SECTION 2
SELECTION OF BANDS TO BE CONSIDERED FOR REALLOCATION

INTRODUCTION

As specified in Title III of BBA 97 only bands allocated to the Federal Government on a primary basis were considered for reallocation. While Title III sets an upper limit of 3 GHz for the spectrum to be considered for reallocation, no lower frequency limit was formally established. A recent NTIA report on High Frequency (3-30 MHz) spectrum planning[1], stated that reallocation of spectrum in this frequency range is a "zero sum" process, in that any gain in spectrum for one radio service is at the expense of another. The report concludes that reallocation of spectrum below 30 MHz is not viable and thus, the lower frequency limit for this reallocation study was set at 30 MHz.

An additional limitation applied in this study involves narrow segments of spectrum that are allocated to specific services. The National Table of Frequency Allocations contains some very narrow segments of allocated spectrum, as small as a few kilohertz.[2] In the spectrum reallocation study performed under OBRA 93, NTIA was advised by industry representatives to the Department of Commerce's Spectrum Planning and Policy Advisory Committee (SPAC)[a] that two megahertz was a reasonable lower limit for the reallocated spectrum size. On this basis, spectrum segments of less than two megahertz were not considered for reallocation, except in cases where two band segments could be paired to create a two megahertz wide segment.

Title III of BBA 97 addresses the concern of avoiding excessive cost and minimizing the operational impact on Federal Government missions during the reallocation process. As shown in Table 1-1, Title III provides five criteria for selecting frequency bands for reallocation from Federal Government to non-Federal use. Of the five criteria specified in Title III, three include a Federal Government cost or operational impact factor that must be considered. The following subsections provide a detailed discussion of how the bands between 30 MHz and 3 GHz, to be considered for reallocation, were selected. The list of bands to be considered for reallocation was the result of an elimination process structured around seven categories representing Federal Government bands that: 1) if reallocated would result in excessive impact (cost and mission) to the Federal Government, 2) could not be made available during the next 15 years, or 3) already provide significant and unique benefits to the public. The seven categories are:

- Civil and commercially provided safety-of-life bands;

- National security bands;

[a] The SPAC, composed of four Federal Government and 15 non-Federal representatives, is chartered to advise the Secretary of Commerce on radio-frequency spectrum allocation and assignment planning and the means by which the effectiveness of Federal Government spectrum management may be enhanced.

- □ Federal law enforcement and public safety communications bands;
- □ Satellite communications bands;
- □ Radio astronomy and passive remote sensing bands;
- □ Consumer-oriented and commercial services sharing with Federal systems;
- □ Bands that have already been identified for reallocation.

CIVIL AND COMMERCIALLY PROVIDED SAFETY-OF-LIFE BANDS

Spectrum Usage

Safe travel, in the air and at sea, is vitally dependent upon interference-free use of the radio frequency spectrum for the provision of radio navigation services. The frequency bands allocated to the aeronautical radionavigation, radionavigation satellite, aeronautical mobile (route), and maritime radionavigation services support a variety of civil, and commercially provided safety-of-life functions, as shown in Table 2-1. All of the frequency bands shown in this table are co-equally shared between Federal and non-Federal users. The Federal Government provides radionavigation services for the safe transportation of people and goods, and to encourage the flow of commerce. The Federal Aviation Administration (FAA), the United States Coast Guard (USCG), and the Department of Defense (DoD) each play a major role in providing these radionavigation services to the public.

TABLE 2-1
CIVIL AND COMMERCIALLY, PROVIDED SAFETY-OF-LIFE BANDS
(30 to 3000 MHz)

Frequency Band (MHz)	Principal Use
108-118	Instrument Landing Enroute Navigation
118-137	Air Traffic Services
328.6-335.4	Instrument Landing
960-1215	Air Traffic Control Enroute Navigation Collision Avoidance
1215-1240	Satellite-Based Navigation
1240-1370	Enroute Radars
1559-1610	Satellite-Based Navigation
2700-2900	Airport Surveillance Radars
2900-3100	Shipborne Navigation Radars

The FAA has the statutory responsibility for managing the National Airspace System (NAS) and for providing aeronautical services to the flying public. The FAA has an estimated investment of $30 billion

in facilities providing aeronautical radionavigation services in the frequency bands below 3 GHz.[3] The frequency bands used for providing aeronautical radionavigation services are allocated for primary use on a worldwide basis under an international treaty developed by the International Telecommunication Union-Radiocommunications Sector (ITU-R). One hundred seventy four nations have agreed to standardized ground facilities and airborne systems using these designated frequency bands worldwide through the International Civil Aviation Organization (ICAO). The United States must maintain this spectrum to ensure interoperability between international aircraft and the U.S. air traffic control system in accordance with these treaty obligations.

The USCG has a statutory responsibility to provide for safe and efficient maritime navigation in coastal and inland waterways under control of the United States. The maritime radionavigation service is subject to international treaty obligations with the International Maritime Organization (IMO) under the Safety of Life at Sea (SOLAS) treaty, which has established standards for worldwide interoperability among maritime stations.

The DoD also develops and uses its own radionavigation services for national defense purposes. DoD radionavigation systems are often shared with the public. For example, the DoD developed and now operates the satellite-based Global Positioning System (GPS) that is revolutionizing navigation and location determination in the U.S. and worldwide. It is envisioned that GPS will be the primary navigation system well into the next century and will become an integral component of the Global Navigation Satellite System (GNSS).

A detailed description of the systems that operate in the bands used to support civil and commercially provided safety-of-life functions are provided in two NTIA reports: U.S. National Spectrum Requirements: Projections and Trends[4] and the Preliminary Spectrum Reallocation Report.[5] A discussion of the estimated investment cost in each of the frequency bands listed in Table 2-1 is contained in the Preliminary Report.[6]

Spectrum Requirements

Each of the bands listed in Table 2-1 is used to support safety-of-life functions provided within the NAS. International treaty obligations require that support be maintained worldwide within the frequency bands identified to ensure interoperability of cross-border aeronautical and maritime traffic. Since the public already has full access to each of these bands, no clear benefit to the public will be realized by removing Federal Government access to the bands. Therefore, reallocation of spectrum within these frequency bands is not considered viable.

NATIONAL SECURITY BANDS

Spectrum Usage

Frequencies in the electromagnetic spectrum below 3 GHz are vitally important to the DoD mission of providing for the national defense. For more than 50 years, the DoD has sponsored the

research and development of communications-electronics (C-E) systems for use in battlefield scenarios. The modern warfighter has become highly dependent on these C-E systems which have become essential in high technology warfare. The electromagnetic (EM) spectrum below 3 GHz is important due to the operating characteristics intrinsic to frequencies in this region of the spectrum. Low propagation losses at these frequencies enable medium-to-long-range voice and data communications between ground troops under varying terrain and foliage conditions. Similarly, communications from airborne and shipborne platforms benefit from the low propagation loss characteristics of frequencies below 3 GHz. In addition, the ability to use small antennas to capture signals at these frequencies enhances the required portability of military C-E systems. This enables compact systems to be designed for use in hand-held, manpack, airborne, and space-based applications. The same low-loss propagation characteristics are imperative to the functional requirements of long-range military radar systems used to detect and track potentially hostile aircraft and projectiles at distances that will provide sufficient time for response. As a result of these factors, billions of dollars have been invested in systems utilizing frequencies below 3 GHz for use by the active military services, the military reserves, the National Guard, and the USCG.

TABLE 2-2
BANDS THAT SUPPORT NATIONAL SECURITY
(30-3000 MHz)

Frequency Band (MHz)	Functions
225-328.6	Communication/Satellite
335.4-399.9	Communication/Satellite
420-450	Radar
902-928	Radar
1215-1350	Radar
1378.55-1383.55	Satellite
1559-1610	Satellite
1755-1850	Communication/Satellite
2200-2290	Communication/Satellite
2900-3100	Radar

Although military C-E systems can be found throughout the spectrum, the frequency bands identified in Table 2-2 represent those bands below 3 GHz that are used extensively by the U.S. military in providing for the national defense. Many of these bands are standardized with U.S. allies in Europe and elsewhere so that interoperability can be achieved during combined actions.

Communication functions performed by the DoD in support of its national security mission are conducted under the fixed and mobile service allocations in the 225-328.6 MHz, 335.4-399.9 MHz, 1755-1850 MHz, and 2200-2290 MHz bands. These functions include, but are not limited to, tactical voice, data, and video communications (secure and non-secure), air traffic control, air combat training, flight testing telemetry, control of remotely piloted vehicles, and weapons and target scoring systems. Most of the systems operating in these frequency bands support

wartime functions; however, extensive peacetime training and alert exercises are conducted to maintain combat readiness and for the development of fighter aircraft. The DoD operates more than 75,000 radio equipments in these bands[7] and the estimated investment costs in communication systems utilizing these frequency bands exceeds $12.3 billion.[8]

Radar systems are operated by the military services under the radiolocation service allocations in the 420-450 MHz, 902-928 MHz, 1215-1350 MHz, and 2900-3100 MHz bands from land-based (fixed and mobile), shipborne, and airborne platforms. Radars performing early warning and missile detection are typically fixed land-based systems that require a long detection range, a large antenna, and a low operating noise environment. These operational requirements constrain long-range search radar operations to the lower portions of the spectrum. Airborne radar serves as the eyes and ears of the crew, providing air and surface surveillance, air interception, target tracking, weapons control, navigation and ground mapping, target illumination, and intelligence gathering functions. Shipborne radars are used principally for surface and air search, height finding, weapons fire control, target illumination, and aircraft control. Battlefield radars are used to provide many of the same functions previously described with the added requirement of tactical mobility. In order to provide adequate immunity to hostile jamming, most military radars have a wide tuning capability that extends over most or all of their allocated frequency band. The loss of even a portion of the band could have a detrimental impact to their operational requirements. The DoD has an estimated investment in radars utilizing these frequency bands of greater than $26.6 billion.[9]

Satellite operations are conducted in the 235-322 MHz, 335.4-399.9 MHz, 1215-1300 MHz, 1559-1610 MHz, 1761-1842 MHz, and 2200-2290 MHz bands under the mobile satellite service, space operation, space research, and radionavigation-satellite service allocations. Functions performed include tactical and strategic military communications, radionaviagation, proliferation detection technology including nuclear burst data, and spacecraft tracking, telemetry, and command (TT&C) operations. Military satellite communications are essential to linking the activities of ground, air, surface, and subsurface mobile platforms. Radionavigation functions are provided to the military worldwide via the GPS system, developed by the DoD to be its primary navigation system well into the next century. The GPS satellites will also transmit an alerting signal at 1381.05 MHz $\pm$ 2.5 MHz in the event that a nuclear burst is detected. Spacecraft TT&C operations consist of space tracking to determine the orbit, velocity, or instantaneous position of the spacecraft, space telemetry for the transmission of data relating to the function of the spacecraft, and space telecommand to initiate, modify, or terminate spacecraft functions. The estimated DoD investment in satellite systems that utilize these bands exceeds $113.7 billion.[10]

A detailed description of the systems that operate in the bands used to support national security are provided in the Spectrum Requirements Report[11] and the Preliminary Report.[12] A discussion of the estimated investment cost in each of the frequency bands listed in Table 2-2 is contained in the Preliminary Report.[13]

Spectrum Requirements

The communications functions provided in the bands discussed above are crucial to DoD operations. For example, the DoD has stated that "… the 225-400 MHz band is the single most critical spectrum resource of the military tactical forces, both nationally and within the North Atlantic Treaty Organization (NATO)".[14] In addition, restructuring of the 225-400 MHz military communications band cannot possibly be accomplished within the rigid time and spectrum-sharing constraints imposed by the Title III legislation.

Most of the radar functions provided in these bands, such as the early warning capabilities of the long-range radar systems, cannot be accomplished in higher frequency bands. Therefore, these systems must be protected to avoid a detrimental impact to national security.

The transmit and receive subsystems on space-borne platforms such as the satellite systems that utilize these bands cannot be easily replaced or re-tuned to conform to a reallocation. Therefore, any changes resulting from a reallocation of these bands would have to be implemented in the next generation satellites, which would likely extend beyond the 15 year criteria imposed by Title III.

Finally, from an economic standpoint, reallocation of any of these bands, assuming there were relocation alternatives for the systems currently in operation, would be cost prohibitive based solely on investment expenditures. Actual relocation costs for each system would be anticipated to run several times the initial investment cost.

For these reasons, reallocation of the bands identified in Table 2-2 as being necessary for national security and required for the ability of our forces to support allies, is not considered to be a practical option.

SATELLITE COMMUNICATION BANDS

Spectrum Usage

The frequency bands below 3 GHz that are used to support satellite communications are vital to performing the missions assigned to the Federal agencies by the President and Congress. These missions include: meteorological observations, space research and exploration, distress and safety-of-life communications, and communications supporting military and non-military operations on a world wide basis. To support these functions, satellite systems owned and operated by the Federal Government, and commercial systems, are employed. The bands below 3 GHz that support Federal satellite communications (operated by the Federal Government) and global satellite communications (operated by commercial entities) are shown in Table 2-3.

There are several Federal mobile-satellite systems in the bands below 3 GHz that are used to support U.S. military operations on a worldwide basis. Tactical and strategic military satellite

communications, are essential to linking the activities of ground-based, airborne, and shipborne platforms. The satellites that operate in the bands below 3 GHz include both geostationary and non-geostationary systems. One of the primary DoD mobile satellite systems is the Navy's Fleet Satellite Communication (FLTSATCOM) Ultra High Frequency (UHF) satellites. This system provides the Navy with worldwide communications between ships, shore stations, and area commanders. The DoD's use of mobile-satellite systems, particularly in the 235-322 and 335.4-399.9 MHz bands is expected to increase in the next few years. The Federal Government has an estimated investment cost exceeding $10 billion in mobile satellite systems operating below 3 GHz.[15] In addition to tactical communication, nuclear detonations around the world are detected by sensors on GPS satellites, and a message is relayed to numerous fixed, transportable, and mobile locations in the spectrum below 3 GHz.

TABLE 2-3
SATELLITE COMMUNICATIONS BANDS
(30-3000 MHz)

Federal Satellite Communications

Frequency Band (MHz)	Functions
137-138	Meteorological Data
235-322	Communications - MSS (military only)
335.4-399.9	Communications - MSS (military only)
400.15-403	Meteorological Data - TT&C
1378.55-1383.55	GPS - Nuclear Burst Detection
1675-1710	Meteorological Data
1755-1850	TT&C
2025-2110	TT&C
2110-2120	TT&C
2200-2300	TT&C

Global Satellite Communications[a]

Frequency Band (MHz)	Functions
148-150.05	Commercial MSS Operations
399.9-401	Commercial Worldwide Navigation
1525-1559	Commercial MSS Operations
1610-1660.5	Commercial MSS Operations
2483.5-2500	Commercial MSS Operations

a) The Federal Government will not operate any satellites in these bands but is expected to be a substantial user of the services.

There are three main meteorological satellite systems that operate in the bands below 3 GHz that are being used by the Federal Government: the Geosynchronous Operational Environmental Satellite (GOES) system; the Polar Orbiting Environmental Satellite (POES) system; and the Defense Meteorological Satellite Program (DMSP) system. The POES and GOES satellite systems are used worldwide for gathering meteorological data for weather prediction, severe weather warning, and research. This data is essential for severe storm notification and public safety, and is used daily on television and radio broadcast weather reporting to the public. Both the POES and GOES carry a Search and Rescue Satellite-Aided Tracking (SARSAT) subsystem. The DMSP will provide weather data (meteorological, oceanographic, and ionospheric)

to meet the specialized requirements for a wide variety of DoD tactical users. The estimated Federal investment in these meteorological satellite systems exceeds $5.4 billion.[16]

The global ground network and Tracking and Data Relay Satellite System (TDRSS) operated by the National Aeronautics and Space Administration (NASA) in the bands below 3 GHz is essential to earth exploration, space operations, and space research activities. Over 50 U.S. space missions, and additional foreign missions, consistent with international agreements will be supported by NASA in the next 5 years using the 2025-2110 MHz band. This will include varying degrees of support from launch and orbital transfer to full-time data relay. These telecommunications links are also made available to commercial expendable launch vehicle operations. One hundred and twenty three satellites from nine countries are either planning or already have begun operations in the 2025-2110 MHz band. Deep Space Network command links for current and future missions such as Voyagers 1 and 2, GALILEO, and ULYSSES are also supported in the spectrum below 3 GHz.

The frequency bands below 3 GHz are extensively used for TT&C of DoD and NASA satellite systems. The spectrum below 3 GHz is important for performing TT&C because an all weather capability is required when communications must be established with a satellite regardless of its orientation. The Space Ground Link Subsystem (SGLS) is used to perform the TT&C to support 96 DoD satellites valued at $115 billion that are critical to national security.[17] Many of these satellites have life expectancies in excess of 15 years, and changing frequencies on satellites that have already been launched is not possible. The SGLS is the planned TT&C system for the next several generations of DoD satellites.

In the global satellite communications bands below 3 GHz the International Maritime Satellite Organization (INMARSAT) provides distress, and safety communications, as a part of the Global Maritime Distress Safety System (GMDSS). All Federal vessel operators use of INMARSAT/GMDSS system. The bands below 3 GHz are used by the SARSAT search and rescue subsystem to relay satellite distress and safety transmissions. The SARSAT is part of the international COSPAS/SARSAT system and is used to communicate safety and distress information from ships and aircraft to search and rescue units. The SARSAT system is used on both the POES and GOES satellite systems. Plans also exist for satellite Emergency Position-Indicating Radio Beacon Stations (EPIRBS) that will relay distress and safety signals between satellites in the bands below 3 GHz.

A detailed description of the systems that operate in the bands used to support satellite communication functions are provided in the Spectrum Requirements Report[18] and the Preliminary Report.[19] A discussion of the estimated investment cost in each of the frequency bands listed in Table 2-3 is contained in the Preliminary Report.[20]

Spectrum Requirements

The public already receives immeasurable benefits from the Federal Government satellite bands that support meteorological observations, space research and exploration, and public-safety communications. Therefore reallocation of the bands that support these functions is not seen as a viable option.

As discussed in Section 1, Title III of BBA 97 requires that 15 MHz of spectrum from the 1990-2110 MHz band be transferred for allocation and assignment through competitive bidding. Based on this, the 2025-2110 MHz portion of the band that is used by the Federal Government for earth exploration, space operations, and space research will not be considered for reallocation in this study.

The Federal Government bands that support military satellite communications and TT&C for DoD satellites are critical to satisfying national defense mission requirements. The life cycle of these satellites in many cases will exceed 15 years. The band selection criteria of Title III, specifically states that the bands identified for reallocation should not cause excessive mission and cost impact to the Federal Government. Because of the criticality to national defense, the extremely high investment in these bands, and the unavailability of the bands in the next 15 years, reallocation for non-Federal use is not considered a viable option.

The global satellite systems are a combination of Federally operated systems and commercially operated systems. However, all Federal use of these bands is strictly as a customer of the commercial services; the Federal Government does not own or operate any satellite networks in these bands. Consequently, reallocation of this spectrum under the requirements of Title III is not applicable.

RADIO ASTRONOMY AND PASSIVE REMOTE SENSING BANDS

Spectrum Usage

Scientific studies of the Universe have intensified in recent years, both within the United States and abroad. Radio astronomy and passive remote sensing are critical to these studies. Research is carried out at numerous Federal and university facilities from Hawaii to Puerto Rico. While it is difficult to estimate Federal investment in radio telescopes on a band-by-band basis, the overall total is approximately $410 million.[21]

Radio astronomers are interested in two distinct types of cosmic signals: wide band continuum emissions and narrowband spectral line emissions. Continuum emissions, both thermal and non-thermal, extend continuously over most of the radio frequency spectrum. Thermal emissions generally increase in intensity with increasing frequency, while the intensity of non-thermal emissions generally decreases with increasing frequency.

Spectral line emissions result from changes in the energy states of individual cosmic atoms and molecules. Spectrum planning for observation of these emissions is difficult because the Doppler effect causes a shift of the apparent frequency of the emissions as a function of the relative velocity of the source.

A number of bands are used exclusively for radio astronomy and passive remote sensing in the 30-3000 MHz frequency range. In this range, the four shaded bands, shown in Table 2-4 along with other bands are important for radio astronomy, support critical spectral line and continuum measurements, and are allocated on a worldwide basis for radio astronomy observations. The possibility of sharing these bands with other radio services is limited by the extreme sensitivity of the receivers used in radio astronomy and other passive service observations. However, in an effort to develop sharing relationships when possible and accommodate private sector spectrum requirements, the radio astronomers have developed an agreement with the FCC that will allow low power medical telemetry devices to operate in the 608-614 MHz band. In order to protect radio astronomy observations from interference the FCC will implement a coordination procedure.[22]

TABLE 2-4
RADIO ASTRONOMY AND PASSIVE REMOTE SENSING BANDS
(30-3000 MHz)

FREQUENCY BAND (MHz)	STATUS
406.1-410	Shared Primary
608-614	Exclusive Primary
1350-1400	Unprotected
1400-1427	Exclusive Primary
1610.6-1613.8	Shared Primary
1660-1660.5	Shared Primary
1660.5-1668.4	Exclusive Primary
1668.4-1670	Shared Primary
1718.8-1722.2	Unprotected
2690-2700	Exclusive Primary

A detailed description of radio astronomy and passive sensing operations is provided in the Spectrum Requirements Report[23] and the Preliminary Report.[24] A discussion of the estimated investment cost is contained in the Preliminary Report.[25]

Spectrum Requirements

The radio astronomy and passive remote sensing have little control over the signals they use. Their spectrum requirements are therefore based on physical phenomena rather than expected growth, as is the case for most other radio services. Simply replacing these frequencies with another set of frequencies is currently not a viable option. The four shaded bands in Table 2-4 are the only bands in the 30-3000 MHz frequency range where a national agreement has been reached to exclude all radio transmissions on a nationwide basis. Because of the importance of the bands allocated on an exclusive primary basis for radio astronomy and passive remote sensing, continued access by the Federal Government to satisfy current and future national and international radio astronomy

programs is essential. These specific frequencies were selected based on the physics of radio astronomy signals, and hence cannot be made available in the foreseeable future. For these reasons, the bands allocated for exclusive radio astronomy and passive remote sensing have not been considered for reallocation.

FEDERAL LAW ENFORCEMENT AND PUBLIC SAFETY COMMUNICATION BANDS

Spectrum Usage

The importance of radio communications to the public safety community cannot be overstated. In a large-scale disaster such as an earthquake, forest fire, or flood, hundreds of agencies from Federal, state, and local governments and thousands of individuals come together to provide emergency medical assistance, fire suppression, rescue operations, infrastructure repair, crowd control and security, food and shelter, and to begin the process of rebuilding. At a time when other means of communication are likely to be inoperable, public safety radio systems must provide interference-free communications between the responders and their agencies. The predominant bands used to support Federal law enforcement and public safety operations in the U.S. are shown in Table 2-5.

TABLE 2-5
FEDERAL LAW ENFORCEMENT AND PUBLIC-SAFETY COMMUNICATIONS BANDS
(30-3000 MHz)

Frequency Band (MHz)	Functions
162-174	Land mobile and associated fixed links
406.1-420	Land mobile and associated fixed links

Federal public safety responsibilities encompass law enforcement, transportation, natural resources, emergency and disaster, and medical and administrative duties. While many of these responsibilities are similar to those incumbent on non-Federal public safety agencies, there are some additional responsibilities that are unique to the Federal operations. Among these unique responsibilities are: protection of the President, and other high-level officials, both U.S. and foreign; promoting public safety and efficiency in traveling via air, water, and land; interdicting entry of illegal personnel and substances into the United States; establishing communications between disaster areas and relief forces; ensuring the swift search and rescue of human life; protecting the national forests, parks, and farmlands; bringing to justice perpetrators of Federal crimes; and ensuring the security of energy generation and distribution networks. In addition, Federal emergency response and public safety organizations conduct large scale exercises to prepare for and respond to a wide variety of emergencies and disasters, such as hurricanes, earthquakes, and chemical and nuclear power plant accidents.

Federal public safety operations have evolved over the years to be critically dependent on the use of the radio frequency spectrum as the only reliable and effective means of communications. Since these types of operations are often highly mobile, spectrum allocated to the land mobile radio service is necessary to support the communication needs. Although most operations are conducted within the land mobile service, public safety agencies also use fixed point-to-point and point-to-multipoint systems under the fixed service allocation. An additional requirement of Federal public safety providers is that operations be supported nationwide and in some cases worldwide.

The Public Safety Wireless Advisory Committee (PSWAC) was established by the FCC and NTIA in June of 1995 to provide advice on the specific wireless communications requirements of public safety agencies through the year 2010 and make recommendations for meeting those needs. In its final report, the PSWAC recognized the 162-174 MHz and 406.1-420 MHz bands as the primary frequency bands used by the Federal Government to support public safety requirements, including Federal law enforcement.[26] The land mobile service is the predominant service used by the Federal agencies in these bands. The 162-174 MHz frequency band supports more frequency assignments, and correspondingly, more equipment usage than any other 12 MHz of the radio spectrum allocated to the Federal Government. Approximately 25 percent of all Federal Government assignments fall into this band.[27] Federal trunked radio communications systems are accommodated primarily in the 406.1-420 MHz band.

A detailed description of the systems that operate in the bands used to support Federal law enforcement and public safety communications are provided in the Spectrum Requirements Report[28] and the Preliminary Report.[29] A discussion of the estimated investment cost in the 162-174 and 406.1-420 MHz bands is contained in the Preliminary Report.[30]

Spectrum Requirements

Although these two bands are already highly congested, assignments have been growing at a rate of 8-12 percent annually for the last several years. Currently, significant effort is being focused on increasing the spectral efficiency and capacity of Federal land mobile services in order to satisfy increasing user demands in these two bands. A channel plan has been adopted by the NTIA for the 162-174 MHz band that halves the previously permissible channel widths of 25 kHz to 12.5 kHz channel widths. This plan is applicable to all new systems introduced after January 1, 1995, and to all systems in the band by January 1, 2005.

In the 406.1-420 MHz band, Federal trunked systems are being accommodated in an effort to promote spectrum efficiency. Trunking improves the spectrum efficiency by providing more user access for a given number of channels. The NTIA and Federal agencies have adopted a migration plan to rechannelize the 406.1-420 MHz band from 25 kHz to 12 kHz channels. The 12.5 kHz channel plan commenced in 1995 for new eqipment and the changeover date for existing equipment is 2008. This new channel plan will increase the number of available channels in this band.

Because of the critical public safety and law enforcement functions performed in these bands, and the benefit that is already provided to the public, reallocation of these bands for non-Federal use is not considered to be a viable option.

CONSUMER-ORIENTED AND COMMERCIAL SERVICES SHARING WITH FEDERAL SYSTEMS

Spectrum Usage

Reallocation of Federal Government spectrum in a manner that disrupts the operations of well established consumer-oriented and commercial services in that spectrum will not serve the public interest if the service disruption out weighs the benefits gained by the public. Commercial and consumer-oriented products and services sometimes share bands allocated to the Federal Government. Title III of BBA 97 requires that the effect on these services be taken into consideration when identifying Federal Government spectrum for reallocation.[31] Federal Government bands that are used extensively for consumer-oriented and commercial services are shown in Table 2-6.

TABLE 2-6
CONSUMER-ORIENTED AND COMMERCIAL SERVICES SHARING WITH FEDERAL SYSTEMS
(30-3000 MHz)

Frequency Band (MHz)	Functions
902-928	Part 15 Devices and Location and Monitoring Service
1435-1525	Aeronautical Telemetry

As discussed in the NTIA Preliminary Report there are currently five separate user groups sharing the 902-928 MHz band, and the relative hierarchy among these users is well established. The 902-928 MHz band is allocated for primary use by the Federal Government for radiolocation, fixed, and mobile services and by users of Industrial, Scientific, and Medical (ISM) devices. Use of the spectrum by Federal Government fixed and mobile and Automatic Vehicle Monitoring (AVM) systems is secondary to both of these uses. The remaining users of the 902-928 MHz band, licensed amateur radio operators and unlicensed devices operating under FCC Part 15 rules, operate on a secondary basis to all other uses, including AVM. In the Location and Monitoring Service Report and Order (LMS R&O), the FCC modified and eliminated outdated regulations that have not kept pace with the technological evolution of AVM and established a new service, the LMS, that both encompasses the old AVM service and future advanced transportation-related services.[32] Despite this complex spectrum allocation structure, this band effectively supports a number of critical Federal requirements and a wide array of consumer and commercial applications.

The Navy operates the AN/SPS-49(V) as a shipborne radar on board approximately 115 ships and shore installations. Operation in the 902-928 MHz band is critical because it offers unique propagation characteristics that permit detection of small, fast moving targets over water, referred to as sea skimmers. A sea skimming missile or aircraft poses a particular problem, since at normal target tracking frequencies in smooth sea conditions there is a tendency for the radar return to be reflected back off the sea surface, causing confusion to the radar resulting in gross errors in assessment of speed and range. This problem has been largely overcome by using frequencies in the 902-928 MHz band.[33] The Navy maintains that continued access to the 902-928 MHz band is essential to meet national defense requirements. Relocating the AN/SPS-49(V) radar to another band may not be possible. Moving it to a lower frequency range could severely degrade the accuracy of the radar and compromise its mission. Moving it to a higher frequency range could significantly degrade the radar's capability to detect very small targets. Based on this unique frequency requirement, reallocation of the entire 902-928 MHz band is not considered a feasible option.[34] Reallocation of a portion of the band for non-Federal use would reduce available spectrum resources to conduct Naval exercises in coastal areas. The resulting increase in radar-to-radar interference would limit the size of combined task force formations to as few as two or three ships, a situation incompatible with Navy mission requirements. Redesign, procurement and installation of a replacement radar to operate in a different band would cost on the order of $1.66 billion.[35]

A large majority of the unlicensed products on the market today operate in the 902-928 MHz band due to the operating range and cost of radio frequency components. Part 15 of the FCC rules permits operation of radio frequency devices without a license from the Commission or the need for frequency coordination. The technical standards for Part 15 transmission systems are designed to ensure that there is a low probability that these devices will cause harmful interference to other users of the spectrum. Part 15 also authorizes the unlicensed operation of spread spectrum transmitters within the 902-928 MHz band at higher power levels than would be normally permitted for other unlicensed devices. Part 15 devices that operate throughout the 902-928 MHz band include: communication systems, cordless telephones, wireless barcode readers, meter reading systems, and commercial and residential wireless alarm systems. There are approximately 4 million Part 15 devices operating in the 902-928 MHz band.[36]

Under Footnote US218, LMS operations are licensed by the FCC. In the LMS R&O the FCC adopted a spectrum plan for the 902-928 MHz band.[37] This plan allocates spectrum in eight sub-bands within the 902-928 MHz band for both multilateration and non-multilateration LMS operations. LMS operations with bandwidths of 2 MHz, 6 MHz, and 8MHz are authorized to operate in the 902-928 MHz band. The FCC expects that in the coming years, LMS systems will play an integral role in the development and implementation of the variety of radio advanced transportation-related services known as the Intelligent Transportation System (ITS).[38]

The military and commercial aerospace industry use various aeronautical telemetry (ATM) systems to support a variety of test flight and equipment development functions. Aeronautical flight

testing is an expensive, technically sophisticated and demanding, and at times dangerous operation. A number of complex and organizationally independent functions must be successfully coordinated to complete a mission. Examples of some of these functions are: range safety (e.g., flight termination capability, clearing the range of non-participants, etc.); "chase" aircraft; weather; measurement support (radar, recorders, etc.); target drone aircraft; nominal test system operation (no test vehicle and system malfunctions); and aeronautical telemetry support. Because the successful scheduling of a mission relies on so many disparate factors, it is important that sufficient interference-free spectrum is available. The aeronautical flight test community extensively uses the 1435-1525 MHz band for ATM operations.

The 1435-1525 MHz band ATM allocation is vital and is used extensively for both Federal Government and commercial aviation flight testing of aeronautical vehicles and sub-systems. The importance of this band as a critical resource for Program Test and Evaluation (T&E) is reflected in letters on file with NTIA from several members of the Aerospace and Flight Test Radio Coordinating Council (AFTRCC)[b] which include: Boeing Defense and Space Group, Bell Helicopter Textron Inc., Raytheon Aircraft Company, and Teledyne Ryan Aeronautical.[39] In each case the correspondent expresses his Company's concerns regarding the 1435-1525 MHz band; the importance of the allocation to maintain international competitiveness; and the Company's commitment to preservation of the flight test allocation.

The unique characteristics of the ATM link make frequency sharing with other radio services in the same geographic area very difficult. The aircraft under test may be at extreme ranges from its monitoring ground station, and its effective antenna pattern experiences severe "fades" due to the various aircraft attitudes encountered during test maneuvers. The ground received signal is therefore often little above the noise level of the ATM monitoring receiver. In addition, because of the altitude of the aircraft, the area affected can be rather large in terms of potential interference from the ATM operation or other possible users of the band. Finally, due to the extremely dense use of the band in several of the most heavily populated areas of the U.S., attempts at "stand-by" use by another service would not be productive, especially during daylight hours.[40]

A detailed description of the systems that operate in the bands used to support consumer-oriented and commercial services sharing with Federal systems are provided in the Spectrum Requirements Report and the Preliminary Report.[41] A discussion of the estimated investment cost in these bands is contained in the Preliminary Report.[42]

[b] The AFTRCC as been recognized by the FCC as the frequency coordinating advisory committee for flight test frequencies.

Spectrum Requirements

The DoD considers that continued access to the full 902-928 MHz band on a primary basis is essential to meet national defense requirements. Based on this stated requirement, reallocation to exclusive non-Federal use is not considered feasible. Part 15 devices currently operating in the 902-928 MHz band allow businesses to operate more effectively and efficiently, without the regulatory complexities of many licensed services. It is envisioned that LMS will play an integral role in the development and implementation of the ITS, improving the efficiency and safety of our nation's highways. In essence a mixed-use allocation exists in this band that can be viewed as being highly successful. The Federal Government radars and other systems are operated while causing little or no impediment to the successful operation and growth of non-Federal users and vice versa. For these reasons, this band will not be considered for reallocation.

The 1435-1525 MHz band is coequally shared between Federal and non-Federal users and represents an important ingredient in the productivity and safety of the flight test process for the military and aerospace industry. The spectrum allocated for extensive airframe testing using telemetering equipment has contributed to the U.S. leadership in the aerospace industry, and will be required for the identifiable future needs of the Federal Government. In recent years, the spectrum available to support the flight test telemetry operations has been reduced by over 30 percent. The current uses of the bands allocated for ATM already provide considerable public benefits. The cost and operational impact to both the Federal and commercial aviation industry of an additional reallocation would far outweigh any positive public benefits. For these reasons the 1435-1525 MHz band is not considered for reallocation.

BANDS THAT HAVE ALREADY BEEN IDENTIFIED FOR REALLOCATION

Spectrum Reallocation Study Required by OBRA 93

In compliance with Title VI of OBRA 93, NTIA performed a spectrum reallocation study that identified 235 MHz of spectrum to be transferred to the FCC for licensing to the private sector.[43] The reallocation study established a schedule by which the President may withdraw or limit Federal frequency assignments in the bands identified for reallocation. The bands below 3 GHz that are scheduled for reallocation are shown in Table 2-7. Since these bands have already been identified for transfer to the FCC they cannot be considered in this study.

Accelerated Availability of the 1710-1755 MHz Band

Title III requires that the planned date for competitive bidding of the 1710-1755 MHz band be accelerated. However, it is clearly stated in the conference report for the BBA 97, that the conferees intend that the Federal stations in the 1710-1755 MHz band are to be withdrawn in accordance with the plan established in the NTIA Final Report.[44] Moreover, the conferees confirm that the sites identified in Appendix F of the NTIA Final Report will be retained indefinitely.

TABLE 2-7.
The Bands Below 3 GHz Scheduled for Reallocation Under OBRA 93

Bands Identified for Reallocation	Reallocation Status	Reallocation Schedule
1390-1400 MHz	Exclusive	January 1999
1427-1432 MHz	Exclusive	January 1999
1670-1675 MHz	Mixed	January 1999
1710-1755 MHz	Mixed	January 1999/2004[a]
a) Earlier availability date applies only to the 25 largest U.S. cities and is further subject to timely reimbursement of Federal costs, including reimbursement directly from the private sector.		

BANDS TO BE CONSIDERED FOR REALLOCATION

After eliminating the Federal bands that fall into one or more of the established categories the bands shown in Table 2-8 were considered for reallocation for non-Federal use.

TABLE 2-8.
Federal Government Bands To Be Considered For Reallocation

Frequency Band	Bandwidth
32-33, 34-35, 36-37, 38-39 MHz	4 MHz
40-42 MHz	2 MHz
138-144 MHz	6 MHz
216-220 MHz	4 MHz
403-406 MHz	3 MHz
932-935/941-944 MHz	6 MHz
1370-1378.55, 1383.55-1390 MHz	15 MHz
1432-1435 MHz	3 MHz
2360-2390 MHz	30 MHz

ENDNOTES

Requests for copies of references from Federal departments and agencies should be referred to the originating organization. Parts of the reference material may be exempt from public release.

1. National Telecommunications and Information Administration, U.S. Department of Commerce, NTIA Special Publication 96-332, *High Frequency (3-30 MHz) Spectrum Planning Options* (Nov. 1996), at 3-2.

2. National Telecommunications and Information Administration, U.S. Department of Commerce, *Manual of Regulations and Procedures for Federal Radio Frequency Management* (September 1995) (Revised September 1996, Jan. and May 1997).

3. National Telecommunications and Information Administration, U.S. Department of Commerce, NTIA Special Publication 94-27, *Preliminary Spectrum Reallocation Report* (Feb. 1994) [hereinafter NTIA Preliminary Report], at 2-7.

4. National Telecommunications and Information Administration, U.S. Department of Commerce, NTIA Special Publication 94-31, *U.S. National Spectrum Requirements: Projections and Trends*, (Mar. 1995) [hereinafter NTIA Spectrum Requirements Report], at 105.

5. NTIA Preliminary Report, *supra* note 3, at 2-2.

6. *Id*. at 2-7.

7. *Id*. at D-8.

8. *Id.* at 2-33.

9. *Id.* at 2-16; NTIA Spectrum Requirements Report, *supra* note 4, at 130.

10. NTIA Preliminary Report, *supra* note 3, at B-4 and B-6.

11. NTIA Spectrum Requirements Report, *supra* note 4, at 125, 128, and 129.

12. NTIA Preliminary Report, *supra* note 3, at 2-10, 2-17, 2-19, 2-23, and 2-33.

13. *Id*. at 2-10, 2-16, 2-20, 2-23, 2-33, and 2-35.

14. Letter from AF Frequency Management Agency, U.S. Department of the Air Force, to NTIA Interdepartment Radio Advisory Committee, *AF Title VI Mission and Financial Impact Statements* (Nov. 9, 1993) (FOR OFFICIAL USE ONLY).

15. NTIA Preliminary Report, *supra* note 3, at 2-20.

16. *Id.* at 2-33, and 2-35.

17. National Telecommunications and Information Administration, U.S. Department of Commerce, NTIA Special Publication 94-27, *Spectrum Reallocation Final Report* (Feb. 1995), [hereinafter - NTIA Final Report] at 4-11, and 4-13.

18. NTIA Spectrum Requirements Report, *supra* note 4, at 53, and 146.

19. NTIA Preliminary Report, *supra* note 3, at 2-19 and 2-33.

20. *Id*. at 2-20, 2-23, and 2-35.

21. NTIA Preliminary Report, *supra* note 3, at 2-10.

22. Letter from Tomas Gergely, NSF IRAC Representative, to E. Drocella, NTIA (Dec. 2, 1997), at 2.

23. NTIA Spectrum Requirements Report, *supra* note 4, at 157.

24. NTIA Preliminary Report, *supra* note 3, at 2-8.

25. *Id.* at 2-10.

26. National Telecommunications and Information Administration, U.S. Department of Commerce, Public Safety Wireless Advisory Committee, Final Report, Vol.1 (Sept. 1996) at 18.

27. National Telecommunications and Information Administration, U.S. Department of Commerce, NTIA TM 94-160, *National Land Mobile Spectrum Requirements* (Jan. 1994), at 25.

28. NTIA Spectrum Requirements Report, *supra* note 4, at 13.

29. NTIA Preliminary Report, *supra* note 3, at D-2.

30. *Id.* at 2-33.

31. Balanced Budget Act of 1997, Pub. L. No. 111, Stat.251 (1997), § 9233 (a) (4).

32. *Amendment of Part 90 of the Commission's Rules to Adopt Regulations for Automatic Vehicle Monitoring Systems*, Report and Order, PR Docket No. 93-61 (Feb. 6, 1995) [hereinafter LMS R&O].

33. NTIA Preliminary Report, *supra* note 3, at 2-14.

34. *Id.*

35. Memorandum for the Assistant Secretary of Defense (C3I), from R.M. Nutwell, Rear Admiral, U.S. Navy, Deputy Director, Space, Information Warfare, Command and Control. Subject: Reallocation of Spectrum in Accordance with the Balanced Budget Act of 1997 (Dec. 9, 1997) at 4.

36. LMS R&O, *supra* note 32, at 12.

37. *Id* at 6.

38. *Id* at 3.

39. Letter from William K. Keane, Arter & Hadden Attorneys at Law, Counsel for the Aerospace & Flight Test Radio Coordinating Council, to Richard D. Parlow, Associate Director Office of Spectrum Management National Telecommunication and Information Administration (July 2, 1997) (on file with NTIA).

40. Department of Defense Comments in Response to the Notice of Inquiry and Request for Comments, *Current and Future Requirements for the Use of Radio Frequencies in the United States*, Docket No. 920532-2132, 57 Fed. Reg. 25,010 (Nov. 5,1992), at 12.

41. NTIA Preliminary Report, *supra* note 3, at 2-28 and 3-10.

42. *Id.* at 2-16 and 2-33.

43. NTIA Final Report, *supra* note 17, at 5-1.

44. Conference Report on H.R. 2015, Balanced Budget Act of 1997, 143 Cong. Rec. H6174 (July 29, 1997).