FCC STA Application

Version 1.1
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Consultant

Distribution List

Organization	Point of Contact	Controlling Authority	Approval
FCC		Shared Spectrum Company	
JSC			

Document Change/Revision Log

Change/ Revision	Date	Section	Preparer	Modification	Approval
1	1/9/2006		McHenry	Original Draft	
1.1	1/11/2006		McHenry	Added FCC suggestions on emissions, test area center latitude/longitude, POC info, contract information, added cover page	

Table of Contents

1.0 Name of Applicant (Company): Shared Spectrum Company

2.0 Mailing Address:

Attention: Mark McHenry
Shared Spectrum Company
Street Address: 1595 Spring Hill Road, Suite 110
City: Vienna
State: Virginia
Zip Code: 22182
Country (If not the United States):
E-mail Address: mmchenry@sharedspectrum.com

3.0 Give the following information of person who can best handle inquiries pertaining to this application:

First Name: Mark
Last Name: McHenry
Title: President
Phone Number (including area code): 703-761-2818 x 103
702 862-7495 (cell)
E-mail Address: mmchenry@sharedspectrum.com

4.0 Please explain in the Area Below Why an STA is Necessary: *

The purpose of this test is twofold:
1) Shared Spectrum is under contract with the Depart of Defense's DARPA XG program to do a demonstration of XG cognitive radio technology. The contract number is FA8750-05-C-0150. The contracting agency is the Air Force Rome Laboratory. This STA is needed for an open air demonstration required by the statement of work "NEXT GENERATION (XG) COMMUNICATIONS PHASE III, PCSN R-5-8067, 17 JUNE 2005", Section.2.4 "Field Demonstrations" of this contract.

2) FCC is now considering Docket 04-186 dealing with possible unlicensed use of TV spectrum using cognitive radio technology. Many of the commenting parties have stressed the importance of real world data in these deliberations. Many of the tests requested in this STA deal with concepts included in the NPRM so that the results of these tests will be a valuable contribution to this ongoing proceeding. Shared Spectrum Company pledges to compile promptly tests results related to Docket 04-186 and to ask DARPA to approve quickly the public release of such information so it can be promptly filed in the public record for the Commission's consideration.

We request expedited processing of this application for the following reasons:

1) Shared Spectrum Company is a small business concern, and its primary revenue source is this contract. A delay in obtaining the STA would cause a significant financial hardship to company because we don't have other projects to put the engineering staff on while waiting for the STA to be granted.

2) The project has a "Go/No-Go" demonstration in July 2006. We need to start the outdoor tests now to prepare for this demonstration.
3) Dynamic spectrum sharing technology will provide great public benefit.
4) Rapid deployment of dynamic spectrum sharing technology is critical to the ability of the government to conduct humanitarian as well as military operations overseas.

5.0 Please explain the purpose of operation: *

This demonstration will show that the XG prototype breadboards utilizing "Dynamic Spectrum Sharing" technology are capable of identifying available spectrum subject to "rules" given the radio.

5.1 Technology Description

Dynamic Spectrum Sharing technology makes spectrum available in bands with other primary and secondary users on a non-collaborative, non-interference use. The approach can support spectrum sharing that is either exclusive basis or on a "Commons" basis. The technology can also improve performance in bands with no Primary users (peer-to-peer sharing).

The long term goal of Dynamic Spectrum Sharing (DSS) technology is to facilitate collaborative spectrum leasing by primary licensees for short periods of time. DSS reduces transaction costs substantially by automating some or all of the elements of lease negotiation. It assures the primary licensees, particularly public safety users with low-duty cycles, can preempt a lessee's use in emergencies. The technology makes spectrum leasing feasible where it would not otherwise be. These capabilities will be demonstrated in future tests, and are not included in this initial application.

The technology has many benefits. It can increase capacity (2X – 5X increase) by making more spectrum available at a base station. The technology supports rapid deployment and can do spectrum management functions in minutes instead of days or weeks. A final benefit is that enables use of the VHF spectrum, which has much better propagation characteristics compared to spectrum above 1 GHz. Operation in the VHF band increases radio range by 2X to 5X, which is critical in many applications such as internet access in rural areas and operations in disaster areas.

5.2 Demonstration Plan

The XG Demonstration Project contains a series of demonstration that test individual aspects of the XG System and the overall system performance.

5.2.1 Test Types

The Detector Demonstrations will confirm that an XG transceiver can reliably detect the presence of "Non-cooperative" transceivers at distances of up to 100 km. The signals transmitted in these tests are "conventional" signals using equipment that is normally used in the band. Most of the tests use existing "off-the-air" signals. Some of the tests use transmitters that we will setup and control. Shared Spectrum will test detectors that use advance technology that are able to identify signals that are significantly below the noise level by using cyclostationary and other technologies.

The Interference Avoidance Demonstrations will show that two XG transceivers can operate on a single channel without causing harmful interference to “Non-cooperative” transceivers. These tests involve 100 m to 100 km separations between XG System and the Non-cooperative signals. The signals transmitted include XG transceiver signals (frequency translated 802.16 signals with a minimum bandwidth of 1.75 MHz) and “conventional” signals using equipment that is normally used in the band.

The Networking Demonstrations will show that the XG System (six mobile transceivers) can form a multi-channel, ad-hoc network without causing harmful interference to the “Non-cooperative” transceivers. These tests are over an area of approximately 2 km by 2 km. The signals transmitted in these tests are XG transceiver signals (frequency translated 802.16 signals with a minimum bandwidth of 1.75 MHz) with at least ten different channels. Also transmitted are “conventional” signals using equipment that is normally used in the band.

5.2.2 Upcoming Tests

This STA request is for initial testing performed indoors and at a remote location to be conducted in the immediate future. Additional STA requests will be submitted for operation in suburban and urban areas., for high transmit power levels (up to 10 W), for operation in multiple spectrum bands 30 MHz to 3000 MHz, and for operation on military bases.

5.3 Requested Demonstration Frequencies

The requested demonstration frequencies for this STA are shown in Table 1. There are 16 frequency requests that utilize different spectrum bands, transmit power levels, signal bandwidths and demonstrations locations.

5.3.1 Requests 1-6 – Frequencies for the XG signals.

Requests 1-6 are for frequencies to be used by the XG transceiver. This system uses an IEEE 802.16 modem (1.75 MHz bandwidth) that can be frequency translated anywhere from 225-600 MHz. These channels were selected to be the same as the Non-Cooperative radios to be used.

Requests 1 through 3 are for low power (100 mW), indoor testing to verify proper system operation. Three spectrum bands are included.

Requests 4 through 6 are for medium power (1 W), outdoor testing in a remote, rural environment.

5.3.2 Requests 7-10 – Operation in the Above Frequencies Using a “Non-cooperative Land Mobile type radio

Requests 7 and 8 are for indoor operation of an Icom F621 UHF land mobile radio.

Requests 9 and 10 are for outdoor testing of the Icom F621 UHF land mobile radio in a remote, rural environment.

5.3.3 Requests 11-16 – Operation in the above frequencies Using a CW Signal Generator

Requests 11 through 13 are of indoor operation of a signal generator transmitting a CW (continuous wave, < 1 Hz bandwidth) signal. This signal is used for simulation of Uncooperative signals and for RF path loss measurements.

Requests 14 through 16 are for outdoor testing using the signal generator in a remote, rural environment.

Table 1 Requested Demonstration Frequencies

Request Number	Purpose	Transmitter Signal Bandwidth	Emission Type	Transmitter Power	Transmitter Height	Location (see Table 2)	Requested Frequency
1	XG Signal in TV band	1.75 MHz	OFDM G2D	100 mW	2 m (indoors)	Inside SSC offices	TV Chan 16, 19, 25, and 31
2	XG Signal in LMR band	Same as above	Same as above	Same as above	Same as above	Same as above	421-449 MHz
3	XG Signal in FRS band	Same as above	Same as above	Same as above	Same as above	Same as above	462-467 MHz
4	XG Signal in TV band	Same as above	Same as above	Up to 1 W	2 m (mobile, outdoors)	Test Areas A and D	TV channels shown in Table 2
5	XG Signal in LMR band	Same as above	Same as above	Same as above	Same as above	Same as above	421-449 MHz
6	XG Signal in FRS band	Same as above	Same as above	Same as above	Same as above	Same as above	462-467 MHz
7	LMR radio Channel	10 kHz	FM-F3E	Up to 100 mW	2 m (indoors)	Inside SSC offices	TV Chan 16
8	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	421-449 MHz
9	Same as above	Same as above	Same as above	Up to 5 W	2 m (mobile, outdoors)	Test Areas A and D	TV channels 14-16 as shown in Table 2
10	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	421-449 MHz
11	Signal Generator in TV Band	CW	CW	Up to 100 mW	2 m (indoors)	Inside SSC offices	TV Chan 16, 19, 25, and 31
12	Signal Generator in LMR Band	Same as above	Same as above	Same as above	Same as above	Same as above	421-449 MHz
13	Signal Generator in FRS Band	Same as above	Same as above	Same as above	Same as above	Same as above	462-467 MHz

14	Signal Generator in TV Band	Same as above	Same as above	Up to 1 W	2 m (mobile, outdoors)	Test Areas A and D	TV channels shown in Table 2
15	Signal Generator in LMR Band	Same as above	Same as above	Same as above	Same as above	Same as above	421-449 MHz
16	Signal Generator in FRS Band	Same as above	Same as above	Same as above	Same as above	Same as above	462-467 MHz

The Shared Spectrum Company (SSC) office location is Latitude=38º 55’ 33’’, Longitude = 77º 14’ 43’’, Vienna, Virginia)

Table 2 Test Areas Used for Each TV Channel

FMHz	TV Channel	Test Area						
		Area A	Area B	Area C	Area D	Area E	Area F	SSC Office
470-476	14							
476-482	15							
482-488	16		X			X	X	X
488-494	17 (PS)	Public Safety Band – No Transmissions						
494-500	18 (PS)							
500-506	19		X	X			X	X
506-512	20	X						
512-518	21							
518-524	22	X						
524-530	23							
530-536	24		X		X	X	X	
536-542	25	X						X
542-548	26							
548-554	27							
554-560	28	X			X	X	X	
560-566	29						X	
566-572	30							
572-578	31				X	X	X	X
578-584	32							
584-590	33				X			
590-596	34							
596-602	35							
602-608	36							

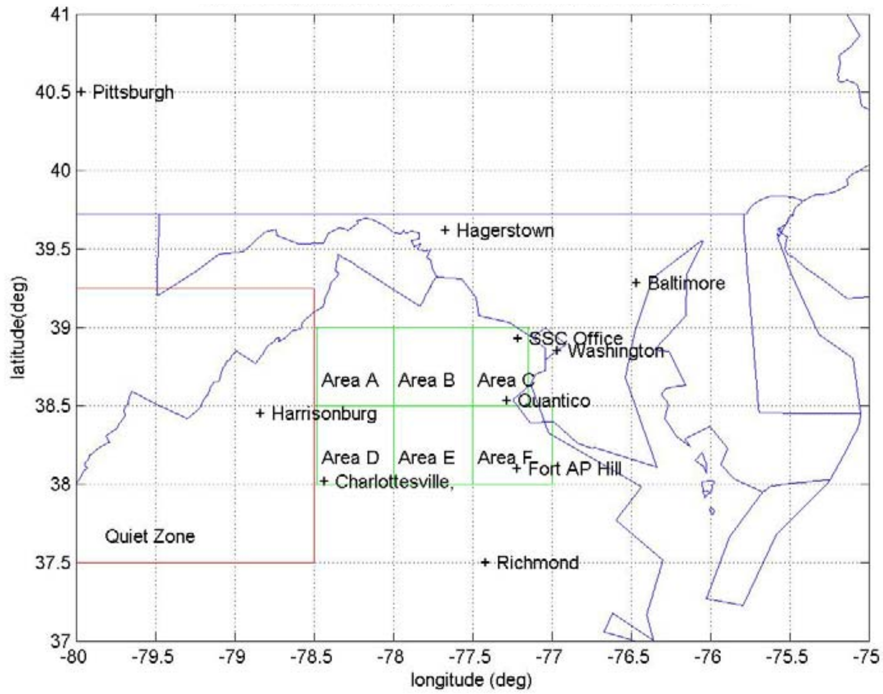


Figure 1 Location of XG Demonstration "Test Areas". The SSC office is located in Area C. The National Radio Quiet Zone is located to the west of the Test Areas.

Table 4 shows the latitudes and longitudes of the test areas.

Table 3 Latitude and Longitude Coordinates of Test Areas

Location	Min Latitude (deg)	Mid Latitude (deg)	Max Latitude (deg)	Min Longitude (deg)	Mid Longitude (deg)	Max Longitude (deg)	Radius (km)
Area A	38º 30' 00"	38º 45' 00"	39º 0' 00"	78º 29' 00"	78º 14' 30"	78º 0' 00"	55
Area B	38º 30' 00"	38º 45' 00"	39º 0' 00"	78º 0' 00"	77º 45' 00"	77º 30' 00"	55
Area C	38º 30' 00"	38º 45' 00"	39º 0' 00"	77º 30' 00"	77º 19' 30"	77º 9' 00"	55
Area D	38º 00' 00"	38º 15' 00"	38º 30' 00"	78º 29' 00"	78º 14' 30"	78º 0' 00"	55
Area E	38º 00' 00"	38º 15' 00"	38º 30' 00"	78º 0' 00"	77º 45' 00"	77º 30' 00"	55
Area F	38º 00' 00"	38º 15' 00"	38º 30' 00"	77º 30' 00"	77º 19' 30"	77º 9' 00"	55
SSC Office	NA	38º 55' 33"	NA	NA	77º 14' 43"	NA	0

5.4 Interference Analysis

This section summarizes the interference analysis performed. Using a combination of separation and spectrum monitoring, we believe that the chance of interference with the existing users is low.

5.4.1 TV Band

All testing will be performed well outside of the TV Grade B contour for each channel. Section 15.1shows the predicted Grade B contour limits and the test locations. The test locations shown in Figure 1 where selected to be clear of the Grade B zones as listed in Table 2.

In addition, to further reduce the chance of interference, we will verify that the TV signal strength at the test location is well below a usable level. Before conducting tests at a location, we will use a specialized, ultra-sensitive detector to measure the TV signal level. This measurement will be made a multiple locations and antenna heights to mitigate multipath effects. We will only use a specific test site if the measured TV signal level is below 0 dB SNR (using a 6 MHz bandwidth), thus, insuring that there are no users of the channel in the near-by environment.

In Section 15.6 we show that the low power XG signals have a small interference distance.

5.4.2 421-449 Band

In Section 15.2, we plot the location of the existing transmitters in this band as per the frequency assignments provided to SSC by the Joint Spectrum Center. The closest existing users are at Andrews Air Force Base, which is approximately 35 km from the SSC offices. SSC has conducted spectrum occupancy measurements in this band that show the occupancy is low as shown in Section 15.3.

To avoid interfering with these existing signals, we will periodically measure the received signal level in the band. When the signal level from the existing transmitter exceeds a threshold value on a certain frequency, we will stop transmitting on this frequency. This off-period will be for five minutes after the existing transmitter received signal level drops below the threshold value.

The interference analysis in Section 15.4 shows that propagation loss values are required to avoid causing interference to the existing users. Section 15.5 shows the propagation losses at which the existing 412-449 MHz transmitters can be detected. Because the XG signal has low power and the existing transmitters use high power, we will easily be able to detect the existing transmitter well before an interference event occurs.

5.5 Precautions Used to Minimize Interference During the Field Demonstrations

During the XG field demonstrations, the following procedures will be used to minimize interference to other spectrum users. Each of these precautions greatly reduces the probability of interference to Non-cooperative “victim” receivers. All of the precautions together make reduce the probability of interference very low.

5.5.1 Frequency List

All XG transmitters will contain the list of frequencies that have been authorized by FCC for this experiment and the equipment will consider allowing transmissions **only** on frequencies within that list. Frequencies not on the list will not be considered and will not be used at all for transmissions.

In all experiments involving TV spectrum, Shared Spectrum will work with NCTA and National Translator Association to determine what cable headend input frequencies and translator inputs are in the area. These frequencies will be omitted from the frequency list for initial tests and later will be carefully monitored in order to avoid all harmful interference to these systems.

'Shared Spectrum will not include in the frequency list any channels in the Public Safety Pool frequencies listed in Section 90.20 of the Commission's Rules, TV channels 17 and 18 (shared with land mobile in the Greater Washington area per Section 90.303), and any other public safety channels identified by the Commission. The frequency list will also not include any frequencies within 50 kHz of any of these frequencies.

After confidence is gained in the XG technology in the initial tests, Shared Spectrum will review progress with the Commission and anticipates that it will request consideration of some access to these frequencies."

5.5.2 Continuous Spectrum Monitoring and Logging

Before each demonstration, the spectrum authorized by FCC will be monitored at the command and control center using a spectrum analyzer, a pre-amplifier and an elevated, dedicated antenna. The monitoring will be done for a 30 minute period before the demonstrations. All channels (using a 25 kHz BW) with received signal levels above –154 dBm/Hz (-174 dBm/Hz + 20 dB NF) will be excluded from use by the XG equipment. Both co-channel and adjacent channel signals will be monitored.

During each demonstration, the spectrum will be monitored to check from proper XG operation. If an XG node has a fault and transmits on a non-approved frequency, the operator at the command and control center will stop the demonstration.

5.5.3 Command and Control

5.5.3.1 Centralized Control of All XG Transmitters

All XG transceivers are networked to a command and control system via a back-haul system consisting of cell-phones and commercial satellite internet stations. The command and control system can stop all transmissions by of any XG node within 10 seconds. If the XG node to command and control center connection is lost for more that 5 minutes, the XG node will limit transmissions to a reduce list of frequencies that are “assigned” as emergency backup with temporary primary status.

Below are the points of contact that are available to immediately cease transmission if interference occurs:

Karl Steadman	650 468-6153 (cell)
Mark McHenry	703-862-7495 (cell)
Michael Conley	703-980-5388 (cell)

5.5.3.2 Continuous Connection to the Outside World via the Internet and/or Cell Phone

The command and control station will have continuous connection to the outside world (i.e. to the local spectrum manager) via the Internet and/or cell phone. If an interference complaint is received from the outside world, the XG system will be immediately turned off to minimize any problems and to diagnose if the XG system is the cause. Prior to each experiment the test personnel involved will notify all parties that NTIA and FCC designate about the pending test and about contact procedures. SSC will also maintain a secure web site with both up to date test schedule information and contact information and will provide access information to FCC and other entities designated by FCC. We will work with NTIA and FCC once a location is decided to determine what a reasonable notification of "neighbors" is.

5.5.4 XG Transmission Characteristics

5.5.4.1 Brief Transmission Periods

The XG demonstrations will involve short transmission periods (several minutes or less). All of the equipment (XG nodes, non-cooperative "victim" receivers and test transmitters) are centrally controlled via computer. They will be switched off between experiments.

5.5.4.2 Omni-Directional Antennas

The XG nodes will use donut shaped gain, "omni-directional" discone type antennas. The transmitted effective radiated power is low.

5.5.4.3 Low Antenna Heights

The transmitter heights will simulate ground vehicles in the vast majority of tests. An antenna height of two-meters will be used. A few tests will involve fixed antennas with 10 meter high antennas.

5.5.5 Low Power Density Waveform

The XG signal bandwidth will usually be at 1 MHz. This will provide a 10.5 dB reduction in spectral density compared to the popular 25 kHz bandwidth signals used it the 225-450 MHz band. The maximum XG signal transmit power is 1 Watt. This limits the potential interference distance in non-line of sight conditions to a few km.

5.5.6 Accountability

5.5.6.1 Logging of All Transmission Frequencies and Times

The XG nodes will log the time, location, frequency and transmit power levels continuously. These logs will be use for our analysis of the XG algorithms. They will be also used to analyze any interference that might occur.

5.5.7 Demonstration Location

5.5.7.1 Operation Only Away from Any Non-Cooperative, Out-of-Band Transmitters

The demonstration areas will be selected to be at least 1 km away from other non-cooperative transmitters in any band. This will avoid potential over-load conditions of the XG receiver. It also avoids any inter-modulation effects with Non-cooperative transceivers that my cause in-band interference to the Non-cooperative transceivers.

5.5.7.2 Isolated Test Locations

The test locations are isolated. We expect minimal external signals will propagate into the test area and vice-versa.

5.5.7.3 <u>Tests will all be outside the National Radio Quiet Zone</u>

5.5.8 Personnel Experience

Karl Steadman and Mark McHenry are the SSC engineers managing the demonstrations. Each has over 10 years of RF-related field measurements including testing of transceivers in a non-interference basis using experimental licenses.

5.5.9 XG Technology

5.5.9.1 <u>Use of Assigned Frequencies</u>

Only the frequencies authorized in the STA will be used by the XG system. A list of blocked out channels will be checked by the XG software in each node continually. If the XG software attempts to transmit on a blocked channel, the action will be blocked and the event recorded.

It is expected that some channels (~100 MHz of spectrum) will be assigned to the XG demonstrations on a secondary, non-interference basis. Some additional spectrum (~3 MHz) will be assigned on a temporary primary basis that will be used as backup channels.

5.5.10 Inherent XG Interference Avoidance Functionality

The XG system use dynamic spectrum sharing technology to detect non-cooperative "victim" transceivers within the XG radio's interference distance. When this condition occurs, the XG transceiver selects another channel. Information about observed frequency use will be stored for a time period to be determined and considered with respect to subsequent possible use of the channel. Thus recurring non-cooperative channel use will be a factor to considering the channel for use – not just whether use is detected at present. In particular, for both simplex and duplex frequencies the equipment will estimate the usage of transmitters that can not be directly observed based on the frequency observations that are detectable.

5.5.10.1 <u>Channel Detector Sensitivity</u>

The XG system will use channel detectors that are much more sensitive than normal receivers in making observations about whether a channel is in use. This is possible due to knowledge of the modulation which is being looked for and the fact that the detector does not need to have an adequate signal-to-noise ratio to demodulate the signal with usable fidelity, rather it only needs enough signal-to-noise ratio to detect the present of the assumed modulation. The detection versus reception advantage depends on the non-cooperative signal emission type and varies from 5 dB for FM modulation to 20 dB for BPSK. The detector sensitivity for NTSV and DTV video signals is being determined now and may exceed 20 dB.

5.5.10.2 <u>Alternative Avoidance Mechanisms</u>

In addition to the listen before talk approach described above, on some frequencies XG will test a geographic system which only allows transmissions within a given area or assures that XG signals in specified areas remain below a specified level. FCC may designate frequencies which are restricted to only certain of these approaches.

6.0 Call Sign: Class of Station: Nature of Service:

EXPERIMENTAL

7.0 Location of proposed operation:

Please enter this information on the antenna registration screen.
Operation Start Date: * Operation End Date: *
01/08/2005 01/10/2005

- - Indicates that this field mu

8.0 List below transmitting equipment to be installed (if experimental, so state): *

Manufacturer Model Number: Experimental
No. of Units Experimental: Six

9.0 Certification:

Neither the applicant nor any other party to the application is subject to a denial of Federal benefits that includes FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. Section 862, because of a conviction for possession or distribution of a controlled substance. Does the applicant or authorized agent so certify? * Yes No

The applicant hereby waives any claim to the use of any particular frequency or electromagnetic spectrum as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise, and requests authorization in accordance with this application. (See Section 304 of the Communications Act of 1934, as amended.)

The applicant acknowledges that all statements made in this application and attached exhibits are considered material representations, and that all the exhibits part hereof and are incorporated herein as if set out in full in this application; undersigned certifies that all statements in this application are true, complete and correct to the best of his/her knowledge and belief and are made in good faith. Applicant certifies that construction of the station would NOT be an action which is likely to have a significant environmental effect. See the Commission's Rules, 47 CFR1.1301-1.1319.

10.0 Signature of Applicant (Authorized person filing application): * Date:

Mark McHenry 01/06/2006
Title of Applicant (if any): President

FEDERAL COMMUNICATIONS COMMISSION
ANTENNA REGISTRATION FORM FOR FILE NUMBER: 0396-EX-ST-2005

The purpose of this application is to:

Add this antenna to the application/license
Edit data pertaining to this antenna
Delete this antenna from the application/license

11.0 Proposed location of transmitter and transmitting antenna:

FIXED/BASE MOBILE BASE AND MOBILE
2b. If permanently located at a FIXED location, give below:
State:
County: City or Town:
Number and street (or other indication of location):
2c. If mobile, describe the exact area of operation:
2d. If fixed, enter the geographical coordinates exact to the nearest second. If mobile or base and mobile, enter either the
area of operation or the fixed/center coordinates and the radius of operation.
North Latitude(DD-MM-SS):
o ' "
West Longitude(DDD-MM-SS):
o ' "
Radius of Operation:
Km

Table 4 Latitude and Longitude Coordinates of Test Areas

Location	Min Longitude (deg)	Mid Longitude (deg)	Max Longitude (deg)	Min Latitude (deg)	Mid Latitude (deg)	Max Latitude (deg)	Radius (km)
Area A	78º 29' 00"	78º 14' 30"	78º 0' 00"	38º 30' 00"	38º 45' 00"	39º 0' 00"	55
Area B	78º 0' 00"	77º 45' 00"	77º 30' 00"	38º 30' 00"	38º 45' 00"	39º 0' 00"	55
Area C	77º 30' 00"	77º 19' 30"	77º 9' 00"	38º 30' 00"	38º 45' 00"	39º 0' 00"	55
Area D	78º 29' 00"	78º 14' 30"	78º 0' 00"	38º 00' 00"	38º 15' 00"	38º 30' 00"	55
Area E	78º 0' 00"	77º 45' 00"	77º 30' 00"	38º 00' 00"	38º 15' 00"	38º 30' 00"	55
Area F	77º 30' 00"	77º 19' 30"	77º 9' 00"	38º 00' 00"	38º 15' 00"	38º 30' 00"	55
SSC Office		77º 14' 43"			38º 55' 33"		0

12.0 Datum:

NAD 83

13.0 Is a directional antenna (other than radar) used? No.

If "YES", give the following information:
(a) Width of beam in degrees at the half-power point:
(b) Orientation in horizontal plane:
(c) Orientation in vertical plane:
OR
The information requested in items a, b and c exists in an exhibit submitted with this application
Yes No

14.0 Will the antenna extend more than 6 meters above the ground, or if mounted on an existing building, will it extend more than 6 meters above the building, or will the proposed antenna be mounted on an existing structure other than a building? If "YES", give the following: No

(a) Overall height above ground to tip of antenna is meters.
(b) Elevation of ground at antenna site above mean sea level is meters.
(c) Distance to nearest aircraft landing area is kilometers.
Yes No
(d) List any natural formations of existing man-made structures (hills, trees, water tanks, towers, etc.) which, in the opinion of the applicant, would tend to shield the antenna from aircraft and thereby minimize the aeronautical hazard of the antenna.
(e) Submit as an exhibit a vertical profile sketch of total structure including supporting building, if any, giving heights in meters above ground for all significant features. Clearly indicate existing portion, noting particulars of aviation obstruction lighting already available. Submit this sketch under the "Antenna Drawing" exhibit type.

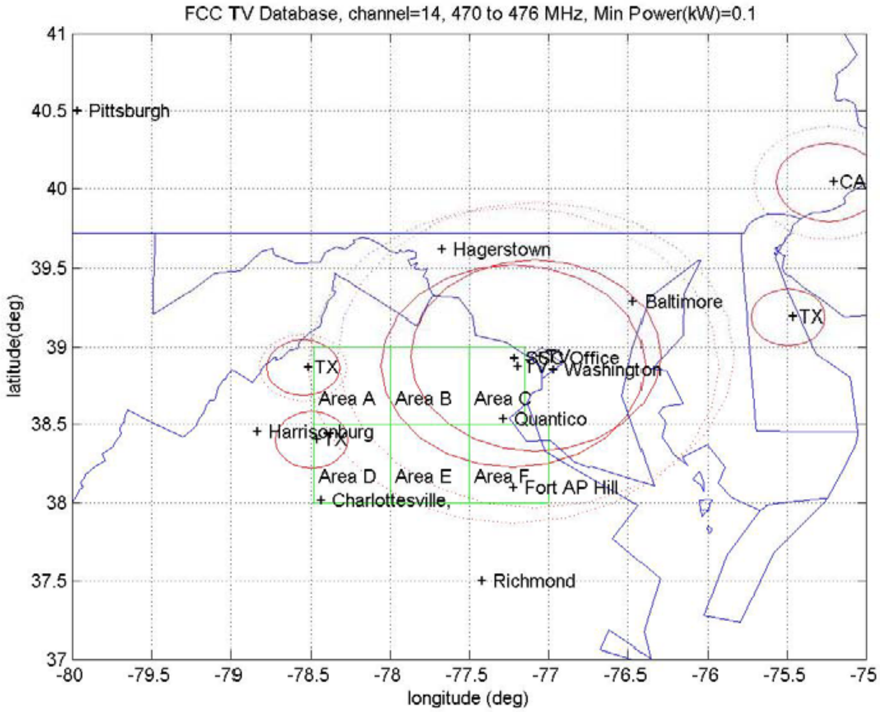
15.0 Appendix

This section provides the results of various analysis and measurements that support these applications.

15.1 Predicted Coverage Maps of TV Channels 14-36 – 470-600 MHz

This section contains plots of TV station coverage in the proposed test areas. The TV station information was obtained from the FCC website on approximately Dec 12, 2005. The FCC's TVFMFS program was used to determine the field strength levels. The FCC Grade B field strength values for NTSC and ATSC signals was obtained from a recent FCC report.[1] The dotted contour lines are the (50,10) TVFMS field strength values. The solid contour lines are the TVFMFS field strength values.

[1] OET BULLETIN No. 69, Longley-Rice Methodology for Evaluating TV Coverage and Interference, February 06, 2004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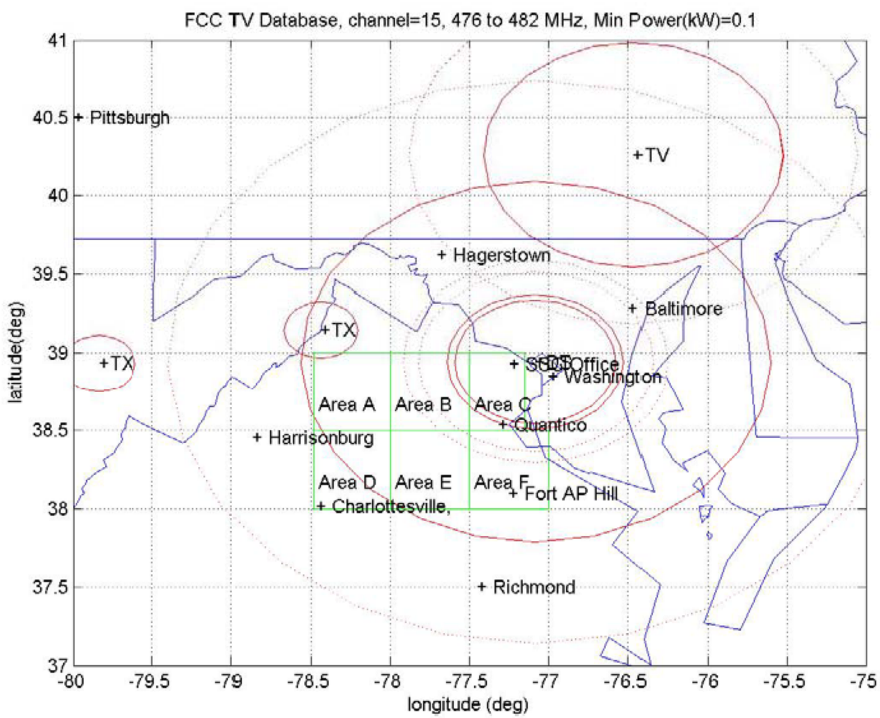
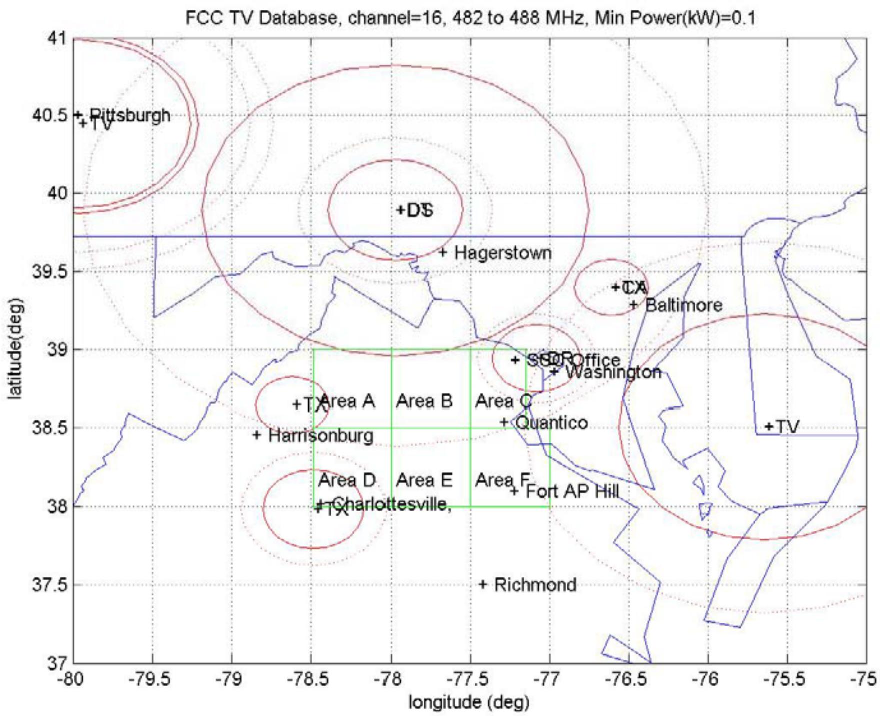
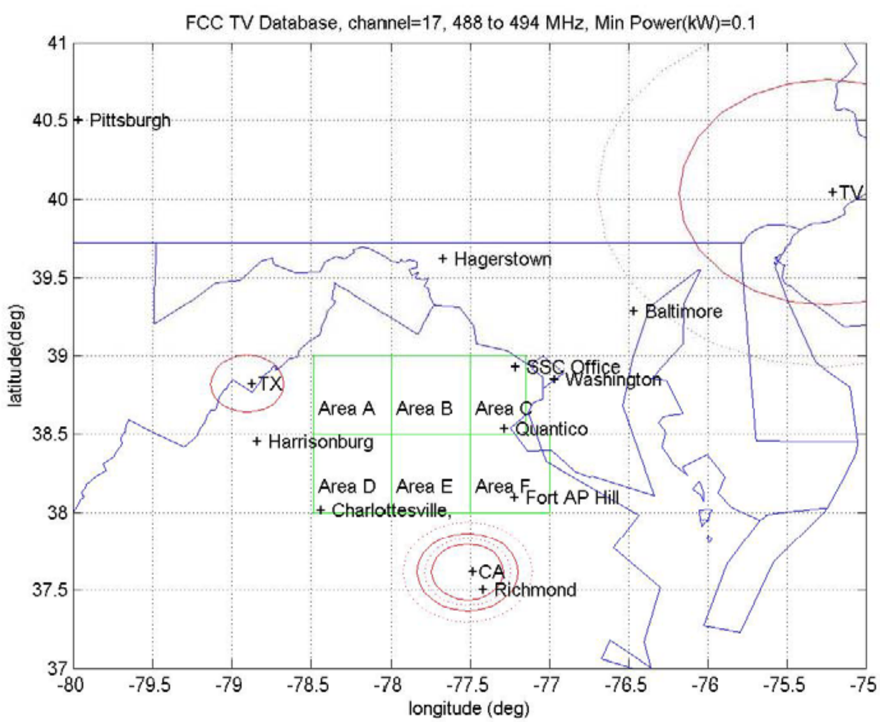
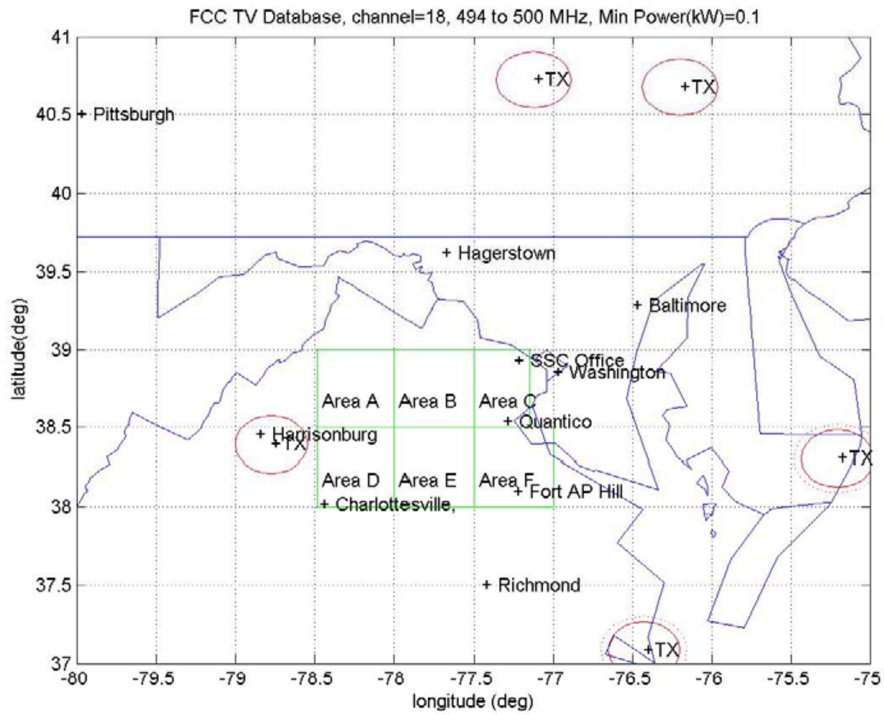
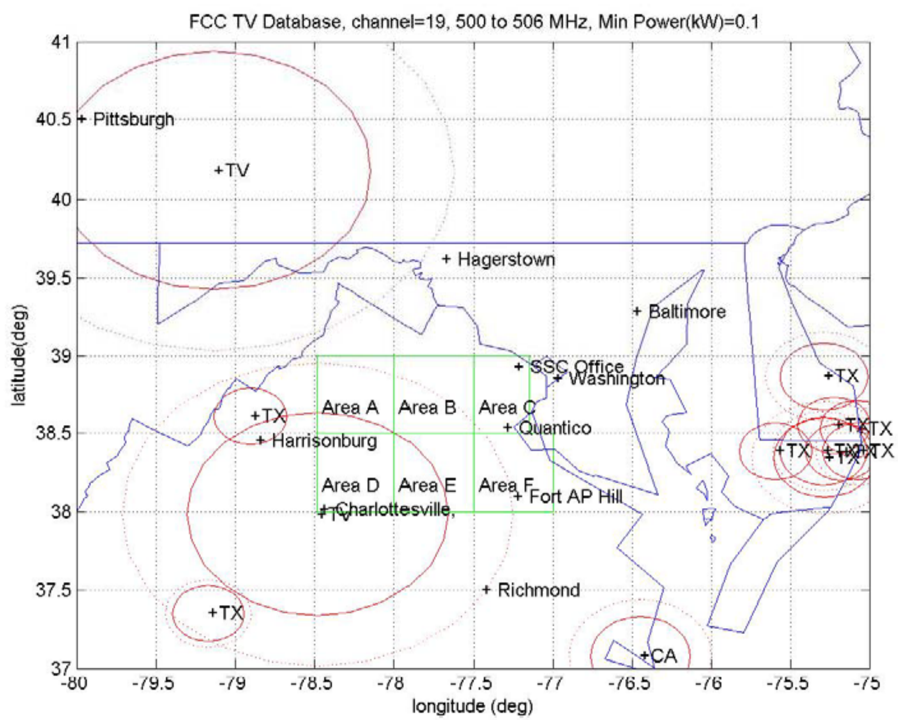
longitude (deg)
+ Pittsburgh
+ Hagerstown
+ Baltimore
+ Washington
+TV
+TX
+CA
Area A
Area B
Area C
Area D
Area E
Area F
+ Quantico
+ Harrisonburg
+ Fort AP Hill
+ Charlottesville,
+ Richmond

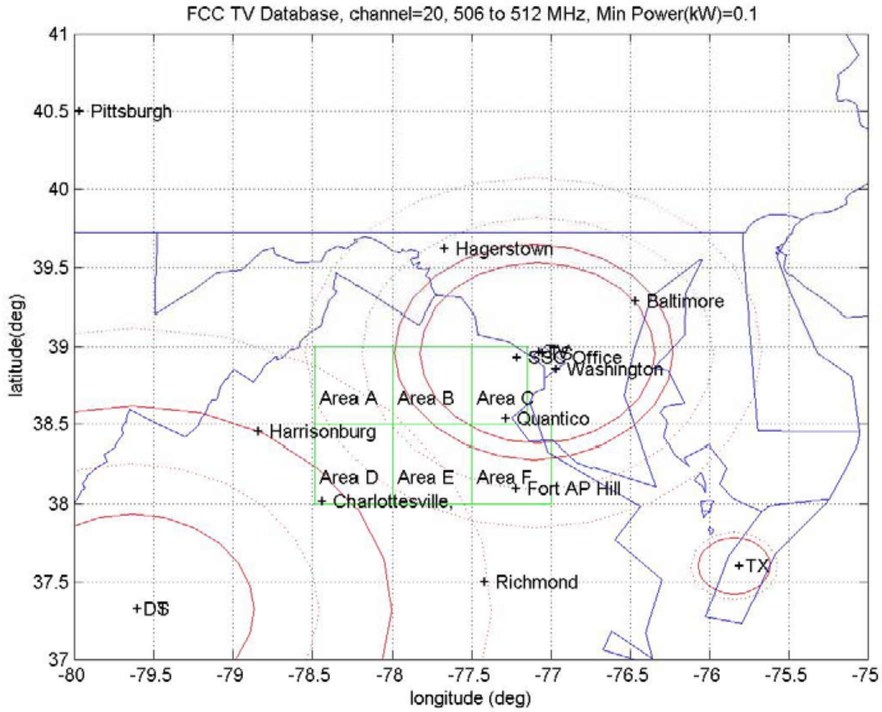

FCC TV Database, channel=15, 476 to 482 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
+ Pittsburgh
+TV
+ Hagerstown
+ Baltimore
+TX
+ Washington
Area A
Area B
Area C
Area D
Area E
Area F
+ Quantico
+ Harrisonburg
+ Fort AP Hill
+ Charlottesville,
+ Richmond

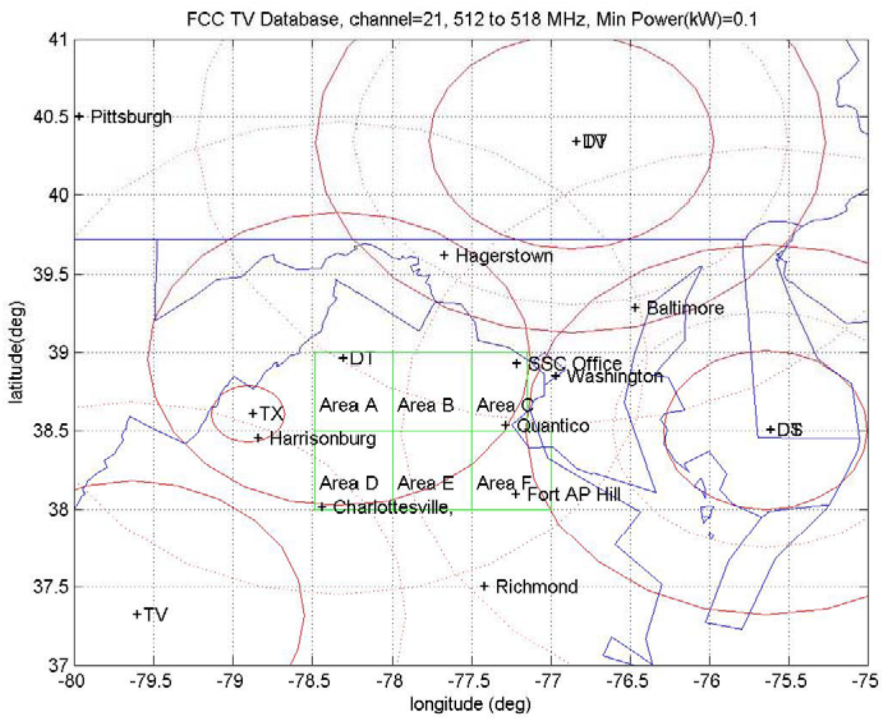

FCC TV Database, channel=16, 482 to 488 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
Pittsburgh
TV
DS
Hagerstown
CA
Baltimore
SSC Office
Washington
TX
Area A
Area B
Area C
Quantico
Harrisonburg
TV
Area D
Area E
Area F
Fort AP Hill
Charlottesville,
TX
Richmond

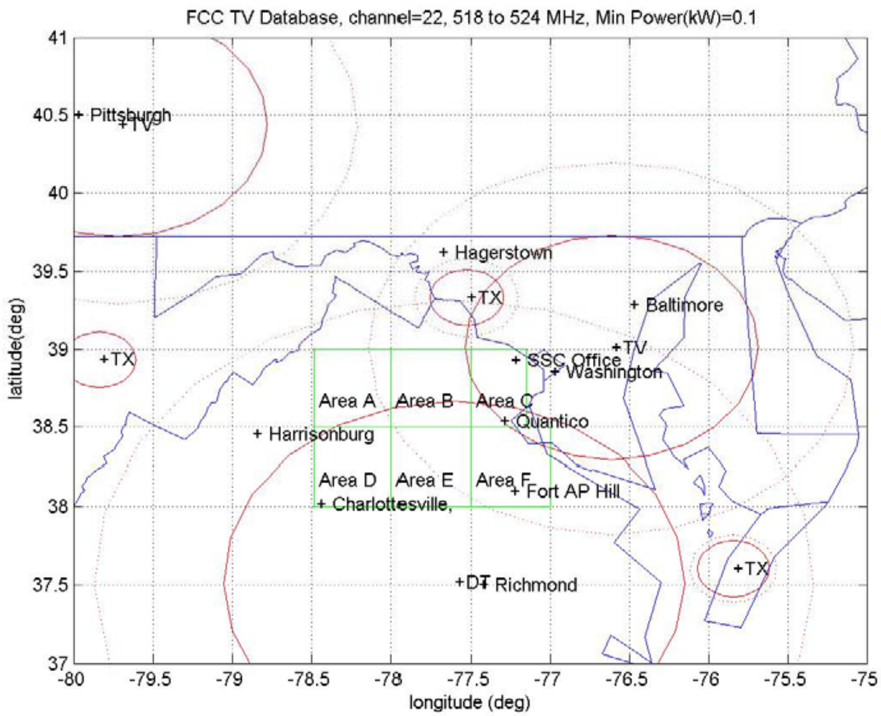

FCC TV Database, channel=17, 488 to 494 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
Pittsburgh
TV
Hagerstown
Baltimore
SSC Office
Washington
TX
Area A
Area B
Area C
Quantico
Harrisonburg
Area D
Area E
Area F
Fort AP Hill
Charlottesville,
CA
Richmond

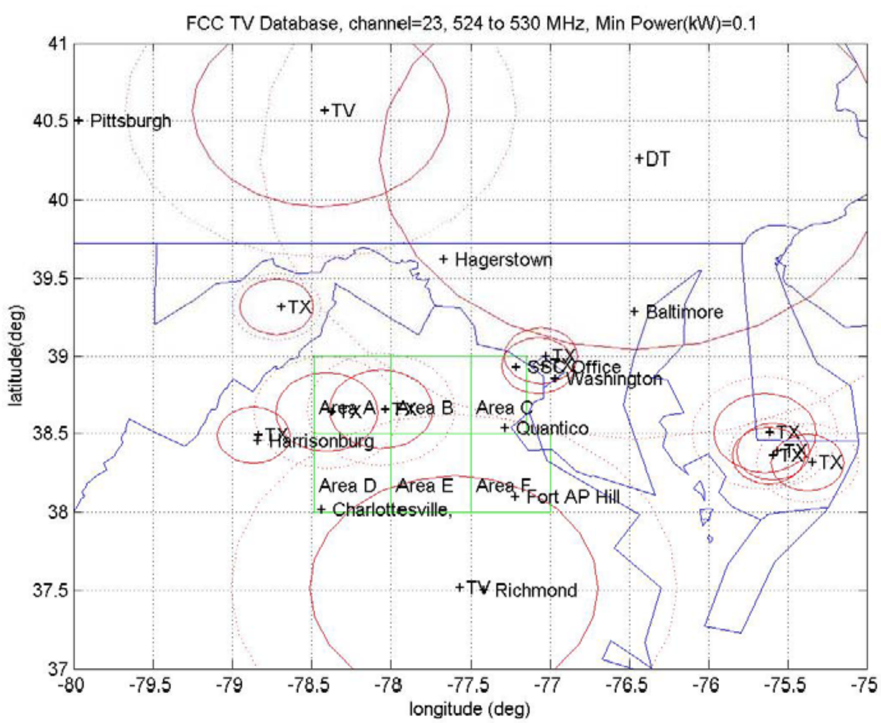

FCC TV Database, channel=18, 494 to 500 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
Pittsburgh
Hagerstown
Baltimore
SSC Office
Washington
Area A
Area B
Area C
Quantico
Harrisonburg
Area D
Area E
Area F
Fort AP Hill
Charlottesville,
Richmond
TX

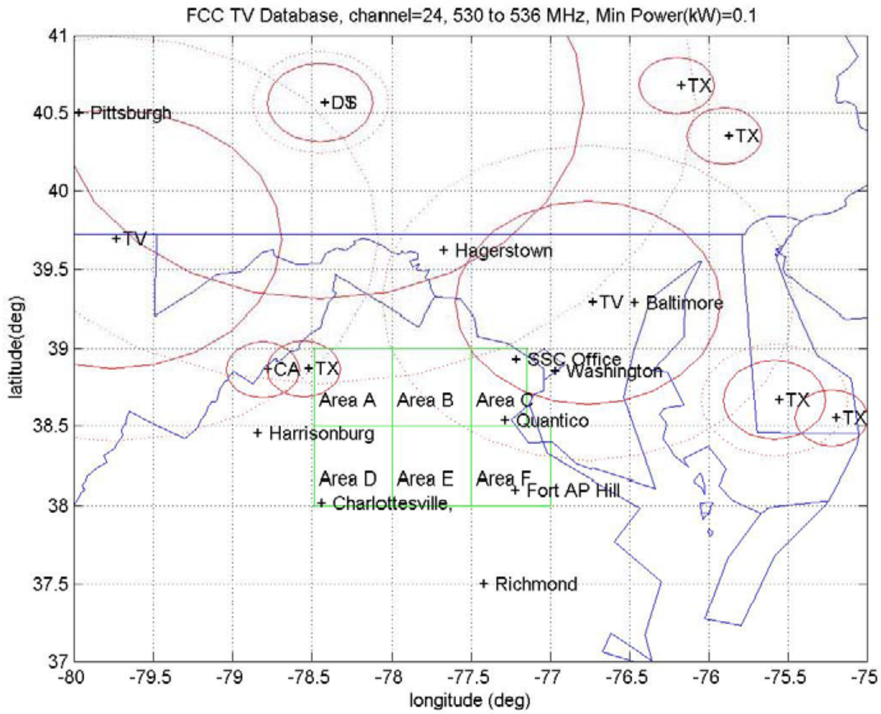

FCC TV Database, channel=19, 500 to 506 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
Pittsburgh
TV
Hagerstown
Baltimore
SSC Office
Washington
Area A
Area B
Area C
Quantico
Harrisonburg
Area D
Area E
Area F
Fort AP Hill
Charlottesville,
Richmond
TX
CA

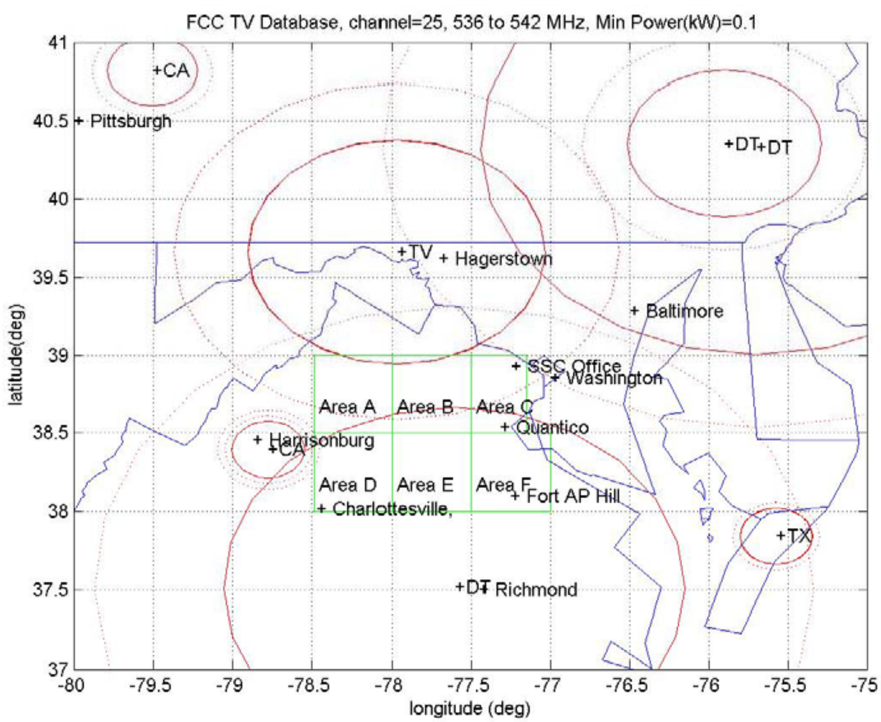

FCC TV Database, channel=20, 506 to 512 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
Pittsburgh
Hagerstown
Baltimore
SSC Office
Washington
Area A
Area B
Area C
Quantico
Harrisonburg
Area D
Area E
Area F
Fort AP Hill
Charlottesville,
TX
Richmond
DS

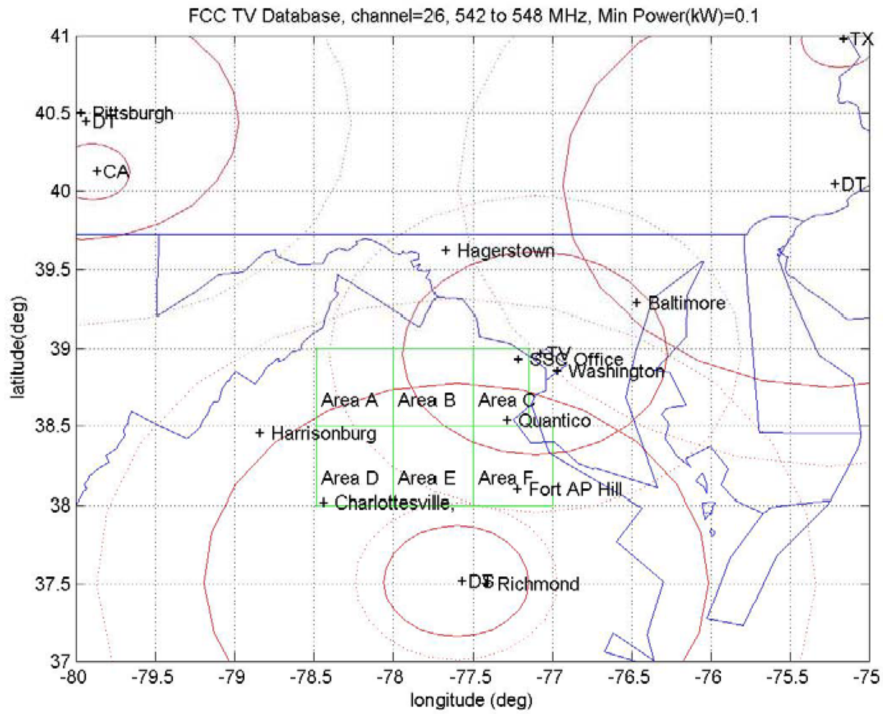

FCC TV Database, channel=21, 512 to 518 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
Pittsburgh
DV
Hagerstown
Baltimore
DT
SSC Office
Washington
TX
Area A
Area B
Area C
Quantico
Harrisonburg
DS
Area D
Area E
Area F
Fort AP Hill
Charlottesville,
Richmond
TV

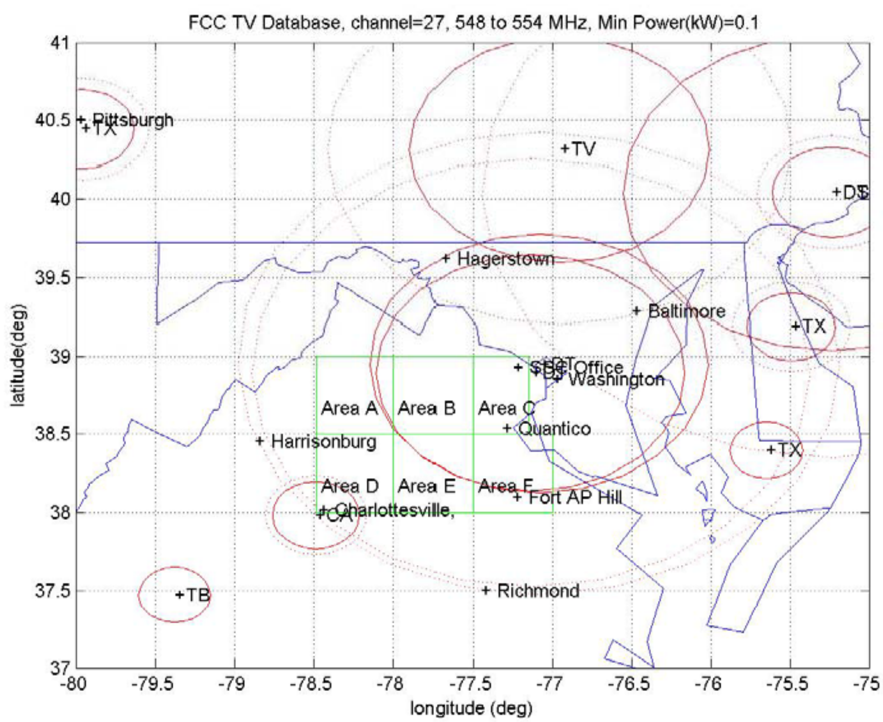

FCC TV Database, channel=22, 518 to 524 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
Pittsburgh
Hagerstown
Baltimore
SSC Office
Washington
Area A
Area B
Area C
Quantico
Harrisonburg
Area D
Area E
Area F
Fort AP Hill
Charlottesville,
Richmond

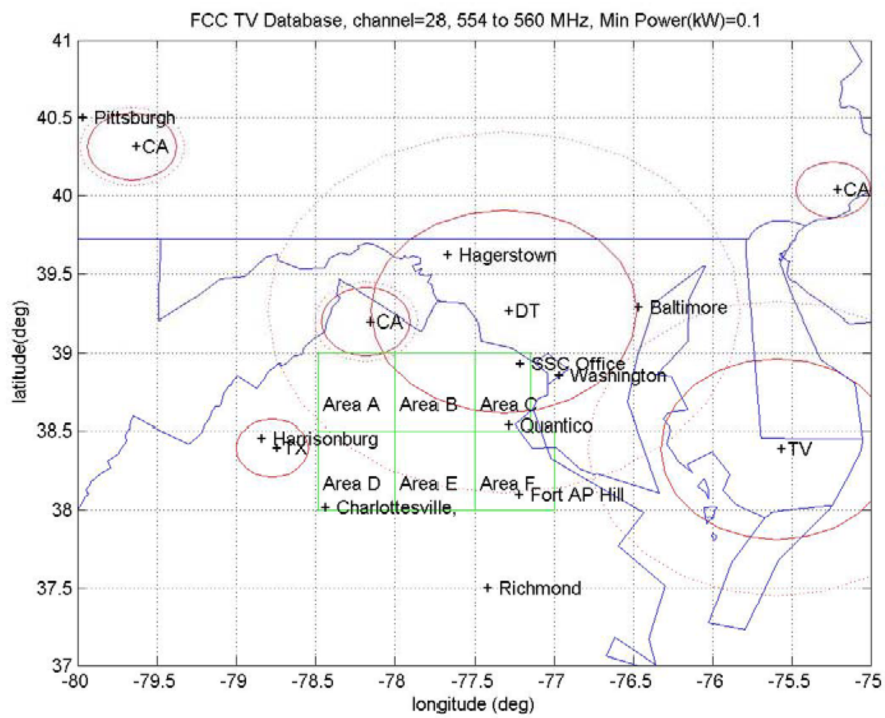

FCC TV Database, channel=23, 524 to 530 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
Pittsburgh
Hagerstown
Baltimore
SSC Office
Washington
Area A
Area B
Area C
Quantico
Harrisonburg
Area D
Area E
Area F
Fort AP Hill
Charlottesville,
Richmond

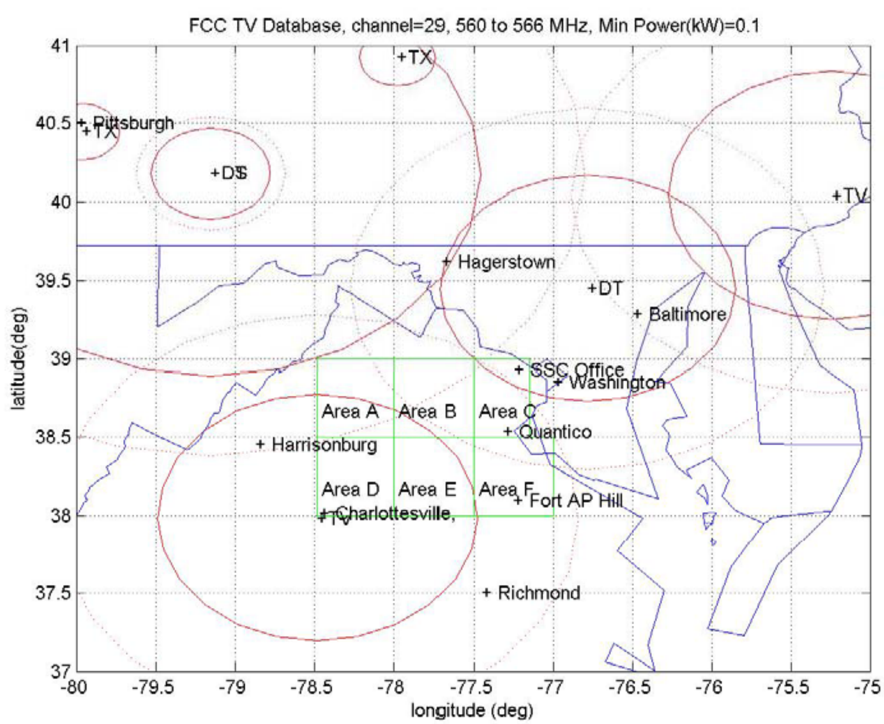

FCC TV Database, channel=24, 530 to 536 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
41
40.5
40
39.5
39
38.5
38
37.5
37
-80
-79.5
-79
-78.5
-78
-77.5
-77
-76.5
-76
-75.5
-75
+ Pittsburgh
+DS
+TX
+TX
+TV
+ Hagerstown
+TV + Baltimore
+CA +TX
+ SSC Office
+ Washington
Area A
Area B
Area C
+ Quantico
+TX
+TX
+ Harrisonburg
Area D
Area E
Area F
+ Fort AP Hill
+ Charlottesville,
+ Richmond

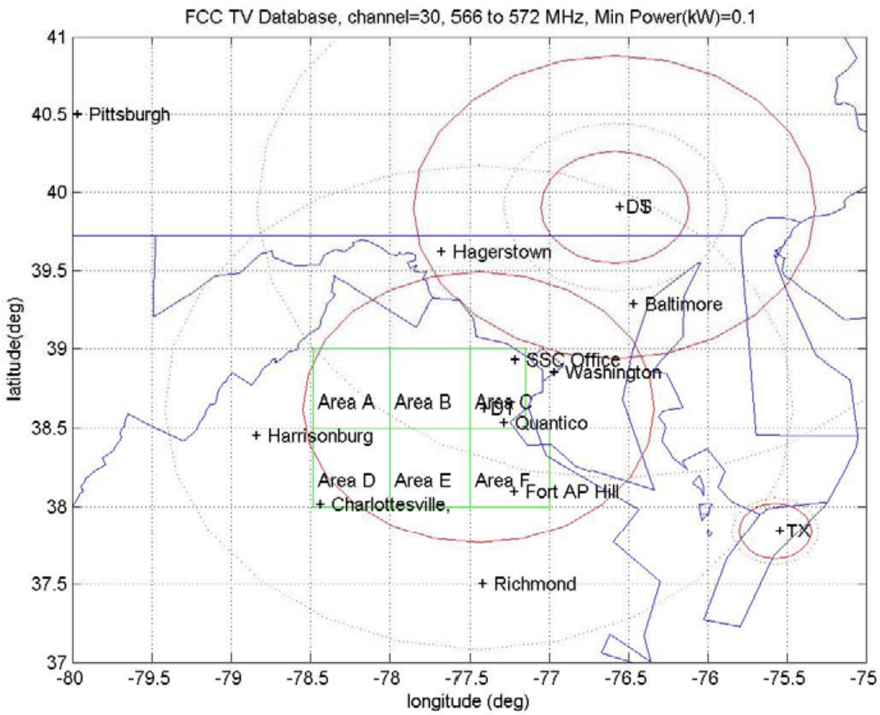

FCC TV Database, channel=25, 536 to 542 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
41
40.5
40
39.5
39
38.5
38
37.5
37
-80
-79.5
-79
-78.5
-78
-77.5
-77
-76.5
-76
-75.5
-75
+CA
+ Pittsburgh
+DT+DT
+TV + Hagerstown
+ Baltimore
+ SSC Office
+ Washington
Area A
Area B
Area C
+ Quantico
+ Harrisonburg
+CA
Area D
Area E
Area F
+ Fort AP Hill
+ Charlottesville,
+TX
+DT
+ Richmond

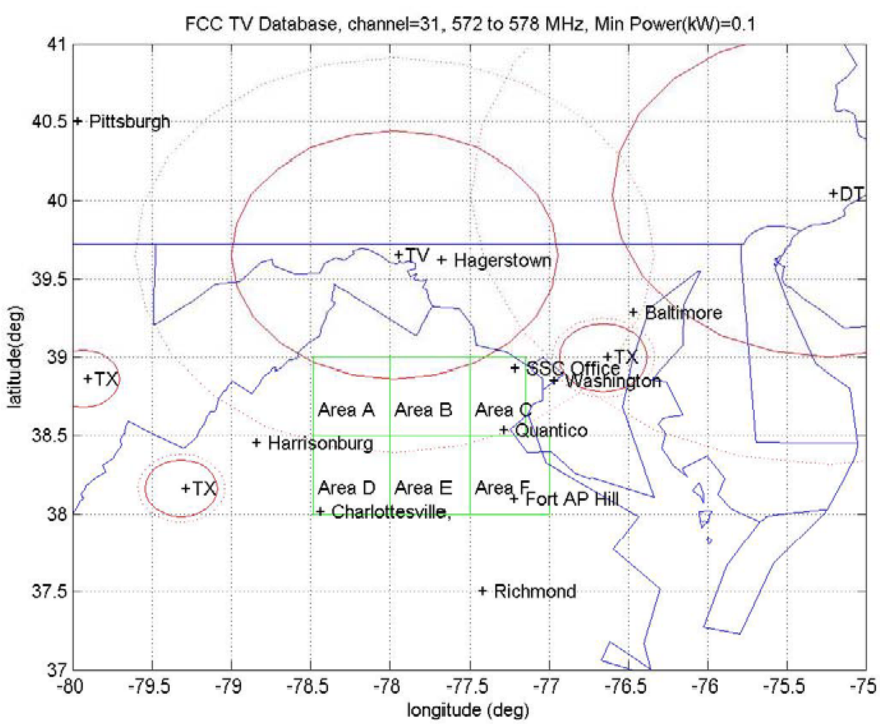

FCC TV Database, channel=26, 542 to 548 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
Pittsburgh
Hagerstown
Baltimore
SSC Office
Washington
Area A
Area B
Area C
Quantico
Harrisonburg
Area D
Area E
Area F
Fort AP Hill
Charlottesville,
Richmond

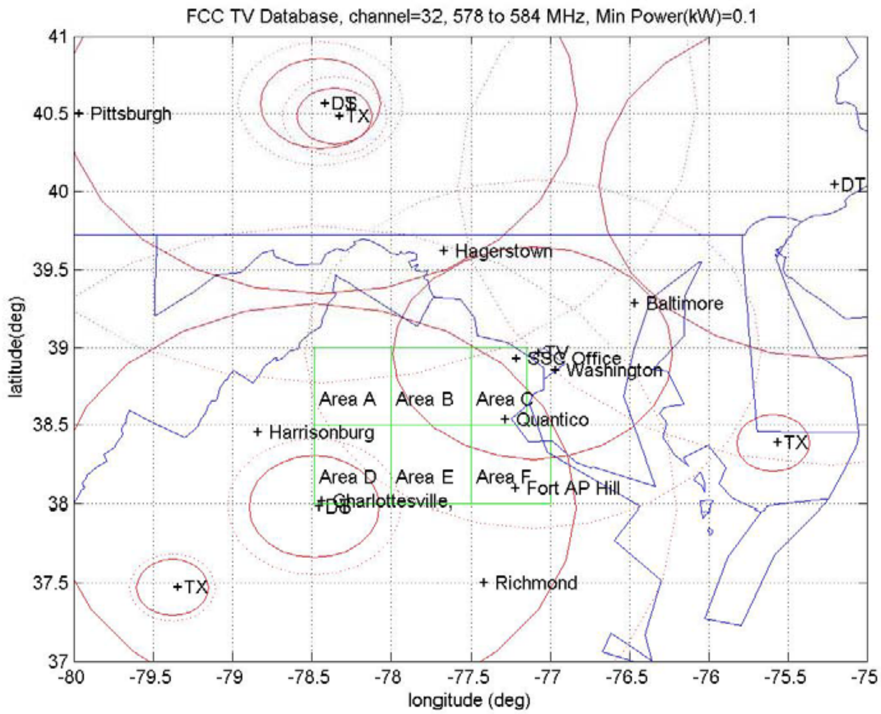

FCC TV Database, channel=27, 548 to 554 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
Pittsburgh
Hagerstown
Baltimore
SSC Office
Washington
Area A
Area B
Area C
Quantico
Harrisonburg
Area D
Area E
Area F
Fort AP Hill
Charlottesville,
Richmond

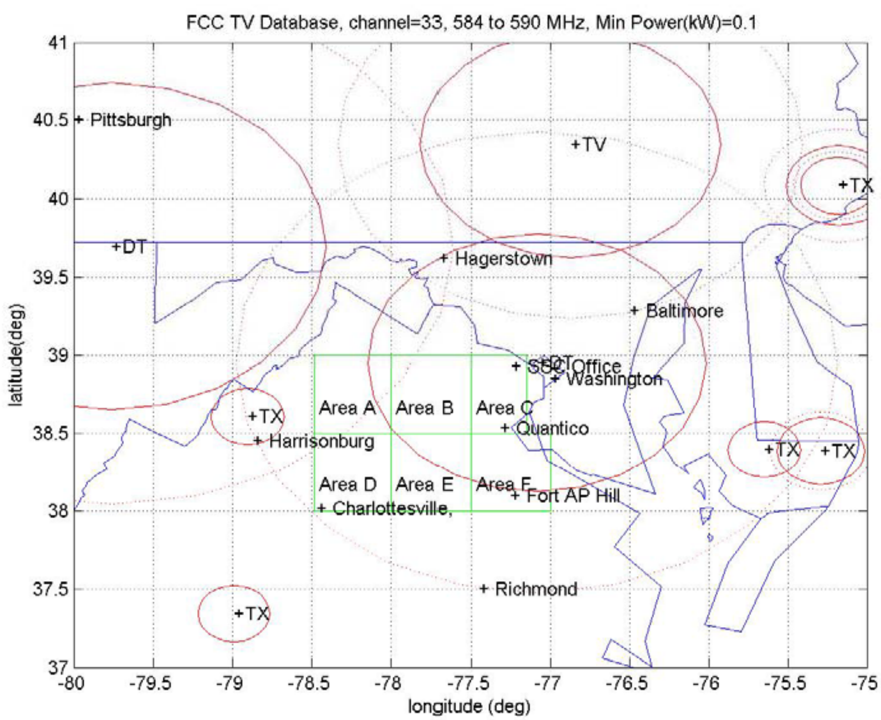

FCC TV Database, channel=28, 554 to 560 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
Pittsburgh
+CA
+CA
Hagerstown
+DT
Baltimore
+CA
SSC Office
Washington
Area A
Area B
Area C
Quantico
Harrisonburg
+TX
+TV
Area D
Area E
Area F
Fort AP Hill
Charlottesville,
Richmond

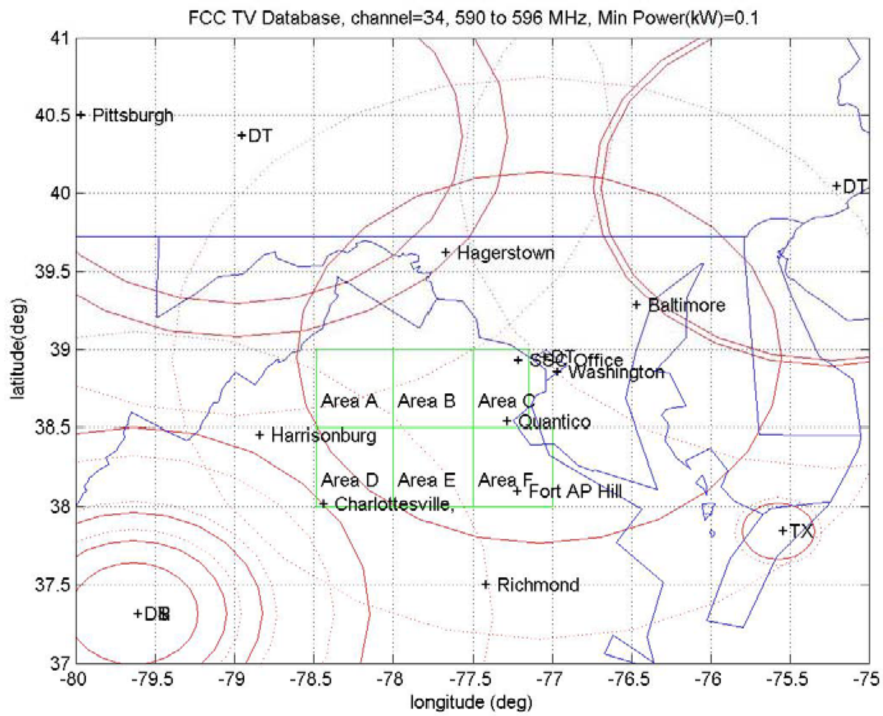

FCC TV Database, channel=29, 560 to 566 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
+TX
Pittsburgh
+TX
+DS
+TV
Hagerstown
+DT
Baltimore
SSC Office
Washington
Area A
Area B
Area C
Quantico
Harrisonburg
Area D
Area E
Area F
Fort AP Hill
Charlottesville,
+TV
Richmond

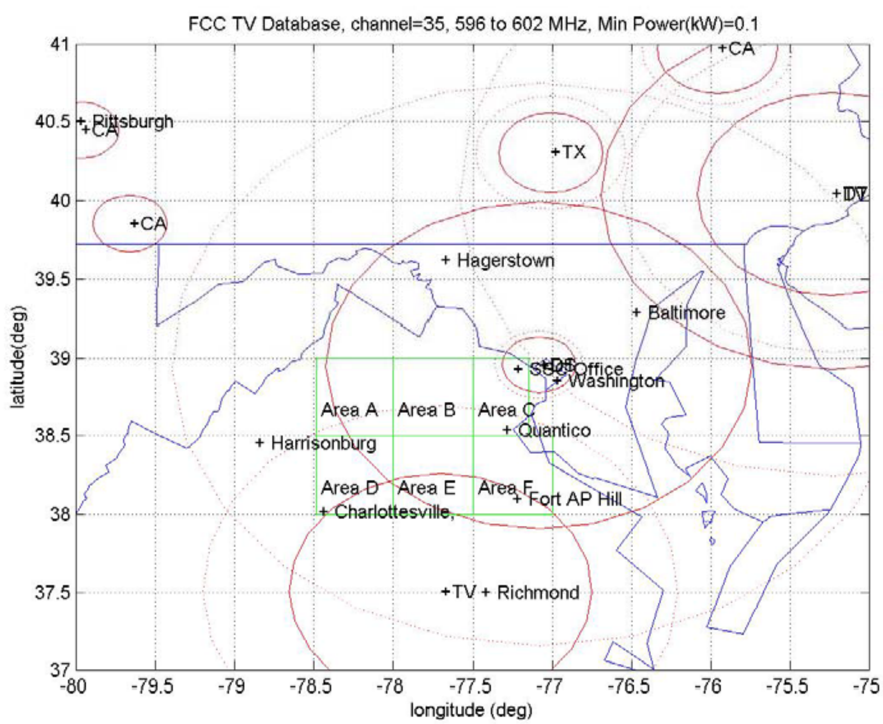

FCC TV Database, channel=30, 566 to 572 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
41
40.5
40
39.5
39
38.5
38
37.5
37
-80
-79.5
-79
-78.5
-78
-77.5
-77
-76.5
-76
-75.5
-75
+ Pittsburgh
+DS
+ Hagerstown
+ Baltimore
+ SSC Office
+ Washington
Area A
Area B
Area C
+DT
+ Quantico
+ Harrisonburg
Area D
Area E
Area F
+ Fort AP Hill
+ Charlottesville,
+TX
+ Richmond

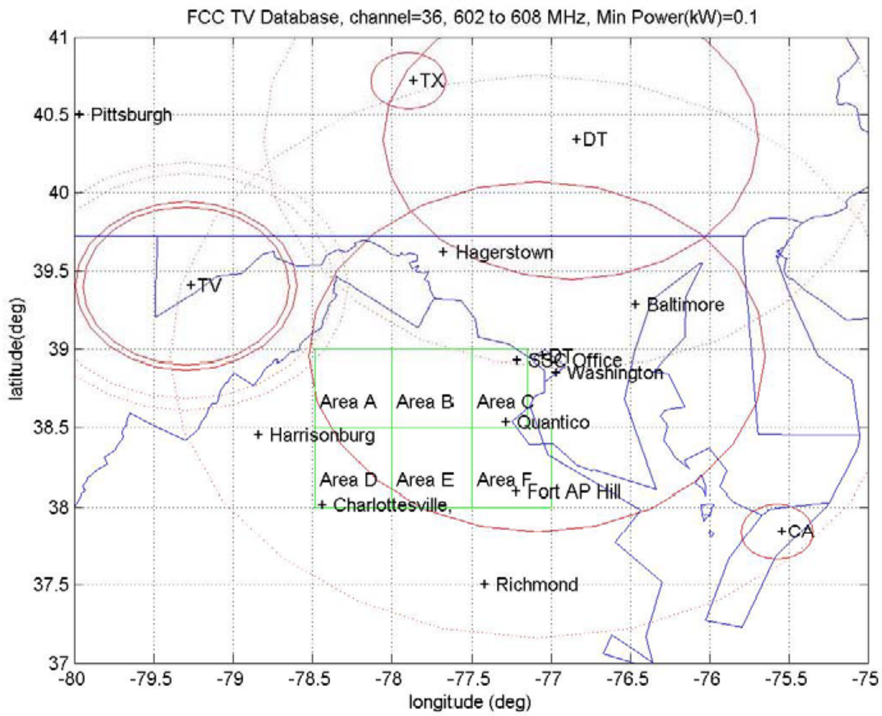

FCC TV Database, channel=31, 572 to 578 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
41
40.5
40
39.5
39
38.5
38
37.5
37
-80
-79.5
-79
-78.5
-78
-77.5
-77
-76.5
-76
-75.5
-75
+ Pittsburgh
+DT
+TV
+ Hagerstown
+ Baltimore
+TX
+ SSC Office
+ Washington
+TX
Area A
Area B
Area C
+ Quantico
+ Harrisonburg
+TX
Area D
Area E
Area F
+ Fort AP Hill
+ Charlottesville,
+ Richmond


FCC TV Database, channel=32, 578 to 584 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
Pittsburgh
Hagerstown
Baltimore
SSC Office
Washington
Quantico
Harrisonburg
Charlottesville,
Fort AP Hill
Richmond
Area A
Area B
Area C
Area D
Area E
Area F
+TX
+DT
+TV


FCC TV Database, channel=33, 584 to 590 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
Pittsburgh
Hagerstown
Baltimore
SSC Office
Washington
Quantico
Harrisonburg
Charlottesville,
Fort AP Hill
Richmond
Area A
Area B
Area C
Area D
Area E
Area F
+TX
+DT
+TV


FCC TV Database, channel=34, 590 to 596 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
Pittsburgh
Hagerstown
Baltimore
SSC Office
Washington
Quantico
Harrisonburg
Fort AP Hill
Charlottesville,
Richmond
Area A
Area B
Area C
Area D
Area E
Area F
+DT
+TX

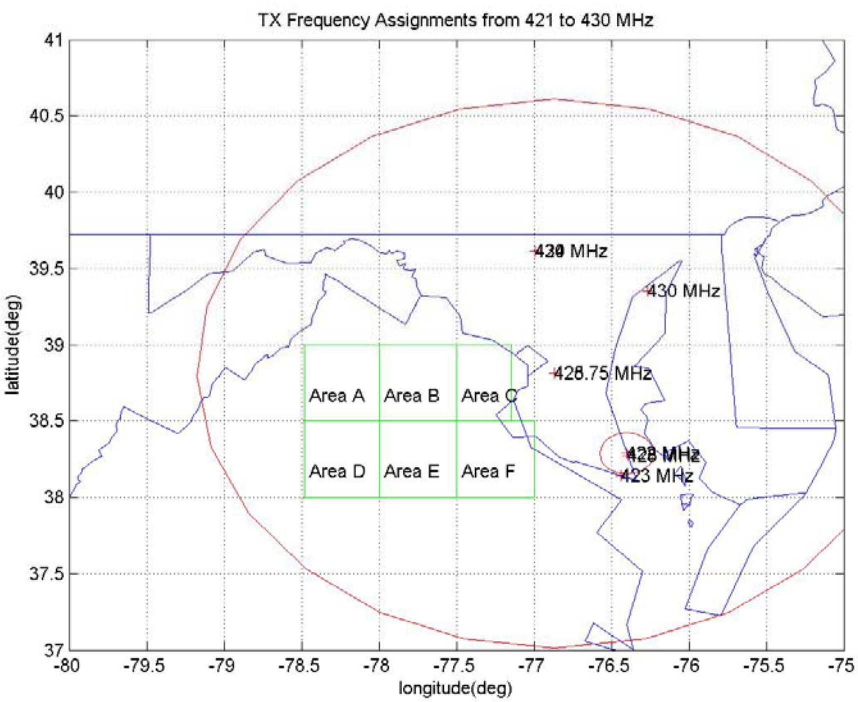

FCC TV Database, channel=35, 596 to 602 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
Pittsburgh
Hagerstown
Baltimore
SSC Office
Washington
Quantico
Harrisonburg
Fort AP Hill
Charlottesville,
Richmond
Area A
Area B
Area C
Area D
Area E
Area F
+CA
+TX
+TV

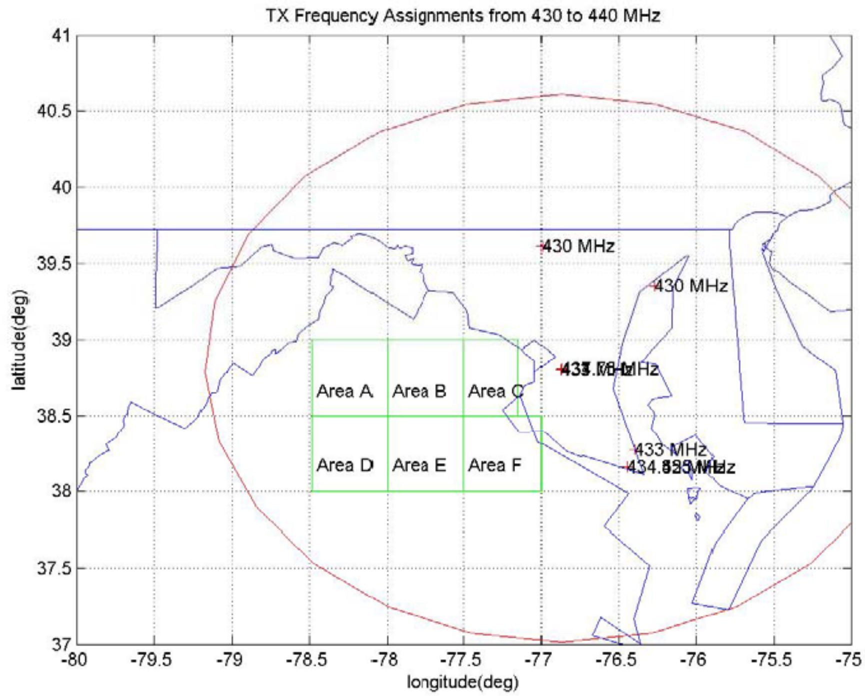

FCC TV Database, channel=36, 602 to 608 MHz, Min Power(kW)=0.1
latitude(deg)
longitude (deg)
41
40.5
40
39.5
39
38.5
38
37.5
37
-80
-79.5
-79
-78.5
-78
-77.5
-77
-76.5
-76
-75.5
-75
+ Pittsburgh
+TX
+DT
+TV
+ Hagerstown
+ Baltimore
+ SSC Office
+ Washington
Area A
Area B
Area C
Area D
Area E
Area F
+ Quantico
+ Harrisonburg
+ Fort AP Hill
+ Charlottesville,
+CA
+ Richmond

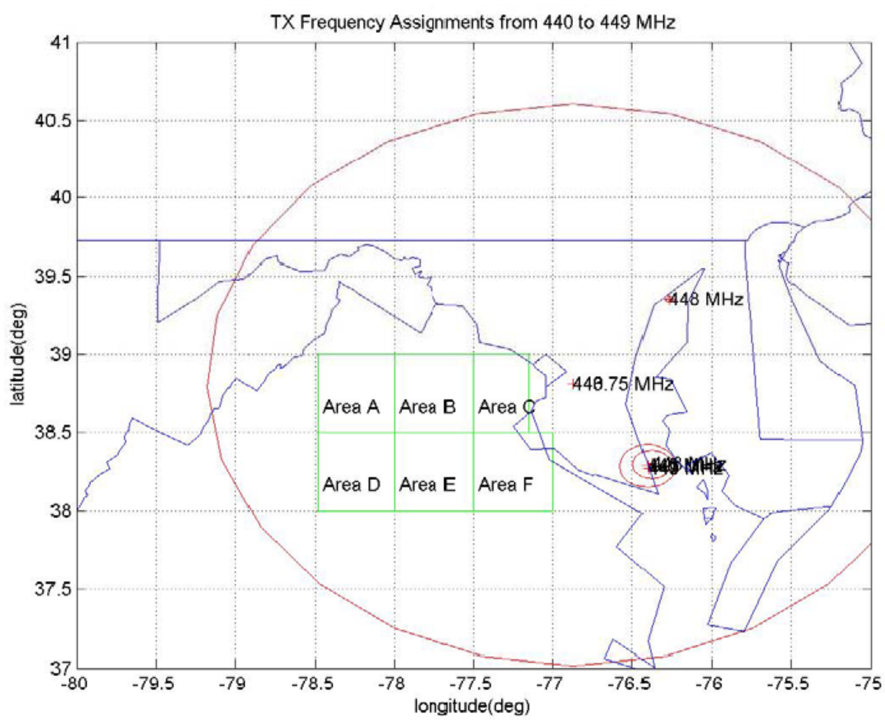
15.2 421-449 MHz Transmitter Locations

This section shows the transmitter locations from 421-449 MHz. For the assignments with a radius of mobility, a circle is drawn to show the limit. If the mobility radius exceeded a value of 200 km, a value of 200 km was used to keep the circle within the plot limits. This plot is based on frequency assignments provided to SSC by the Joint Spectrum Center. The spatial limit of this data set is 38-39.8 latitude and -78.5 to -75.7 longitude, hence, some assignments might be near the Test Areas. We have requested a list of assignments from the JSC and the FCC ULS website.

The transmitters in the JSC database are located to the east of the Radio Quiet Zone, which starts to the west of longitude -78.5°.




TX Frequency Assignments from 430 to 440 MHz
latitude(deg)
longitude(deg)
430 MHz
430 MHz
433 MHz
Area A
Area B
Area C
Area D
Area E
Area F
41
40.5
40
39.5
39
38.5
38
37.5
37
-80
-79.5
-79
-78.5
-78
-77.5
-77
-76.5
-76
-75.5
-75


TX Frequency Assignments from 440 to 449 MHz
latitude(deg)
longitude(deg)
448 MHz
Area A
Area B
Area C
Area D
Area E
Area F
41
40.5
40
39.5
39
38.5
38
37.5
37
-80
-79.5
-79
-78.5
-78
-77.5
-77
-76.5
-76
-75.5
-75

15.3 Spectrum Occupancy Measurements of the 421-449 MHz Band

Shared Spectrum Company's measurements of the 421-449 MHz band's spectrum occupancy show that this band is lightly used, hence the transmitters in this band are generally not located near these measurement locations or they are not used often.

These spectrum measurements were made at Tysons Corner and at Riverbend Park, Virginia. These measurement plots are shown in Figure 2 and Figure 3. The first subplot represents the maximum power value versus frequency measured during the period. The power values are the levels at the antenna port, and are corrected for cable losses, filter losses, and amplifier losses. The time shown on the plot is the measurement start time.

The second subplot is a waterfall-type of plot showing occupancy versus time and frequency. Occupancy is determined when the power level exceeds a threshold. The threshold value was intentionally selected for each run, and is shown as a dotted line on the upper subplot. Note that, in some cases, the noise level exceeds the threshold, causing inflated occupancy levels. To correct this, the threshold would have had to be hand-selected for each plot, which was not done.

The third subplot is the fraction of time the signal is "on", versus the frequency measured during the period. If the fraction of time is '1', it means that the signal was on during the entire period of measurement collection, and vice versa.

Of interest are 421-449 MHz signals based at Andrews Air Force Base, which is 35 km from Tysons Corner and 39 km from Riverbend Park is 35 km from Andrews. During the above measurement periods, the 421-449 MHz signals were seen infrequently and not with strong amplitude. We believe that the 421-449 MHz transmitters are typically located far from the Northern Virginia area.

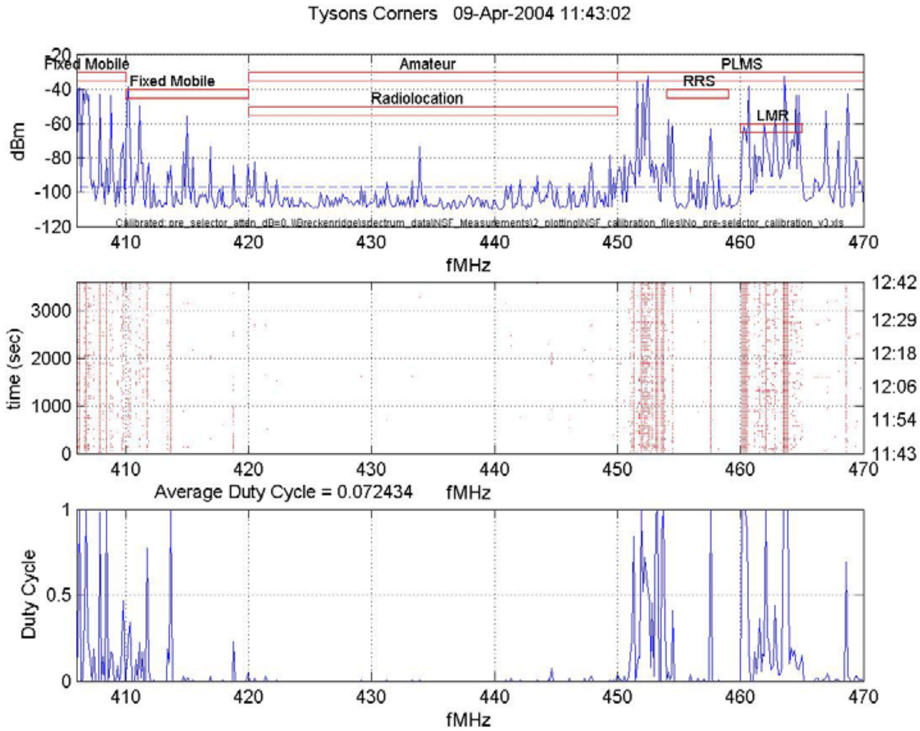


Figure 2: 406 MHz to 470 MHz, measured at Tysons Corner, Vienna, Virginia.

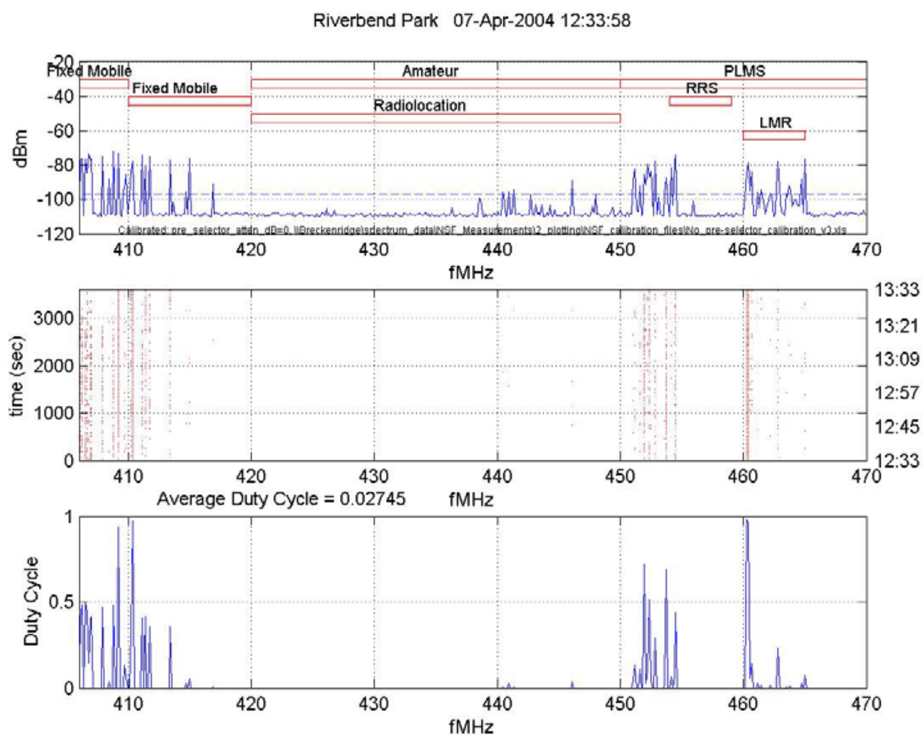


Figure 3: 406 MHz – 470 MHz, measured at Riverbend Park, Virginia.

15.4 Detectability of 421-449 MHz Signals

The 421-449 MHz signals have large transmit power levels, and are easily detectable. Hence, the existing 421-449 MHz transmitters will easily be detected before they are physically located close enough to the XG transceivers to be interfered with.

Table 5 shows that various assignments in the 421-449 MHz band and the calculated "Maximum Detectable Prop Loss". These values are much larger than the propagation loss where interference occurs as shown in Table 5.

Table 5 421-449 MHz Frequency Assignments and the Maximum Detectable Propagation Loss

AgnSerNum	NOMEN	YCOORD	XCOORD	CITY_BASE	FREQ_MIN (MHz)	POWER (dBm)	BDW_NEC (kHz)	Transmitter Power Density (dBm/Hz)	Thermal Noise (dBm/Hz)	NF (dB)	Detection SNR (dB)	Maximum Detectable Prop Loss (dB)
TRAN710023		38.7833	-77.0833	WASHINGTON	419.9750	36.0	16	-6.0	-174.0	5.0	10.0	153.0
TRAN710023		38.7833	-77.0833	WASHINGTON	419.9750	36.0	16	-6.0	-174.0	5.0	10.0	153.0
N 016890	AN/AEW TEST RADAR	38.2928	-76.3806	PATUXENT RIVER	420.0000	68.0	1200	7.2	-174.0	5.0	10.0	166.2
NG 008627		39.1836	-76.6858	ANNE ARUNDEL	420.0000	80.0	2950	15.3	-174.0	5.0	10.0	174.3
NG 008627		39.1836	-76.6858	ANNE ARUNDEL	420.0000	80.0	5530	12.6	-174.0	5.0	10.0	171.6
N 962013	SANENVIRONMENTALGN	38.2875	-76.4011	PATUXENT RIVER	422.0000	85.1	857	25.8	-174.0	5.0	10.0	184.8
N 831053	AN/URW-19	38.2717	-76.3967	PATUXENT RIVER	423.0000	47.0	700	-11.5	-174.0	5.0	10.0	147.5
N 874787	AAIPIONEERRPV	38.1406	-76.4361	WEBSTER FIELD	423.0000	48.0	250	-6.0	-174.0	5.0	10.0	153.0
NG 993121		39.6117	-76.9922	WESTMINSTER	424.0000	47.0	4000	-19.0	-174.0	5.0	10.0	140.0
AF 910080	AN/FRW2	38.2717	-76.3967	PATUXENT RIVER	425.0000	60.0	600	2.2	-174.0	5.0	10.0	161.2
N 864122	AN/URW-14A	38.2717	-76.3967	PATUXENT RIVER	425.0000	50.0	600	-7.8	-174.0	5.0	10.0	151.2
AF 008055	AN/ASQ-177	38.8117	-76.8667	ANDREWS	425.7500	50.0	6500	-18.1	-174.0	5.0	10.0	140.9
AF 910098	AN/FRW2	38.2717	-76.3967	PATUXENT RIVER	428.0000	60.0	600	2.2	-174.0	5.0	10.0	161.2
N 054553	AN/FRW2	38.2717	-76.3967	PATUXENT RIVER	428.0000	60.0	205	6.9	-174.0	5.0	10.0	165.9
AF 008056	AN/ASQ-177	38.8117	-76.8667	ANDREWS	428.7500	50.0	6500	-18.1	-174.0	5.0	10.0	140.9
AR 916564	AYDT-105U	39.3500	-76.2667	ABERDEEN PG	430.0000	37.0	500	-20.0	-174.0	5.0	10.0	139.0
NG 993122		39.6117	-76.9922	WESTMINSTER	430.0000	47.0	4000	-19.0	-174.0	5.0	10.0	140.0
AF 008057	AN/ASQ-177	38.8117	-76.8667	ANDREWS	431.7500	50.0	6500	-18.1	-174.0	5.0	10.0	140.9
AF 978207	MXNDM530	38.8056	-76.8722	ANDREWS	433.0000	37.0	16	-5.1	-174.0	5.0	10.0	153.9
AF 978207	MXNDM530	38.8056	-76.8722	ANDREWS	433.0000	37.0	16	-5.1	-174.0	5.0	10.0	153.9
N 831054	AN/URW-19	38.2717	-76.3967	PATUXENT RIVER	433.0000	47.0	700	-11.5	-174.0	5.0	10.0	147.5
N 006479	JHUEXDB400	38.1583	-76.4411	WEBSTER FIELD	434.3250	33.0	20	-10.0	-174.0	5.0	10.0	149.0
N 006480	JHUEXDB400	38.1583	-76.4411	WEBSTER FIELD	434.4500	33.0	20	-10.0	-174.0	5.0	10.0	149.0
N 006481	JHUEXDB400	38.1583	-76.4411	WEBSTER FIELD	434.5250	33.0	20	-10.0	-174.0	5.0	10.0	149.0
AF 008058	AN/ASQ-177	38.8117	-76.8667	ANDREWS	434.7500	50.0	6500	-18.1	-174.0	5.0	10.0	140.9
AF 008059	AN/ASQ-177	38.8117	-76.8667	ANDREWS	437.7500	50.0	6500	-18.1	-174.0	5.0	10.0	140.9
AF 008060	AN/ASQ-177	38.8117	-76.8667	ANDREWS	440.7500	50.0	6500	-18.1	-174.0	5.0	10.0	140.9
AF 008061	AN/ASQ-177	38.8117	-76.8667	ANDREWS	443.7500	50.0	6500	-18.1	-174.0	5.0	10.0	140.9
N 962014	SANENVIRONMENTALGN	38.2875	-76.4011	PATUXENT RIVER	445.0000	85.1	857	25.8	-174.0	5.0	10.0	184.8
AF 008062	AN/ASQ-177	38.8117	-76.8667	ANDREWS	446.7500	50.0	6500	-18.1	-174.0	5.0	10.0	140.9
N 864123	AN/URW-14A	38.2717	-76.3967	PATUXENT RIVER	447.0000	50.0	600	-7.8	-174.0	5.0	10.0	151.2
AR 916565	AYDT-105U	39.3500	-76.2667	ABERDEEN PG	448.0000	37.0	30	-7.8	-174.0	5.0	10.0	151.2
N 987518	EMRSDT4050EDR	38.2972	-76.3758	PATUXENT RIVER	448.0000	37.0	25	-7.0	-174.0	5.0	10.0	152.0
N 861087	TDI-OTHTDCS	38.2717	-76.3967	PATUXENT RIVER	449.0000	37.0	20	-6.0	-174.0	5.0	10.0	153.0
N 861087	TDI-OTHTDCS	38.2717	-76.3967	PATUXENT RIVER	449.0000	47.0	20	4.0	-174.0	5.0	10.0	163.0

15.5 Interference Link Analysis

This section estimates the required propagation loss between an SSC transmitter and a typical victim receiver. Estimates are made for the SSC signals outdoors and indoors (with an assumed 10 dB building propagation loss).

Table 6 shows the required propagation loss between an XG transmitter and a typical victim receiver. The XG system has a 1.75 MHz bandwidth and can use a variety of transmit power levels. An interference-to-noise (I/N) level of 0 dB is used. The victim's receiver noise figure is assumed to be 5 dB.

For example, if the XG transmit power level is 100 mW, there needs to be 126.6 dB of propagation loss to the victim receiver. If the XG system is indoors, then there needs to be approximately 116.6 of propagation loss. If the XG system is operated outdoors with 1 W transmit power, then 136.6 dB of propagation loss is required to avoid interference.

Table 6 Interference Link Analysis – XG Transmitted Power Density Equaling Victim Receiver Noise Level

		XG Transmit Power Level			
		Pt=1 mW	Pt=10 mW	Pt=100 mW	Pt=1 W
Pt - Transmit Power Level	Watts	0.001	0.01	0.1	1
Pt - Transmit Power Level	dBm	0.0	10.0	20.0	30.0
Date Rate	Mb/sec	1.8	1.8	1.8	1.8
Spectral Efficiency	bps/Hz	1.0	1.0	1.0	1.0
BW - Transmitted Bandwidth	MHz	1.8	1.8	1.8	1.8
Transmit Spectral Density	dBm/Hz	-62.4	-52.4	-42.4	-32.4
kT - Thermal Noise Density	dBm/Hz	-174.0	-174.0	-174.0	-174.0
NF - Receiver Noise Figure	dB	5.0	5.0	5.0	5.0
N - Receiver Noise Density	dBm/Hz	-169.0	-169.0	-169.0	-169.0
I/N - Maximum Interference to Noise Ratio	dB	0.0	0.0	0.0	0.0
Minimum Propagation Loss	dB	106.6	116.6	126.6	136.6
Building Penetration Loss	dB	10.0	10.0	10.0	10.0
Minimum Propagation Loss (Not Including Building)	dB	96.6	106.6	116.6	126.6

Table 7 shows the required propagation loss between a 25 kHz bandwidth Non-cooperative transmitters and a typical victim receiver. For example, if the Non-cooperative transmit power level is 1 W, there needs to be 156.6 dB of propagation loss to the victim receiver. If the Non-cooperative system is indoors, then there needs to be approximately 146.6 of propagation loss.

Table 7 Interference Link Analysis – Non-cooperative Transmitted Power Density Equaling Victim Receiver Noise Level

		Non-cooperative Transmit Power Level			
		Pt=10 mW	Pt=100 mW	Pt=5 W	Pt=45 W
Pt - Transmit Power Level	Watts	0.01	0.1	5	45
Pt - Transmit Power Level	dBm	10.0	20.0	37.0	46.5
Date Rate	Mb/sec	1.8	1.8	1.8	1.8
Spectral Efficiency	bps/Hz	1.0	1.0	1.0	1.0
BW - Transmitted Bandwidth	MHz	0.0	0.0	0.0	0.0
Transmit Spectral Density	dBm/Hz	-33.0	-23.0	-6.0	3.5
kT - Thermal Noise Density	dBm/Hz	-174.0	-174.0	-174.0	-174.0
NF - Receiver Noise Figure	dB	5.0	5.0	5.0	5.0
N - Receiver Noise Density	dBm/Hz	-169.0	-169.0	-169.0	-169.0
I/N - Maximum Interference to Noise Ratio	dB	0.0	0.0	0.0	0.0
Minimum Propagation Loss	dB	136.0	146.0	163.0	172.5
Building Penetration Loss	dB	10.0	10.0	10.0	10.0
Minimum Propagation Loss (Not Including Building)	dB	126.0	136.0	153.0	162.5

15.6 Propagation Analysis

In this section, we estimate the minimum separation between the XG transceivers and the potential victim receivers, and the minimum separation between the Non-cooperative transceivers and the potential victim receivers. This analysis assumes that the Dynamic Spectrum Sharing technology is not being used. In these initial XG demonstrations we are designing the tests so that even in this situation, the chance for interference is low.

The worst case analysis is the free space propagation loss, where there are no obstacles. Figure 4 shows the predicted free space propagation loss at 400 MHz versus distance. To obtain the 116 dB propagation loss described above, a separation distance of 38 km is required.

$$L\ (dB) = -20 * \log10(\lambda/(4*\pi*d))$$

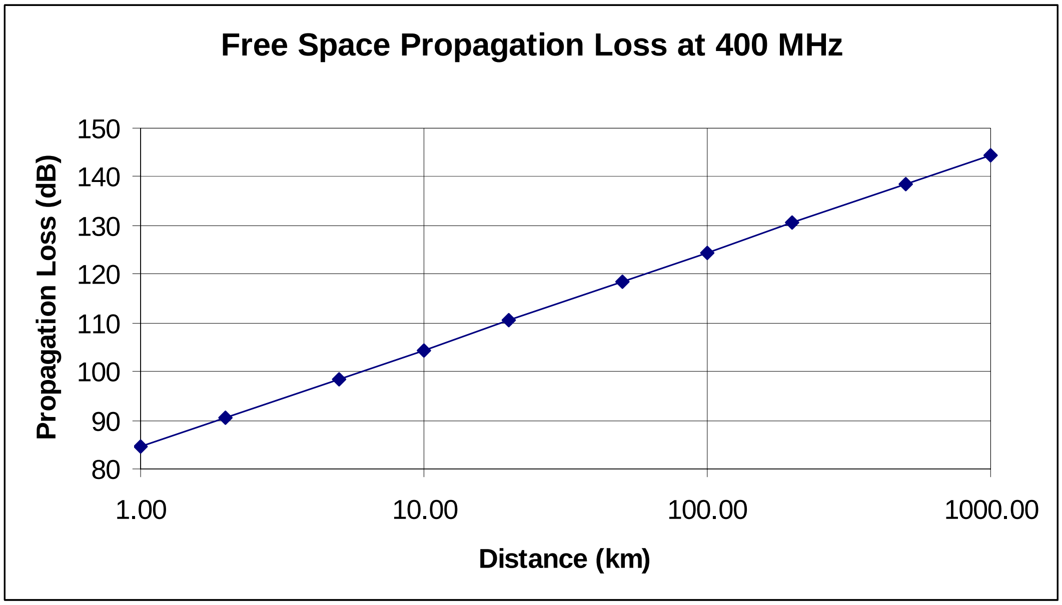


Figure 4 Predicted Free Space propagation loss at 400 MHz versus distance.

A more typical case is where there are obstacles along the signal path. Figure 5 shows a plot of propagation loss values versus distance from an empirical propagation model.. The analysis used a frequency of 500 MHz, a 3 meter antenna height and a 10 m height at the potential victim.

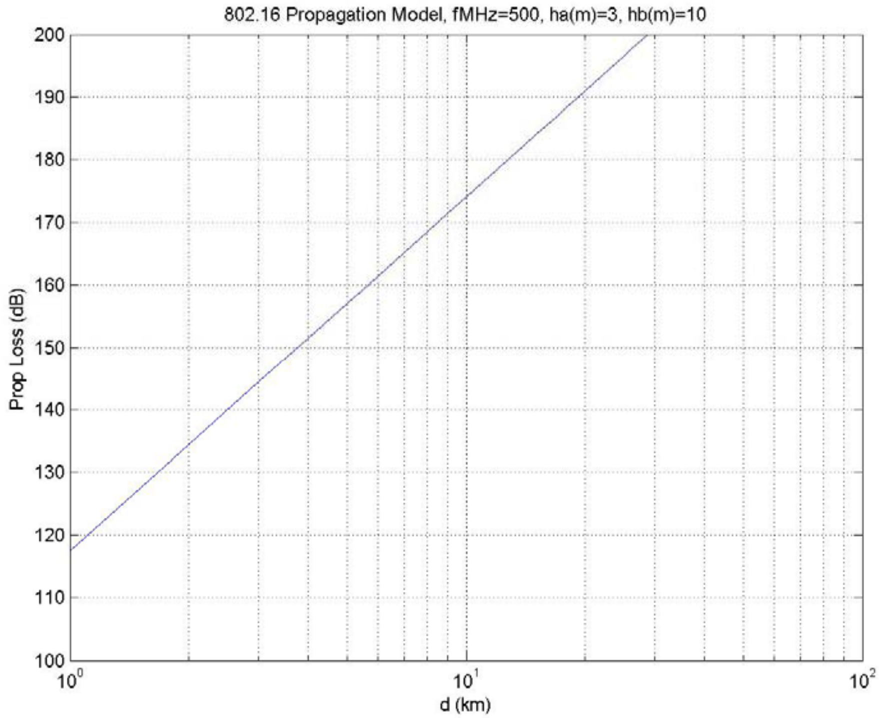


Figure 5 Propagation loss versus frequency with obstacles using the IEEE 802.16 propagation model (500 MHz, 3 transmitter height, and 10 meter receiver height).

Table 8 shows a summary of the distances between the XG and Non-cooperative transmitters and an existing receiver to avoid interference. The Free Space minimum separation distances are not relevant in most cases since the XG antennas will be a low heights and the test locations will not use elevated locations. Generally, the minimum separation distances using the 802.16 propagation model (which considers typical obstacles) are relevant.

Table 8 XG/Non-Cooperative Transmitters to Potential Victim Separation Distances

Transmitter Type	Transmit Power Level	Indoor / Outdoor	Minimum Propagation Loss (dB)	Minimum Separation Assuming Free Space Loss (km)	Minimum Separation Assuming 802.16 Prop Model Loss (km)
XG	100 mW	Indoor	117	41	1
XG	1 W	Outdoor	137	410	2.5
Non-Cooperative	100 mW	Indoor	136	380	2.4
Non-Cooperative	5 W	Outdoor	152	2200	5