1300 - 1350 MHz

1. Band Introduction

The band 1300-1350 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.

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)**
1300-1350 AERONAUTICAL RADIONAVIGATION 5.337 Radiolocation G2 US342	1300-1350 AERONAUTICAL RADIONAVIGATION 5.337 US342	Aviation (87)

2b. Additional Allocation Table Information

5.337 The use of the bands 1300-1350 MHz, 2700-2900 MHz and 9000-9200 MHz by the aeronautical radionavigation service is restricted to ground-based radars and to

associated airborne transponders which transmit only on frequencies in these bands and only when actuated by radars operating in the same band.

G2 In the bands 216-217 MHz, 220-225 MHz, 420-450 MHz (except as provided by US217 and G129), 890-902 MHz, 928-942 MHz, 1300-1390 MHz, 2310-2390 MHz, 2417-2450 MHz, 2700-2900 MHz, 3300-3500 MHz (except as provided by footnote US108), 5650-5925 MHz, and 9000-9200 MHz, the Federal radiolocation service is limited to the military services.

US342 In making assignments to stations of other services to which the bands:

13360-13410 kHz	42.77-42.87 GHz*
25550-25670 kHz	43.07-43.17 GHz*
37.5-38.25 MHz	43.37-43.47 GHz*
322-328.6 MHz*	48.94-49.04 GHz*
1330-1400 MHz*	76-86 GHz
1610.6-1613.8 MHz*	92-94 GHz
1660-1660.5 MHz*	94.1-100 GHz
1668.4-1670 MHz*	102-109.5 GHz
3260-3267 MHz*	111.8-114.25 GHz
3332-3339 MHz*	128.33-128.59 GHz*
3345.8-3352.5 MHz*	129.23-129.49 GHz*
4825-4835 MHz*	130-134 GHz
4950-4990 MHz	136-148.5 GHz
6650-6675.2 MHz*	151.5-158.5 GHz
14.47-14.5 GHz*	168.59-168.93 GHz*
22.01-22.21 GHz*	171.11-171.45 GHz*
22.21-22.5 GHz	172.31-172.65 GHz*
22.81-22.86 GHz*	173.52-173.85 GHz*
23.07-23.12 GHz*	195.75-196.15 GHz*
31.2-31.3 GHz	209-226 GHz
36.43-36.5 GHz*	241-250 GHz
42.5-43.5 GHz	252-275 GHz

are allocated (*indicates radio astronomy use for spectral line observations), all practicable steps shall be taken to protect the radio astronomy service from harmful interference. Emissions from spaceborne or airborne stations can be particularly serious sources of interference to the radio astronomy service (*see* ITU *Radio Regulations* at Nos. **4.5** and **4.6** and Article **29**).

3. Federal Agency Use

3a. Federal Agency Frequency Assignments Table

Table 1 lists the frequency band, types of allocations, types of applications, and the number of frequency assignments by agency.

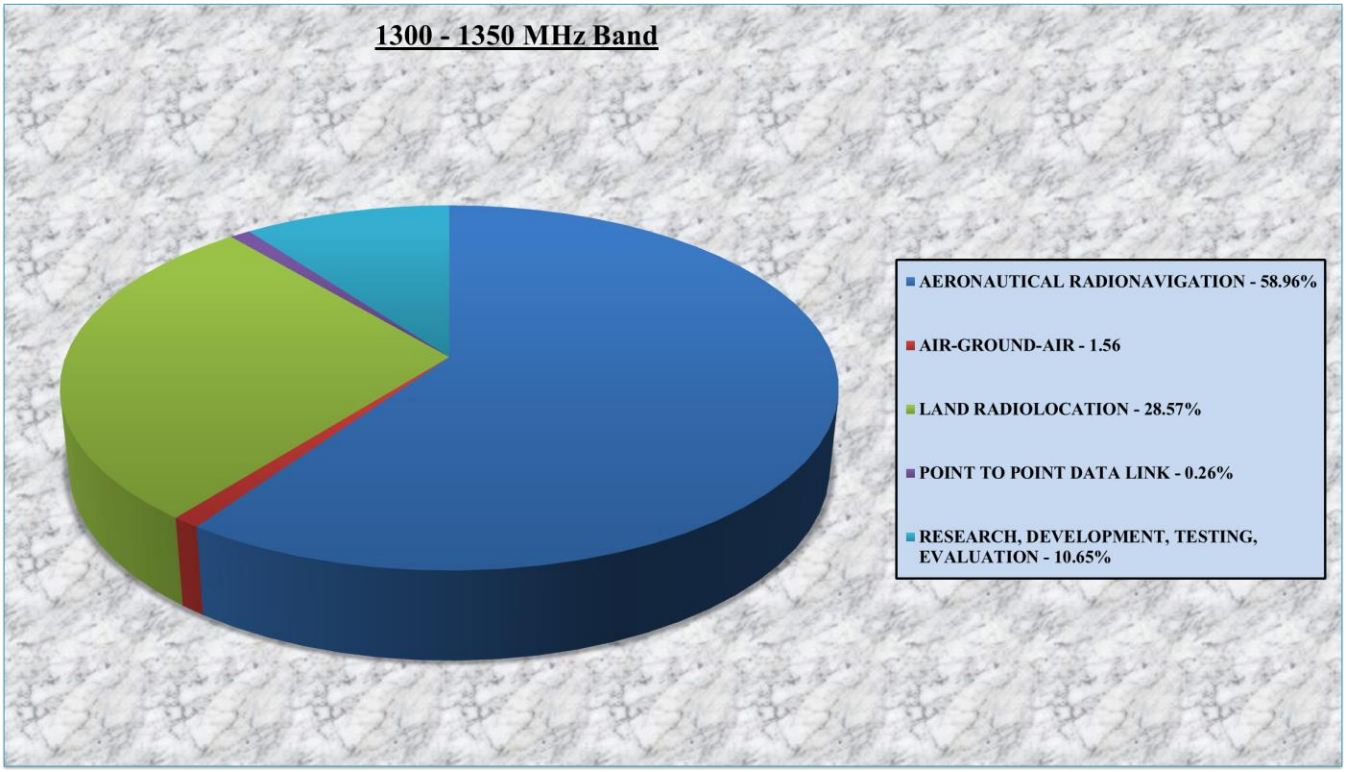
Federal Frequency Assignment Table

1300-1350 MHz Band						
SHARED BAND						
	AERONAUTICAL RADIONAVIGATION RADIOLOCATION					
	TYPE OF APPLICATION					
AGENCY	AERONAUTICAL RADIONAVIGATION	AIR-GROUND-AIR OPERATIONS	LAND RADIOLOCATION	POINT TO POINT DATA LINK	RESEARCH DEVELOPMENT TESTING EVALUATION	TOTAL
AF	2		4		29	35
AR			48	1		49
FAA	220				1	221
MC	1		45			46
N	4		13		11	28
TVA		6				6
TOTAL	227	6	110	1	41	385

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.

3b. Percentage of Frequency Assignments Chart

The following chart displays the percentage of frequency assignments from the Government Master File (GMF) for the different station classes of systems operating in the 1300 – 1350 MHz frequency band.



4. Frequency Band Analysis By Application

In the 1300-1350 MHz band there are allocations for aeronautical radionavigation and radiolocation. Some of the radar systems have assignments under both allocations depending on the system use. The radar systems in this band can be ground-based fixed, ground-based transportable, tethered, or man-portable.

4a. Aeronautical Radionavigation

The Federal Aviation Administration (FAA) and Department of Defense (DoD) operate long-range aeronautical radionavigation radar systems in the 1300-1350 MHz band. 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 that operate throughout this band measure range, bearing, and velocity of aircraft and other targets.[1]

The aeronautical radionavigation radar systems operating in the 1300-1350 MHz band 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 upward 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 the fixed radar systems, and approximately 20 feet for the transportable radar systems. The typical antenna rotation rate for radar systems operating in this band is 5 to 6 revolutions per minute.

4b. Radiolocation

In addition to the radar systems used for aeronautical radionavigation, the military operates tactical radar systems in the 1300-1350 MHz band.
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 they need to be able 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 1300-1350 MHz operated by the federal government and DoD are similar to the ones described in the following tables.

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.

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.

In addition to the operational radars in the band 1300 -1350 MHz, the FAA and DoD have 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 frequency assignments for these research and development efforts for the FAA are limited to the FAA Technical Center in Atlantic City, New Jersey, and the Mike Monroney Aeronautical Center located in Oklahoma City, Oklahoma. 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.

In band 1300-1350 MHz, hundreds of high-power long-range radar systems operate across the country. In some cases near large population centers with airports, multiple radars must operate in close proximity. 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.[2] 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 choose and coordinate the frequencies of each of their systems that operate in this band. Radar systems that operate in the band 1300 -1350 MHz with power levels above 1 kilowatt must comply with the NTIA Radar Spectrum Engineering Criteria (RSEC) Category C.[3] 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.

4c. Spectrum Contours

The following spectrum contours for the radars operating in the aeronautical radionavigation, and radiolocation, services have been computed for a generic receiver. The contours represent the locations where the power of the radar signal causes the receiver thermal noise power to increase by 1 dB.[4] These contours do not represent the coverage area of the radar; rather they

2. 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.

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

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

represent the locations where the signal level of the radar system causes the receiver to exceed the interference threshold. Any receiver inside the contour plot would experience interference from the radar.

The contours are shown in Figures 1 through 24 in 5 MHz blocks of bandwidth for the radar systems operating in the 1300 - 1350 MHz band.

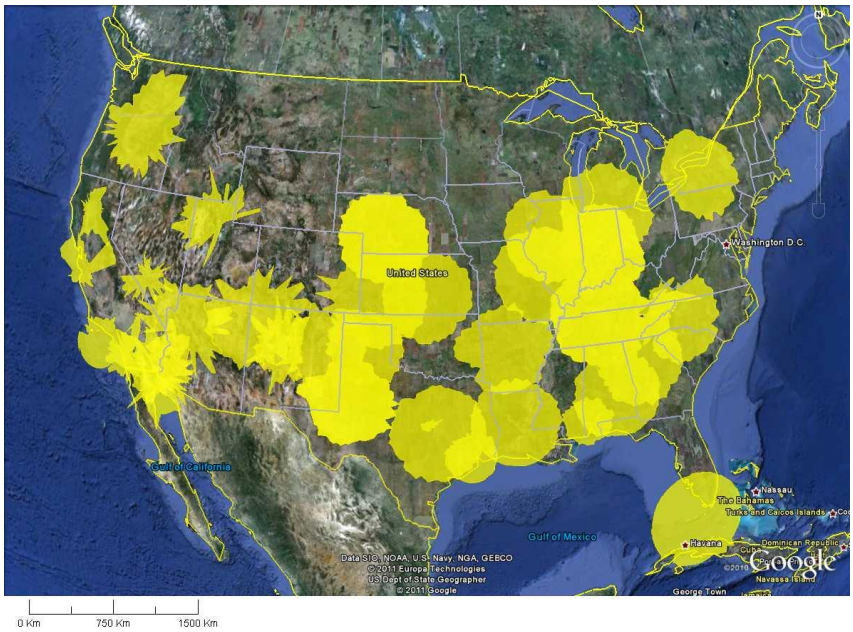


Figure 1
1300-1305 MHz Band Segment – Continental United States

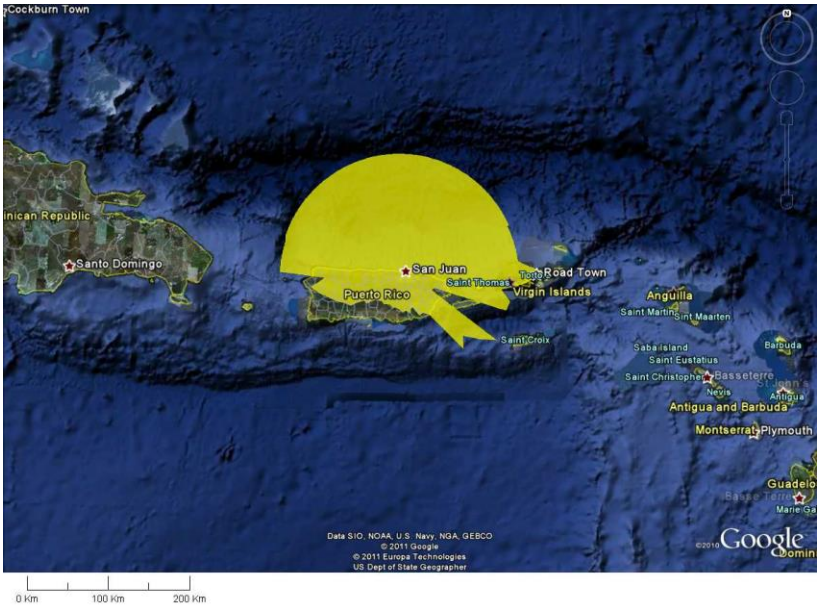


Figure 2
1300-1305 MHz Band Segment - Puerto Rico

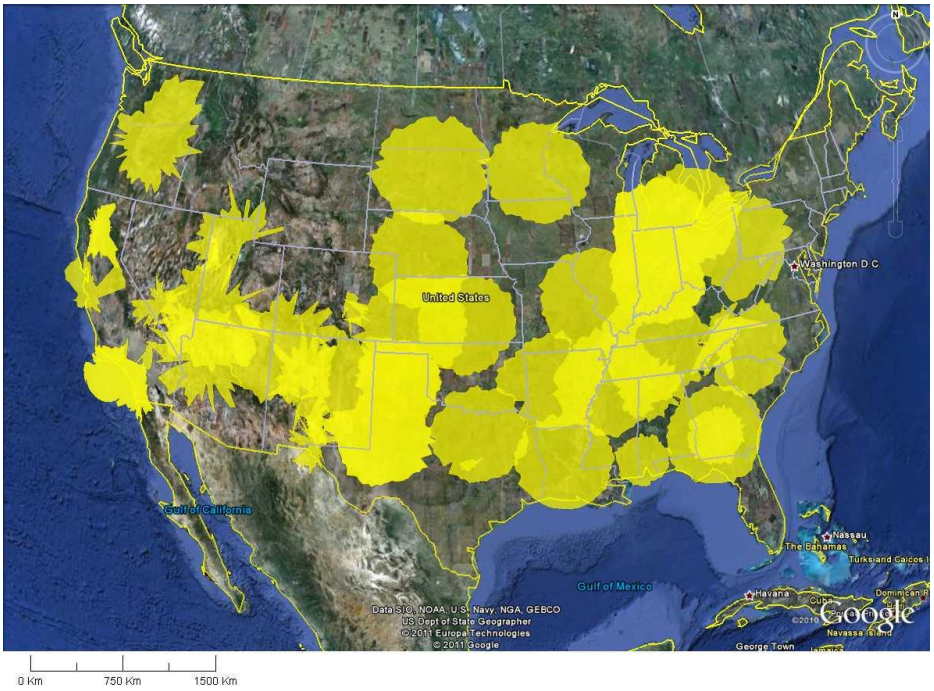


Figure 3
1305-1310 MHz Band Segment – Continental United States

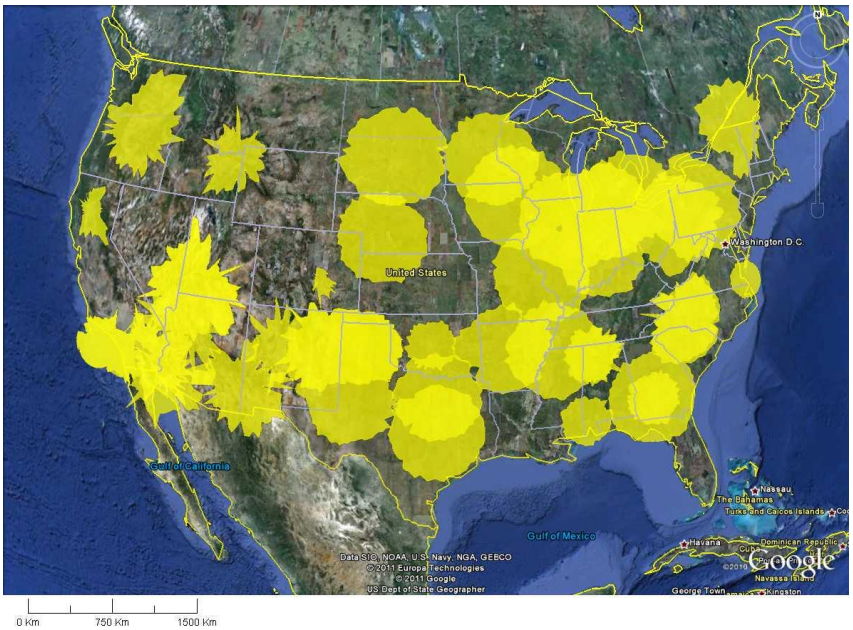


Figure 4
1310-1315 MHz Band Segment – Continental United States

Figure 5
1310-1315 MHz Band Segment - Alaska

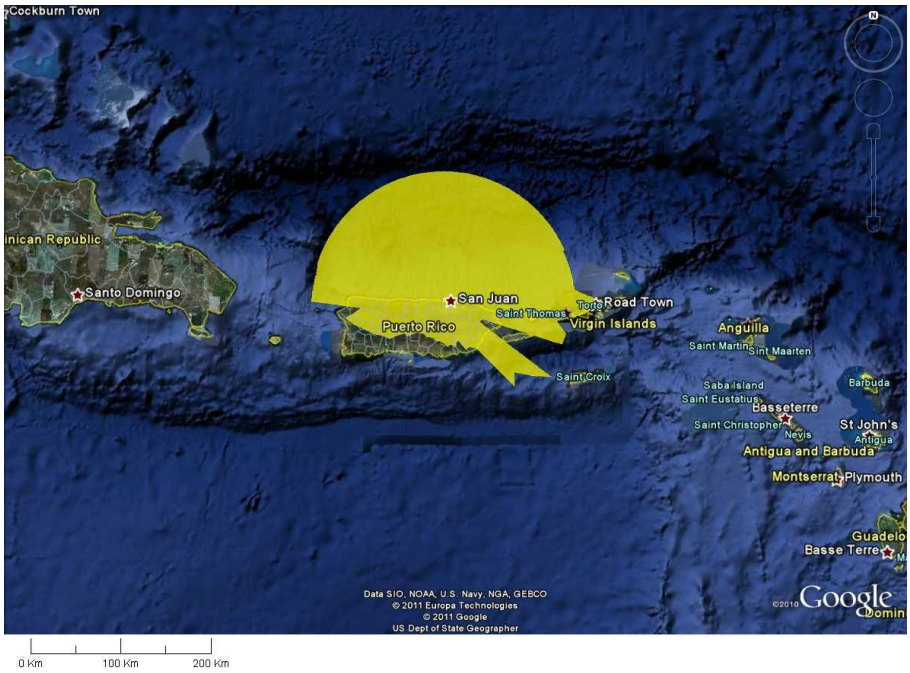


Figure 6
1310-1315 Band Segment - Puerto Rico

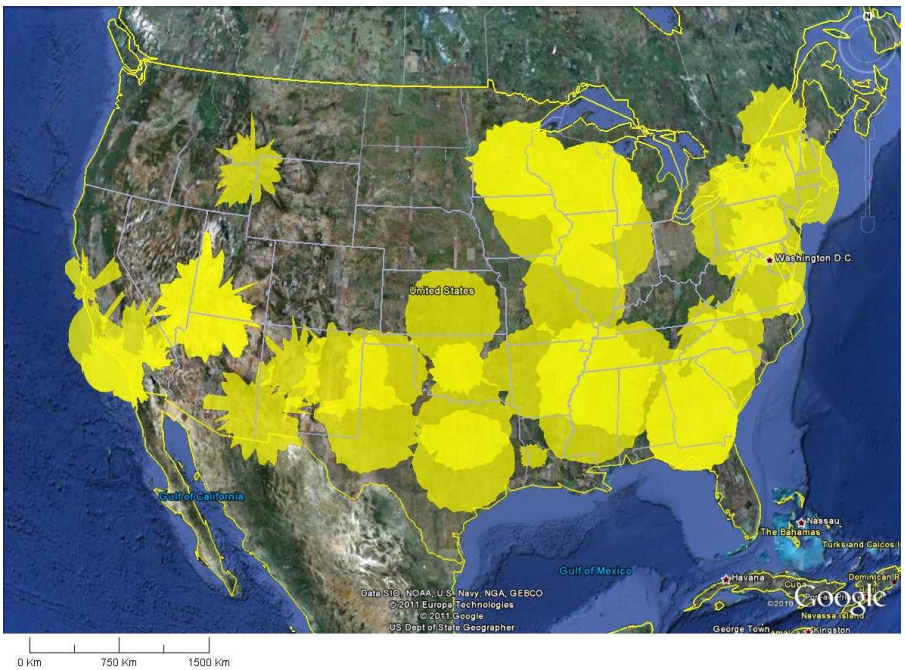


Figure 7
1315-1320 MHz Band Segment – Continental United States

Figure 8
1315-1320 MHz Band Segment - Alaska

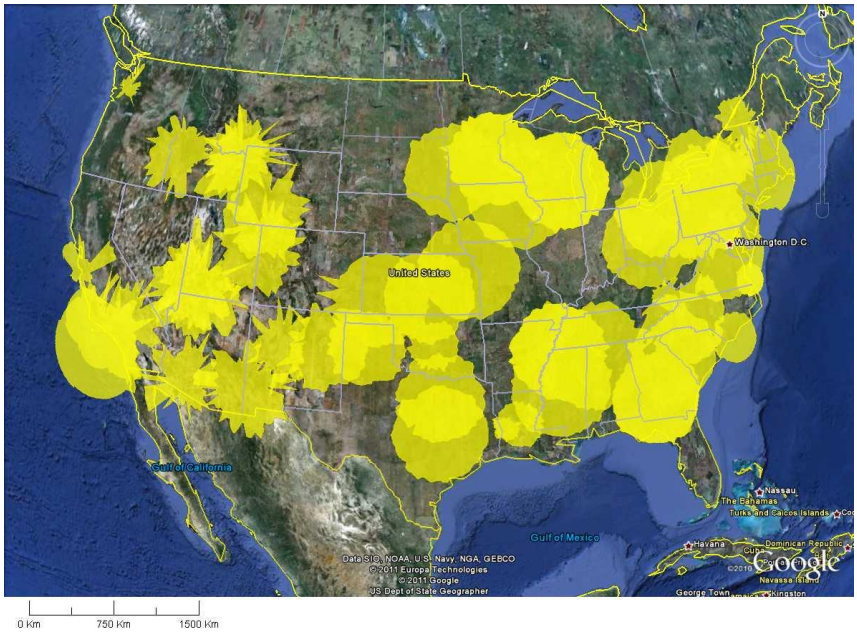


Figure 9
1320-1325 MHz Band Segment – Continental United States

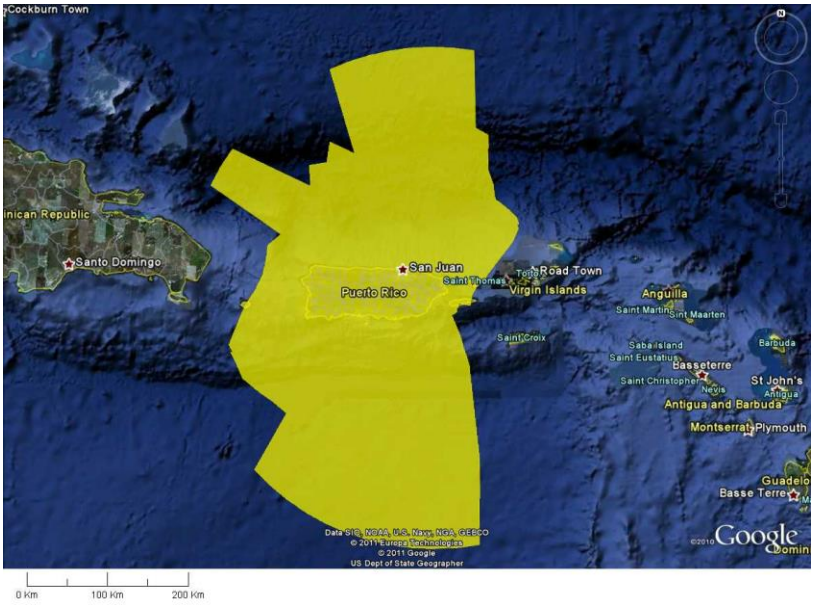


Figure 10
1320-1325 MHz Band Segment - Puerto Rico

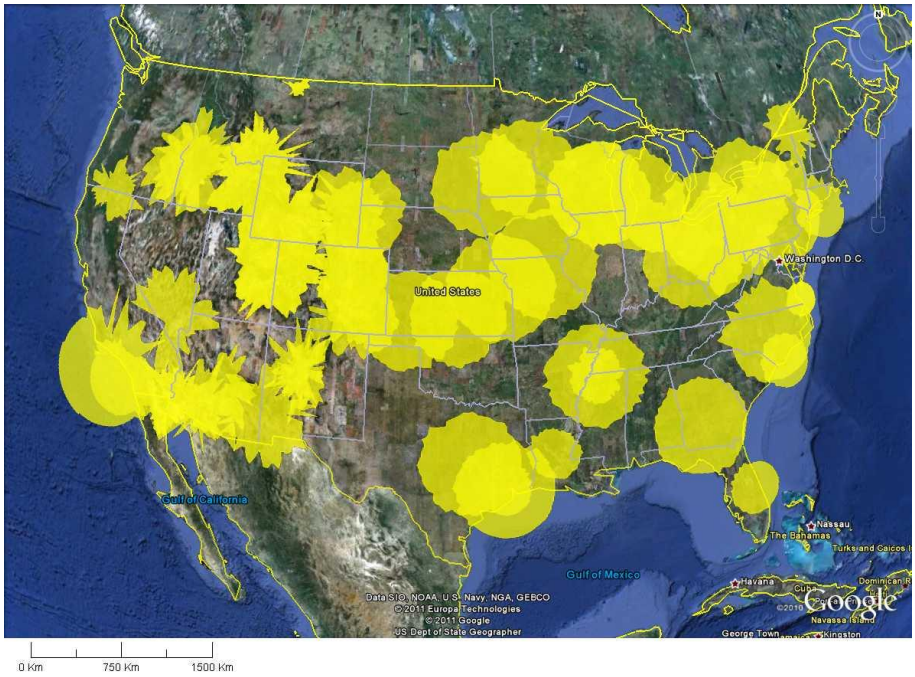


Figure 11
1325-1330 MHz Band Segment – Continental United States

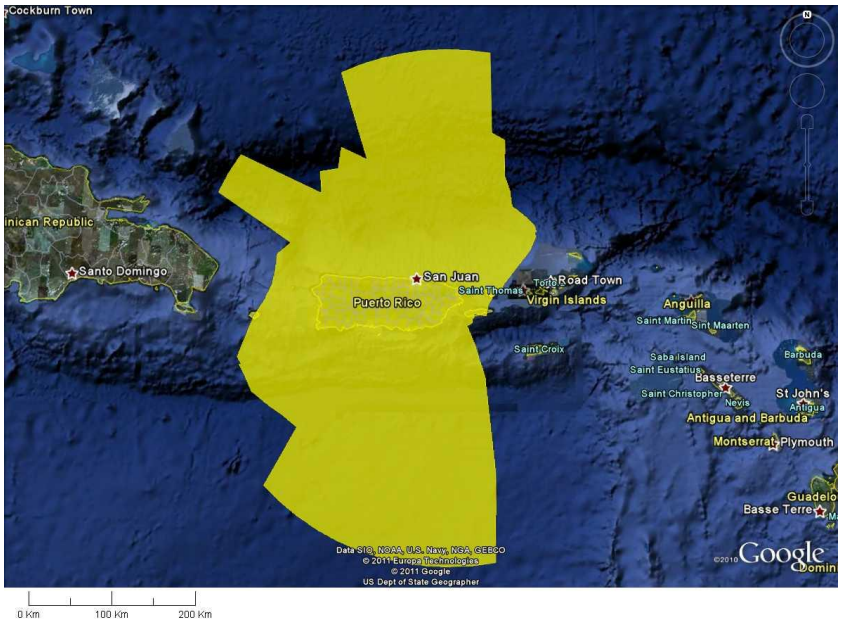


Figure 12
1325-1330 MHz Band Segment - Puerto Rico

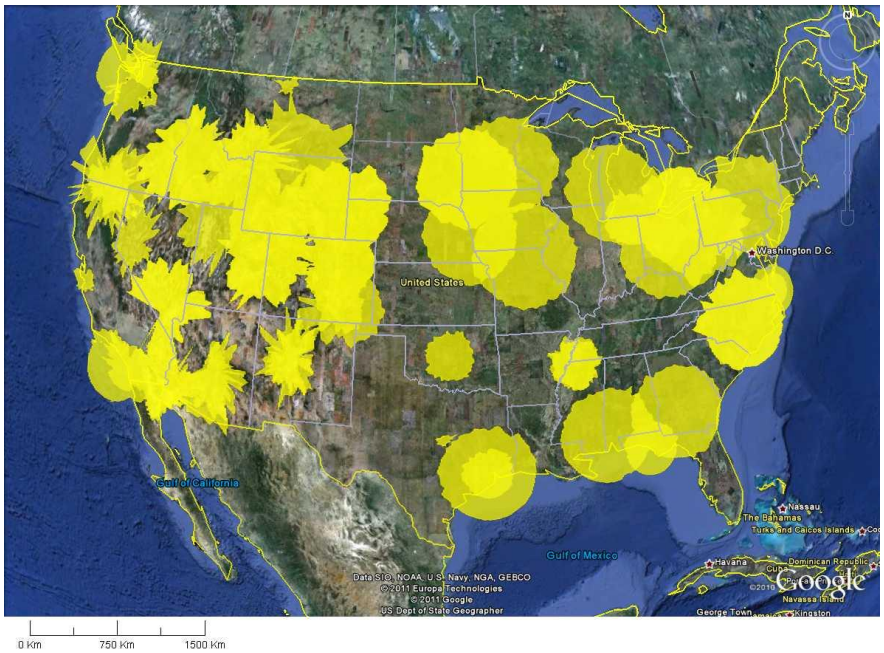


Figure 13
1330-1335 MHz Band Segment – Continental United States

Figure 14
1330-1335 MHz Band Segment Alaska

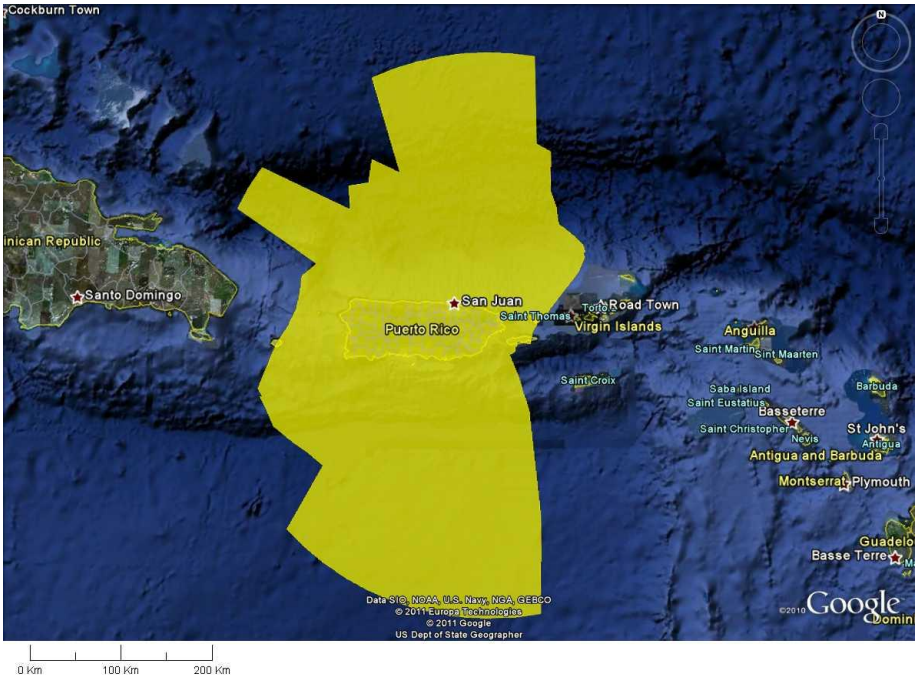


Figure 15
1330-1335 MHz Band Segment - Puerto Rico

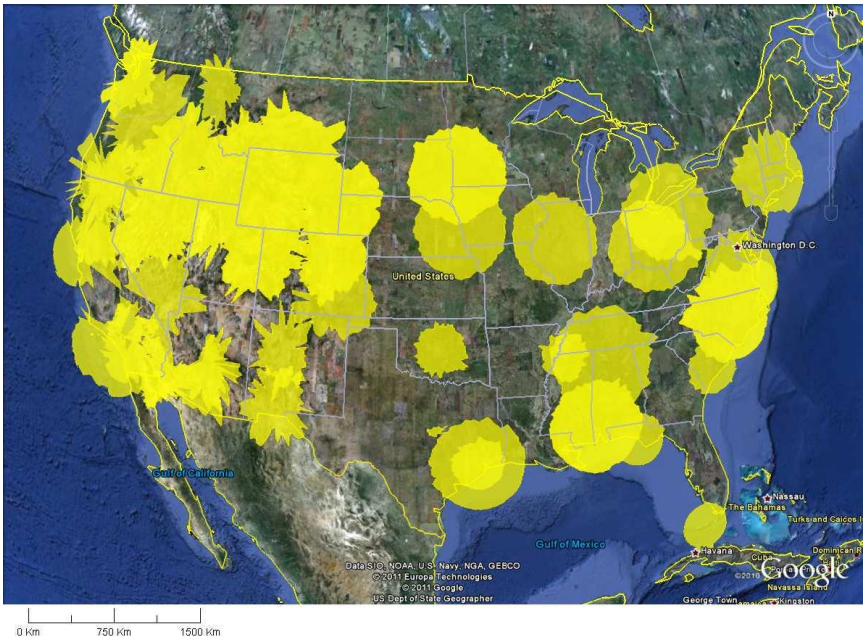


Figure 16
1335-1340 MHz Band Segment – Continental United States

Figure 17
1335-1340 Band Segment - Alaska

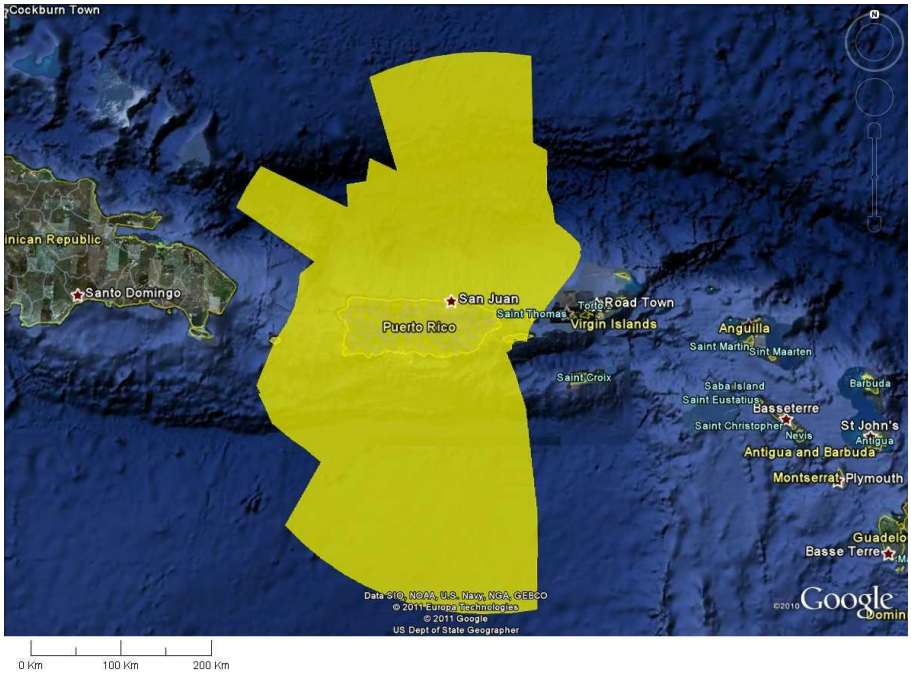


Figure 18
1335-1340 MHz Band Segment Puerto Rico

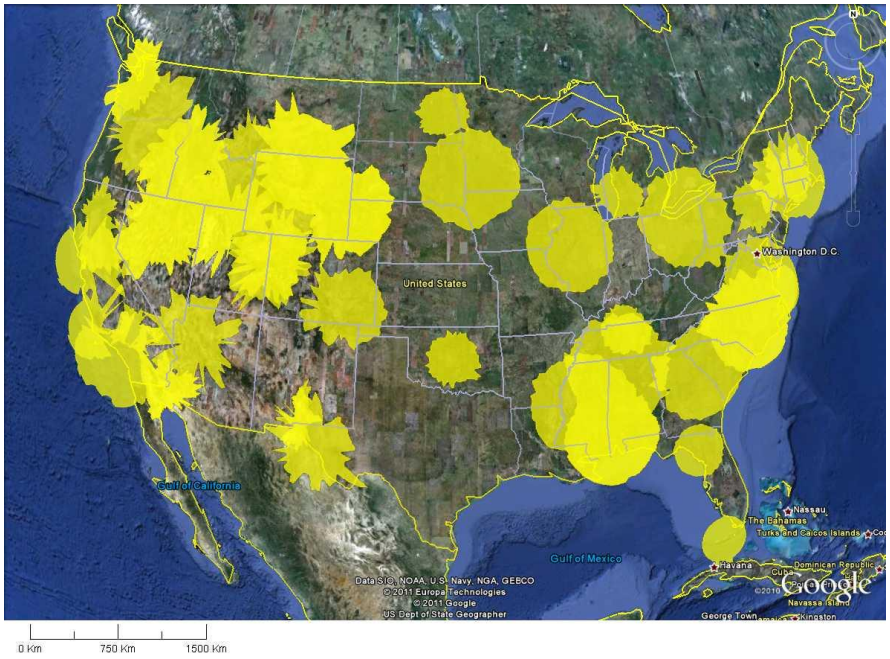


Figure 19
1340-1345 MHz Band Segment – Continental United States

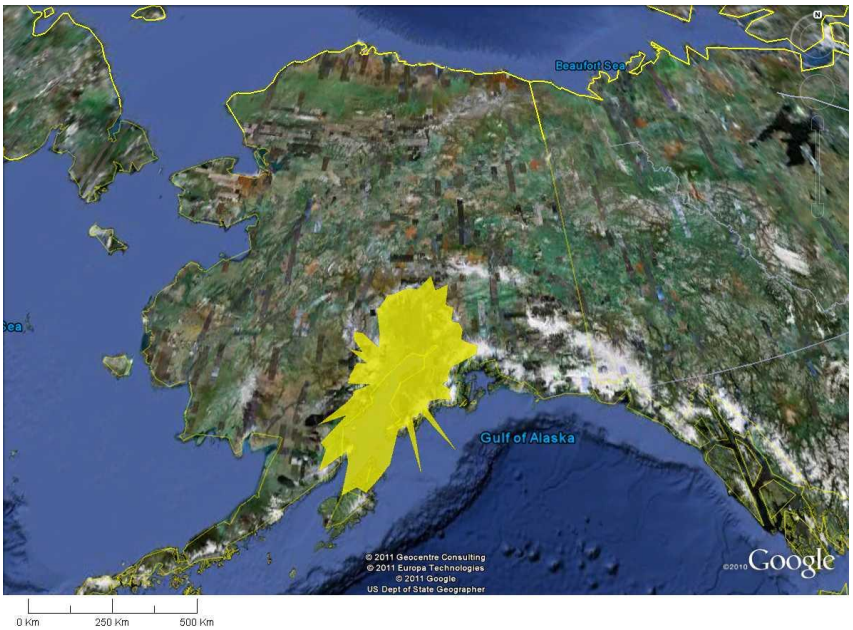


Figure 20
1340-1345 MHz Band Segment - Alaska

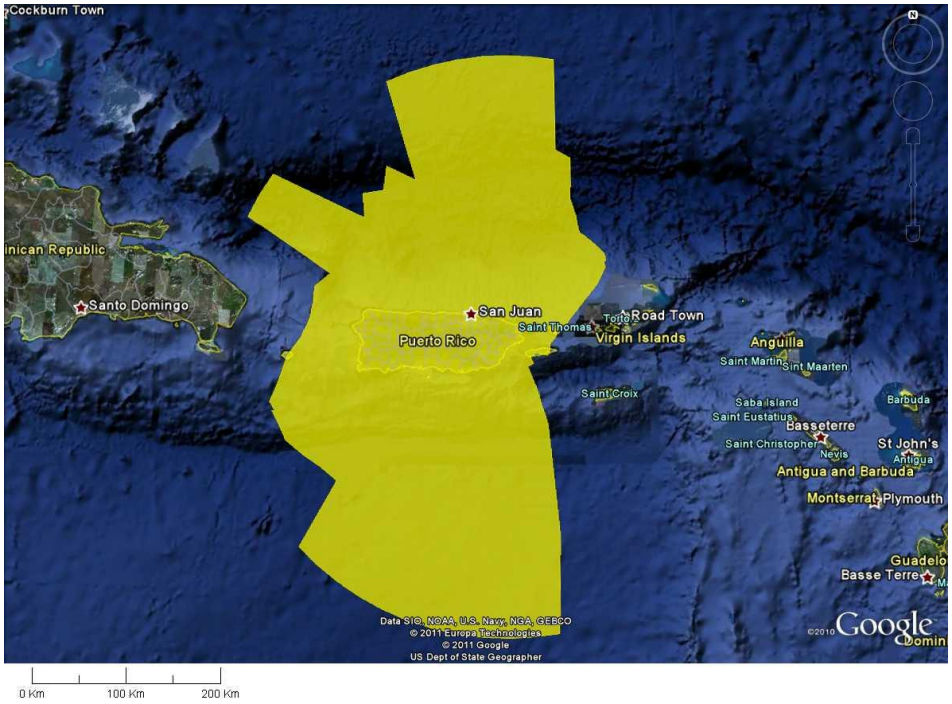


Figure 21

1340-1345 MHz Band Segment - Puerto Rico

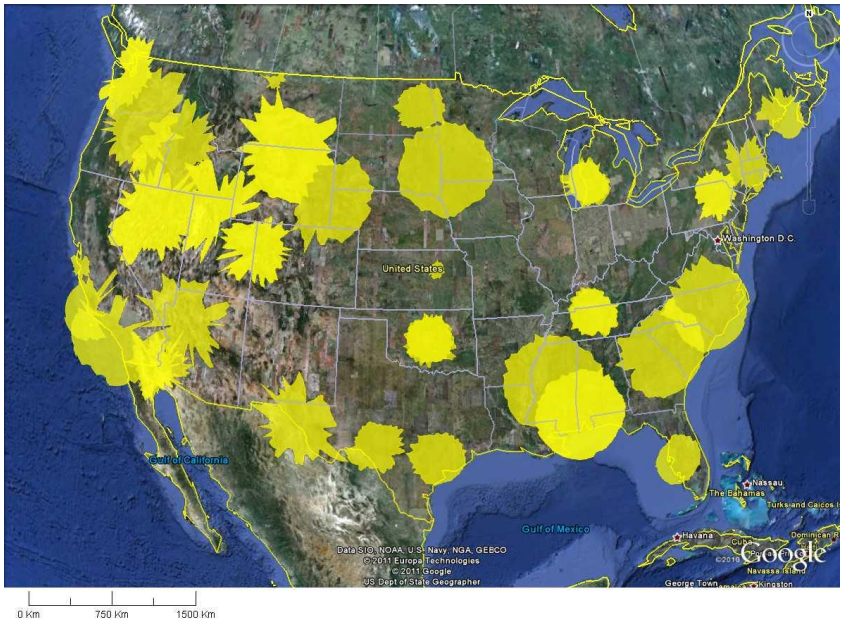


Figure 22
1345-1350 MHz Band Segment – Continental United States

Figure 23
1345-1350 MHz Band Segment - Alaska

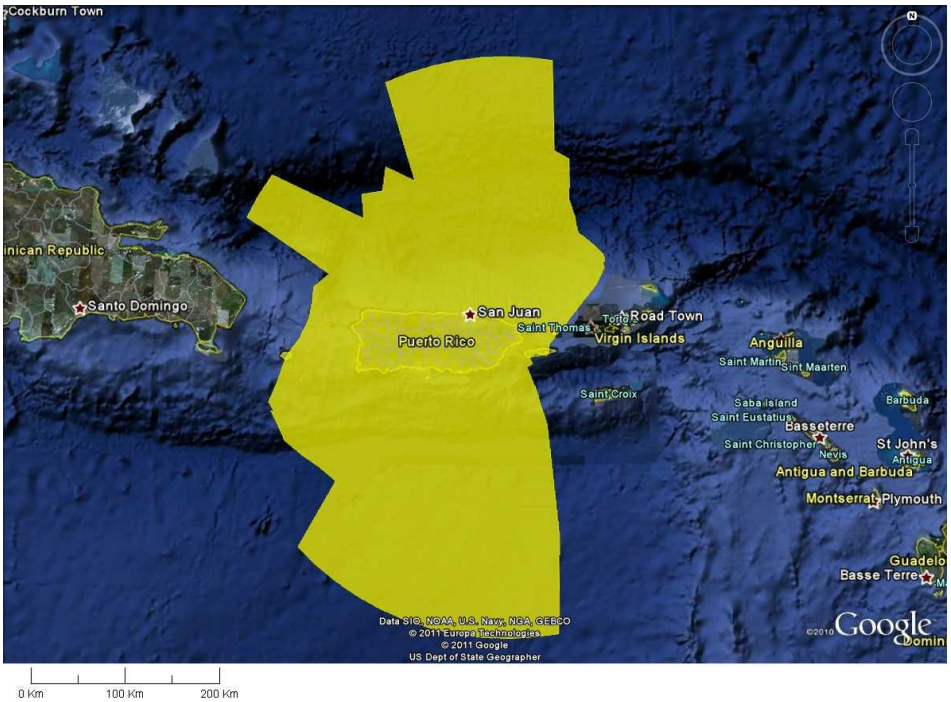


Figure 24
1345-1350 MHz Band Segment - Puerto Rico

5. Planned Use

The Federal use for the 1300 - 1350 MHz band for the long-range radar systems will remain the same for the foreseeable future. Although many of the programs are not planning any new installations in the immediate future, new radar sites could be added if the need arises to monitor additional airspace or other vital assets. These radars are expected to operate for at least the next twenty years, and the older upgraded radars could operate for at least ten years.

The tactical and air defense radars operated by the military will continue to operate in this band for the foreseeable future.

There are not any viable or feasible technologies that can replace the radar operations in the 1300 -1350 MHz band, which would meet the requirements for long-range air traffic control, navigation, tactical surveillance, and battlefield operations. The future spectrum requirements for long-range radars within the 1300-1350 MHz band can be expected for the foreseeable future. As new radionavigation satellite service systems from other administrations are launched there may be instances of interference to aeronautical radionavigation radar systems operating adjacent to the band 1300-1350 MHz. This may result in additional radar systems being relocated to this band increasing the demand for spectrum in the future.