1215-1240 MHz

1. Band Introduction

The band 1215-1240 MHz is used by Federal agencies for operating various types of long-range radar systems that perform missions critical to safe and reliable air traffic control (ATC) in the national airspace, border surveillance, early warning missile detection, and drug interdiction. These radar systems ensure the safe transportation of people and goods, encourage the flow of commerce, and provide for national defense. Long-range radars are operated in this portion of the radio frequency spectrum because the effects of rain and fog on radar target detection are very low, the external background noise levels are low, and high-power transmitter tubes operate very efficiently. These factors are important to achieve the long-range detection of different size aircraft as well as other targets.

Various radionavigation-satellite systems operate in the space-to-earth and space-to-space directions. Global Navigation Satellite Systems (GNSS) is the standard generic term for radionavigation-satellite systems that provide autonomous geo-spatial positioning with global coverage. In the United States, such systems are referred to as Positioning, Navigation, and Timing (PNT) systems. These systems allow receivers to determine their location (longitude, latitude, and altitude) using signals transmitted from satellites and provide precise timing for a multitude of users worldwide. The 1227.6 MHz ± 15 MHz frequency band is used to transmit the Global Positioning System (GPS) radionavigation-satellite service L2 signal for military, aviation, space, and commercial applications. The other components of the GNSS that currently or plan to transmit navigation signals in the band 1215-1240 MHz include: the Russian Federation Global Navigation Satellite System (GLONASS), the European Union Galileo, Japan’s Quasi Zenith Satellite System, and China’s Compass. The Federal Aviation Administration operates ground reference stations that receive the L2 signal for use by the Wide Area Augmentation System (WAAS) to augment the GPS to improve accuracy, integrity, and availability.

2. Allocations

2a. Allocation Table

The frequency allocation table shown below is extracted from the Manual of Regulations and Procedures for Federal Radio Frequency Management, Chapter 4 – Allocations, Allotments and Plans.

Table of Frequency Allocations

United States Table

Federal Table	Non-Federal Table	FCC Rule Part(s)
1215-1240 EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION G56 RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) G132 SPACE RESEARCH (active) 5.332	1215-1240 Earth exploration-satellite (active) Space research (active)	

2b. Additional Allocation Table Information

5.332 In the band 1 215-1 260 MHz, active spaceborne sensors in the Earth exploration-satellite and space research services shall not cause harmful interference to, claim protection from, or otherwise impose constraints on operation or development of the radiolocation service, the radionavigation- satellite service and other services allocated on a primary basis. (WRC-2000)

G56 Federal radiolocation in the bands 1215-1300, 2900-3100, 5350-5650 and 9300-9500 MHz is primarily for the military services; however, limited secondary use is permitted by other Federal agencies in support of experimentation and research programs. In addition, limited secondary use is permitted for survey operations in the band 2900-3100 MHz.

G132 Use of the radionavigation-satellite service in the band 1215-1240 MHz shall be subject to the condition that no harmful interference is caused to, and no protection is claimed from, the radionavigation service authorized under ITU Radio Regulation No. 5.331. Furthermore, the use of the radionavigation-satellite service in the band 1215-1240 MHz shall be subject to the condition that no harmful interference is caused to the radiolocation service. ITU Radio Regulation No. 5.43 shall not apply in respect of the radiolocation service. ITU Resolution 608 (WRC-03) shall apply.

3. Federal Agency Use

3a. Federal Agency Frequency Assignments Table

The following table identifies the frequency band, types of allocations, types of applications, and the number of frequency assignments in the Government Master File (GMF) by agency.

Federal Frequency Assignment Table

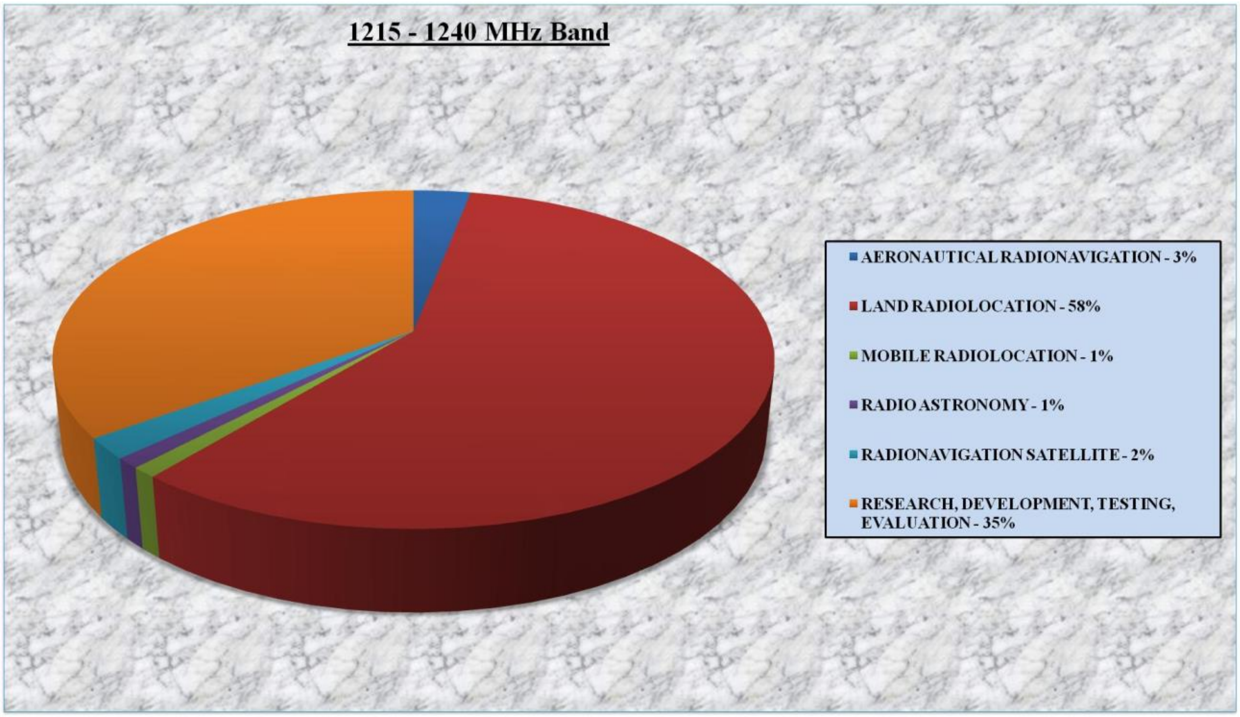
1215-1240 MHz Band							
SHARED BAND							
	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) SPACE RESEARCH (active)						
	TYPE OF APPLICATION						
AGENCY	AERONAUTICAL RADIONAVIGATION	LAND RADIOLOCATION	MOBILE RADIOLOCATION	RADIO ASTRONOMY	RADIONAVIGATION SATELLITE	RESEARCH DEVELOPMENT TESTING EVALUATION	TOTAL
AF		27			2	26	55
AR		56	2			9	67
DOC					1		1
DOE	2						2
FAA	1					1	2
MC	2	14					16
N		1				12	13
NASA		3					3
NSF				1			1
TOTAL	5	101	2	1	3	48	163
The number of actual systems, or number of equipments, may exceed and sometimes far exceed, the number of frequency assignments in a band. Also, a frequency assignment may represent, a local, state, regional or nationwide authorization. Therefore, care must be taken in evaluating bands strictly on the basis of assignment counts or percentages of assignments.							

1215 – 1240 MHz

The majority of the user equipment will not be reflected in the GMF or elsewhere because devices are receive-only. Therefore, the actual use of the band would be mischaracterized if a measure of such use relied solely on frequency assignment data.

3b. Percentage of Frequency Assignments Chart

The following chart displays the percentage of frequency assignments in the GMF for the systems operating in the frequency band 1215–1240 MHz.



4. Frequency Band Analysis By Application

4a. Aeronautical Radionavigation

The Federal Aviation Administration (FAA) and Department of Defense (DoD) operate long-range aeronautical radionavigation radar systems in the band 1215-1240 MHz. These radar systems are used to monitor aircraft and other targets within the national airspace, along the border areas, and around military bases and airfields. The Air Route Surveillance Radar (ARSR) systems and tactical radars that operate in this band measure range, bearing, and velocity of aircraft and other targets.[1] [2] The ARSR systems track aircraft flying across the country in support of the National Airspace System.

The aeronautical radionavigation radar systems operating in the band 1215-1240 MHz use a continually rotating antenna mounted on a tower. The antennas are mounted on a tower to provide an unobstructed view of the airspace they are monitoring. The antennas are directed slightly upwards to remove the effects of local obstructions (e.g., ground clutter), that would degrade the performance of the radar system. Each system installation is unique but the typical antenna height is approximately 45 feet for fixed radar systems, and approximately 20 feet for transportable radar systems. The typical antenna rotation rate for radar systems operating in this band is 5 to 6 revolutions per minute.

4b. Radiolocation Service

The military operates tactical radar systems in the band 1215-1240 MHz.
Tactical radars are designed to be more easily tuned than air traffic control radars, since they may have to operate in a battlefield environment with many other systems and require the flexibility to change frequencies to reduce their exposure to hostile forces.

The Tethered Aerostat Radar (TAR) system also operates in this band. The TAR consists of balloon mounted radars that are used for monitoring the southern borders and Caribbean airspace for drug interdiction. The balloon is tethered to a ground station and the radar monitors the airspace, sending data down to the ground control station where the information is relayed to appropriate authorities. The TAR system is used as much as weather patterns permit, and the balloon can be maintained.

The technical characteristics of systems operating in this band can be found in ITU-R M 1463-2 titled "*Characteristics of and protection criteria for radars operating in the radiodetermination service in the frequency band 1 215-1 400 MHz*". The systems in the band 1214-1240 MHz operated by the federal government and DoD are similar to the ones described in the following tables.

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[1] The radar systems operating in this band transmit pulsed radio frequency signals that are reflected from the surface of aircraft or target. The time required for a reflected signal that is transmitted to return from an aircraft and the direction of the reflected signal are measured. From this information, the radar can determine the distance of the aircraft from the antenna, the direction of the aircraft relative to the antenna, and in some cases the altitude.

[2] The information collected by the radar systems is displayed on a plan position indicator scope at the radar site and relayed to regional ATC centers for further processing.

TABLE 1

1 215-1 400 MHz radiodetermination system characteristics

Parameter	Units	System 1	System 2	System 3	System 4	System 5	System 6	System 7	System 8
Peak power into antenna	dBm	97	80	76.5	80	73.9	96	93	78.8
Frequency range	MHz					1 215-1 400	1 280-1 350	1 215-1 350	1 240-1 350
Pulse duration	μs	2	88.8; 58.8 (Note 1)	0.4; 102.4; 409.6 (Note 2)	39 single frequency 26 and 13 dual frequency (Note 3)	2 each of 51.2 2 each of 409.6	2	6	115.5; 17.5 (Note 4)
Pulse repetition rate	pps	310-380 staggered	291.5 or 312.5 average	200-272 long-range 400-554 short-range	774 average	240-748	279.88 to 370.2	279.88 to 370.2	319 average
Chirp bandwidth for frequency modulated (chirped) pulses		Not applicable	770 kHz for both pulse widths	2.5 MHz for 102.4 μs 625 kHz for 409.6 μs	Not applicable	1.25 MHz	Not applicable	Not applicable	1.2 MHz
Phase-coded sub-pulse width	μs	Not applicable	Not applicable	Not applicable	1	Not applicable	Not applicable	Not applicable	Not applicable
Compression ratio		Not applicable	68.3:1 and 45.2:1	256:1 for both pulses		64:1 and 256:1	Not applicable	Not applicable	150:1 and 23:1
RF emission bandwidth (3 dB)	MHz	0.5	1.09	2.2; 2.3; 0.58	1	0.625 or 1.25	1.2	1.3	1.2
Output device		Klystron	Transistor	Transistor	Cross-field amplifier	Transistor	Magnetron/ Amplitron	Klystron	Transistor
Antenna type		Horn-fed reflector	Stack beam reflector	Rotating phased array	Parabolic cylinder	Planar array with elevation beam steering	47′ × 23′ (14.3 × 7 m) cosecant squared	45′ × 19′ (13.7 × 5.8 m) cosecant squared	Horn-fed reflector
Antenna polarization		Horizontal, vertical, LHCP, RHCP	Vertical, circular	Horizontal	Vertical	Horizontal	CP/LP	Linear orthogonal and CP	Vertical; RHCP

TABLE 1 (*continued*)

Parameter	Units	System 1	System 2	System 3	System 4	System 5	System 6	System 7	System 8
Antenna maximum gain	dBi	34.5, transmit 33.5, receive	32.4-34.2, transmit 31.7-38.9, receive	38.9, transmit 38.2, receive	32.5	38.5	34	35	34.5
Antenna elevation beamwidth	degrees	3.6 shaped to 44	3.63-5.61, transmit 2.02-8.79, receive	1.3	4.5 shaped to 40	2	3.75 (cosecant squared)	3.75 (cosecant squared)	3.7 shaped to 44 (cosecant squared)
Antenna azimuthal beamwidth	degrees	1.2	1.4	3.2	3.0	2.2	1.2	1.3	1.2
Antenna horizontal scan characteristics	rpm	360° mechanical at 5 rpm	360° mechanical at 5 rpm	360° mechanical at 6 rpm for long range and 12 rpm for short range	360° mechanical at 6, 12 or 15 rpm	5	6	5	360° mechanical at 5 rpm
Antenna vertical scan characteristics	degrees	Not applicable	–7 to +30 in 12.8 or 13.7 ms	–1 to +19 in 73.5 ms	Not applicable	−6 to +20	−4 to +20	−4 to +20	Not applicable
Receiver IF bandwidth	kHz	780	690	4 400 to 6 400	1 200	1 250 625	720 to 880 (log) 1 080 to 1 320 (MTI)	270 to 330 (20 series log) 360 to 480 (20 series MTI) 540 to 660 (60 series log) 720 to 880 (60 series MTI)	1 200
Receiver noise figure	dB	2	2	4.7	3.5	2.6	4.25	9	3.2

TABLE 1 (*end*)

Parameter	Units	System 1	System 2	System 3	System 4	System 5	System 6	System 7	System 8
Platform type		Fixed	Fixed	Transportable	Transportable	Fixed terrestrial	Fixed terrestrial	Fixed terrestrial	Fixed
Time system operates	%	100	100	100	100	100	100	100	100

LHCP: left-hand circularly polarized

RHCP: right-hand circularly polarized

NOTE 1 – The radar has 44 RF channel pairs with one of 44 RF channel pairs selected in normal mode. The transmitted waveform consists of a 88.8 μs pulse at frequency f_1 followed by a 58.8 μs pulse at frequency f_2. Separation of f_1 and f_2 is 82.854 MHz.

NOTE 2 – The radar has 20 RF channels in 8.96 MHz increments. The transmitted waveform group consists of one 0.4 μs P0 pulse (optional) which is followed by one 102.4 μs linear frequency modulated pulse (if 0.4 μs P0 is not transmitted) of 2.5 MHz chirp which may be followed by one to four long-range 409.6 μs linear frequency modulated pulses each chirped 625 kHz and transmitted on different carriers separated by 3.75 MHz. Normal mode of operation employs frequency agility whereby the individual frequencies of each waveform group are selected in a pseudo-random manner from one of the possible 20 RF channels within the frequency band 1 215-1 400 MHz.

NOTE 3 – The radar has the capability of operating single frequency or dual frequency. Dual RF channels are separated by 60 MHz. The single channel mode uses the 39 μs pulse width. In the dual channel mode, the 26 μs pulse is transmitted at frequency f, followed by the 13 μs pulse transmitted at f+ 60 MHz.

NOTE 4 – This radar utilizes two fundamental carriers, F1 and F2, with two sub-pulses each, one for medium range detection and one for long range detection. The carriers are tunable in 0.1 MHz increments with a minimum separation of 26 MHz between F1 (below 1 300 MHz) and F2 (above 1 300 MHz). The carrier sub-pulses are separated by a fixed value of 5.18 MHz. The pulse sequence is as follows: 115.5 µs pulse at F1 + 2.59 MHz, then a 115.5 µs pulse at F2 + 2.59 MHz, then a 17.5 µs pulse at F2 – 2.59 MHz, then a 17.5 µs pulse at F1 – 2.59 MHz. All four pulses are transmitted within a single pulse repetition interval.

4c. Radionavigation Satellite

4c(1). Radionavigation-Satellite (Space-to-Earth) Service

Use of the band 1215-1240 MHz by the U.S. Global Positioning System (GPS) is coordinated with other international RNSS systems through bi-lateral or multilateral agreements with other nations so that the various global navigation systems can operate and not interfere with each other. Such agreements are crucial given the intensive use of this band by global RNSS systems and the missions and functions such systems support globally. The Federal and non-Federal GNSS receivers associated with this system operate throughout the country but do not require a frequency assignment in the GMF.

As of 2010, GPS was the only fully operational GNSS.[3] GPS is a dual-use, space-based, radionavigation service that provides access to precise positioning, navigation, and timing (PNT) on a continuous, worldwide basis, regardless of weather conditions. The GPS constellation nominally consists of at least twenty-four satellites in non-geostationary orbit (altitude of 20,200 km) that transmit encrypted signals, which are used by United States and allied military forces, and unencrypted signals, which are used worldwide in a myriad of government, public and private infrastructures, public safety, commercial, consumer, and scientific applications, including critical safety-of-life operations. GPS has become an integral component of the global information infrastructure and is being used in non-federal applications such as: aeronautical, maritime, and ground-based navigation; surveying; construction; precision agriculture; timing synchronization (e.g., telecommunications, digital television, power distribution, banking, Internet); emergency medical response and disaster management; and search and rescue operations. Today there are millions of GPS receivers in use around the world.

The Federal Radionavigation Plan provides a detailed description of how the Federal agencies use the GPS service for aviation, maritime, space and land navigation. Non-navigation applications such as geodesy and surveying, mapping and charting, agriculture and natural resources, Geographic Information Systems, meteorological and timing are also described.[4] The requirements of non-Federal and military users for radionavigation services based upon the technical and operational performance needed for military missions, transportation safety, and economic efficiency are also described.

The RNSS frequency requirements for GPS are based upon an assessment of user accuracy requirements, space-to-Earth propagation delay resolution, multipath suppression, and equipment cost and configurations. Three carrier frequencies are centered at 1575.42 MHz

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[3] Information on the Global Positioning System is available at http://www.navcen.uscg.gov/gps/geninfo/.

[4] The Federal Radionavigation Plan is published by the Department of Defense, Department of Homeland Security, and Department of Transportation and is available at www.navcen.uscg.gov.

(GPS L1 signal), 1227.6 MHz (GPS L2 signal), and 1176.45 MHz (GPS L5 signal). The L1 and L5 radionavigation signals are used by aviation receivers during all phases of flight. The L1, L2, and L5 radionavigation signals are used by commercial-grade receivers. The L1 and L2 radionavigation signals are used by the military. Implementation of the L5 signal began in 2009.

The GPS L2 radionavigation signal is transmitted in the 1227.6 ± 12 MHz segment of the 1215-1240 MHz RNSS band. On the L2 carrier frequency two radionavigation signals can be transmitted: the L2 Coarse/Acquisition (C/A) code signal and the L2 Precision (P(Y)) code signal.[5] The GPS provides two levels of service: Standard Positioning Service (SPS) which uses the C/A code on the L1 carrier frequency and the Precision Positioning Service (PPS) which uses the P(Y) code on both the L1 and L2 carrier frequencies. The L1 radionavigation signal is used to resolve a user's location to within 22 meters. The radionavigation signal transmitted on the L2 carrier frequency provides receivers the necessary frequency diversity and wider bandwidth for increased range accuracy for Earth-to-space propagation delay resolution and for multipath suppression to increase the total accuracy by an order of magnitude.[6]

Planned future RNSS systems include the European Union's Galileo operating in the 1260-1300 MHz segment of the RNSS band; and Japan's Quasi Zenith Satellite System (QZSS) will transmit a radionavigation signal centered at 1268.52 MHz. China's Compass will transmit two radionavigation signals in the 1215-1300 MHz band. As part of the GNSS receivers that take advantage of these systems may benefit from additional satellite signals, increased redundancy and improved performance over that obtained from just one system alone[7].

As part of the GPS modernization program a new civilian use signal (L2C) transmitted on the L2 carrier frequency. The new L2C will provide better performance than the current C/A code signal to support future civilian receiver applications[8]. The L2C is a civilian GPS radionavigation signal designed specifically to meet commercial needs. When

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[5] Unlike the L1 carrier frequency the C/A and P(Y) codes are not transmitted simultaneously on the L2 carrier frequency.

[6] Any combination of two or more signals can be used to provide the necessary frequency diversity and wider bandwidth for increased range accuracy for Earth-to-space propagation delay resolution and redundancy.

[7] The Russian GLONASS is a GNSS in the process of being restored to full operation. The European Union Galileo system is a GNSS in initial deployment phase, scheduled to be operational in 2013. The People's Republic of China has indicated it will expand its regional Beidou navigation system into the global Compass navigation system by 2015.

[8] *Id.* at 3-7.

combined with the L1/C/A and L1C radionavigation signals in a dual frequency receiver, L2C enables ionospheric correction techniques that increase accuracy, deliver faster signal acquisition and enhance reliability. The first GPS satellite transmitting the L2C radionavigation signal was launched in 2005. As of 2009, there are seven GPS satellites transmitting the L2C radionavigation signal.[9]

In addition to the GPS service, the Federal Aviation Administration (FAA) operates the Wide Area Augmentation System (WAAS), which augments the signals provided by GPS and provides the additional accuracy, integrity, and availability necessary to enable users to rely on GPS for all phases of flight.[10] WAAS is based on a network of approximately 25 ground reference stations that covers a very large service area in the United States. Signals from GPS satellites are received by wide area ground reference stations (WRSs). Each of these precisely surveyed reference stations receive GPS signals and determine if any errors exist. These WRSs are linked to form the U.S. WAAS network. Each WRS in the network relays the data to the Wide area Master Station (WMS) where correction information is computed. The WMS calculates correction algorithms, and assesses the integrity of the system. Currently, this information is broadcast from the WAAS geostationary satellites to WRS receivers and WAAS enabled receivers using the radionavigation signals transmitted in the L1 and L2 frequency bands.[11]

The U. S. Coast Guard operates the Nationwide Differential GPS (NDGPS) a system of 87 reference stations that receive both the L1 and L2 radionavigation signals and broadcast corrections, which can be used by a GPS receiver to improve accuracy, integrity, and availability of GPS position location.[12] NDGPS is used in a myriad of applications including maritime navigation, positive train control, precision farming, dredging, graphic information systems, and surveying. Differential GPS uses the fixed location of a reference station to determine the inaccuracy of the satellite signal.[13] The location derived from the satellite signal is compared to the reference station. That difference, or inaccuracy, can then be transmitted to GPS receivers. By comparing the inaccuracy to the

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[9] For more information on GPS modernization, go to the Department of Commerce Office of Space Commercialization website at http://www.space.commerce.gov/gps/modernization.shtml.

[10] Internationally the WAAS is referred to as Space Based Augmentation System (SBAS).

[11] Examples of satellites that transmit WAAS signals are Galaxy 15, Anik F1R, and Inmarsat-4 F3.

[12] The NDGPS correction message is transmitted in the 285-325 kHz frequency band.

[13] Positive train control is a system of monitoring and controlling train movements to provide increased safety.

satellite signal, the GPS receivers can then accurately determine their location.[14] Approximately 92 percent of the lower 48 states have coverage from a single NDGPS broadcast station and 65 percent have coverage from two stations.[15]

GNSS receivers on the ground with a fixed position will; be able to use the L2C radionavigation signal can also be used to calculate the precise time as a reference for scientific experiments. GPS-provided time and frequency has become a critical component of our national infrastructure supporting telecommunications systems, power grids, and many military applications. GPS is extensively used for the synchronization needed for commercial communication networks.

The National Aeronautics and Space Administration (NASA) conduct research and development in a number of GPS application areas in the space, aeronautics, and terrestrial environments. NASA uses the RNSS bands, where GPS service operates space-to-Earth, as a critical enabler for space operations and science missions. NASA is also investing in augmentation services to GPS, including supporting the continued development of the International GNSS Service (IGS) and the Global Differential GPS System (GDGPS). The data received from this network of GPS monitoring stations is providing data products on a daily basis that are distributed via the Internet for users worldwide, with products including measurement of Earth crustal movement at the centimeter per year level. A possible byproduct of this research could be the eventual development of reliable techniques to be used for earthquake early warning and prediction. The GDGPS system is a high accuracy GPS augmentation system to support the real-time positioning, timing, and determination requirements of NASA science missions. In addition, GPS is used during launches to provide position updates and improve the precision of the Inertial Navigation Systems that guide the vehicle from the surface to orbit.

NASA also uses GPS receivers to perform atmospheric radio occultation measurements where the GPS receiver antenna is pointed towards the Earth limb to measure properties of the atmosphere. The GPS receiver in low earth orbit observes the propagation delay of the GPS signals that travel through the atmosphere. Occultations occur as each GPS satellite rises or sets on the horizon as viewed by the space receiver. From the changing delay, the (altitude) variation in the atmosphere's index of refraction can be measured and altitude profiles of the ionosphere electron density, atmospheric density, pressure, temperature, and water vapor can be derived.

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[14] The closer to the broadcast station transmitter the more accurate the determination. Using current techniques, this correction is most accurate near the NDGPS facilities (approximately 1 meter) and degrades up to 3 meters at the edge of the coverage area, which is up to 402 kilometers away.

[15] Information on NDGPS is available from the United States Coast Guard at http://www.navcen.uscg.gov/AccessASP/NDgpsReportAllSites.asp.

4c(2) Radionavigation-Satellite (Space-to-Space) Service

GNSS receivers used for spaceborne applications operate in the 1227.6 ± 15 MHz segment of the 1215-1240 MHz RNSS band. The primary navigation function for NASA missions is performed through communication channel tracking by NASA's Ground and Space Networks, and ground-based trajectory analysis of observables. Individual missions may use autonomous navigation capabilities through on-board processing of inertial measurements, celestial measurements, and radiometric signals including GPS. The U.S. space community also uses GPS in a number of spacecraft and science instrument applications.

Onboard the satellite, GPS may be used to determine satellite position as an input to navigation software that calculates and propagates the satellite's orbit. GPS also may provide accurate time synchronization for satellites as well as spacecraft attitude determination. The spaceborne use of GNSS receivers combines the ability to sense space vehicle trajectory, attitude, time, and relative ranging between vehicles into one package, resulting in a reduction of the sensor complement employed on spacecraft and significant reductions in space vehicle operations cost. Research satellites use GNSS receivers for precise positioning in support of onboard science instruments with the goal of achieving centimeter level accuracy.

4d. Space Research (Active) Service

There are no Federal systems operating in the space research (active) service.

4e. Earth Exploration-Satellite (Active) Service

There are no Federal systems operating in the Earth exploration-satellite active service.

4f. Radio Astronomy Service

There is a frequency assignment for a radio astronomy facility located in Agustin, New Mexico**.** The assignment is for a receive-only system operated by the National Science Foundation and has a band assignment from 1215 to 1730 MHz and is authorized on a non-protected basis.

4g. Research Testing and Development

In addition to the operational radars in the band 1215 -1240 MHz, there are frequency assignments for research and development purposes to examine hardware and software improvements for existing systems. The research and development includes examining new waveforms and testing new signal processing techniques. The operation of radar systems used for research and development are carefully coordinated to ensure that they do not cause harmful interference to operational aeronautical radionavigation radar systems.

The Federal agencies also operate GPS re-radiating devices for testing and training purposes in accordance with Section 8.3.28 (Fixed Devices), Section 8.3.29 (Mobile Devices) and Section 8.3.30 (Aircraft Devices) of the NTIA Manual.

4h. Frequency Coordination and Sharing

In the band 1215-1240 MHz, high-power long-range radar systems operate across the country. In some cases near large population centers with airports, multiple radars must operate in the same geographic area. Compatible operation between different types of radar systems is accomplished through careful design of the radar receivers, frequency selection, and NTIA spectrum standards. The radar receivers use various types of circuitry and signal processing to reduce or eliminate the effects of pulsed interference from other radars.[16] The careful assignment of frequencies for radars operating in this band is crucial to prevent interference to and from other radar systems. The FAA and DoD carefully select and coordinate the frequencies of each radar system that operates in this band.

Radar systems that operate in the band 1215-1240 MHz with power levels above 1 kilowatt are expected to comply with the NTIA Radar Spectrum Engineering Criteria (RSEC) Category C.[17] The RSEC regulates how much bandwidth radars are permitted to use, based on the parameters of the transmitted pulses and the amount of unwanted or spurious emissions they emit. The NTIA regulations place design criteria on radars operating in the band 1215–1240 MHz to facilitate compatibility and spectrum sharing.

The radars operating in the band 1215-1240 MHz are not assigned frequencies in the 1227.6 MHz ± 15 MHz portion of the band. This limits the amount of spectrum that is available for the radars operating in the band. The signals from RNSS systems operated by

[16] These techniques are not effective in mitigating the effects of interference from continuous signals such as those generated by communication systems as discussed in NTIA Report TR-06-444, *Effects of RF Interference on Radar Receivers* (September 2006) available at www.its.bldrdoc.gov/publications.

[17] National Telecommunications and Information Administration, Manual of Regulations and Procedures for Federal Radio Frequency Management.

other administrations may place additional limitations on the spectrum available for the radar systems operating in this band.

4i. Spectrum Contours

The following spectrum contours for the radars operating in the aeronautical radionavigation, and radiolocation services have been computed for a generic ground-based communication receiver. The contours represent the locations where the power of the radar signal causes the thermal noise power of the generic receiver to increase by 1 dB.[18] These spectrum contours do not represent the coverage area of the radar; rather they represent the locations where the signal level of the radar system causes a generic receiver to exceed the interference threshold. Any receiver operating inside contour would experience interference from the radar.

The spectrum contour plots for the radar systems operating in 5-MHz segments of the band 1215-1240 MHz are shown in Figure 2 through Figure 10.

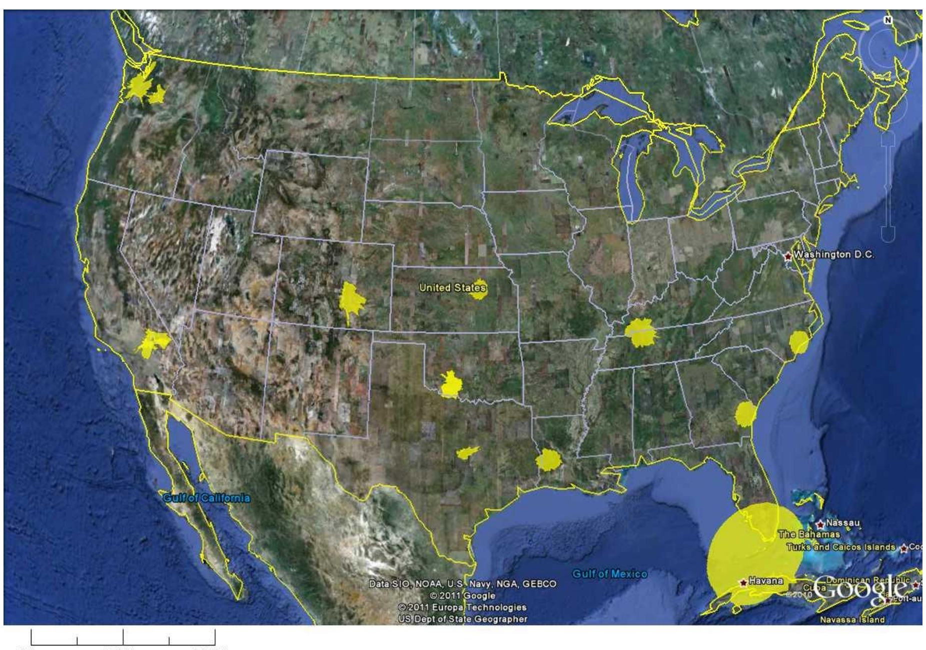

Figure 2. 1215-1220 MHz Band Segment

[18] A 1 dB increase in receiver noise is equivalent to an interference-to-noise (I/N) ratio of -6 dB, which is a commonly accepted value for a first level interference threshold used in electromagnetic compatibility analyses.

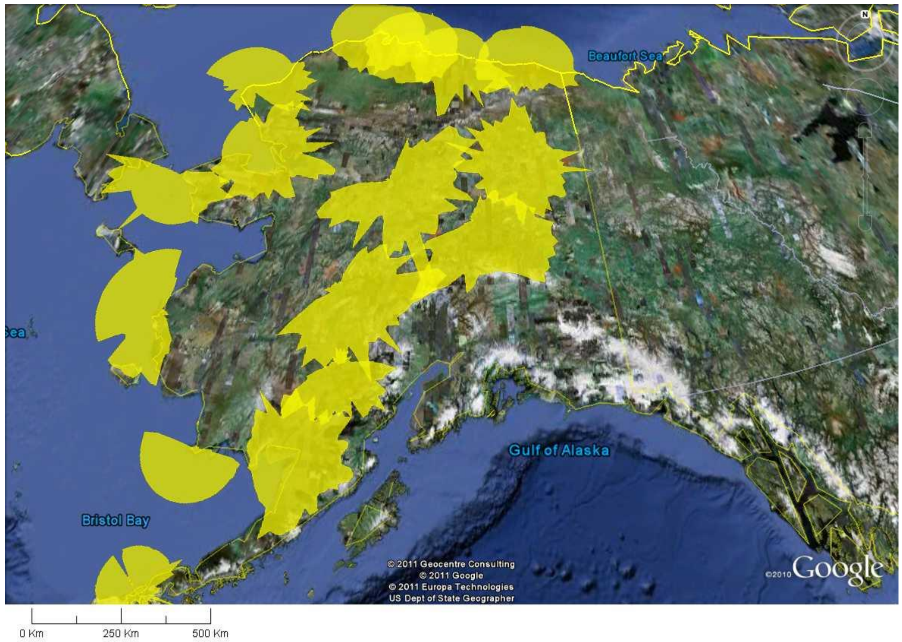

Figure 3. 1215-1220 MHz Band Segment

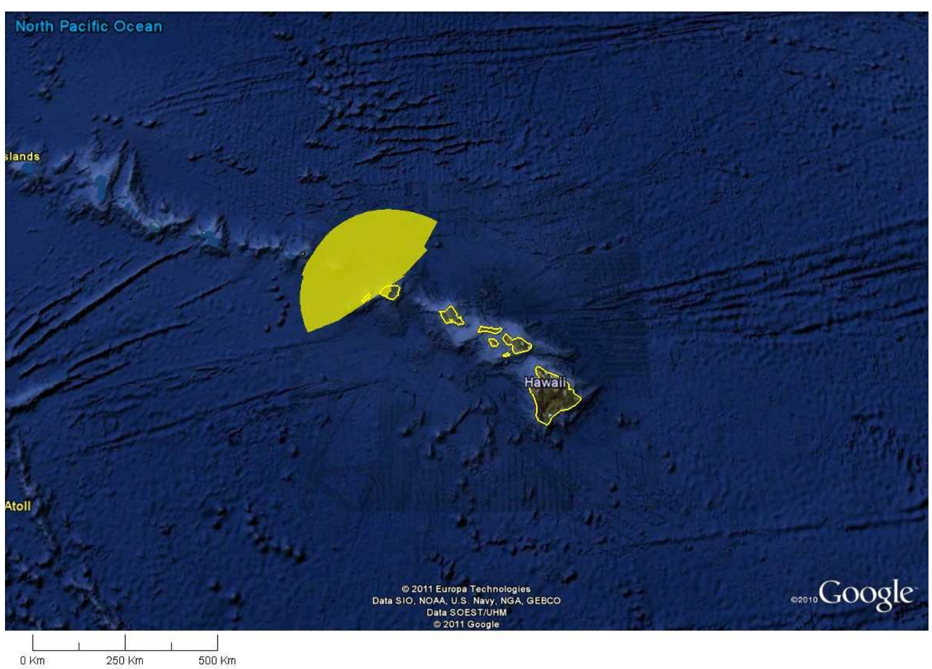

Figure 4. 1215-1220 MHz Band Segment

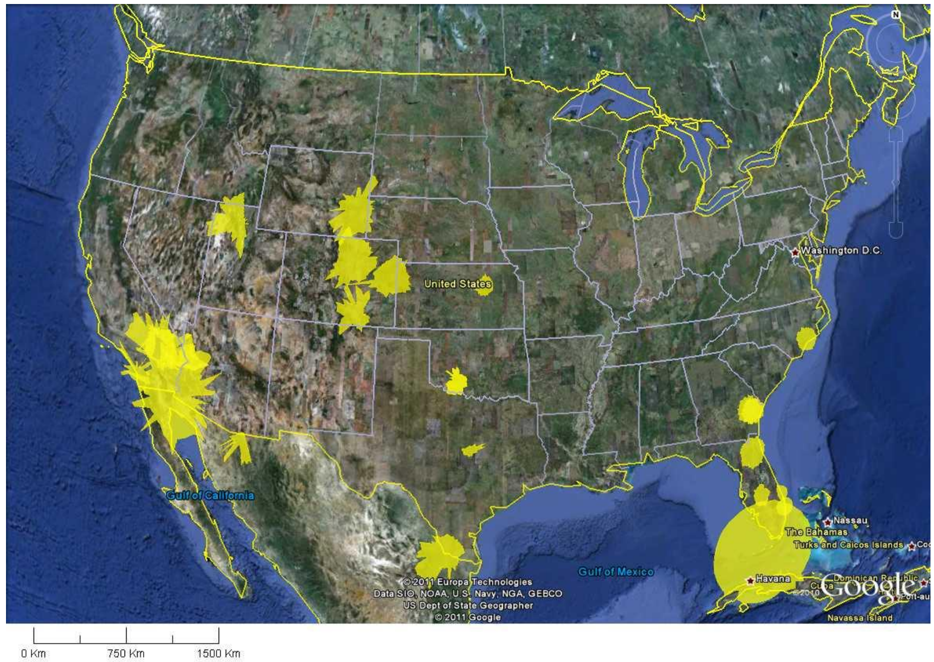

Figure 5. 1220-1225 MHz Band Segment

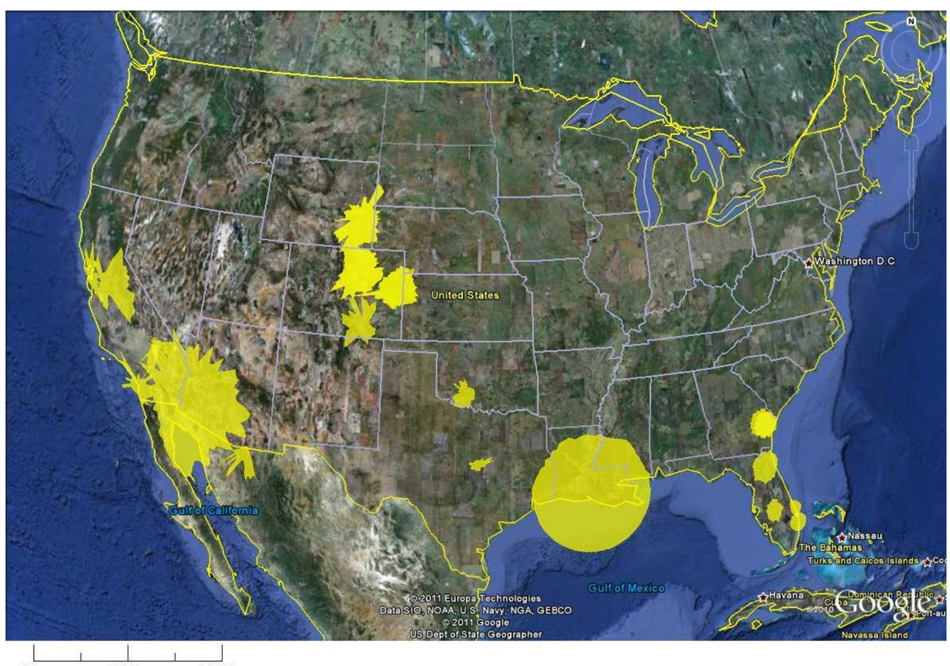

Figure 6. 1225-1230 MHz Band Segment

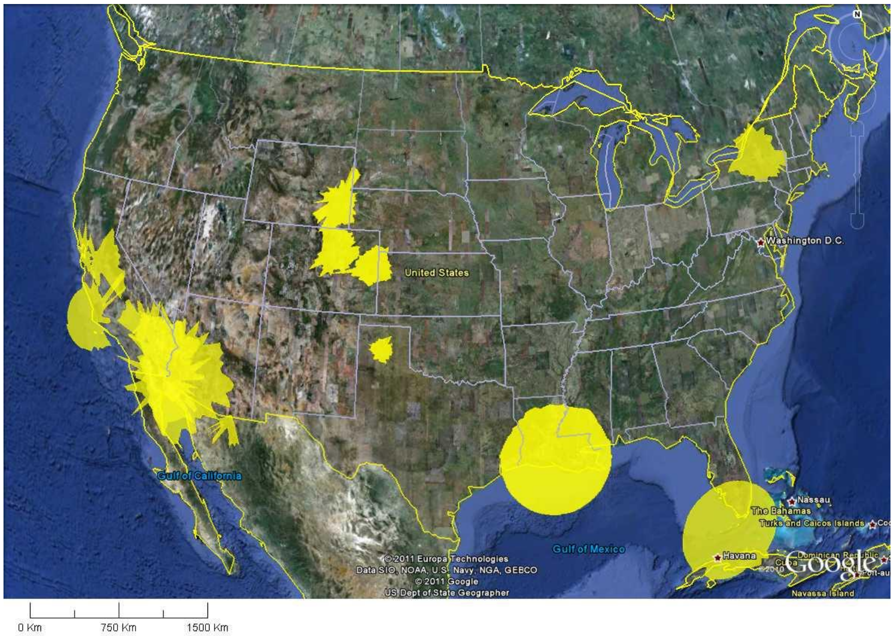

Figure 7. 1230-1235 MHz Band Segment

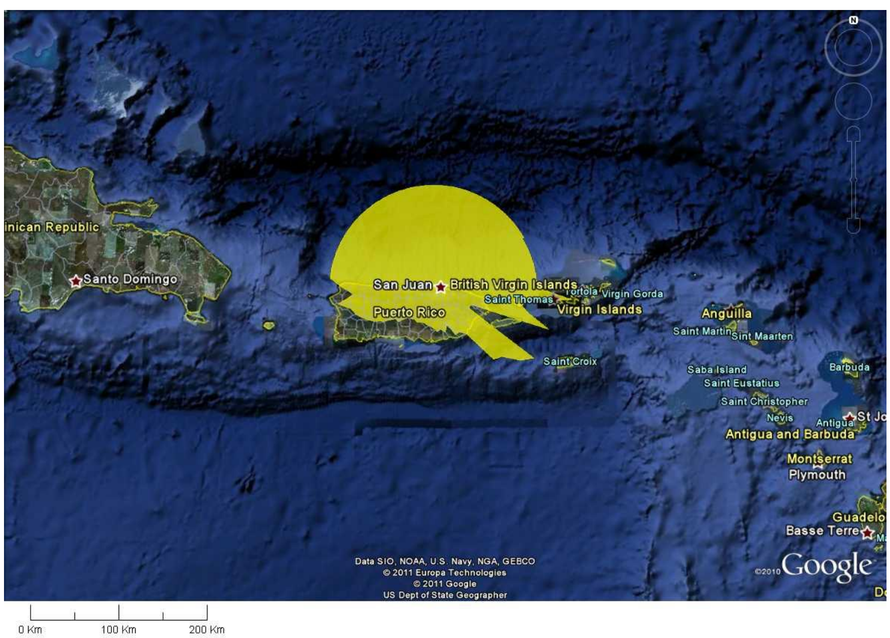

Figure 8. 1230-1235 MHz Band Segment

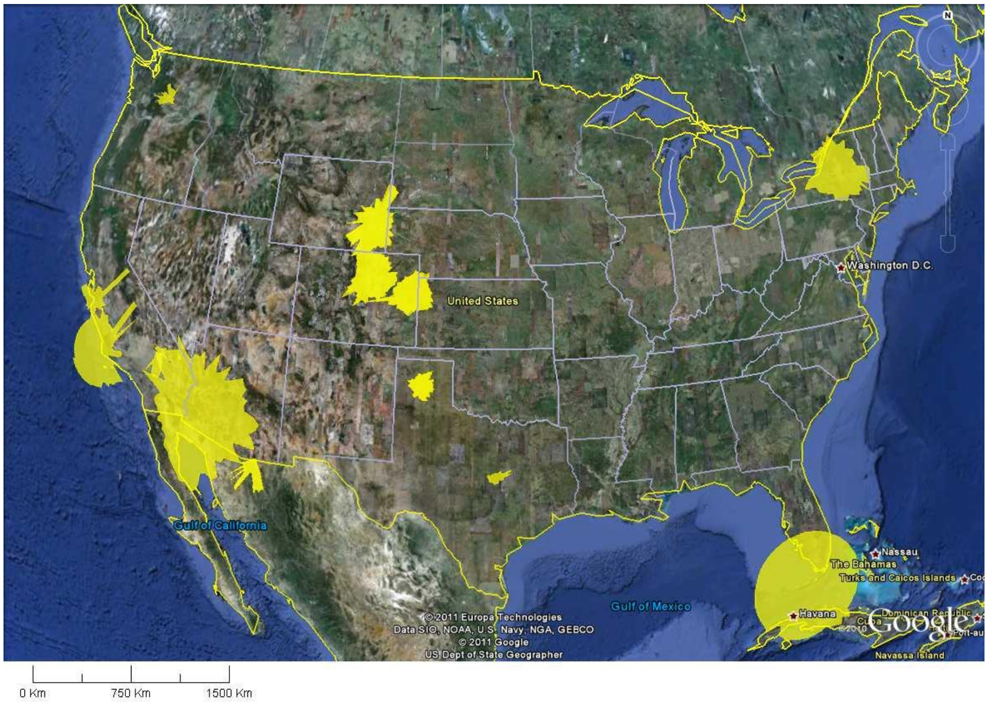

Figure 9. 1235-1240 MHz Band Segment

Figure 10. 1235-1240 MHz Band Segment

5. Planned Use

The federal agencies will continue to operate ATC and tactical long-range radar systems in the band 1215-1240 MHz for the foreseeable future.

At this time there are no new installations planned, however new radar sites could be added if the need arises to monitor additional airspace or other vital assets.

Multiple radionavigation signals allow Federal and non-Federal users to obtain greater precision and availability at lower cost than achievable with augmentation systems. However, the different radionavigation signals combined with augmentation signals for even greater precision and reliability. The long-term spectrum requirements for the RNSS are driven by requirements to support specific GNSS systems. Trends towards more accurate and reliable satellite-based technologies are making some older systems obsolete, potentially reducing the current and future spectrum needs in frequency bands other than those used by GNSS systems.

GPS will be the primary Federally-provided radionavigation system for the foreseeable future. GPS will be augmented and improved to satisfy future civil and military requirements for accuracy, availability, continuity, coverage, and integrity.

Federal and civilian use of the GPS-based navigation system will continue to grow and this will require spectrum availability for the foreseeable future.

Given the large GPS-user growth projections and the importance of GPS to the U.S. critical infrastructure, on-going access to, and sustainment of, spectrum for the L2 and L2C radionavigation signals in the band 1215-1240 MHz will be crucial to a multitude of users in multiple sectors (e.g., military, civil, commercial, and scientific).

The spectrum for the L2 and L2C radionavigation signals used by all GPS and augmentation system (WAAS, LAAS, and NDGPS) receivers will be needed indefinitely.

The use of GPS for spaceborne applications, environmental monitoring, and scientific applications is expected to increase.

The use of GPS for accurate and reliable timing applications critical to the national infrastructure will continue indefinitely.

GNSS systems are operated or planned by other nations, and it is critical that the agreements and cooperation including spectrum access continue to allow systems to operate compatibly. It is expected that commercial GNSS receivers will be capable of utilizing radionavigation signals from these foreign satellites.