings, procurement and distribution of supplies, utilization and disposal of property, transportation, traffic, and communications management, stockpiling of strategic materials, and the management of the Governmentwide ADP resources program.

Assignments

The information contained in the GMF accurately and completely reflects GSA's current access to the spectrum with the exception of recently requested frequency assignments for Athens, GA (2215 and 2216 MHz), which are not yet listed in the data base.

The number of operational transmitting and receiving devices associated with a given frequency assignment is as follows: for each frequency listed in the GMF, there is a transmitting and a receiving device assigned that operates point-to-point full-duplex. The required type of spectrum access is a full-time, full-period operation (24 hours per day).

Future Plans

GSA contemplates having future requirements created as a result of the deregulation of American Telephone and Telegraph (AT&T) and the competitive procurement process.

DEPARTMENT OF HEALTH AND HUMAN SERVICES (HHS)

The principal user of radio spectrum in the HHS is the Public Health Service (PHS). The Indian Health Service (IHS), a component of the Health Resources and Services Administration, a PHS operating agency, is responsible for about 80% of the approximately 1400 frequency assignments utilized by HHS. The IHS supports the delivery of health care to Native Americans by using radio communications to emergency vehicles, remote health stations, and mobile health units. Radio is also used extensively for paging systems to communicate with key medical personnel. The frequencies 1718.0 and 1847.0 MHz are used for radio communications to support a comprehensive biomedical communications system on the Papago Indian Reservation in Arizona, which provides improved health care and faster emergency service to Indian beneficiaries of the IHS in remote areas of the reservation.

Assignments

The information in the GMF accurately and completely reflects HHS usage of the following frequencies: 1718.0 MHz, 1736.0 MHz, 1740.0 MHz, 1837.0 MHz, 1843.0 MHz, and 1847.0 MHz. These frequencies are used to operate six Farinon Model TR 2000 transmitters and receivers. Instantaneous access is required for HHS frequency assignments.

Future Plans

At this time, there are no additional requirements for future use of the 947-17,700 MHz band.

DEPARTMENT OF INTERIOR (DOI)

DOI is charged with the conservation and development of the nation's natural resources. It has a wide variety of radio operations throughout the spectrum, which are distributed among nine operating bureaus that have diverse

missions aimed at serving the public and protecting the country's natural resources. The major activities requiring RF spectrum are point-to-point fixed base station and mobile radios for land management and protection and development of natural resources as required by the Bureau of Land Management, and water management, control, and distribution by the Bureau of Reclamation, a major factor in the growth and economy of the west. Telemetry, land mobile, and point-to-point radios are essential to the operation of the Bureau's 320 water storage dams and reservoirs, 344 diversion dams, 82,000 km of carriage and distribution channels and canals, and 145 very large pumping stations.

Assignments

The information contained in the GMF accurately and completely reflects DOI's access to the spectrum in the 947-17,700 MHz bands.

US INFORMATION AGENCY (USIA)

USIA, formerly the US International Communication Agency (USICA), is responsible for the Government's overseas informational and cultural programs, including the Voice of America and the Fulbright Scholarship Program. USIA is known overseas as the US Information Service (USIS). USIA is responsible for conducting international information programs, including exchange programs designed to build bridges of mutual understanding between the people of the US and the rest of the world. USIA engages in a wide variety of communication activities, from academic and cultural exchanges to press, radio, television, film, seminar, library, and cultural center programs abroad, to accomplish its goals of strengthening foreign understanding of American society and support of US policies.

USIA also has the responsibility to report to the President and the Secretary of State, as well as to advise the National Security Council, on worldwide public opinion relevant to the formulation and conduct of US foreign policy.

Assignments

USIA states that the GMF is an accurate record of their spectrum use. They have 46 assignments between 7125-8400 MHz.

DEPARTMENT OF JUSTICE (Justice)

The Department of Justice represents the public in enforcing the law. Organizational Units of Justice, which use or coordinate use of the radio frequency spectrum, are:

1. Bureau of Prisons (BOP)
2. Drug Enforcement Administration (DEA)
3. Federal Bureau of Investigation (FBI)
4. Immigration and Naturalization Service (I&NS)
5. Justice Management Division
6. United States Marshals Service (USMS).

Radio systems are used by Justice to serve the national security, to safeguard life and property, and to support crime prevention and law enforcement. These systems consist primarily of land mobile radios. Tactical communications among investigative, protective, and enforcement personnel in the field, as well as liaison communications with cooperating law enforcement organizations, are essential operational tools. Mission success, as well as safety of life and property, is frequently dependent upon the availability of radio communications systems.

Assignments

Justice's information in the GMF relating to the 947-17,700 MHz band is accurate and complete. They operate one transmitter and one receiver for each RF assignment in the 947-17,700 MHz band listed in the GMF.

Justice requires immediate (instantaneous) response (access) from these communications facilities to perform its mandated mission functions and provide for the safety of its agents and officers.

Future Plans

Fixed radio communications links in the 947-17,700 MHz band are, and will be, required by Justice as its land mobile radio systems have been, and will be, upgraded to provide voice privacy protection.

US NAVY (USN)

The USN includes the Executive Office of the Secretary of the Navy, the Office of the Chief of Naval Operations, the Headquarters US Marine Corps, and other commands and activities located at the seat of the Government; the entire operating forces of the Navy and Marine Corps, including reserve components; all shore and field activities under the control of the Secretary of the Navy; and, in time of war when the President so directs, the US Coast Guard.

The Navy fleets are a vital part of our defense establishment in peacetime, as well as in wartime. Their mission is to perform specific functions in connection with area defense, rapid-response strike forces, control and protection of shipping, search and rescue, harbor defense, continental air defense, logistics support, and domestic emergencies.

Navy and Marine Corps Air Stations support shore-based aircraft and fleet-deployed aircraft squadrons. These aircraft are equipped with communications transmitters and receivers, and equipment such as search radars, identification-friend-or-foe (IFF) systems, navigational-aid systems (NAVAIDS), antisubmarine-warfare (ASW) systems, electronic-countermeasures (ECM) systems, and weapon control systems.

The Naval Telecommunications System (NTS) provides command, control, and communications support to the Navy and Marine Corps operating forces and other military activities. The NTS must be responsive to the requirement for the

command, control, and support of unilateral naval operations, as well as joint operations undertaken by a Unified Command. The NTS is a worldwide system configured to support naval and joint forces in those ocean areas where the presence of US military and naval power has been determined essential by the Joint Chiefs of Staff or other higher authority. The basic shore elements of the system are the Naval Communications Area Master Stations and their supporting naval communications stations. They serve the operating forces and provide a DCS interface.

Operation of communications-electronics equipment, systems, and subsystems is a necessity to support, coordinate, and control Marine Air/Ground Task Forces and other independently operating Fleet Marine Force (FMF) units. The equipment and systems that require frequency spectrum, are tactical radios, sensors, battlefield surveillance radars, air defense radars, tactical data link terminals, and satellite communication links.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA's basic mission is to carry out the provisions of Government directives and related legislation that relate to aeronautical and space research and development activities. In addition to NASA's expanding space transportation system (Space Shuttle), the Tracking and Data Relay Satellite System (TDRSS), NASA's proposed space station program, and NASA's deep space programs (e.g., VOYAGER and GALILEO), NASA and Canada's Department of Communications have signed an arrangement to cooperate in the definition of a space program that could lead to the development of commercial satellite service to meet mobile communications needs in both countries. This approach is in accordance with the President's commercialization of space policy and could lead immediately to a commercial satellite system and simultaneously allow for the development of advanced research and development to support second generation systems.

Assignments

The GMF accurately reflects NASA's current use of the 947-17,700 MHz bands. In general, NASA has approximately 1500 assignments in the GMF and

about 50% are contained in the 947-17,700 MHz bands (i.e., approximately 750 transmitters and 950 receivers).

In general, NASA's access can be categorized as frequent, and in most cases, ranges from scheduled to continuous.

Future Plans

NASA has indicated that its future requirements will expand in order to carry out its mission. There will also be a gradual increase in the use of the deep space allocations (5.2-10.9 GHz).

NATIONAL SCIENCE FOUNDATION (NSF)

Organizations associated with the NSF use the radio spectrum both directly and indirectly to support basic scientific research. Spectrum is used indirectly to provide communications for experiment coordination and for telemetry of data. Radio astronomers use the spectrum directly, collecting data on natural radio frequency emissions from cosmic sources in order to learn the composition and physical conditions in those sources. To summarize the current radio astronomy use of the spectrum from 947-17,700 MHz, radio astronomy stations in the US use all of the frequency bands that appear in the international and national allocations tables either as formal allocations to radio astronomy or as footnotes that notify use. Major radio astronomy stations using the 947-17,700 MHz frequency range are located in Puerto Rico, Massachusetts, West Virginia, New Mexico, and California.

Assignments

The NSF is concerned with access to the spectrum for radio astronomy. Such information is not contained in the GMF, making an important data base deficient in this regard. Likewise, statistical material on spectrum utilization never includes radio astronomy use because the statistics are based on assignments, and radio astronomy stations do not have assignments.

Many NSF frequency authorizations are temporary in that they are intended to provide support for a short-term scientific experiment. During the course of the experiment, the assignments are used randomly, 24 hours per day, 7 days per week. The following is a list of the ongoing functions served by NSF assignments in the fixed and mobile bands from 947-17,700 MHz (with the approximate frequency in parenthesis): computer data link (1765,1825 MHz), planetary radar (2380 MHz), plant security (7760, 7850 MHz), and data and control telemetry (8310 MHz).

Future Plans

Construction on a major new radio astronomy telescope is scheduled to begin this year. Known as the Very Long Baseline Array (VLBA), this telescope is comprised of ten antennas, one at each of ten locations in the continental US (CONUS), Hawaii, and Puerto Rico. The VLBA is designed to operate in the radio astronomy designated bands in the following frequency ranges: 312-342, 580-640, 1300-1800, 2100-2700, and 4500-5100 MHz, and 10.1-11.2, 14.4-15.4, 21.0-26.0, and 42.3-43.5 GHz

DEPARTMENT OF STATE

The Department of State advises the President in the formulation and execution of foreign policy. Their primary objective in the conduct of foreign relations is to promote the long-range security and well-being of the US. They determine and analyze the facts relating to American overseas interests, make recommendations on policy and future action, and take the necessary steps to carry out established policy. In so doing, the Department of State engages in continuous consultations with the American public, the US Congress, other US departments and agencies, and foreign governments; negotiates treaties and agreements with foreign nations; speaks for the US in the United Nations and in more than 50 major international organizations in which the US participates; and represents the US at more than 800 international conferences annually.

Assignments

The Department of State has no frequency assignments in the 947-17,700 MHz band; however, they have 158 assignments in other bands of the spectrum.

DEPARTMENT OF TREASURY (TREASURY)

Treasury is responsible for enforcement of Federal laws pertaining to protection of the President and other designees, as well as laws pertaining to counterfeiters, forgers, smugglers, moonshiners, gun-law violators, tax evaders, etc.

Radio frequency devices such as portables, mobiles, base stations, lasers, infrared beams, microwave sensors, ground intrusion sensors, and radars play a vital role in the detection and apprehension of criminals, and the safety and welfare of law enforcement officers. Radio communications are vital for the administration and management of the US Secret Service, US Customs Service, Internal Revenue Service, and the Bureau of Alcohol, Tobacco and Firearms, as well as the nonlaw enforcement bureaus such as the Bureau of Engraving and Printing, the Bureau of the Mint, the Comptroller of the Currency, and the Federal Law Enforcement Training Center. Frequency support is also provided to the Federal Reserve System.

Assignments

Treasury's assignments recorded in the GMF are accurate and complete for the 947-17,700 MHz bands.

Future Plans

Treasury has had minimal requirements in the bands above 947 MHz. For many years, they have supported the Federal Government's need for land mobile 25-kHz channels in the 800-900 MHz reserve spectrum.

Now, Treasury has substantial future requirements above 947 MHz. These requirements for additional spectrum are based on the fact that current Treasury land mobile digital systems utilizing 12 kb/s digital signals will not pass digital information over existing telephone lines. Therefore, its need for fixed links to satisfy current and planned systems requirements will increase.

US POSTAL SERVICE (USPS)

USPS became a member of the IRAC September 11, 1979. The USPS has a total of 1177 assignments. USPS assignments are used for vehicle control, plant maintenance and mail processing. They also make extensive use of radio frequencies for law enforcement purposes.

Assignments

The USPS does not use the bands between 947 and 17,700 MHz.

Future Plans

At the present time, USPS has no plans for use of the 947-17,700 MHz bands.

VETERANS ADMINISTRATION (VA)

The VA provides health care, education, insurance, and mortgage benefits for US military veterans, and their widows and orphans. To provide expeditious health care, the VA has over 1933 radio frequency assignments for operation in radio paging, two-way radios, wireless microphones, cardiac telemetry, emergency medical service radio nets, citizens band (CB) radio, vehicular radar, microwave video transmission systems, and HF emergency contingency radio nets.

VA research is continuing on the biological effects of microwave radiation, RF devices for the blind and the deaf, and new applications of RF technology to improve health care for the military veterans and their dependents.

Assignments

The VA has 32 assignments in the 7125-8400 MHz band.

Future Plans

The VA anticipates no requirements for increased usage in the 947-17,000 MHz band.

SECTION 5

PLANNED GOVERNMENT USE, BY BAND, IN THE 947-17,700 MHz BANDS

GENERAL

This section provides data on spectrum use, by bands, reflecting government plans. The bands recommended in the Phase I report for possible sharing are discussed at the end of this section. Additional information on these bands is given to complete the discussion of sharing. This data is presented in several ways.

Assignments are grouped to show the nature of spectrum use in each band. Fixed and mobile represent all station classes falling into those services. Satellite represents all station classes involving satellites. Radiodetermination represents all station classes within the radiolocation and radionavigation services. Experimental and developmental pertain to all experimental or developmental station classes. Looking at use in these areas also indicates the percentage of use that is actually fixed or mobile and shows the level of experimental and developmental work that often leads to usage growth. The mobile grouping is subdivided into mobile, aeronautical mobile, and telemetry. Mobile represents stations not falling into the other two categories. This is done to reflect the level of telemetry use, which like fixed use, is generally limited in its location (usually test ranges) and may provide an opportunity for greater sharing.

Also, assignment growth is estimated for a five-year period. These estimates were developed by taking GMF assignment counts from 1982 to the fall of 1984 and then estimating, by a straight-line method, the growth rate over the next five years. The year 1982 was chosen because GMF data was not complete for all the bands prior to that time. These estimates are not intended as predictions, but are given to show the assignment growth that will result if recent trends continue. Specific growth figures provided by Government agencies were combined with the straight-line estimate when

available. Estimates for the two bands where this method was used (1710-1850 MHz and 14.5-15.35 GHz) represent something closer to actual projections.

Equipment-to-assignment ratios (E/As) are calculated to gain an appreciation of present and future use. For this report, these ratios were calculated in the following manner. A data file of those assignment records with a completed NRM field was created from the GMF. This file did not include the assignments of those agencies that submitted equipment counts for this report. The equipment counts in the responses were added to the counts contained in the NRM field. The total equipment count was then divided by the number of assignments related to the equipment counts.

A concept termed equipment density is mentioned in order to provide a relative estimate of spectrum congestion. For this report, the discussion of spectrum use is restricted to the US and its possessions. Because the assignments are all restricted to the same area, a relative national density can be calculated based upon assignments per given frequency range. A dominant necessary bandwidth was chosen for each band. This bandwidth, taken from the GMF, was the one most commonly found in the records or, in cases where there was a somewhat even distribution, represented a median. This dominant necessary bandwidth was divided into the total frequency range in a specific band to give a number of nonoverlapping sectors or channels. The number of assignments or equipments divided by this number of channels gives a relative density per channel. The GMF is not really designed to provide the data necessary to determine a true density. However, such a concept is important to the analysis phase of a spectrum resource assessment. A study is needed to determine the data required for these analyses, and that study should be followed by changes to the GMF. Though there are limitations to the method used in this report to determine density, it does allow a cursory comparison of the bands with respect to level of use. Estimates based upon assignment trends are also provided on these numbers to show trends in spectrum congestion.

Data compiled from agency submissions, the NTIA Systems Review File, and the ECAC FAL are presented to demonstrate Government plans including new systems being introduced to, or planned for, the spectrum. These two files, one Governmentwide and one limited to DoD, list systems for which spectrum

support has been requested during one or more of the system procurement stages. Systems were included in this report if they were not yet operational and support had been requested after January 1980. No classified information is provided, so it must be understood that a number of operational or planned systems are not shown.

The discussion for each band is completed by an evaluation of sharing potential.

BANDS NOT RECOMMENDED FOR FURTHER REVIEW OF SHARING POSSIBILITIES BY THE PHASE I REPORT

1427-1535 MHz

The 1427-1535 MHz band is a shared band. Government assignments have been predominantly used for telemetry. Assignments break down into the following percentages:

Fixed	1%
Mobile	88%
Aeronautical Mobile (3%)	
Telemetry (85%)	
Experimental or Developmental	11%

The growth in the number of assignments has been averaging 24 per year (see Figure 5-1) . The assignment density (assignments per channel), using a dominant necessary bandwidth of 1 MHz is estimated to grow from 7.8 to 8.5 by 1990.

The correlation between the number of equipments and assignments in this band is 5.1 to 1. The equipment density is estimated to rise from 40 to 45 by 1990.

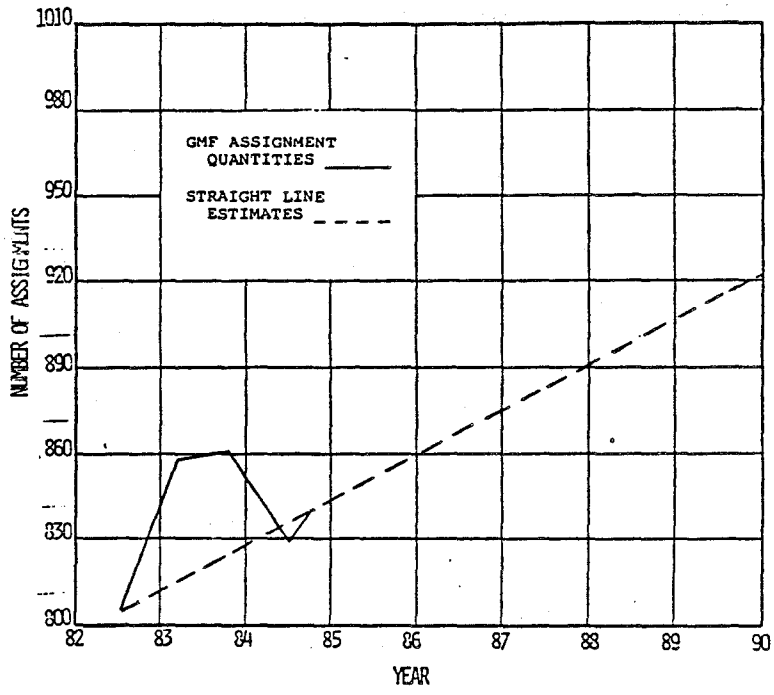

Figure 5-1. Assignment growth trend for the 1427-1535 MHz band.

The following are the plans for this band by agency:

Army - continued tactical training and research and development on radio relay equipment, continued use of telemetry at test ranges; planned systems -- AN/GRC-103(V)4

DOE - continued data communication in nuclear research and development programs

FAA - continued use of aeronautical telemetering

NSF - a major new radio astronomy telescope VLBA will operate across this band.

The following systems were identified as planned systems within the NTIA Systems Review File or the ECAC FAL.

AN/DSQ-X Telemetry System	Stage 3	Air Force
AN/USQ-X Scoring System	Stage 2	Navy
Microcom T4H Telemetry	Stage 2	Army
Extended Range Antiarmor Munition (ERAM)	Stage 3	Army
Vector T202LE Telemetry	Stage 3	Army
MTM-3WL Telemetry	Stage 3	Navy

This band is heavily used by both Government and non-Government for telemetering purposes. Provision has been made for the non-Government fixed service on a secondary basis from 1427-1435 MHz. Heavy use of mobile telemetry restricts the use of fixed systems due to potential interference problems. There does not appear to be a need to change allocations in this band.

1700-1710 MHz

The 1700-1710 MHz band is a shared band with few assignments. These assignments break down into the following percentages:

Fixed	33%
Satellite	33%
Experimental or Developmental	33%

The growth in the number of assignments has been averaging 0.4 per year (see Figure 5-2). The assignment density (assignments per channel) using a dominant necessary bandwidth of 3 MHz is estimated to grow from 1.8 to 2.4 by 1990.

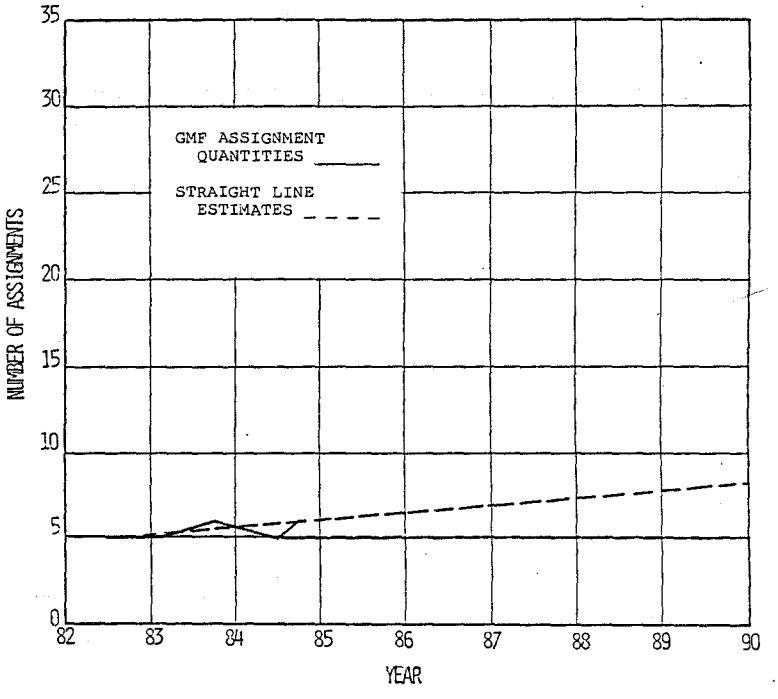

Figure 5-2. Assignment growth trend for the 1700-1710 MHz band.

The correlation in the number of equipments and assignments in this band is 1 to 1. Therefore, the equipment density will equal the rise in assignment density.

The following are the plans for this band by agency.

DOC - METSAT use is expected to remain stable

Justice - Increased use to absorb overflow of requirements which cannot be met in the 1710-1850 MHz band is expected.

NSF - a major new radio astronomy telescope VLBA is planned to operate across this band.

Though the numbers of assignments and projected growth is low, this band may soon be required to serve as an overflow band for fixed systems previously in the 1710-1850 MHz band. Footnote G118 requires that spectrum be unavailable in the 1710-1850 MHz band before Government fixed assignments move into this band. The 1710-1850 MHz band is currently heavily used and experiencing high growth, therefore movement into the 1700-1710 MHz band is likely. The possibility of increased satellite activity also creates a situation where changes to the tables may cause difficulties.

The 1710-1850 MHz band is a Government exclusive fixed and mobile band. USDA, DOD, and DOE have the greatest number of assignments. Fixed systems represent a large portion of the current assignments. Assignments break down into the following percentages:

Fixed	78.4%
Mobile	7.4%
Mobile (0.8%)	
Aeronautical Mobile (2.6%)	
Telemetry (4.0%)	
Satellite	9.0%
Experimental or Developmental	5.2%

The growth in the number of assignments has been averaging 433 per year (see Figure 5-3). The assignment density (assignments per channel) using a dominant necessary bandwidth of 1.6 MHz is estimated to grow from 37 to 63 by 1990.

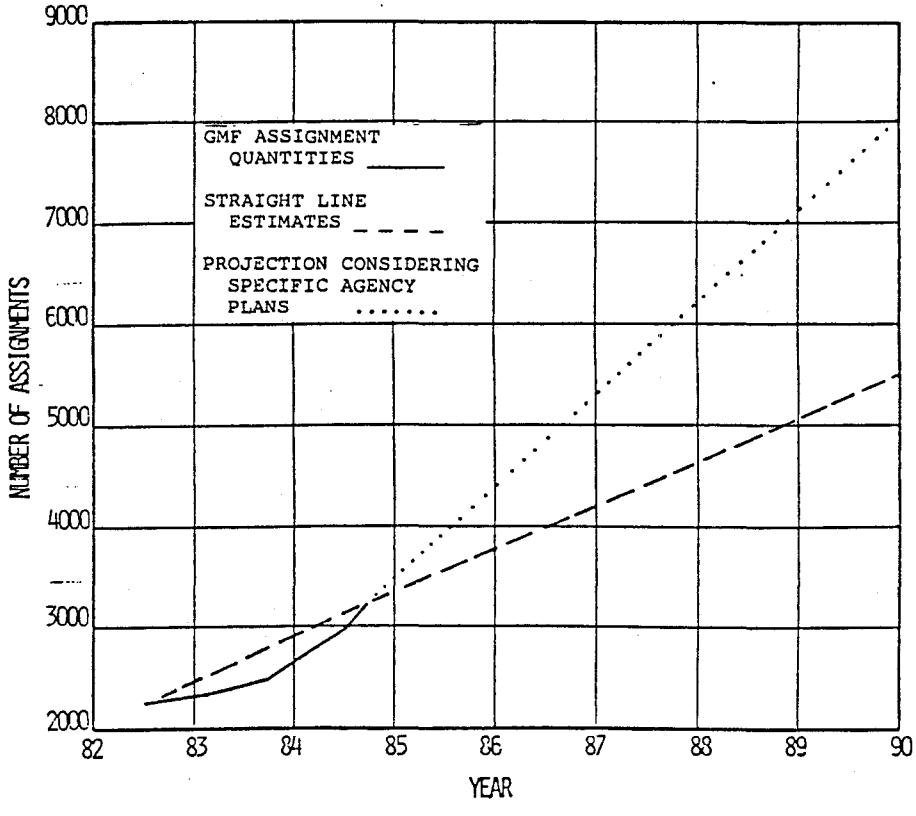

Figure 5-3. Assignment growth trend for the 1710-1850 band.

The correlation between the number of equipment and assignments in this band is 1.8 to 1. The equipment density is estimated to rise from 66 to 113 by 1990. Specific agency plans show that expected growth exceeds the straight line estimates and will increase the density to 165 by 1990.

The following are the plans for this band by agency:

USDA - a growth to 2360 assignments for Forest Service use is expected by 1990

USAF - continued use of tracking, telemetry, and command and control systems

Army - continued use of various microwave and digital communications systems for training in multichannel line-of-sight radio relay, operation of locks and dams, remote control of power facilities, and video and digital data gathering for remotely piloted vehicles

DOC - the number of fixed systems is expected to remain constant

DOE - growth is expected in data transfer for nuclear waste and nuclear research and development programs across the US, additional links for control and operation of power transmission systems are also planned

FAA - the number of airport point-to-point communications systems is expected to grow from 228 to 2280

FEMA - line-of-sight radio subsystem of the Direction, Control and Warning Communications System (DCWCS) will be placed in operation in this band

HHS - continued use of current assignments

Justice - upgrade of current land mobile systems with voice privacy protection is expected

NSF - continued use of computer data links at 1765 and 1825 MHz. A major new radio astronomy telescope is planned to operate up to 1800 MHz

Treasury - continued use of current assignments.

The following systems were identified as planned systems within the NTIA Systems Review File or the ECAC FAL.

Instrumented Test Vehicle	Stage 2 Air Force
AN/USQ-X Scoring System	Stage 2 Navy

Upgraded Packet Radio	Stage 2 Navy, Army, Air Force
Transportable Mobile Ground Station	Stage 2 Air Force
Automated Remote Tracking Station (ARTS)	Stage 2 Air Force
GPS Operational Control Segment (Uplink)	Stage 3 Air Force
High Speed Data Link CTS-710V	Stage 3 Air Force
Interim Data Link System Command Uplink	Stage 3 Army
Charge Coupled Device (CCD) Seeker System	Stage 3 Navy
Hughes Helicopter Video Monitoring System	Stage 3 Army
Vector Miss Distance Indicator	Stage 3 Air Force
Aircraft Space Position Measuring System	Stage 3 Air Force

Heavy use and high projected growth makes sharing of this band infeasible.

2200-2290 MHz

The 2200-2290 MHz band is a government exclusive band used predominantly for telemetry. Assignments break down into the following percentages:

Fixed	13.0
Mobile	56.0%
Aeronautical Mobile (0.8%)	
Telemetry (55.0%)	
Satellite	13.0%
Experimental or Developmental	17.9%

The growth in the number of assignments has been averaging 11 per year (see Figure 5-4). The assignment density (assignments per channel) using a dominant necessary bandwidth of 1 MHz is estimated to grow from 18 to 19 by 1990.

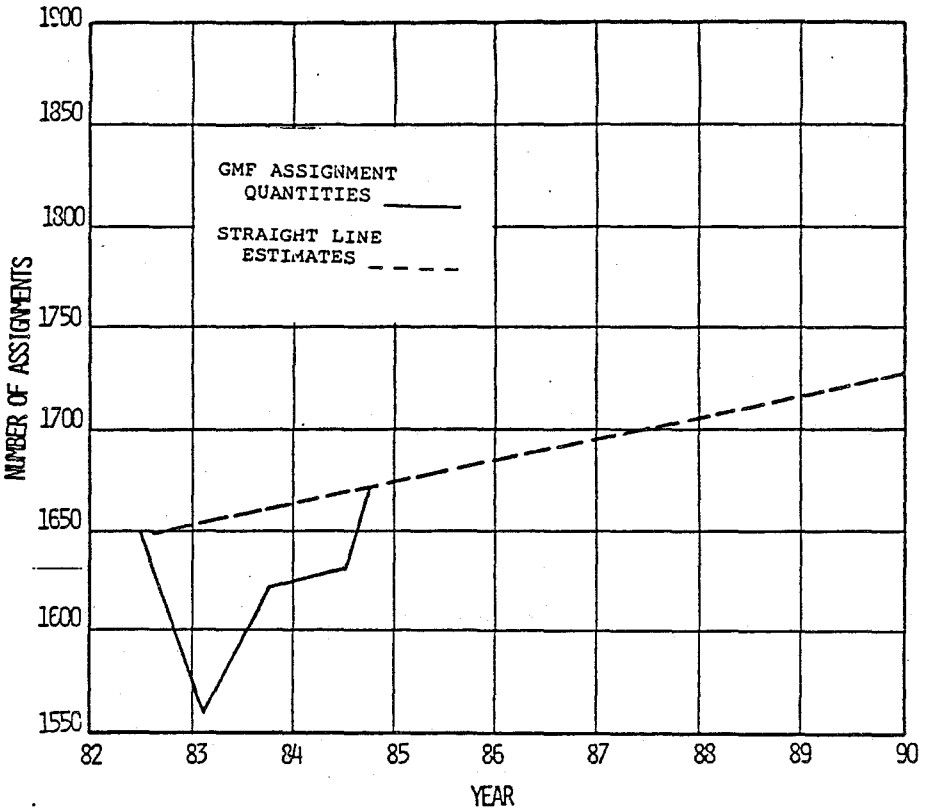

Figure 5-4. Assignment growth trend for the 2200-2290 MHz band.

The correlation between the number of equipment and assignments in this band is 5.4 to 1. The equipment density is estimated to rise from 99 to 102 by 1990.

The following are the plans for this band by agency:

USAF - continued use of tracking, telemetry, and command and control systems

Army - growing telemetry requirements

DOC - no significant changes are expected in telemetry or satellite use

DOE - addition of one data link for the nuclear research and development program in San Francisco, CA

FAA - this band is being considered for FAA's radar microwave link

NSF - no current or planned transmitter use; a major new radio astronomy telescope VLBA is planned to operate across this band.

The following systems were identified as planned systems within the NTIA Systems Review File or the ECAC FAL:

GEOSTAT-A Downlink	Stage 2	Navy
TOPEX Stage 1	NASA	
Instrumented Test Vehicle	Stage 2	Air Force
AN/DSQ-X Telemetry	Stage 3	Air Force
AN/USQ-X Telemetry	Stage 2	Navy
Transportable Mobile Ground Station	Stage 2	Air Force
Automated Remote Tracking Station (ARTS)	Stage 2	Air Force
GPS Operational Control Segment (Downlink)	Stage 3	Air Force
Shuttle TV System	Stage 3	NASA
Vector TM 500S	Stage 2	Navy
Instrumentation and Flight Safety System	Stage 3	Air Force
P80-1 Spacecraft Transponder	Stage 3	Air Force
AN/DKT-4 (XMG-1)	Stage 3	Navy
Improved Hawk Telemetry System	Stage 2	Navy
AMRAAM Telemetry	Stage 3	Air Force
Vector T-102S Telemetry	Stage 3	Navy
Interim Data Link System (IDLS)	Stage 3	Army
AN/DKT-58(V)	Stage 3	Navy
ASW/SOW Stage 3	Navy	
Small Caliber Guided Projectile Telemetry	Stage 2	Air Force

This band is an important band for the Government, with many assignments in the mobile service for telemetering. There is also a considerable number of experimental assignments, along with growing space research and fixed assignments. Though the growth rate since 1982 was gradual, the rate since February 1983 has increased significantly. The band shares the use of 2285-2290 MHz for the TDRSS by a recent footnote. With the present nature of band usage and expanding space research use, this band does not lend itself to increased sharing with non-Government users at this time.

4400-4500 MHz

The 4400-4500 MHz band is a Government exclusive band used primarily for fixed systems. Assignments break down into the following percentages:

Fixed	71.6%
Mobile	9.8%
Mobile (2.1%)	
Aeronautical Mobile (3.0%)	
Telemetry (4.9%)	
Experimental or Developmental	18.6%

The growth in the number of assignments has been averaging 16 per year (see Figure 5-5). The assignment density (assignments per channel) using a dominant necessary bandwidth of 3 MHz is estimated to grow from 7.7 to 10.2 by 1990.

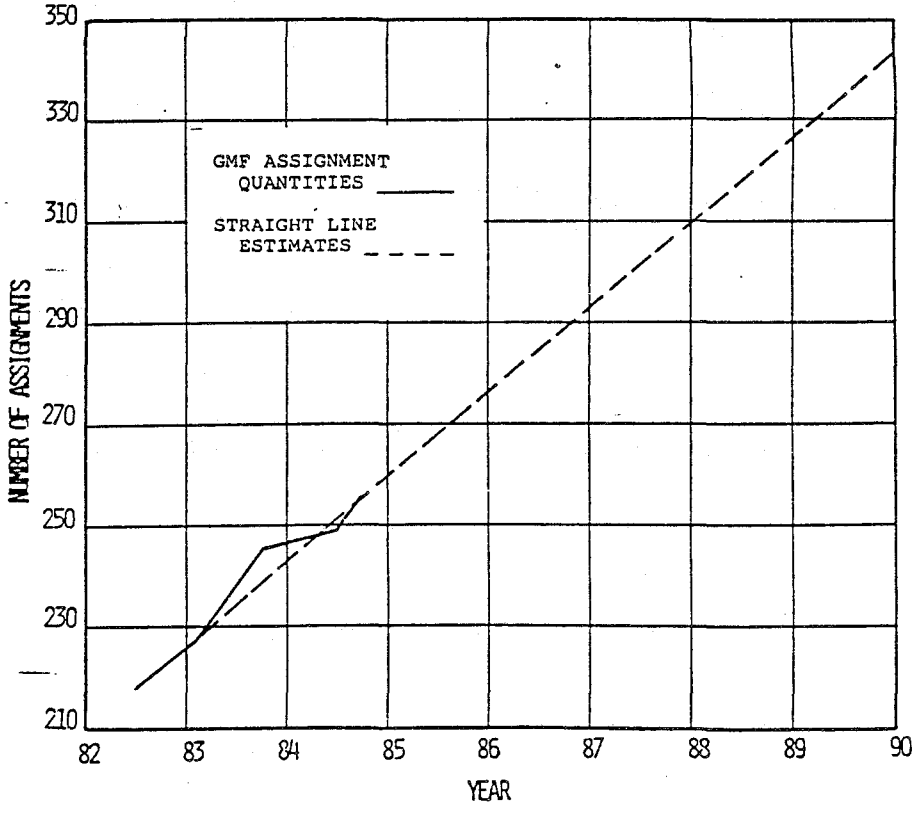

Figure 5-5. Assignment growth trend for the 4400-4500 MHz band

The correlation between the number of equipments and assignments in this band is 17.3 to 1. The equipment density is estimated to rise from 133 to 176 by 1990.

The following are the plans for this band by agency:

Army - continued growth of telemetry and research and development of digital microwave and troposcatter systems

DOE - addition of one fixed link for the nuclear research and development program in San Francisco, CA

FAA - this band is being considered for FAA's radar microwave link.

The following systems were identified as planned systems within the NTIA Systems Review File or the ECAC FAL:

Digital Microwave Radio	Stage 1 Army
Vega 6156/6157 Target Control System	Stage 3 Navy
Type N/R ECM System Command Uplink	Stage 3 Army
RHG-FMR Transmitter	Stage 2 Navy
ICNS RPV Video Downlink	Stage 3 Army

There appears to be room for growth in this band. However, assignments are distributed fairly evenly over the US. Consideration of sharing with the non-Government should be held in abeyance until growth trends can be confirmed.

4500-4800 MHz

The 4500-4800 MHz band is a shared band used predominantly for fixed systems and mobile telemetry. Assignments break down into the following percentages:

Fixed	69.6%
Mobile	17.3%
Mobile (2.0%)	
Aeronautical Mobile (1.0%)	
Telemetry (14.0%)	
Radiodetermination	0.6%
Experimental or Developmental	12.5%

The growth in the number of assignments has been averaging 37 per year (see Figure 5-6). The assignment density (assignments per channel) using dominant necessary bandwidth of 1 MHz is estimated to grow from 1.7 to 2.3 by 1990.

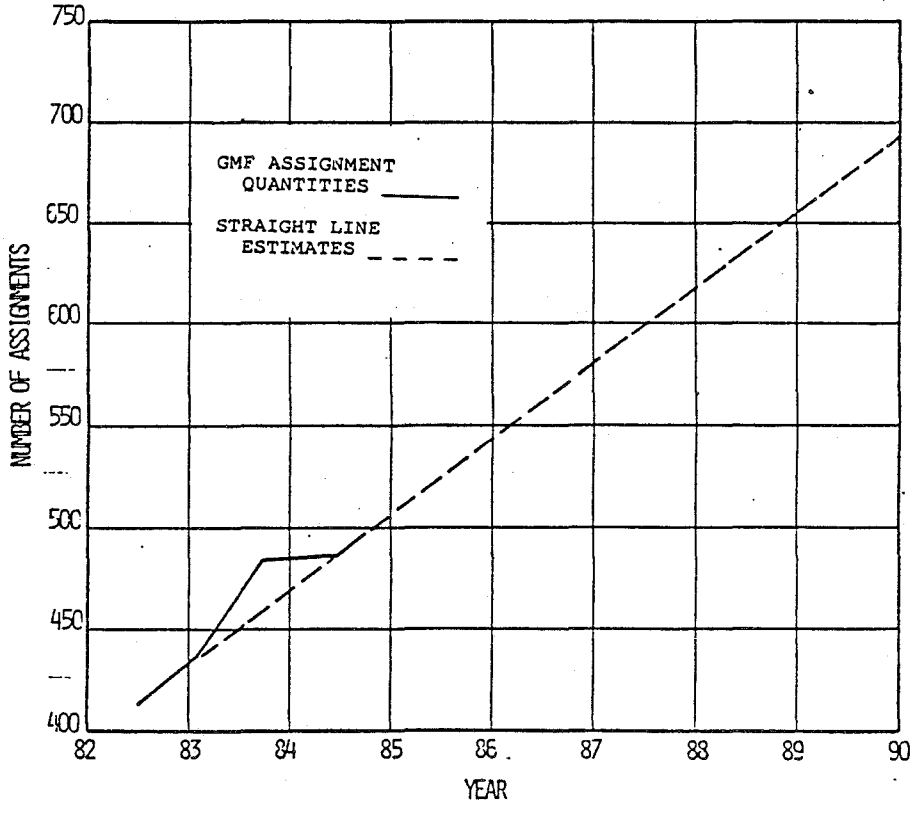

Figure 5-6. Assignment growth trend for the 4500-4800 MHz band.

The correlation between the number of equipments and assignments in this band is 25.7 to 1. The equipment density is estimated to rise from 43 to 59 by 1990.

The following are the plans for this band by agency:

Army - continued growth in the use of tactical line-of-sight microwave and troposcatter communications systems

DOE - addition of one fixed link for the nuclear research and development program in San Francisco, CA

FAA - this band is being considered for the FAA's radar microwave link

NSF - the major new radio astronomy telescope VLBA is planned to operate across this band.

The following systems were identified as planned systems within the NTIA Systems Review File or the ECAC FAL:

Digital Microwave Radio	Stage 1	Army
Vega 6156/6157 Target Control System	Stage 3	Navy
RHG-FMR Transmitter	Stage 2	Navy
ICNS-RPV Stage 2		Army

Most of the assignments in this band are to be the Government fixed service (75%). Tropospheric scatter systems that operate in this band are very important to the military for tactical communication purposes. The new fixed-satellite allocation to non-Government may pose some interference potential to existing systems. This band at present tends to have many assignments in a few geographic areas. There are 15 states with no assignments and another 9 with only one assignment. However, because of the importance of the troposcatter systems, limited sharing is desirable.

4800-4990 MHz

The 4800-4990 MHz band is a Government exclusive band used predominantly for fixed systems. A significant amount of experimentation is being carried

out in this band. Assignments break down into the following percentages:

Fixed	55.0%
Mobile	13.4%
Aeronautical Mobile (2.6%)	
Telemetry (11.0%)	
Radiodetermination	0.3%
Experimental or Developmental	31.3%

The growth in the number of assignments has been averaging 46 per year (see Figure 5-7). The assignment density (assignments per channel), using a dominant necessary bandwidth of 3 MHz, is estimated to grow from 5.3 to 9.1 by 1990.

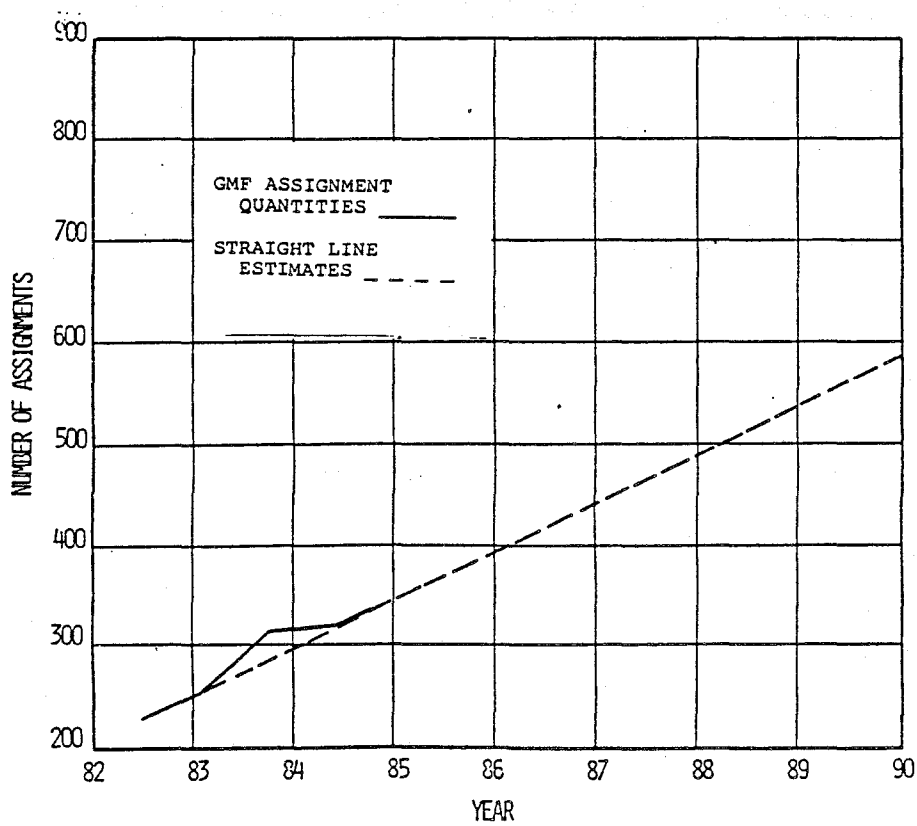

Figure 5-7. Assignment growth trend for the 4800-4900 MHz band.

The correlation between the number of equipments and assignments in this band is 28.7 to 1. The equipment density is estimated to rise from 152 to 261 by 1990.

NSF plans to operate a major new radio astronomy telescope across this band.

The following systems were identified as a planned system within the NTIA Systems Review File or the ECAC FAL:

Digital Microwave Radio	Stage 1 Army
ICNS RPV Status Uplink	Stage 2 Army

Consideration of sharing with the non-Government should be held in abeyance until growth trends and equipment numbers can be confirmed.

7125-8400 MHz

The 7125-8400 MHz band is a Government exclusive band (excluding some sharing by footnote). Fixed systems dominate the band. Assignments break down into the following percentages:

Fixed	86.2%
Satellite	08.7%
Experimental or Developmental	05.1%

The growth in the number of assignments has been averaging 249 per year (see Figure 5-8). The assignment density (assignments per channel) using a dominant necessary bandwidth of 20 MHz is estimated to grow from 124 to 145 by 1990.

The correlation between the number of equipment and assignments in this band is 1.3 to 1. The equipment density is estimated rise from 161 to 188 by 1990.

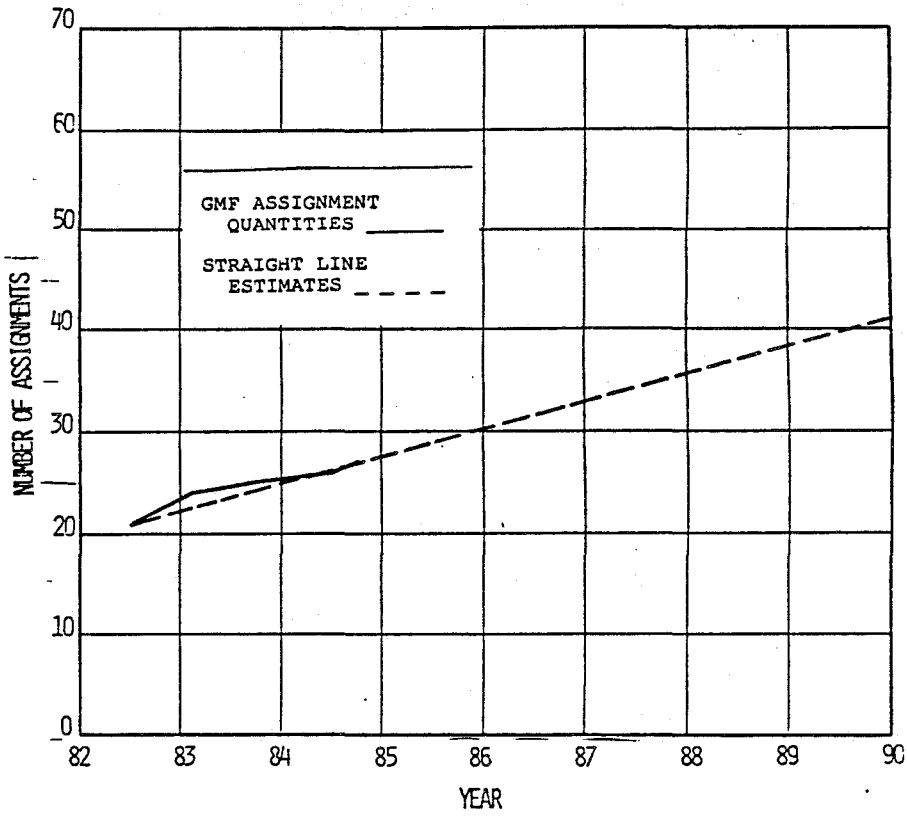

Figure 5-8. Assignment growth trend for the 7125-8450 MHz band.

The following are the plans for this band by agency:

USDA - this band is expected to receive a significant overflow of Forest Service fixed microwave systems from the 1710-1850 MHz band

USAF - continued use of microwave communications links; use of Sure Comm (Part of Jam Resistant Secure Communications (JRSC Program) Systems - Philco LC 8D

Army - continued use of wide area microwave systems for test range support, radar data links, satellite links, and research and development of new modulation techniques

DOC - meteorological remoting levels are expected to remain constant

DOE - addition of one fixed link for the nuclear research and development program in San Francisco, CA

FAA - the number of radar microwave link stations in this band is expected to grow from 3633 to approximately 4000

FEMA - the satellite communications subsystem of the Direction, Control and Warning Communications System (DCWCS) will operate in this band

Justice - upgrade of current land mobile systems with voice privacy protection is expected

NSF - continued use of data and control links at 8310 MHz and plant security links at 7760 and 7850 MHz.

The following systems were identified as planned systems within the NTIA Systems Review File or the ECAC FAL.

Venus Radar Mapper	Stage 1	NASA
Nellis AFB Digital MW Command System	Stage 3	Air Force
Galileo Uplink	Stage 3	NASA
Quasat Deep Space Program	Stage 1	NASA
TCM - 704 Stage 3	Navy	
Farinon FV 2/5 ( )P Digital MW Link	Stage 2	Navy

Heavy use and high growth prevent consideration of this band for sharing.

14.4-14.5 GHz

The 14.4-14.5 GHz band is shared, with most assignments in the fixed service. Assignments break down into the following percentages:

Fixed	57.1%
Satellite	7.1%
Experimental or Developmental	35.7%

The growth in the number of assignments has been averaging 2.7 per year (see Figure 5-9). The assignment density (assignments per channel) using a dominant necessary bandwidth of 25 MHz is estimated to grow from 6.8 to 10.3 by 1990.

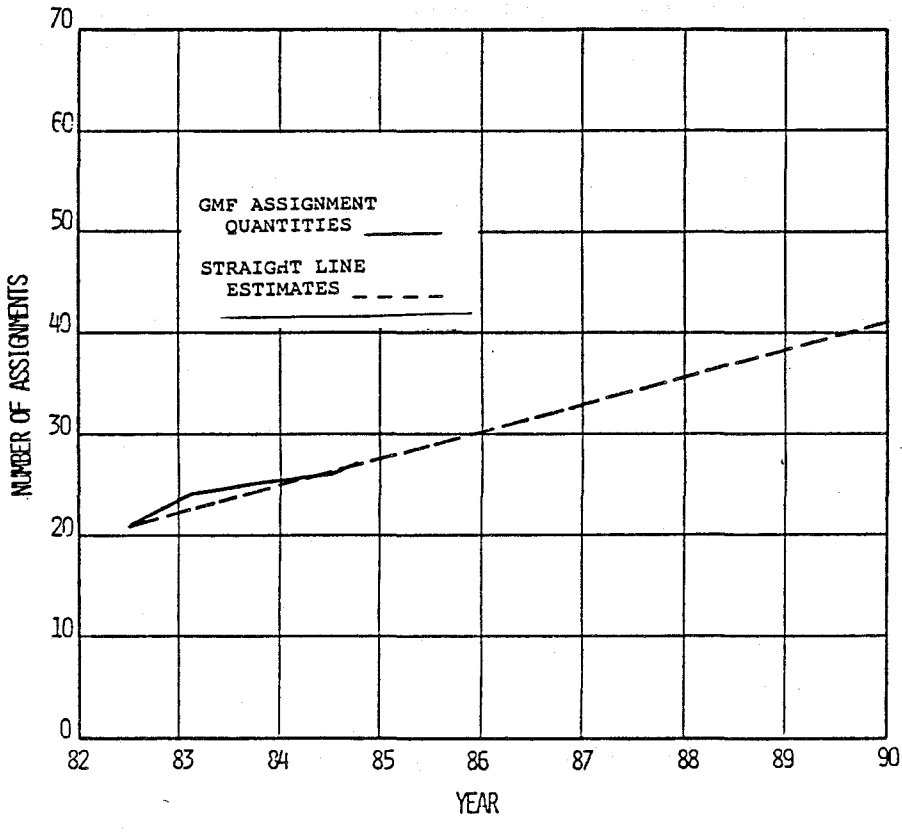

Figure 5-9. Assignment growth trend for the 14.4-14.5 GHz band.

The correlation between the number of equipment and assignments in this band is 7.3 to 1. The equipment density is estimated to rise from between 49 to 75 by 1990.

The following are the plans for this band by agency:

Army - research and development of tactical digital microwave communications

DOE - continued use of links for the nuclear research and development links in Nevada

FAA - expansion of the television microwave link system is expected. This band is also being considered for airport radar microwave links

Justice - continued use of fixed assignments

NSF - the major new radio astronomy telescope. VLBA is planned to operate across this band.

The following system was identified as a planned system within the NTIA Systems Review File or the ECAC FAL:

Digital Microwave Radio	Stage 1	Army
Low Cost Decoy Data Link	Stage 3	Air Force
Wideband Downlink Data Link (Pave Mover)	Stage 2	Air Force
Duplex Command Link (Pave Mover)	Stage 2	Air Force
Cubic TX P/N 153251	Stage 2	Army

The primary allocation in this band is to the non-Government fixed-satellite service. Government fixed and mobile assignments are secondary. Though satellite systems are growing nationally, they have not significantly changed the number of assignments in the band over the past 5 years. However, this is misleading since there are 112 satellite-related systems that require bandwidths that extend into this band from the lower adjacent band. These wideband assignments show about a 10% growth per year over the past 3 years. The FAA is also looking to expand in this band. Increased sharing with the non-Government would be premature at this time.

BANDS RECOMMENDED FOR FURTHER REVIEW OF SHARING POSSIBILITIES BY THE PHASE I REPORT

1350 - 1400 MHz

TABLE 5-1 shows the current US Table of Frequency Allocations from the NTIA Manual for the 1350-1400 MHz band. There are 98 assignments in 14 states

TABLE 5-1

US TABLE FREQUENCY ALLOCATIONS

FOR THE 1350-1400 MHz BAND[a]

Band MHz *1*	*National Provisions* *2*	*Government Allocation* *3*	*Non-Government Allocation* *4*	*Remarks* *5*
1350-1400	714 718 720	RADIOLOCATION Fixed Mobile G2 G27 G114		

G2 In the bands 216-225, 420-450 (except as provided by US217), 890-920, 928-942, 1300-1400, 2300-2450, 2700-2900, 5650-5925, and 9000-9200 MHz, the Government radiolocation is limited to the military services.

G27 The Fixed and Mobile Services are limited to the military services.

G114 In the band 1350-1400 MHz, the frequency 1381.05 MHz with emissions 1limited to ±12 MHz is also available to the Aeronautical Radionavigation service on a primary basis.

714 Additional allocation: In Canada and the United States, the bands 1240-1300 MHz and 1350-1370 MHz are also allocated to the Aeronautical Radionavigation service on a primary basis.

718 In making assignments to stations of other services, administrations are urged to take all practicable steps to protect the spectral line observations of the Radio Astronomy Service from harmful interference in the band 1330-1400 MHz. Emissions from space or airborne stations can be particularly serious sources and interference to the radio astronomy service (see Nos. 343 and 344 and Article 36).

720 The bands 1370-1400 MHz, 2640-2655 MHz, 4950-4990 MHz, and 15.20-15.35 GHz are also allocated to the space research (passive) and earth exploration-satellite (passive) services on a secondary basis.

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a. From the NTIA Manual

which are mainly to military radar systems. Many of these radars are mobile, so in time of war emergency or tactical training exercises, they could be operated anywhere in CONUS. These high power transmitting systems pose the greatest problem to sharing of this band with non-Government users. Fixed and mobile systems are allocated on a secondary basis and have played a lesser role. There is also a great deal of experimental use. Assignments break down into the following percentages:

Fixed	4.8%
Mobile (telemetry)	1.0%
Satellite	1.9%
Radiodetermination	39.4%
Experimental or Developmental	52.9%

The transmitting and receiving systems in the 1350-1400 MHz band are located as shown on the map of Figure 5-10. This map does not include 43 systems tunable over a range from the lower adjacent band, which can tune into the 1350-1400 MHz band. There are 36 states with no assignments in this band. As can be seen from Figure 5-10, the assignments tend to be somewhat concentrated in specific locations.

The growth in the number of assignments, as indicated in Figure 5-11, has been averaging 5.3 per year. The assignment density (assignments per channel) using a dominant necessary bandwidth of 1 MHz is estimated to grow from 2.0 to 2.5 by 1990. The correlation between the number of equipments and assignments in this band is 6.2 to 1. The equipment density is estimated to rise from 12 to 16 by 1990.

The following are the plans for this band by agency:

USAF - continued use of the Minimally Attended Radar (MAR)

Army - development of radiolocation systems

NSF - the major new radio astronomy telescope VLBA will operate across this band.

Figure 5-10. Geographic plot of Government assignments in the 1350-1400 MHz band.

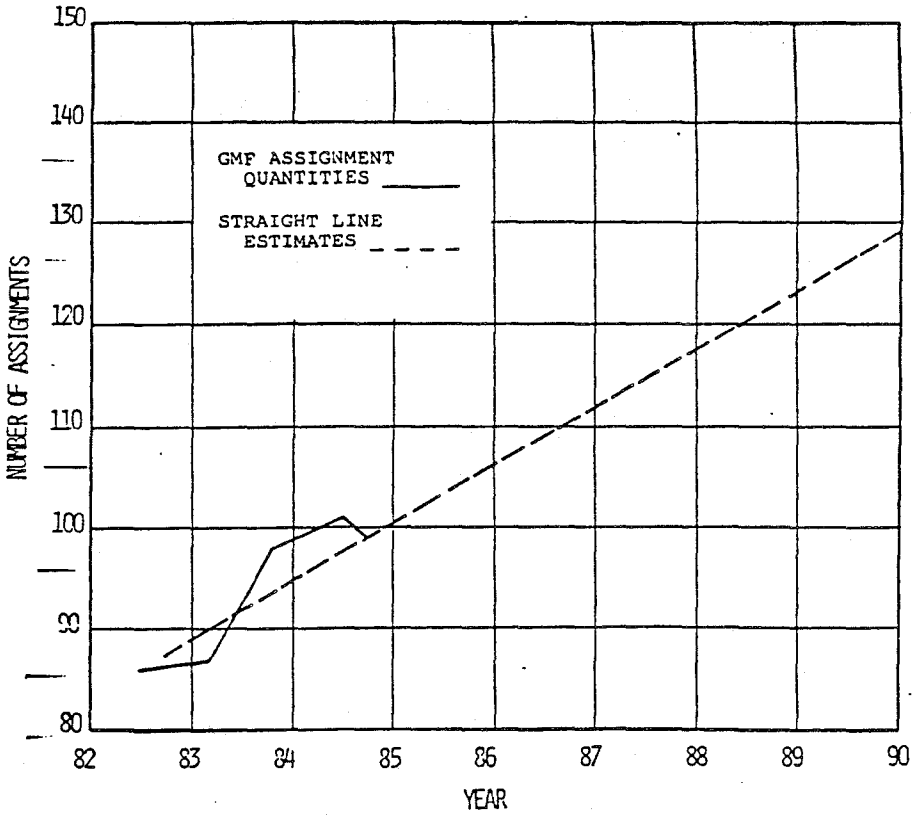

Figure 5-11. Assignment growth trend for the 1350-1400 MHz band.

The following systems were identified as planned systems (not yet Stage 4) within the Systems Review File or the ECAC FAL:

Transponder Position Location System	Stage 3	Air Force
POPS Telemetry System	Stage 3	Army
Expendable Precision Emitter Location Systems	Stage 3	Army

Due to few assignments, low growth, and geographical concentration of existing assignments, this band could provide an opportunity for sharing with the non-Government to meet demonstrated requirements. Sharing would have to be limited to fixed systems and have geographic restrictions such as those shown in Figure 5-12 where areas are determined by the radius from each radar location.

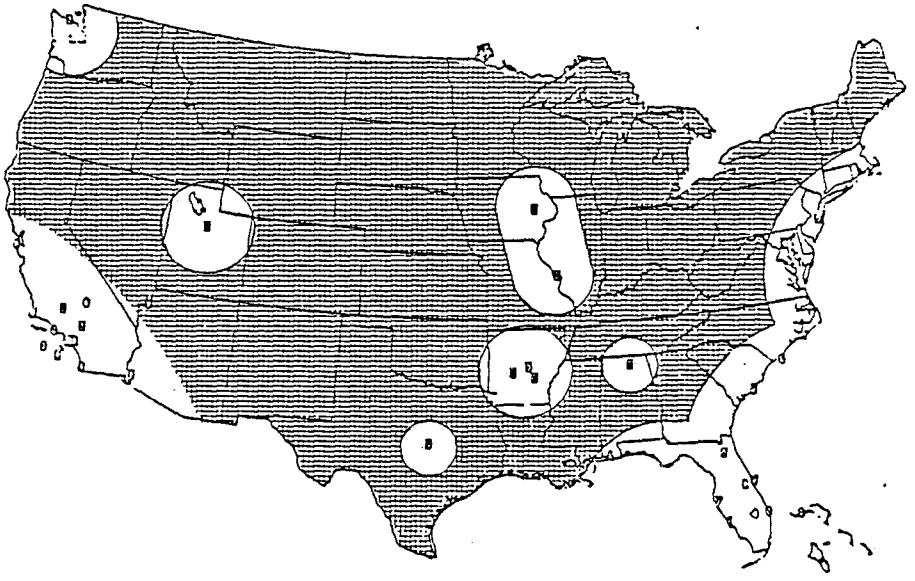

Figure 5-12. Areas of recommended sharing in the 1350-1400 MHz band.

2290-2390 MHz

The 2290-2300 MHz portion of the band is used mainly for space research (deep space only) assignments and has little potential for increased sharing. The 2300-2390 MHz portion is basically a Government radiolocation band; however, radiolocation use of frequencies between 2310-2390 MHz is very sparse. There are 26 states in CONUS that do not have Government assignments in the 2290-2390 MHz band, with another 9 having only one.

The 2310-2390 MHz band is a Government and non-Government shared band. The Government allocations are to radiolocation and mobile services on a primary coequal basis and to fixed services on a secondary basis. The non-Government allocation is to the mobile service on a primary basis. Footnote G2 restricts the Government radiolocation service to military use only, and Footnote US 276 states that the use of the 2310-2390 MHz band by the mobile service is limited to aeronautical telemetering and associated telecommands and operations. All other mobile telemetering uses are secondary.

Assignments by service break down into the following percentages:

Fixed	10.2%
Mobile	19.3%
Mobile (1.1%)	
Aeronautical Mobile (1.1%)	
Telemetry (17.0%)	
Satellite	9.1%
Radiodetermination	10.2%
Experimental or Developmental	51.1%

The growth in the number of assignments has been averaging 4 per year (see Figure 5-13). The assignment density (assignments per channel) using a dominant necessary bandwidth of 3.3 MHz is estimated to grow from 2.8 to 3.8 by 1990.

The correlation between the number of equipments and assignments in this band is 2.7 to 1. The equipment density is estimated to rise from 7.5 to 9.3 by 1990.

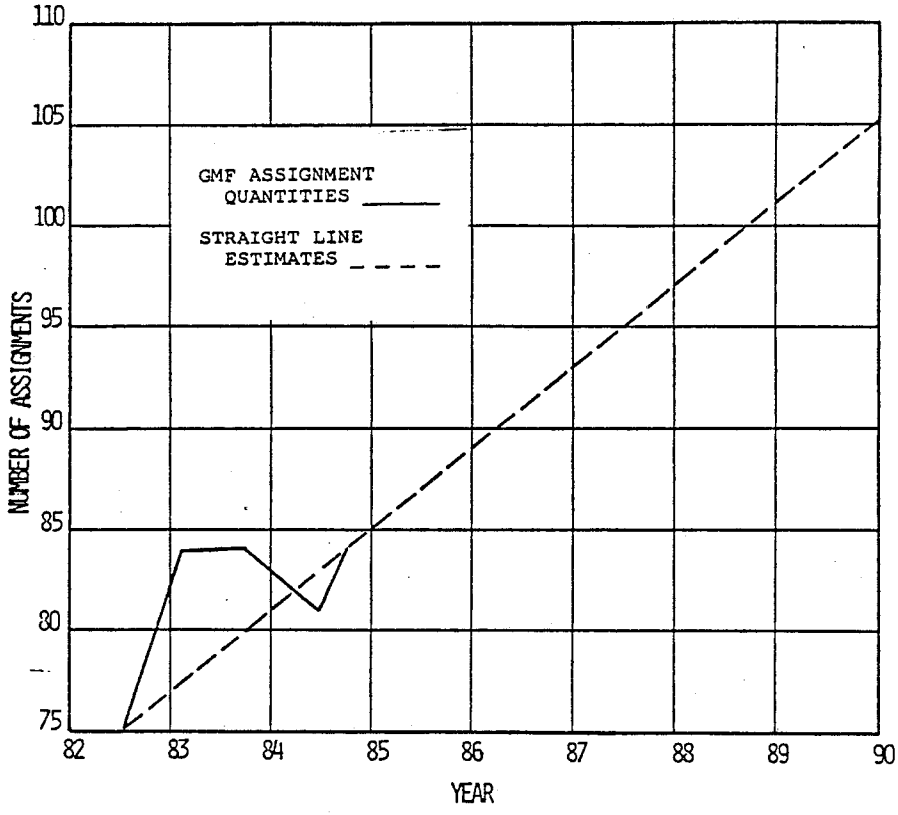

Figure 5-13. Assignment growth trend for the 2290-2390 MHz band.

As a result of increased flight test telemetry use in the 1435-1535 MHz band, the band has become congested. The US supported the use of the 2310-2390 MHz band for flight test telemetry on a primary basis at WARC-79 to relieve congestion in the 1435-1535 MHz band. The IRAC established Ad Hoc 185 in April of 1982 to review Government requirements, proposed regulatory changes (IRAC Doc. 22614, 1982 - FCC petition for rulemaking from the Aerospace and Flight Test Radio Coordinating Council (AFTRCC)), and prepare draft changes to the NTIA Manual. The AFTRCC had petitioned the FCC (RM-4077) requesting that Parts 2 and 87 of the FCC Rules and Regulations be amended to permit the operation of aeronautical flight test telemetering airborne stations in the 2310-2390 MHz band. The AFTRCC also requested certain rules and regulations governing such operations be classified.

The FCC in General Docket 84-186 (FCC, 1984) released an NPRM proposing to amend the Commission's flight test telemetry rules to conform to WARC-79 recommendations and to address the AFTRCC petition.

On February 12, 1985, the IRAC approved changes to the NTIA Manual, which add the use of flight test telemetry to this band. Figure 5-14 shows the geographic distribution of assignments in the 2310-2390 MHz band. As seen in the figure, there are many states with no assignments. This band was recommended in the Phase I report for possible sharing of the non-Government fixed service on a secondary basis. Figure 5-15 shows the geographical distribution of assignments in the 1427-1535 MHz band that is rapidly becoming congested. Many of the new systems and uses proposed for this band will now, with the new allocation and assignment procedure, be considered for the 2310-2390 MHz band. It is anticipated that, in a few years, the 2310-2390 MHz band will show a geographical distribution of assignments more like the 1427-1535 MHz band. (The growth estimates on pages 5-26 and 5-27 do not reflect this change.)

The following are the plans for this band by agency:

Army - continued use of Army Corps of Engineers radio relay in support of lock and dam operations and telemetry at test ranges; research and testing of Pershing II missile terminal guidance system

DOE - continued use of data links for various nuclear research and development programs

FAA - continued use of aeronautical telemetering

NSF - continued use of planetary radar at 2380 MHz; the major new radio astronomy telescope VLBA is planned to operate across this band.

Figure 5-14. Geographic plot of Government assignments in the 2310-2390 MHz band.

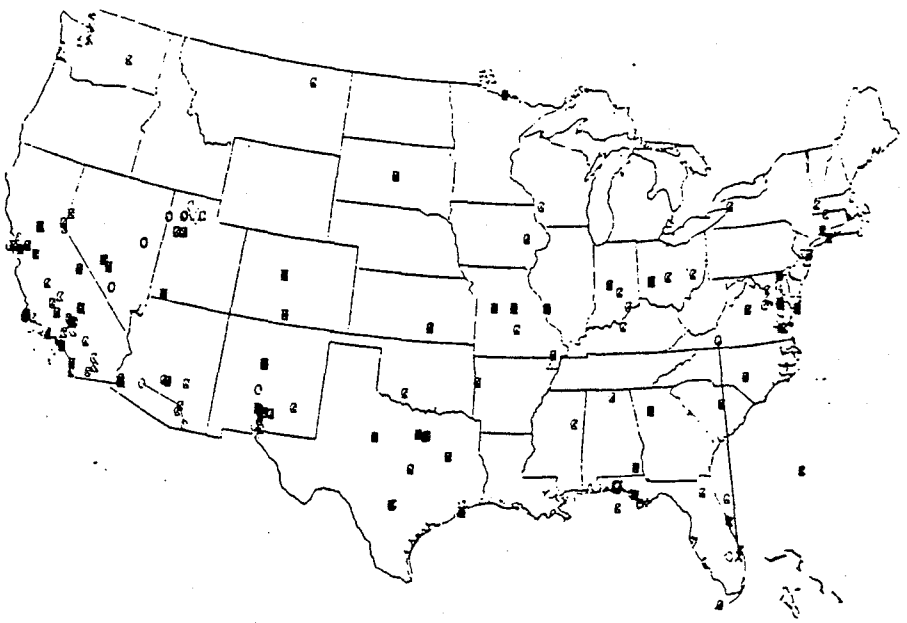

Figure 5-15. Geographic plot of Government assignments in the 1427-1535 MHz band.

The following systems were identified as planned systems within the NTIA Systems Review File or the ECAC FAL:

AN/DSQ-X Telemetry	Stage 3	Air Force
Venus Radar Mapper	Stage 1	NASA
Microwave Data Link	Stage 3	Navy
Cartwright Bullet Hit Indicator Telemetry	Stage 3	Air Force
Motorola Bullet Hit Indicator	Stage 3	Air Force

Based on the new use of flight test telemetry by both Government and non-Government in the 2310-2390 MHz band, it is concluded that further sharing with the non-Government fixed services would not be practical at this time.

8400-8500 MHz

TABLE 5-2 shows the US table of frequency allocations for the 8400-8500 MHz band as given in the NTIA Manual. Prior to WARC-79, the 8400-8500 MHz band was a Government exclusive band for fixed, mobile, and space research on a primary coequal basis. After WARC-79, the US Tables of Allocations were revised, splitting the old band into two segments, 8400-8450 and 8450-8500 MHz. Mobile assignments, which were almost nonexistent, were dropped from the band, and non-Government space research (space-to-earth) was added.

Power-flux-density (PFD) limits at the earth's surface, from space stations sharing with the fixed and mobile services, are given in Chapter 8 of the NTIA Manual, specifically Section 8.2.36. Coordination of assignments for terrestrial stations located within the coordination area of a receiving earth station are also given in Chapter 8. Appendix B of the NTIA Manual provides the coordination contours for this band.

TABLE 5-2

US TABLE OF FREQUENCY ALLOCATIONS
FOR THE 8400-8500 MHz BANDS

Band MHz *1*	*National Provisions* *2*	*Government Allocation* *3*	*Non-Government Allocation* *4*	*Remarks* *5*
8400–8450		FIXED SPACE RESEARCH (Space-to-Earth) (Deep Space Only)		
8450–8500		FIXED SPACE RESEARCH (Space-to-Earth)	SPACE RESEARCH (Space-to-Earth)	

Assignments in this band break down into the following percentages:

Fixed	68.5%
Satellite	5.5%
Experimental or Developmental	26.0%

Figure 5-16 shows the frequency assignment distribution. Note that the 45 assignments are to 15 different frequencies.

Figures 5-17 and 5-18 show the geographic distribution of assignments for the two subbands, 8450-8500 and 8400-8450 MHz, respectively.

The growth in the number of assignments has been averaging 2.7 per year (see Figure 5-19). The assignment density (assignments per channel) using a dominant necessary bandwidth of 6 MHz is estimated to grow from 3.0 to 3.9 by 1990.

The correlation between the number of equipments and assignments in this band is 3.9 to 1. The equipment density is estimated to rise from 12 to 15 by 1990.

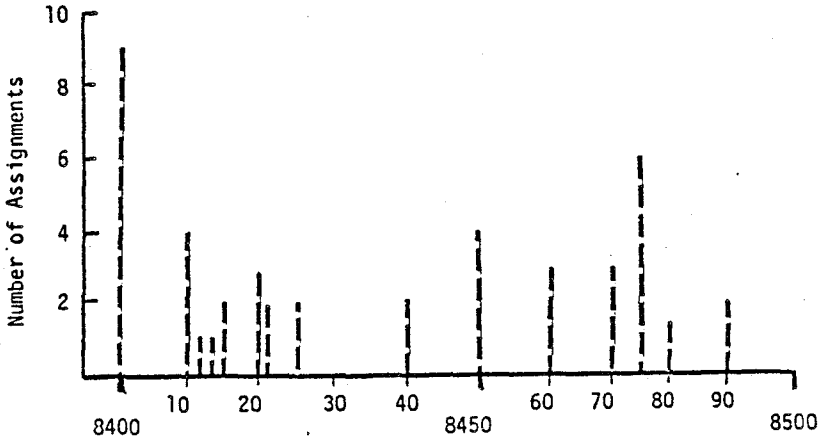

Figure 5-16. Frequency assignment distribution for the 8400-8500 MHz band.

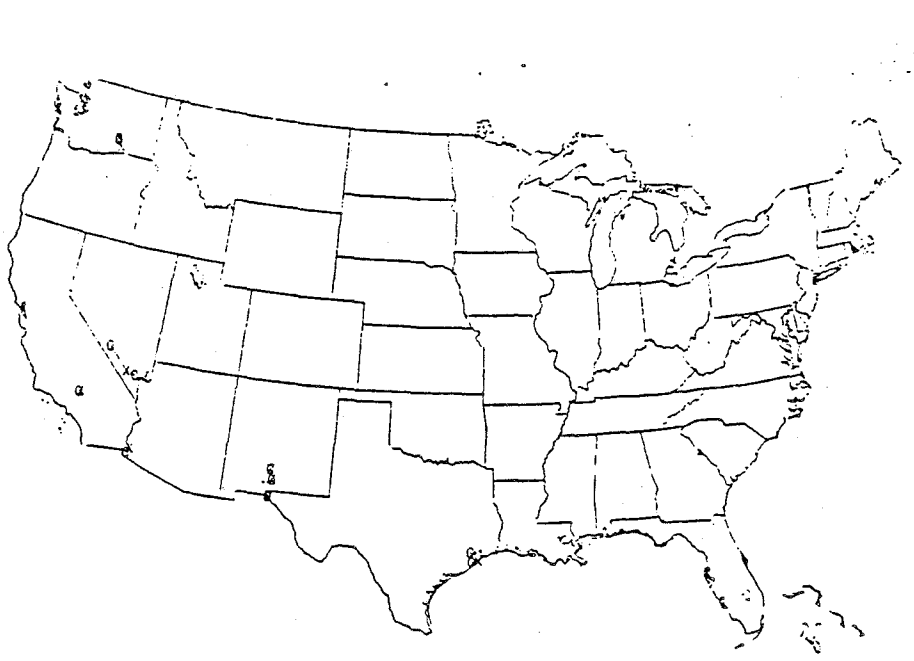

Figure 5-17. Geographic plot of Government assignments in the 8450-8500 MHz band.

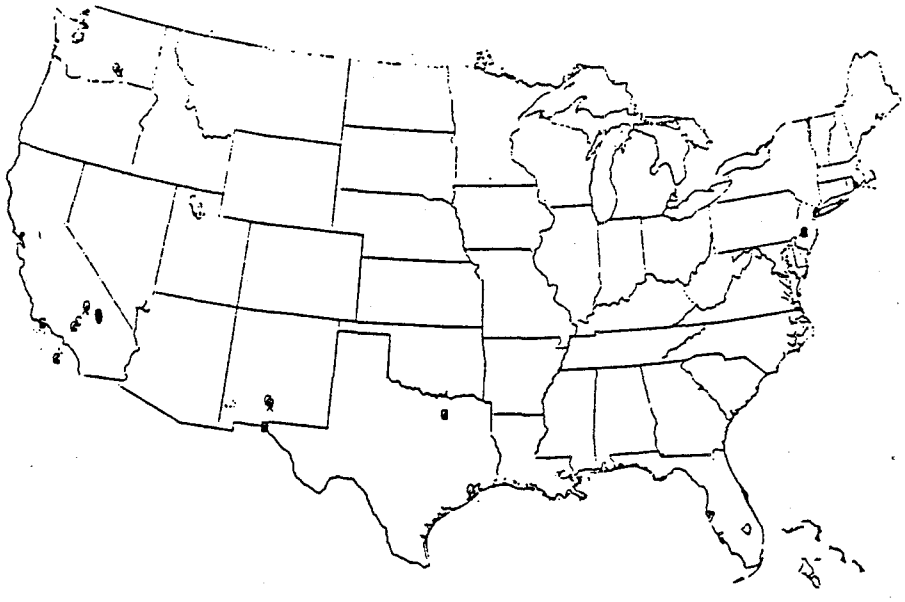

Figure 5-18. Geographic plot of Government assignments in the 8400-8450 MHz band.

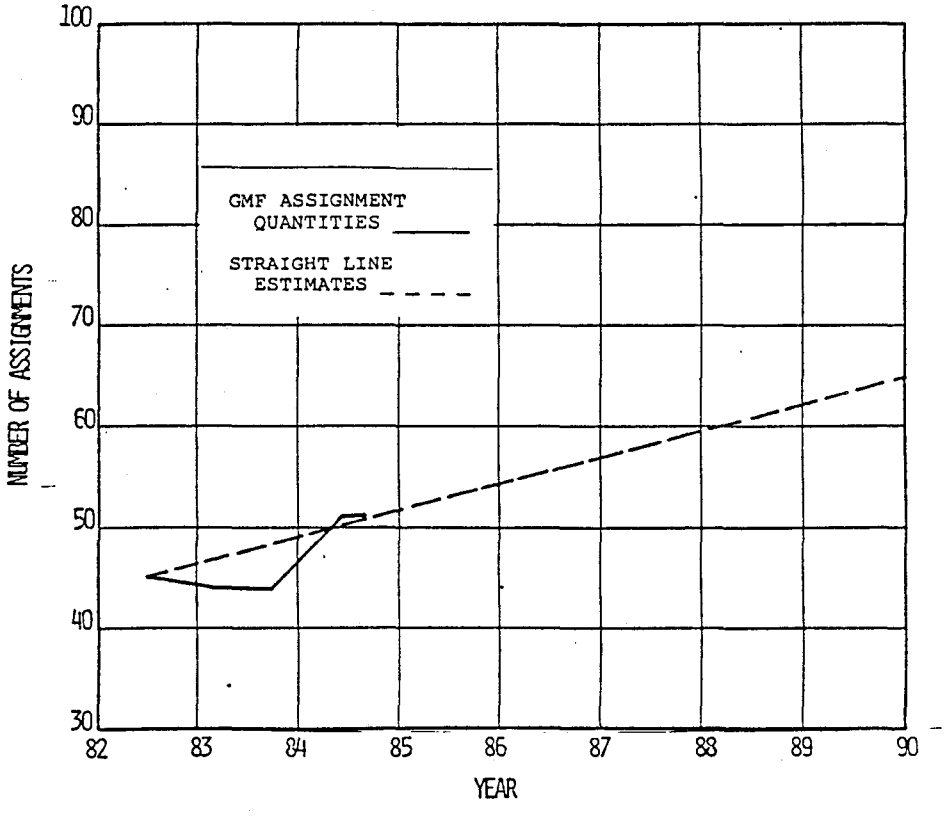

Figure 5-19. Assignment growth trend for the 8400-8500 MHz band.

The following are the plans for this band by agency:

Army - addition of microwave communications links

DOE - addition of two links for the nuclear emergency search team in Nevada

Justice - continued use of fixed assignments.

Most systems in the band are short hop microwave links used for remoting radars, remoting CTV systems, and communications and data transmissions. There are nine states with assignments; however, the Justice Department has four assignments to the US and its possessions, which allows them to set up links where needed in CONUS, taking into account certain coordination requirements in California, Texas, and Washington.

The systems used in the band are as follows:

AN/DPT-1 radar for EW training

AN/SLQ-32 shipboard EMC training

AN/MST-1 AEW/ECM training

Collins MDR 8-5N point-to-point microwave system

Collins MDR 8 point-to-point microwave system

Collins MW 518/WB point-to-point microwave system

International Microwave Corp. 7080 point-to-point microwave system

Farinon Electric FV8F radar video microwave link

Household Data Services -

GD 1205 short distance video link

GD 1305 short distance video link

GD 1145 short distance video link.

The 8400-8500 MHz spectrum is treated as two separate bands in the Phase I report, 8400-8450 MHz and 8450-8500 MHz. However, the conclusions are similar for the two bands, so they are treated as one band in this report. From 8400-8500 MHz, Government use or non-Government use is not extensive.

This is deliberate so that the bands from 7125-8400 MHz would be used first to their fullest extent and that, as they became congested, the bands from 8400-8500 MHz would be utilized. There are many bands in the 7125-8400 MHz spectrum that are already congested. Government requirements will result in a dramatic increase in the use of this band in the next decade. However, it would seem possible at this time to open the band to non-Government use for fixed systems on a primary basis. Each request for use by a non-Government user would need to be brought to the IRAC for approval.

14.5-15.35 GHz

The 14.5-15.35 GHz band is a Government exclusive band, with most of the assignments to the fixed services. The band has shown considerable growth over the past 10 years, and many new systems are being planned for use in the future.

Assignments break down into the following percentages:

Fixed	47.4%
Mobile	6.1%
Mobile (1.8%)	
Aeronautical Mobile (0.4%)	
Telemetry (3.9%)	
Satellite	5.8%
Radiodetermination	2.7%
Experimental or Developmental	38.0%

There are three subbands in the 14.5-15.35 GHz band, as shown in TABLE 5-3. From 14.5-14.7145 GHz, the allocation is to Government fixed and mobile Services on a primary coequal basis and to space research on a secondary noninterference basis. From 14.7145-15.1365 GHz, the allocation is to Government mobile services on a primary basis, with fixed and space research secondary. From 15.1365-15.35 GHz, the allocation is to the

TABLE 5-3

US TABLE OF FREQUENCY ALLOCATIONS
FOR THE 14.5-15.35 GHz BANDS

Band GHz *1*	*National Provisions* *2*	*Government Allocation* *3*	*Non-Government Allocation* *4*	*Remarks* *5*
14.5-14.7145		FIXED Mobile Space Research		
14.7145-15.1365		Fixed MOBILE Space Research G119		
15.1365-15.35	US211 720	FIXED Mobile Space Research		

720 The bands 1370-1400 MHz, 2640-2655 MHz, 4950-4990 MHz, and 15.20-15.35 GHz are also allocated to the space research (passive) and earth exploration-satellite (passive) services on a secondary basis.

US 211 In the bands... 15.1365-15.35 GHz... applicants for airborne or space station assignments are urged to take all practicable steps to protect radio astronomy observations in the adjacent bands from harmful interference; however US 74 applies.

G119 In the band 14714.5-15136.5 MHz, assignments in the fixed service which were in existence as of January 1, 1982 may continue on a primary basis until January 1, 1990.

Government fixed service as primary and to mobile and space research as the secondary allocation. International Footnote 720 states that space research (passive) and earth-exploration-satellite (passive) services are allowed from 15.2-15.35 GHz on a secondary basis. Footnote US 211 states that systems, particularly airborne or space station assignments, are urged to take all practicable steps to protect radio astronomy observations in the

15.35-15.4 GHz band. Before the adoption of the new allocation tables, which were revised based mainly on WARC-79 agreements and IRAC and FCC consequential changes, the band from 14.5-15.35 GHz was allocated to Government fixed and mobile services on a primary coequal basis with space research (space-to-earth) secondary. The band was divided into three subbands to decrease potential interference problems between mobile and fixed systems operating, or scheduled for operation, in the band. Coordination of assignments for transmission or reception of earth stations in the 14.5-15.35 GHz band is given in the NTIA Manual, Chapter 8, Section 8.4.13. There is a channeling plan for fixed service assignments in this band.

The FAA has the most assignments, with 147 used for remoting television systems for runway viewing, remoting air traffic control radars, remoting communications receivers, and television microwave links dealing with the air traffic control network. The USAF has 108 assignments for remoting radars for military air traffic control, various data and communications lines, microwave links to relay mission support data from launch sites to mobile vans during missile/satellite launch operations, microwave links for the transmission of timing and frequency data, antenna testing facilities, prelaunch checks of satellites, and to relay video data to central TB control facilities during missile/satellite launch operations.

Figure 5-20 shows the geographic distribution of assignments in the 14.5-15.35 GHz band. There are still some states without assignments; but with planned growth, the band will be heavily used within the next decade.

The growth in the number of assignments has been averaging 60 per year (see Figure 5-21). The assignment density (assignments per channel) using a dominant necessary bandwidth of 20 MHz is estimated to grow from 12 to 20 by 1990.

The correlation between the number of equipments and assignments in this band is 3.0 to 1. The equipment density is estimated to rise from 37 to 59 by 1990. Specific agency plans show that expected growth exceeds the straight line estimates and will increase the density to 152 by 1990.

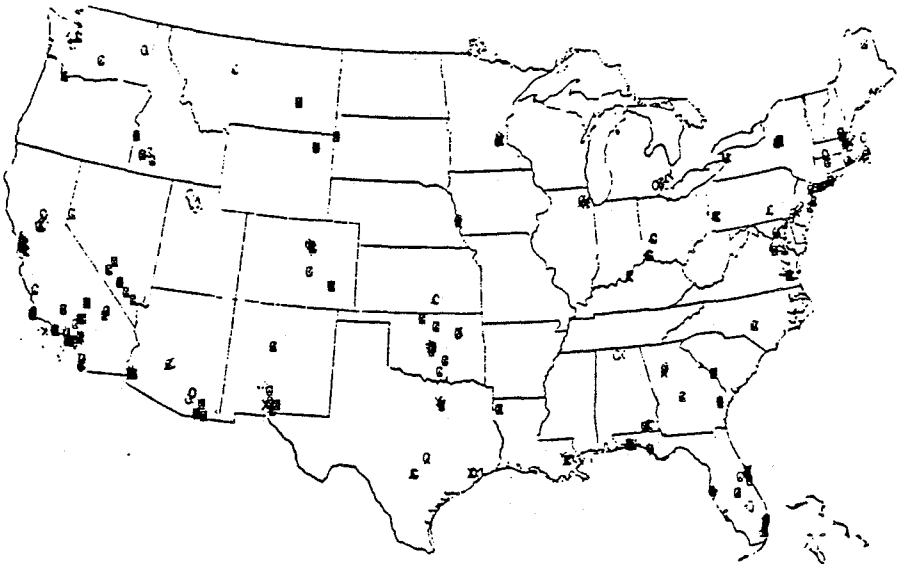

Figure 5-20. Geographic plot of Government assignments in the 14.5-15.35 GHZ band.

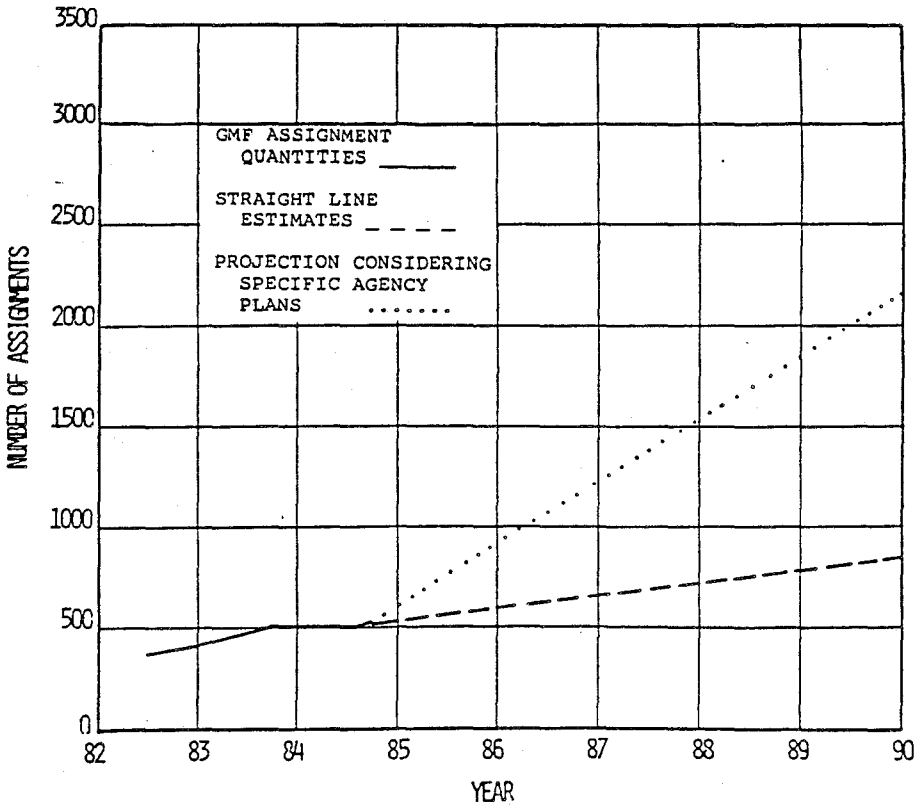

Figure 5-21. Assignment growth trend in the 14.5-15.35 GHz band.

The following are the plans for this band by agency:

- USAF - continued use of microwave data and communications links
- Army - testing of phased-array communications systems and tactical microwave landing systems; research and development of wideband digital data systems
- DOE - Addition of two links within the nuclear research and development program in San Francisco, CA
- FAA - the number of television microwave links is expected to grow from 147 to approximately 1470; this band is also being considered for airport radar microwave links and the airport packet radio
- Justice - continued use of fixed assignments
- NSF - the major new radio astronomy telescope VLBA is planned to operate across this band.

The following systems were identified as planned systems within the NTIA Systems Review File or the ECAC FAL:

Digital Microwave Radio	Stage 1	Army
Low Cost Anti-Jam Data Link	Stage 3	Air Force
Airport Packet Radio	Stage 1	FAA
Duplex Command Link (Pave Mover)	Stage 2	Air Force
Wideband Data Link (Pave Mover)	Stage 2	Air Force
Cubic TX P/N 153251	Stage 2	Army
Norwegian NSL-8 Down the Hill Radio	Stage 2	Army
Farinon FV 2/5 ( )P Digital Data MW Link	Stage 2	Navy

Due to the rapid increased use of this band by Government systems and the near-future proposed uses, it could only support minimal non-Government use. It is therefore recommended that the band from 14.5-15.35 GHz be continued as a Government exclusive band.

SUMMARY

TABLE 5-4 and Figure 22 represent tabular and graphic summaries of the data presented in this section. The bands within this report clearly fall into several groupings.

The 1710-1850 MHz, 4400-4500 MHz, 4800-4990 MHz, 7125-8400 MHz, and 14.5-15.35 MHz bands are estimated to have the greatest growth in the next five years. Three bands, 4800-4990 MHz, 1710-1850 MHz, and 14.5-15.35 MHz have been, or are, expected to experience particularly high growth rates. Additional data documenting the high equipment-to-assignment ratios for the 4400-4500 MHz and 4800-4990 MHz bands would be helpful in clarifying the use levels in these bands.

TABLE 5-4

SUMMARY OF ESTIMATED GOVERNMENT USE

FREQUENCY	ASSIGNMENTS			ASSIGNMENT DENSITY		EQUIPMENT		EQUIPMENT DENSITY	
	CURRENT	1989 (ESTIMATED)	AVERAGE ASSIGNMENT GROWTH/YR[a]	CURRENT	1989 (ESTIMATED)	CURRENT	1989 (ESTIMATED)	CURRENT	1989 (ESTIMATED)
1350-1400 MHz	98	126	5.3	2.0	2.5	608	780	12.0	16.5
1427-1535 MHz	840	922	15.6	7.8	8.5	4284	4702	40.0	43.0
1700-1710 MHz	6	8	0.4	1.8	2.4	6	8	1.8	2.4
1710-1850 MHz	3205	8070[b]	433.0	37.0	63.0[b]	5769	14526[b]	66.0	166.0[b]
2200-2290 MHz	1672	1730	11.0	18.0	19.0	9029	9341	99.0	102.0
2290-2390 MHz	84	105	4.0	2.8	3.8	227	284	7.5	9.3
4400-4500 MHz	255	339	16.0	7.7	10.2	4412	5865	133.0	176.0
4500-4800 MHz	497	691	37.0	1.7	2.3	12773	17765	43.0	59.0
4800-4990 MHz	334	576	46.0	5.3	9.1	9586	16517	152.0	261.0
7125-8400 MHz	7932	9239	249.0	124.0	125.0	10312	12011	161.0	188.0
8400-8500 MHz	51	65	2.7	3.0	3.9	199	254	12.0	15.0
14.4-14.5 GHz	27	41	2.7	6.8	10.3	191	301	49.0	75.0
14.5-15.35 GHz	518	833[b]	60.0	12.0	20.0[b]	1554	2499[b]	37.0	59.0[b]

a. GMF Sept. 82 - Oct. 84 (current Oct. 84).
b. Straight-line estimates supplimented by agency planning figures.

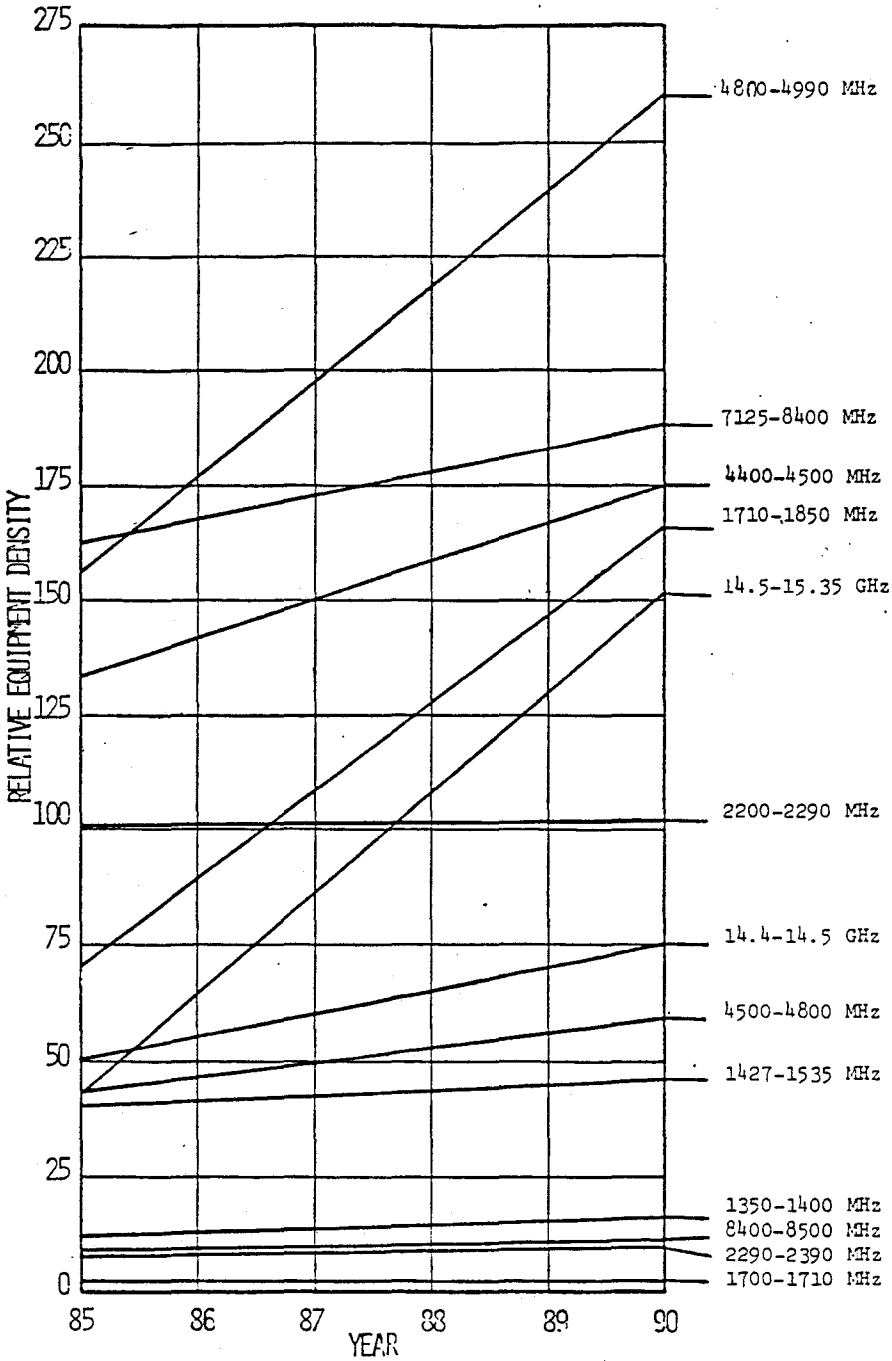

Figure 5-22. Comparison of band density estimates.

The second grouping includes the 1427-1535 MHz, 4500-4800 MHz, and 14.4-14.5 MHz bands. These bands are in the middle when comparing equipment density and are all experiencing slight growth.

The 1350-1400, 1700-1710, 2290-2390, and 8400-8500 MHz bands all have low densities and have shown little growth.

The growth of the 2200-2290 MHz band appears to be extremely low. This is probably deceiving. A significant drop in assignment levels recorded in the GMF occurred from late 1982 to mid 1983. This trend was reversed, and a rapid increase has recently been experienced. This band may actually fall into the high growth grouping during the next five years.

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7. Grant, W. and C. Chilton (1984), National Telecommunications and Information Administration Report 84-161, Subject: Spectrum Resource Assessment of the Fixed and Mobile Services in the 947-17,700 MHz Band, Phase I, September.

8. IRAC (1982), Interdepartment Radio Advisory Committee Document No. 22614, Subject: FCC Petition for Rulemaking from AFTRCC to Amend Parts 2 and 87 of the Commission's Rules Regarding the Band 2310-2390 MHz for Aeronautical Telemetry, April.

9. IRAC (1983), Interdepartment Radio Advisory Committee Document No. 23553, Memorandum from IRAC Chairman to IRAC Members, Subject: Critical spectrum Usage Data Required for Band from 947 MHz to 17.7 GHz, October.

10. ITU (1982), International Telecommunication Union, Radio Regulations, Geneva, Switzerland, Revised 1985.

11. NTIA (Sept. 1982 - Oct. 1984), National Telecommunications and Information Administration Government Master File.

12. NTIA (1982), Summary of the Federal Government's Use of the Radio Frequency Spectrum, July.

APPENDIX A

LIST OF AGENCY RESPONSE LETTERS

1. Agriculture (1984), Department of Agriculture letter from B. Jacobsen to R. Parlow (NTIA), August.

2. Army (1984), Department of the Army letter from E. Holliman to R. Parlow (NTIA), August.

3. DOC (1984), Department of Commerce letter from W.J. VanWinegarden to R. Parlow (NTIA), Subject: Critical Spectrum Usage, Phase II, 947 MHz - 17.7 GHz, August.

4. DOE (1983), Department of Energy letter from R.M. Lewis to L. Buss (IRAC), November.

5. FAA (1984), Federal Aviation Administration letter from G. Markey to R. Parlow (NTIA), August.

6. FAA (1984), National Airspace System Plan, Federal Aviation Administration, April.

7. GSA (1984), Government Services Administration letter from J. DeMarco to R. Parlow (NTIA), August.

8. IRAC (1983), Interdepartment Radio Advisory Committee Document No. 23595, VA Memorandum from R. Holt to Chairman (IRAC), Subject: Critical Spectrum Usage Data Required for 947 MHz - 17.7 GHz Band, October.

9. IRAC (1983), Interdepartment Radio Advisory Committee Document No. 23644, FEMA letter from J. Odom to E. Dinkle (IRAC), December.

10. IRAC (1983), Interdepartment Radio Advisory Committee Document No. 23697, USCG letter from W.A. Pappas to Executive Secretary (IRAC), Subject: Spectrum Usage Data, January.

11. IRAC (1984), Interdepartment Radio Advisory Committee Document No. 23707, HHS letter from H.E. Johnson to Executive Secretary (IRAC), Subject: Critical Spectrum Usage Data Required for Band from 947 MHz - 17.7 GHz, January.

12. Justice (1984), Department of Justice Memorandum from M. Linker to E. Dinkle (IRAC), Subject: Critical Spectrum Usage Data Required for Band from 947 MHz - 17.7 GHz, September.

13. NASA (1984), National Aeronautics and Space Administration letter from D. Struba to N. Schroeder (NTIA), Subject: IRAC Document No. 23904, December.

14. NSF (1984), National Science Foundation letter from V. Pankonin to R. Parlow (NTIA), September.

15. State (1984), Department of State letter from R. Shrum to R. Parlow (NTIA), August.

16. Treasury (1984), Department of the Treasury letter from J. Kapp to R. Parlow (NTIA), Subject: Spectrum Resource Assessment 947 MHz to 17.7 GHz, September.

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15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

A Phase I spectrum resource assessment based upon use of the bands containing fixed and mobile services in the 947-17,700 MHz portion of the radio frequency spectrum as completed in 1984. From the total number of fixed and mobile bands, four bands (1350-1400 MHz, 2310-2390 MHz, 8400-8500 MHz, 14.5-15.35 GHz) were selected for further analysis of their potential for sharing.

This is the Phase II report that includes actual system and equipment counts (where available) and projected future use by the various Government agencies who have, or plan, future services in the fixed and mobile bands from 947-17,700 MHz. It also provides an evaluation of the potential for sharing between Government and non-Government users in those bands selected during Phase I. Sharing is recommended for the 1350-1400 MHz and 8400-8500 MHz bands.

16. Key Words *(Alphabetical order, separated by semicolons)*

Fixed and Mobile Services; Geographic Sharing; Government Exclusive Bands; Government/Non-Government Shared Bands; Long-Range Plan; Spectrum Management; Spectrum Sharing; 947-17,700 MHz

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