HWG | HARRIS, WILTSHIRE & GRANNIS LLP

October 3, 2019

Ex Parte

Marlene Dortch, Secretary
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Re: *Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295; *Expanding Flexible Use in Mid-Band Spectrum between 3.7 and 24 GHz*, GN Docket No. 17-183

Dear Ms. Dortch:

On October 1, 2019, Chuck Lukaszewski of Hewlett Packard Enterprise ("HPE"); Michael Ghorbanzadeh and Kurt Schaubach of Federated Wireless; Steven Rowings of Akin Gump Strauss Hauer & Feld LLP, counsel to Federated Wireless; Joely Denkinger of Harris, Wiltshire & Grannis LLP; and I met with FCC Office of Engineering and Technology staff Julius Knapp, Aspa Paroutsas, Bahman Badipour, Barbara Pavon, Hugh Van Tuyl, Ira Keltz, Karen Rackley, Michael Ha, Navid Golshahi, Nicholas Oros, and Paul Murray.

In the meeting, we discussed the attached presentation addressing an Automated Frequency Coordination ("AFC") prototype that will allow standard-power unlicensed radio local area network ("RLAN") deployments in the 6 GHz band to operate while providing robust protection to incumbent licensees. To illustrate the findings described in this presentation, we provided an interactive demonstration of this AFC prototype, as illustrated in the attached materials. The demonstration confirmed that an AFC system can provide real-time authorization for RLAN operators while applying conservative fixed service ("FS") protection criteria. Mr. Lukaszewski also reiterated HPE's position on the importance of multiple RLAN device classes.

Pursuant to the FCC's rules, I have filed a copy of this notice electronically in the above referenced dockets. If you require any additional information, please contact the undersigned.

Sincerely,

Paul Margie
Counsel to Hewlett Packard Enterprise

Enclosures
cc: Meeting Participants

ATTACHMENT

Automated Frequency Coordination (AFC) Prototype Demonstration

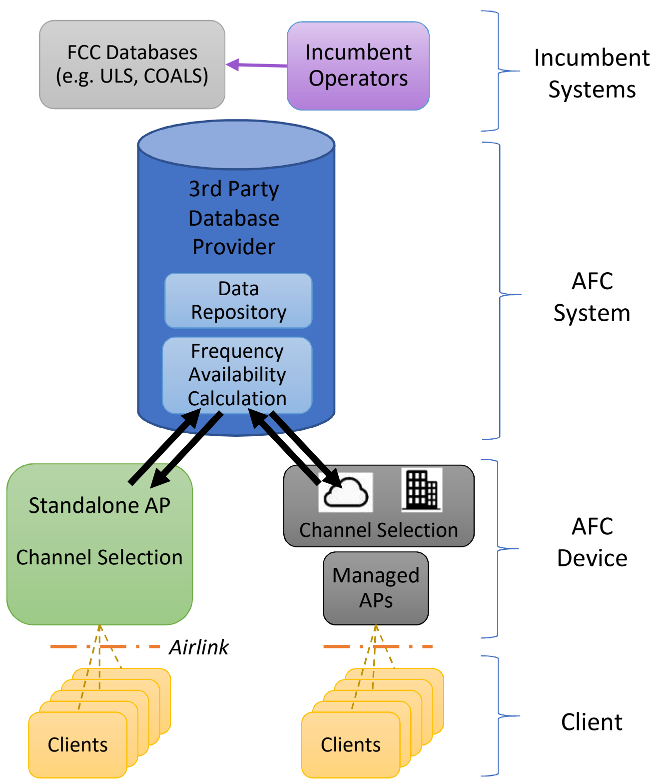
October 1, 2019

AFC Prototype Motivations

Prototype development and validation underway for 12 months

- Demonstrate the efficacy of database-enabled sharing for 6 GHz RLANs
  - Efficacy of using FCC databases, such as ULS, as global ground truth
  - Simplicity and precision of exclusion zone-based incumbent protection
  - Flexibility to update fixed service registrations, protection criteria, etc.
- Demonstrate simplicity and responsiveness of a cloud-based AFC
  - RLAN access enabled through a lightweight & secure API accessed via a public Internet connection
  - AFC interactions similar to functions already performed by commercial RLAN devices (e.g., a software or firmware update)
- Demonstrate AFC technical development is ready to proceed to standardization and multistakeholder alignment
- Enable performance vs. complexity studies of AFC algorithms and interfaces
- Enable studies of spectrum availability under different operating assumptions

AFC Prototype Architecture/Functionality



Functional Architecture of Cloud-based AFC

- AFC database populated with I/N protection contours for each 6 GHz incumbent
  - Incumbents extracted from FCC ULS & COALS
  - Terrain-aware contours created using RLAN Group propagation model[1] and standard incumbent receiver antenna patterns (e.g., F.1245, UHX12, UHX6)
- RLAN uses encrypted REST API for channel availability requests to AFC
  - Request includes RLAN 3D position/uncertainty, EIRP, and cell edge RSL
- AFC computes RLAN service area (RSA) and I/N contours overlapping RSA
  - REST API used to inform RLAN of spectrum availability with 1 MHz granularity

[1] *https://ecfsapi.fcc.gov/file/10216633127609/6%20GHz%20RLAN%20Group%20Comments%20(Feb%2015%202019).pdf at 43-44*.

AFC Theory of Operations

Single user protection-based AFC

- The AFC calculates a protection area around every incumbent receiver based on licensee data in the FCC's Universal Licensing System (ULS) and RLAN operating data including its 3D position and effective EIRP
- The AFC protects against interference from clients of an RLAN by calculating an RLAN service area (RSA)
- An RSA contour is determined by the limit at which a client can receive control signals from its serving AP
- Permissible RLAN operating frequencies are those where the RSA does not collide with any incumbent user contour

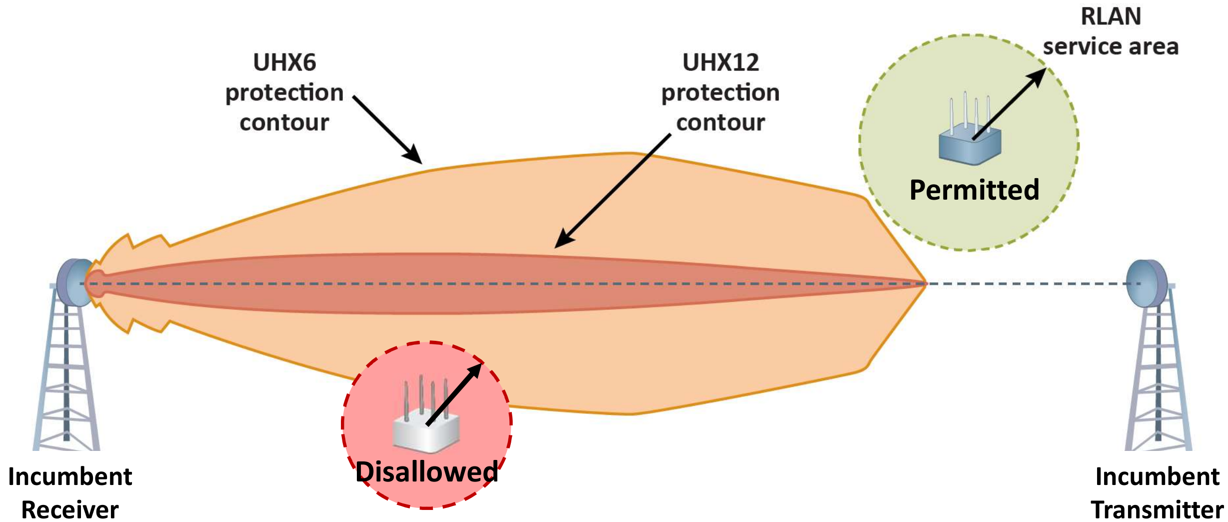


Illustration of computed contours for an incumbent user and RLAN devices

Determining Effective RLAN EIRP

- The "Effective" EIRP of the RLAN determines both the selected incumbent protection contour and the RSA contour
- $EIRP_{eff}$ is the net RLAN energy emitted in the direction of the incumbent receiver, expressed in dBm/MHz
- This includes both "global" losses applied across the board, and scenario-specific losses

$$EIRP_{eff} = EIRP_{1MHz} - Loss_{Global} - Loss_{Scenario}$$

$EIRP_{1MHz}$

- Calculated as:
- $EIRP_{\mathrm{RLAN}} - 10\log(\frac{Bandwidth}{1\ MHz})$
- E.g. for 4W EIRP in 80 MHz channel:
  - 36 – 10 log (80/1) = 36 – 19 = 14

***$Loss_{Global}$**

- Polarization: 3 dB
- FS Feeder: 2 dB

***$Loss_{Scenario}$**

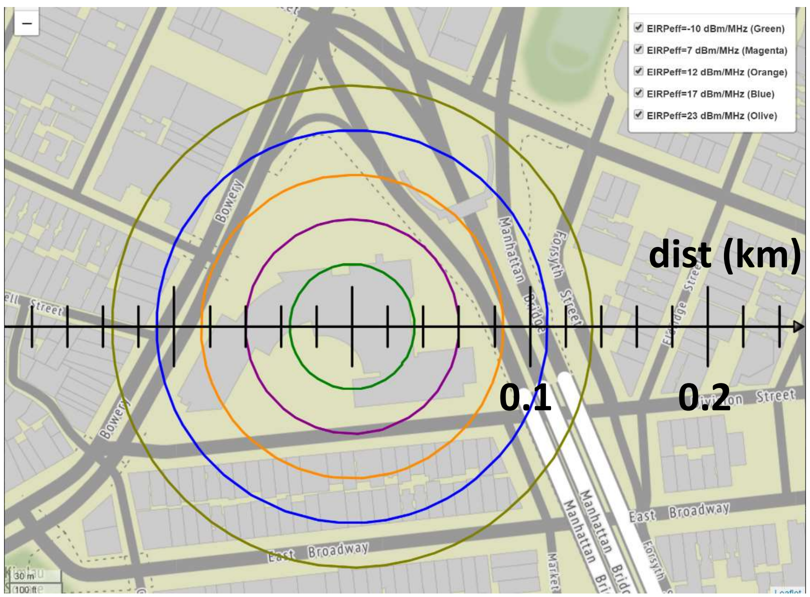
- Building Entry Loss: *Variable*
- Body Loss: 4 dB
- RLAN Antenna Mismatch: *Variable*

* For the AFC prototype, these values are summed and entered as a single loss value

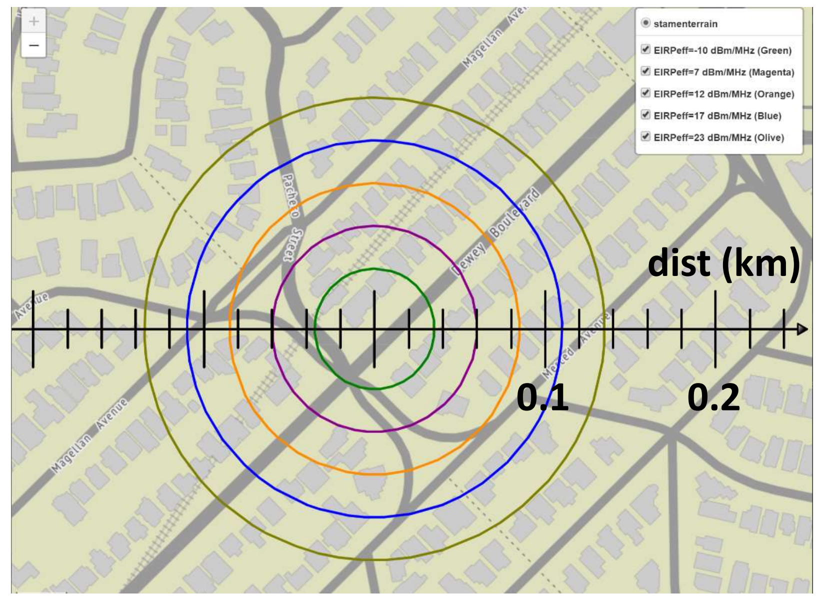
RLAN Service Area Contours

Urban/Suburban - Dominated by Winner II, resulting in circular RSAs for most EIRP

New York



San Francisco

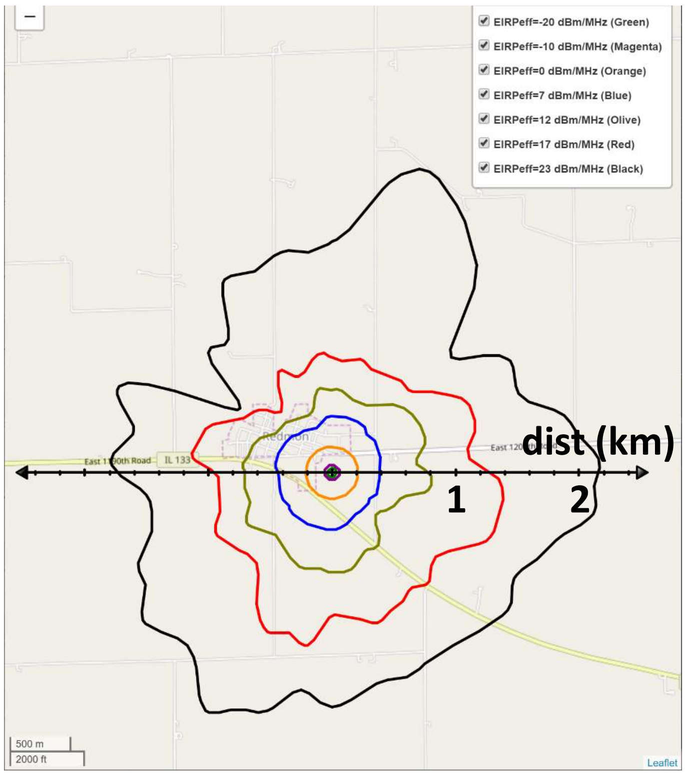


Representative computations of RLAN Service Areas for different RLAN EIRPs (dBm/MHz)

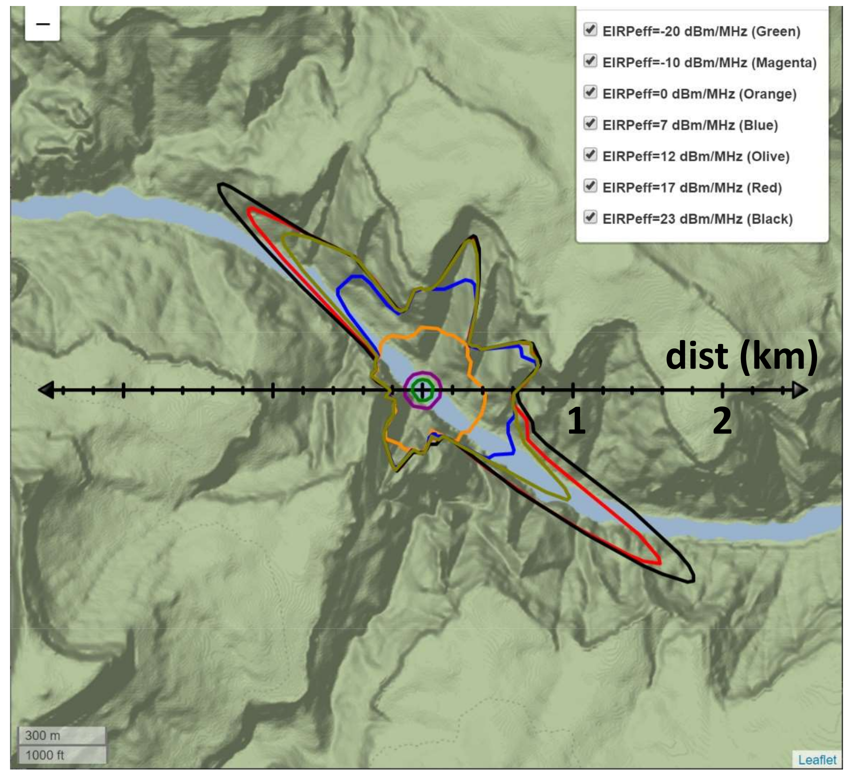
RLAN Service Area Contours

Rural – P.452, dependent on terrain

Redmon, Illinois



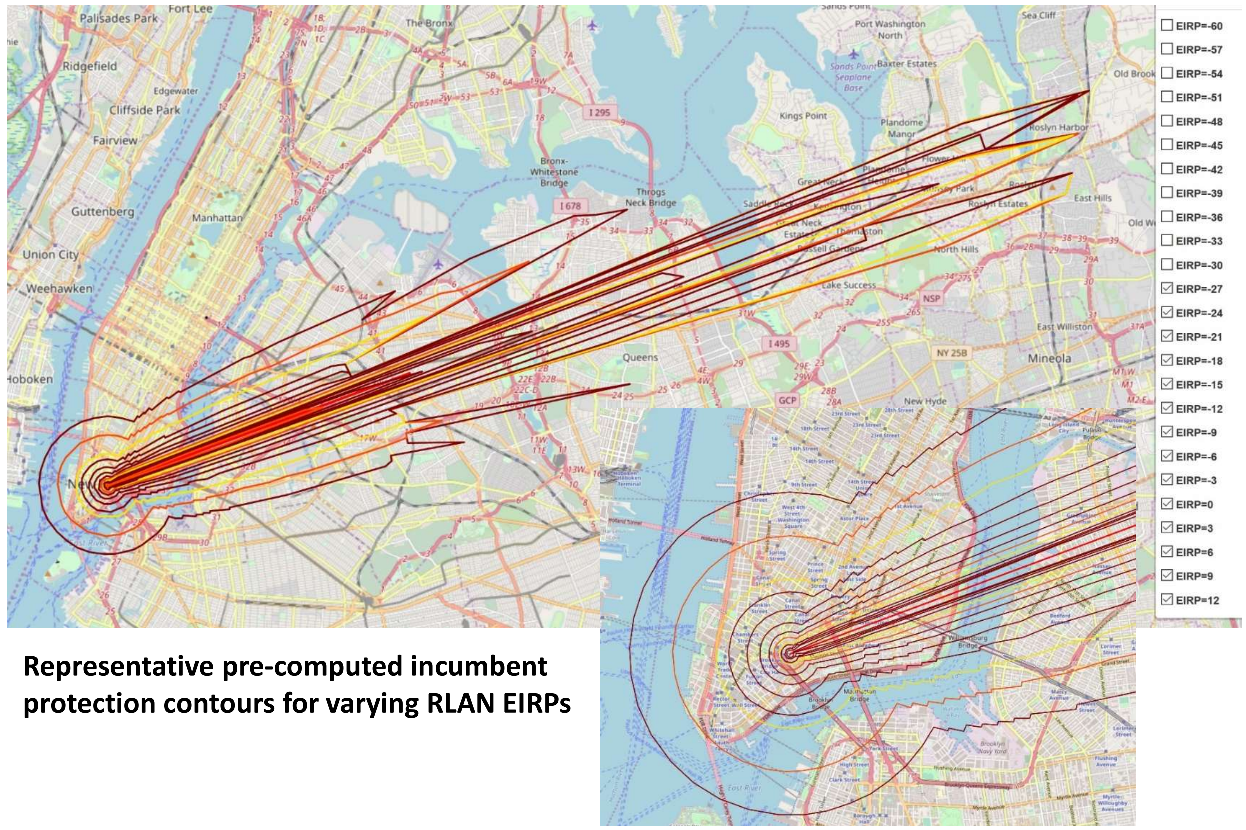
Grand Canyon



Representative computations of RLAN Service Areas for different RLAN EIRPs (dBm/MHz)

Precalculated Library of Incumbent Protection Contours Developed for AFC Prototype

- Precalculated terrain-aware patterns for each of ~100,000 incumbent receivers in ULS
- Each incumbent receiver has 675 stored contours:
  - 25 RLAN EIRP$_{eff}$ values in 3 dB steps
  - 3 elevations (3m, 100m, 200m)
  - 3 antenna patterns (UHX12, UHX6, F.1245)
  - 3 land categories (Urban, Suburban, Rural)
- Library size is roughly 100K * 25 * 3 * 3 *3 = 67.5 million contours



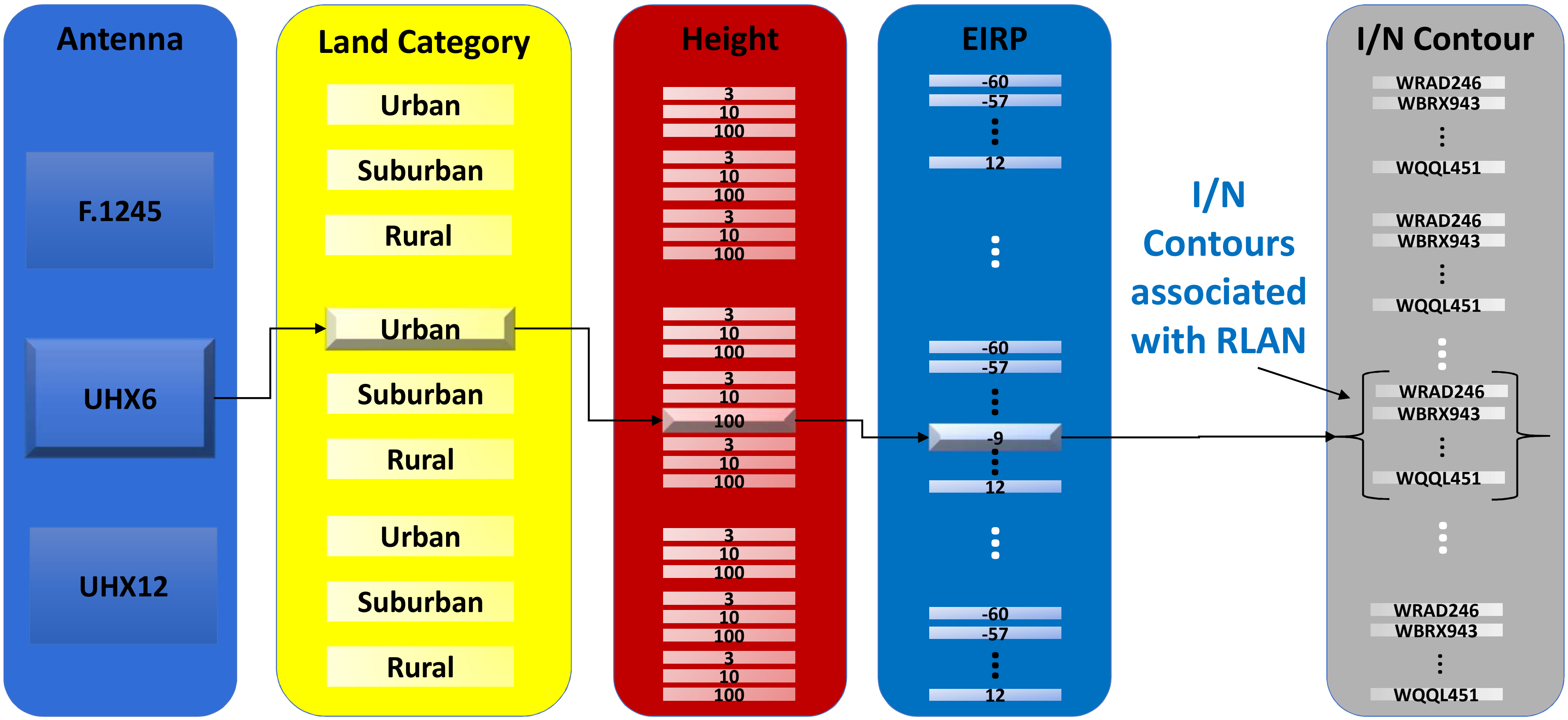
Representative pre-computed incumbent protection contours for varying RLAN EIRPs

A production AFC will have more granular EIRP and elevations and use actual FS antenna patterns.

Rapid Queries of Large I/N Contour Database

Hierarchical partitioning allows scaling and rapid parsing of very large I/N contour database

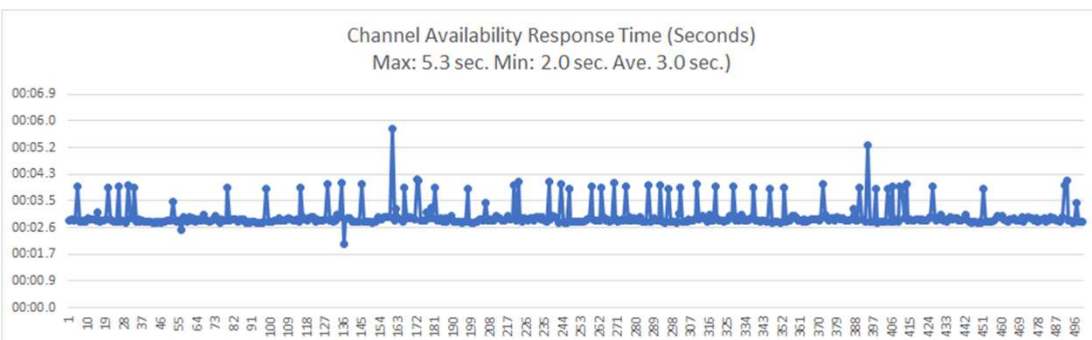
Example: Incumbent with UHX6 antenna and -9 dBm RLAN with height 100m in urban area:



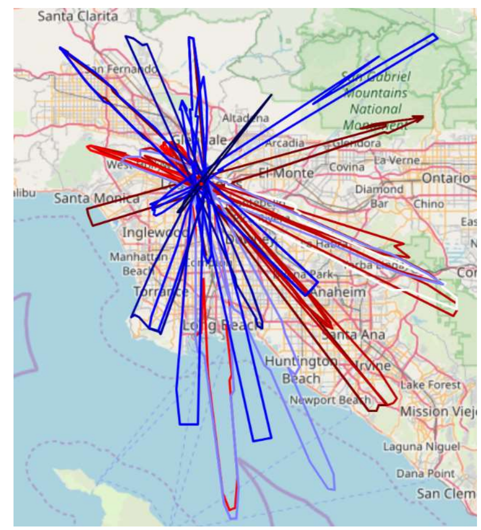
AFC Prototype Demonstrates Fast Response Times for the Most Complex Incumbent Geographies

Further improvements can be achieved in production system

- Processing time dominated by ***RLAN service area calculation*** and ***I/N contour intersection***
- RSA calculation time varies little with location, requiring ~2-3 seconds
- I/N contour intersection calculation depends on number of incumbents near RLAN
  - Typically 1 second or less
- Some jitter due to REST API, message handling, …
  - Max channel availability response time in current implementation ~15 seconds
- Example with large number of incumbents: Los Angeles



Profiling of AFC channel availability response time



Incumbent protection scenario used for AFC response time profiling

Collision Analysis & Spectrum Availability Determination

- The AFC identifies the appropriate incumbent contour set based on antenna pattern, EIRP$_{eff}$, elevation (plus vertical uncertainty) and other input parameters
- The AFC computes the RLAN service area and adds horizontal and vertical uncertainty
- The AFC retrieves the incumbent contour set from its datastore to determine which contours overlap the RSA. Any overlap results in that incumbent receiver being protected by the AFC.
- While both shapes depend on EIRP$_{eff}$, they are independently calculated and have no dependency.
- After all incumbent receivers have been evaluated, the AFC returns a list of available spectrum (if there is any)

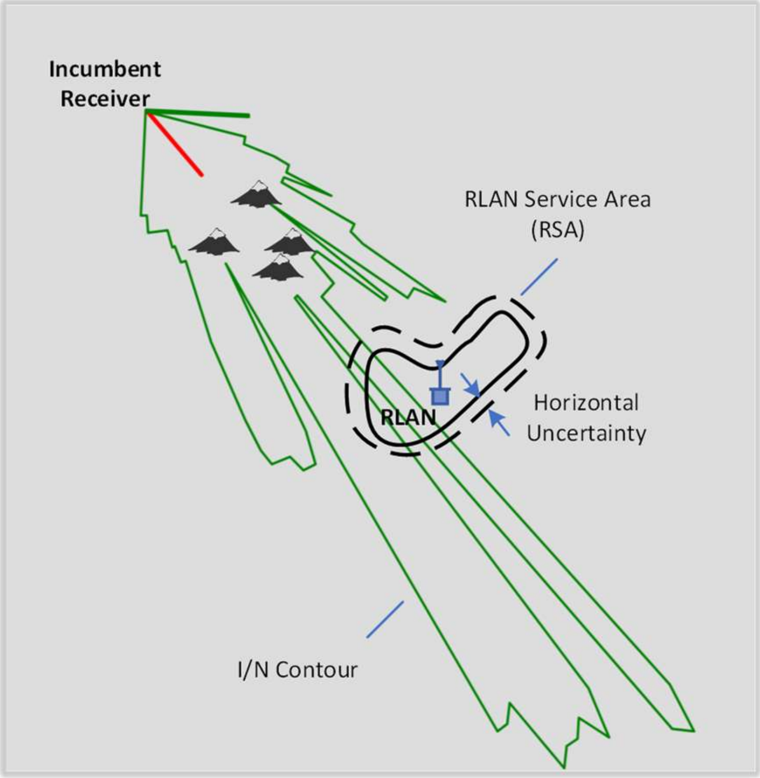


Illustration of application of horizontal location uncertainty in RLAN Service Area computation

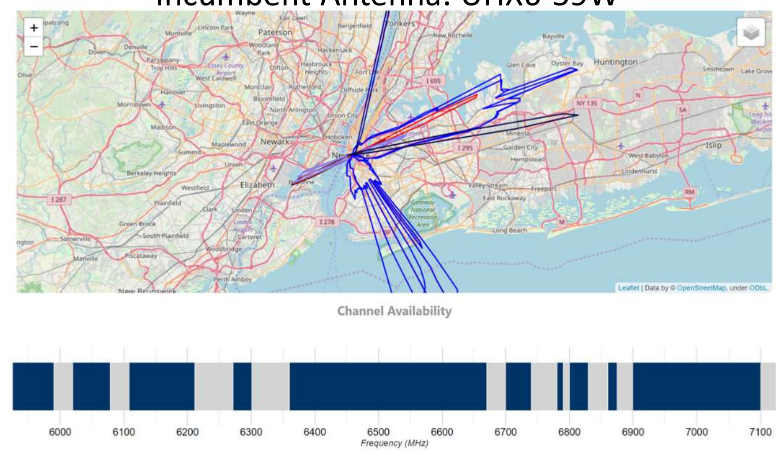
Spectrum Availability Analysis Example

Incumbent antenna pattern impact on spectrum availability

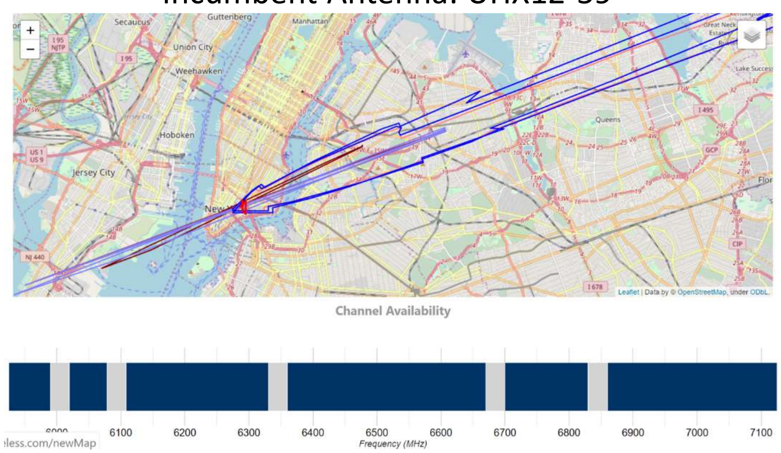
# RLAN Parameters
Latitude = 40.7147
Longitude = -73.99587
HorUncertainty = 10 m
VerUncertainty = 3 m
CellEdgeRSL = -95 dBm/MHz
EIRP = 17 dBm / MHz
Height = 3 m
BuildingEntryLoss = 0 dB

# I/N Parameters
ProtectionCriteria = -6 dB

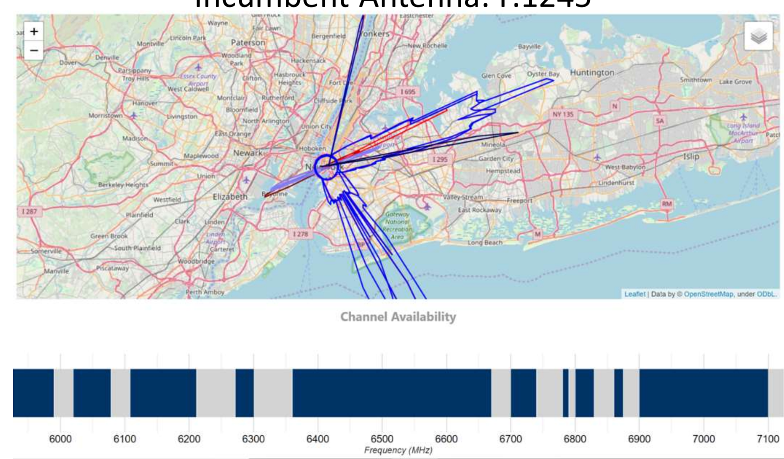
Incumbent Antenna: UHX6-59W



Incumbent Antenna: UHX12-59



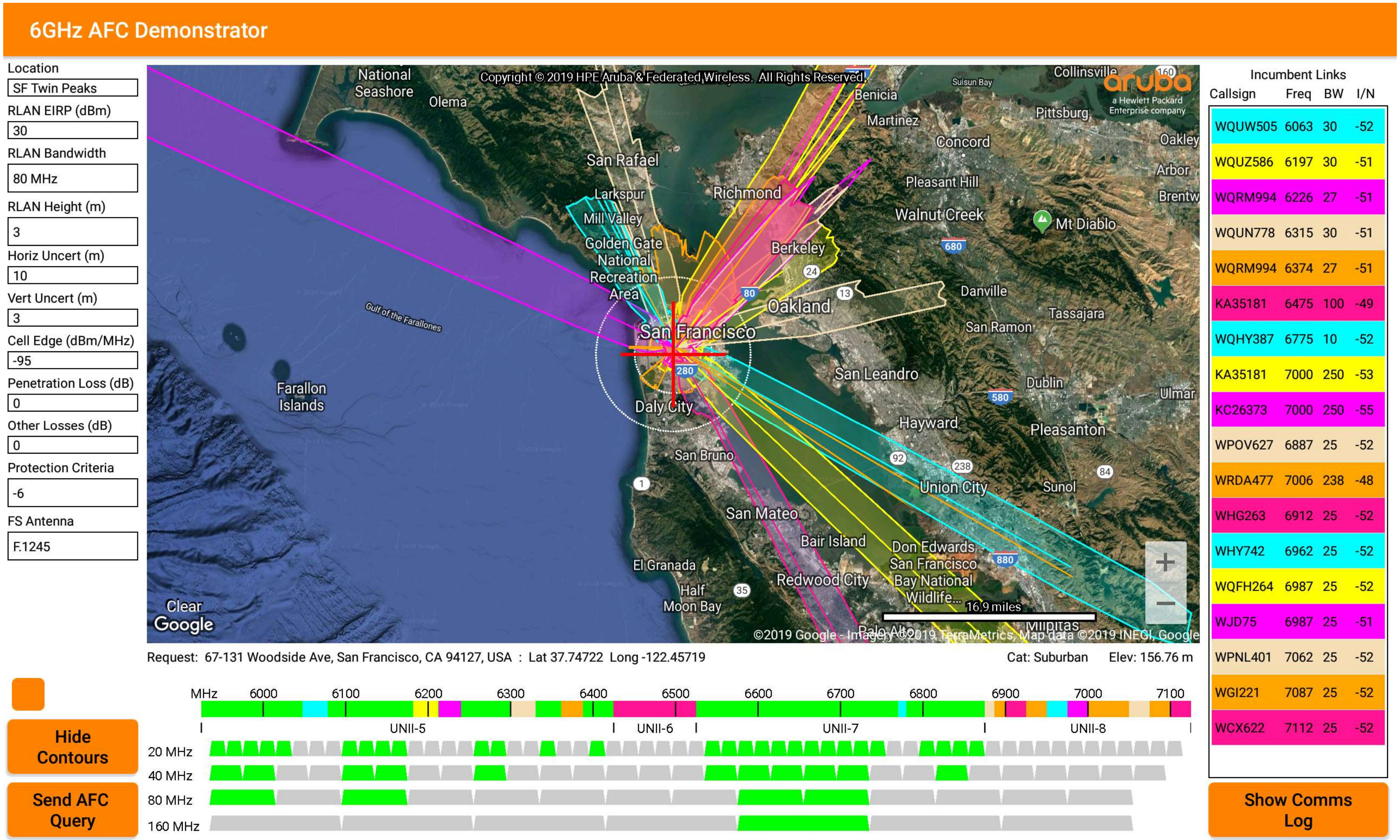
Incumbent Antenna: F.1245



Sample AFC spectrum availability analysis results for different incumbent antenna masks (available spectrum shown in blue)

Example: New York City

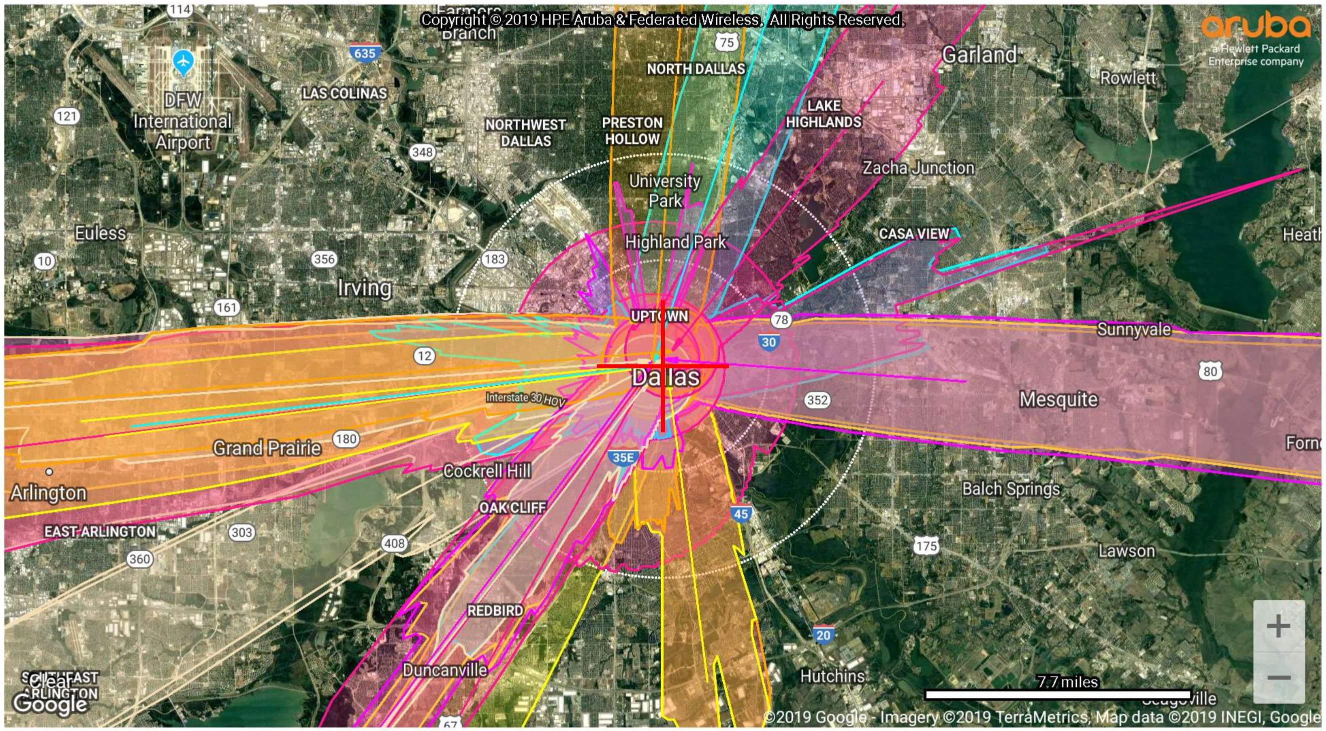
Example: San Francisco



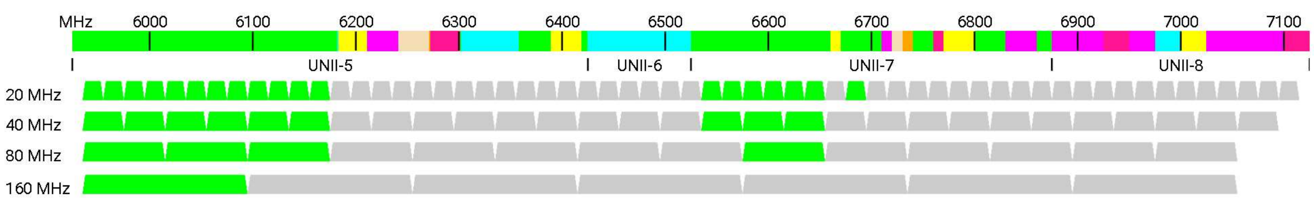
Example: Dallas

6GHz AFC Demonstrator

Location	TX DFW 1
RLAN EIRP (dBm)	30
RLAN Bandwidth	80 MHz
RLAN Height (m)	3
Horiz Uncert (m)	10
Vert Uncert (m)	3
Cell Edge (dBm/MHz)	-95
Penetration Loss (dB)	0
Other Losses (dB)	0
Protection Criteria	-6
FS Antenna	F.1245



Request: 1417 Commerce St, Dallas, TX 75201, USA : Lat 32.78028 Long -96.79869 Cat: Urban Elev: 132.41 m



Hide Contours

Send AFC Query

Incumbent Links

Callsign	Freq	BW	I/N
WED400	6197	30	-40
WQUY451	6197	28	-40
WED398	6226	30	-40
WPXA458	6256	30	-32
WED398	6286	30	-40
WQUY451	6286	28	-31
WQUY414	6330	56	-41
WQHP903	6404	30	-33
KC25013	6475	100	-38
KA59090	6475	100	-41
KA74840	6475	100	-38
KC25013	6475	100	-39
WPYT430	6475	100	-34
WED398	6665	10	-41
WPWZ943	6725	30	-32
WPXA458	6725	10	-33
WPWZ943	6735	10	-33
WED400	6765	10	-41
WPWZ943	6785	30	-32

Show Comms Log

Example: Washington, D.C.

6GHz AFC Demonstrator

Location
DC FCC Building 100r

RLAN EIRP (dBm)
20

RLAN Bandwidth
80 MHz

RLAN Height (m)
100

Horiz Uncert (m)
10

Vert Uncert (m)
3

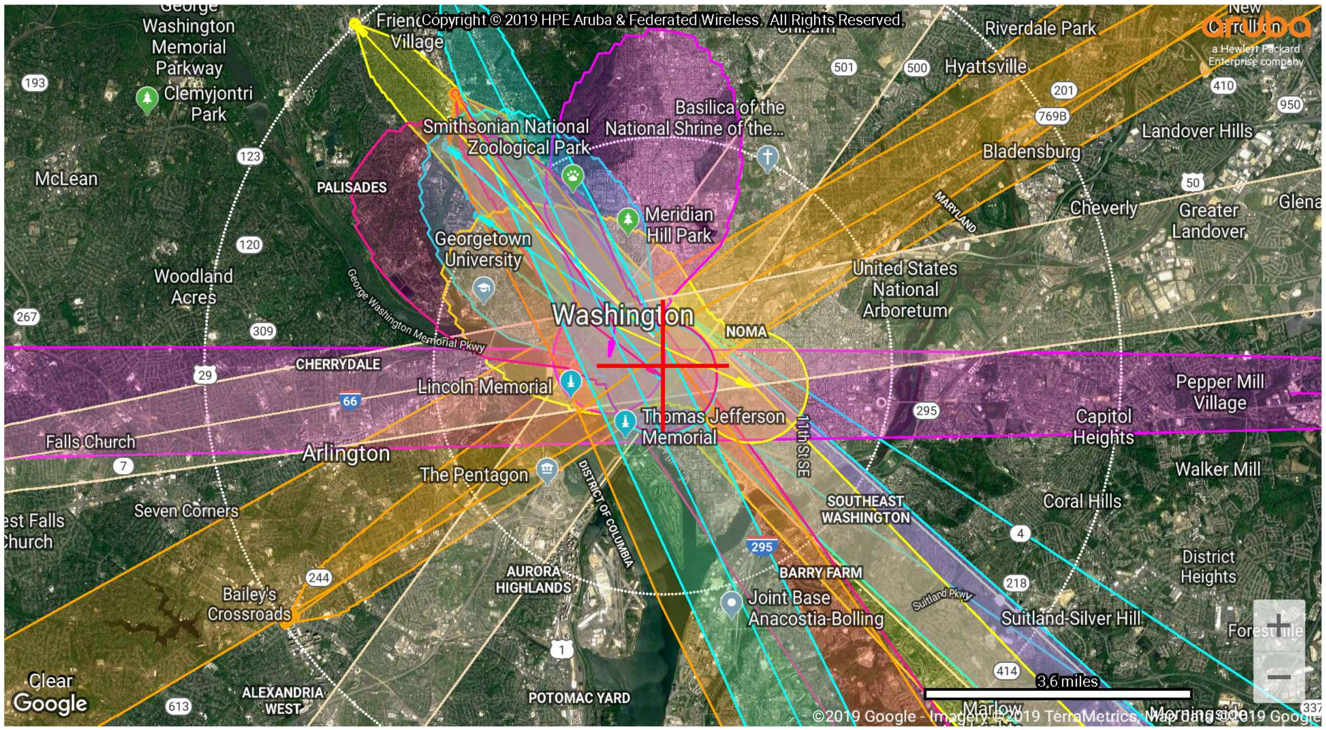
Cell Edge (dBm/MHz)
-95

Penetration Loss (dB)
0

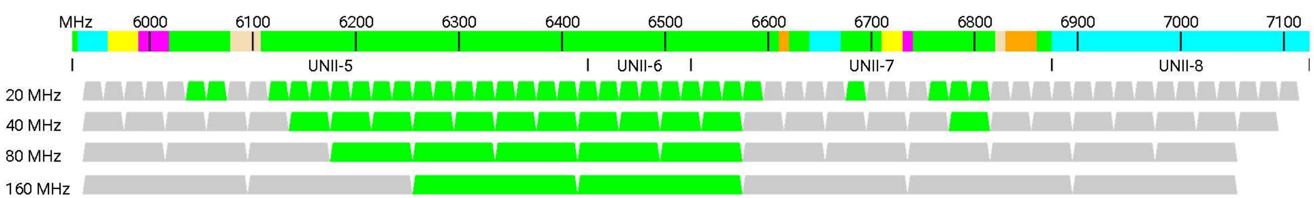
Other Losses (dB)
0

Protection Criteria
-6

FS Antenna
F.1245



Request: 555 12th St NW, Washington, DC 20004, USA : Lat 38.89687 Long -77.02711 Cat: Urban Elev: 7.69 m



Hide Contours

Send AFC Query

Incumbent Links

Callsign	Freq	BW	I/N
WQVA547	5945	30	-1
WQOD499	5974	30	2
WQOD499	6004	30	2
WQOX982	6093	30	4
WQVB790	6615	10	11
WQNJ727	6655	30	2
WQOD499	6655	30	2
WQQM525	6725	30	12
WNTJ339	6735	10	2
WPYK539	6825	10	6
WQPG539	6845	30	4
KK4462	7000	250	1
KK4462	7000	250	-26
KK4462	7000	250	-0
KK4462	7000	250	-10
KA4515	7000	250	3
WQOY796	7000	250	-4
WQOY796	7000	250	-22
WPQT500	7000	250	-7

Show Comms Log

Example: Grand Canyon