Protecting Grandfathered Wireless Services

CBRS Method of Procedure

Supplement to the Key Bridge Proposal
to Administer a Spectrum Access System

Key Bridge LLC

Jesse Caulfield, CEO

1750 Tysons Blvd., Suite 1500
McLean, VA 22102
Phone: +1 (703) 542-4140
http://keybridgewireless.com

Document Information

Document Status	Public
Version	1.0.0
Date Printed	September 27, 2016
Copyright	© 2016 Key Bridge LLC. All Rights Reserved

1 Introduction

On August 19, 2016 the Wireless Telecommunications Bureau released a Public Notice establishing the final methodology for determining and protecting Grandfathered Wireless Broadband Services.[1] This guidance follows, supplements and clarifies methods and concepts previously discussed in the Commission's request for comment.[2]

This document describes a method of procedure to implement protection of Grandfathered Wireless Broadband Services in a Spectrum Access System.

2 Method of Procedure

A SAS protects Grandfathered Wireless Broadband Services (WBS) locations in the 3,650 – 3,700 MHz band by adjusting CBSD transmit power in a manner consistent with the Commission's rules and implemented according to the following procedure, which implements a standard point-to-area path loss analysis to compute received interference power levels at the edge of, and also within, a computed WBS Protection Zone.[3] The procedure includes the following steps:

1. Identify candidate WBS stations
2. Calculate WBS protection zones
3. Identify candidate CBSDs
4. Calculate specific received interference power level
5. Calculate aggregate received interference power level
6. Implement interference mediation techniques (if required)

2.1 Identify candidate WBS stations

Candidate WBS service records are identified in the ULS database as having the radio service code "NN" and may be retrieved according to the following filter selection:

- Table HD: the *license_status* field is "A"
- Table HD: the *grant_date* field is after April 17, 2016

1 *Wireless Telecommunications Bureau and Office of Engineering and Technology Announce Methodology for Determining the Protected Contours for Grandfathered 3650-3700 MHz Band Licensees*, DA 16-946, GN Docket No. 12-354, Public Notice, (*Grandfathered Licensee Methodology PN*).

2 *Wireless Telecommunications Bureau Seeks Comment on an Appropriate Method for Determining the Protected Contours for Grandfathered 3650-3700 MHz Band*, GN Docket No. 12-354, Public Notice, DA 15-1208 (*Grandfathered Licensee Comment PN*).

3 See *Grandfathered Licensee Methodology PN* at 10. "CBSDs must meet the aggregate power limit at any point within the Grandfathered Wireless Protection Zone and not simply along the edge of the contour."

- Table HD: the *radio_service_code* field is “NN”
- Table FR: the *frequency_assigned* field is between 3650 and 3700

Key Bridge already mirrors the entire FCC ULS database and recently updated our web services API to include a CBRS search resource to retrieve candidate WBS service records and to convert those records to our standardized WSIF data format. A sample screen shot of this API service is shown below in Illustration 1.

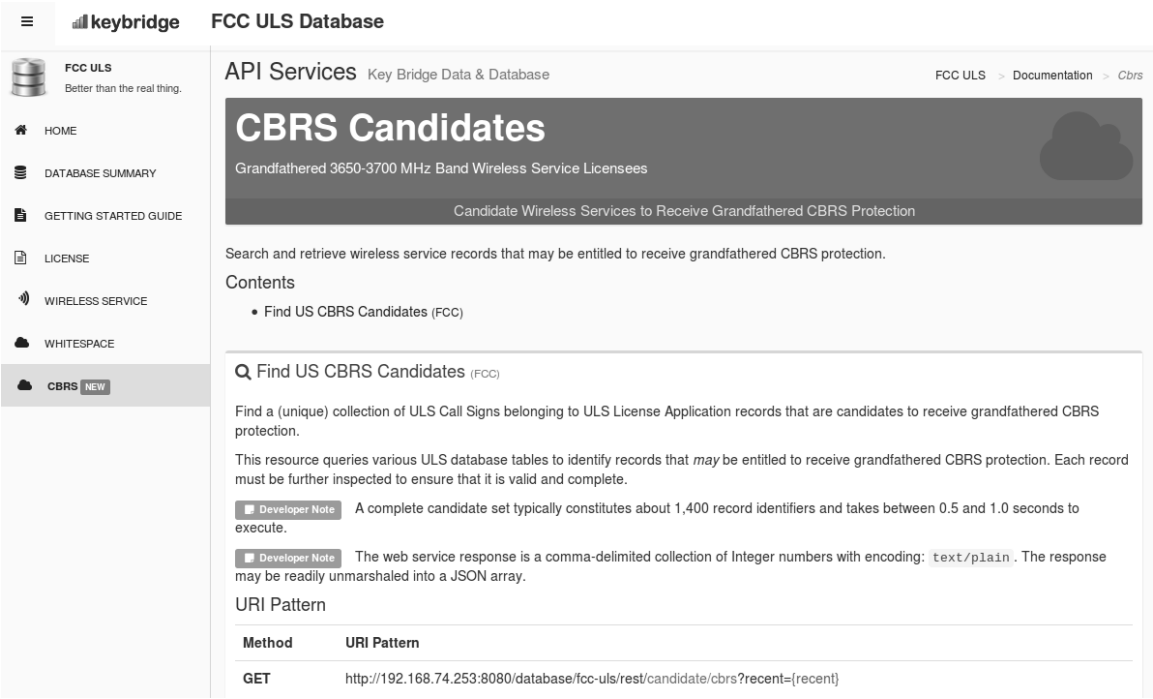

Illustration 1: The Key Bridge API for Candidate CBRS Records

This new query service, when combined with our Wireless Services converter, provides a ready solution to identify candidate records, to evaluate and confirm their validity, and to calculate WBS protection zones.

2.2 Calculate WBS protection zones

The Key Bridge SAS will implement the calculation of protection zones for Grandfathered Wireless Broadband Services according to the procedures identified in the Grandfathered Licensee Methodology PN and currently available information in the ULS database. Candidate WBS sector configurations may be retrieved from the ULS database as follows:

- Table AN: the *beamwidth* field indicates the sector width in degrees
- Table AN: the *azimuth* field indicates the antenna pointing angle

Presently (as of September 26, 2016) the ULS database does not record base station operating frequency or indicate whether a sector contains registered or unregistered CPE, or the CPE operating radius from the base station. As these fields becomes available the Key Bridge SAS will pick up and incorporate the information into WBS Protection Zone determination.

2.3 Identify candidate CBSDs

Using the methodology identification in Appendices A and B of the Grandfathered Licensee Methodology PN, the maximum effective range of a CBSD is estimated below.

CBSD Type	**Max EIRP (dBm)**	**Estimated Max Range (km)**
Category A	30	9.5
Category B	47	66.9

The estimated CBSD effective range is combined with the WBS protection zone contour to establish a new WBS Effective Zone within which a CBSD is potentially subject to interference mediation techniques. The WBS Effective Zone is the WBS Protection Zone buffered by the estimated CBSD maximum range. This concept is shown below in Illustration 2.

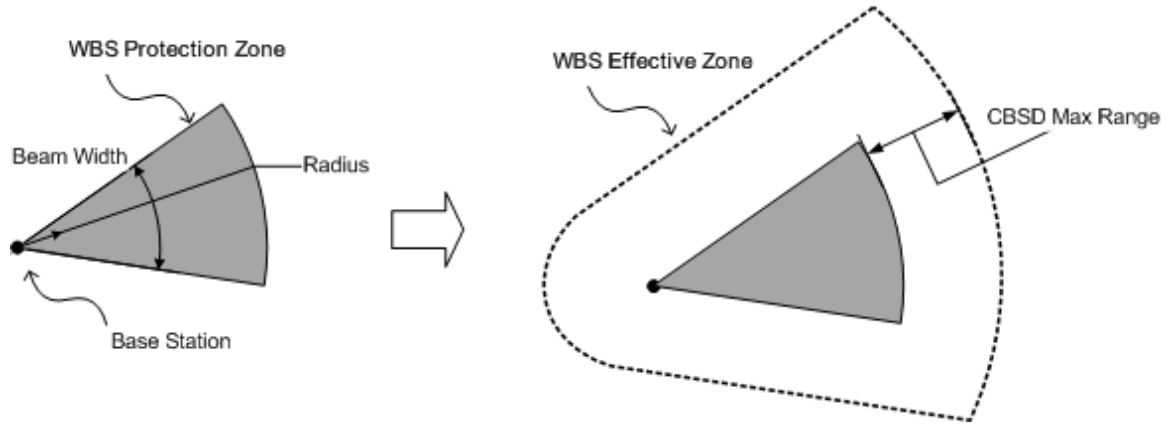

Illustration 2: WBS Effective Zone is the WBS Protection Zone, buffered.

Candidate CBRS devices are selected based upon their type and distance from a WBS Protection Zone. Candidate CBRS devices are identified when their position lies within a SAS-calculated WBS Effective Zone. The WBS Effective Zone is the WBS Protection Zone, buffered by the estimated maximum CBSD range identified in the table above.

2.4 Calculate specific received interference power level

The WBS received interference power level is calculated for each candidate CBSD using a point-to-area path loss calculation strategy, with the area of interest defined as the WBS Protection Zone

(inclusive of its border). The product of this calculation is a geo-referenced coverage grid of estimated received interference power level values. This concept is shown in Illustration 3, where a point-to-area calculation estimates the received interference power level within the WBS Protected Zone. The complete point-to-area calculation is shown in grey tones for context.

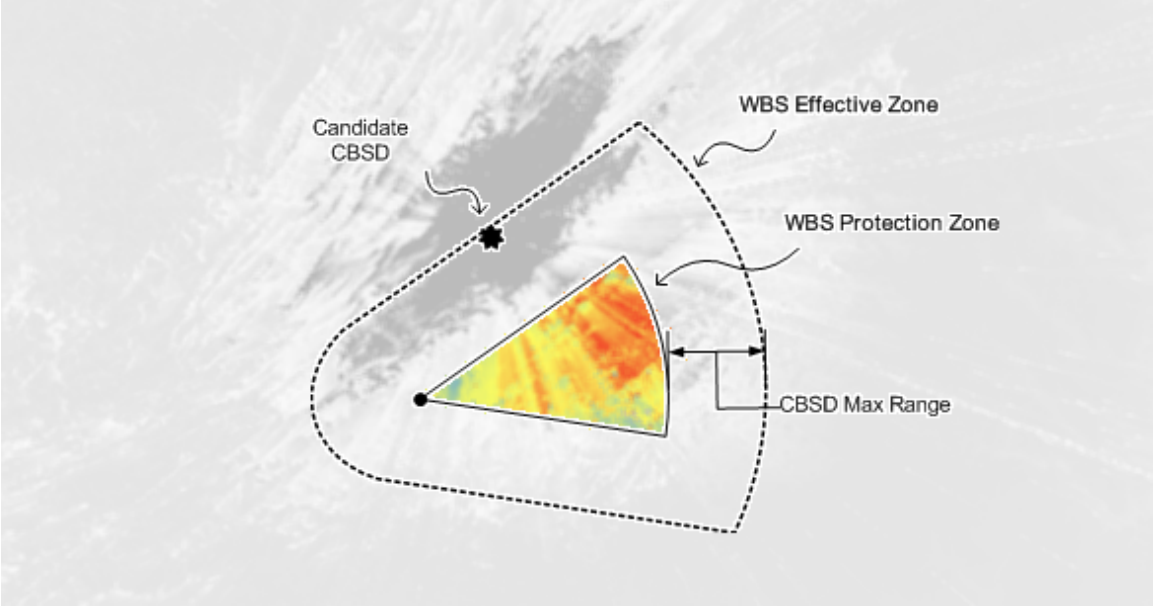

Illustration 3: Point-to-area estimate of CBSD received interference power level.

Each cell within the WBS Protection Zone coverage grid identifies the received interference power level, in dBW, from the candidate CBSD at the cell's geographic position.

2.5 Calculate aggregate received interference power level

The model first calculates the received interference signal level for each CBSD device using the procedure described in Section 2.4. The result is a collection of geo-referenced coverage grids (i.e. Tiles) associated with the responsible CBSD.

The aggregate received interference power level (in dBW) from the set of candidate CBSDs is calculated on a cell-by-cell basis for each cell within the WBS Protection Zone by summing each geo-referenced grid coverage calculated in Section 2.4. This concept is shown in Illustration 1, where any number of CBSD tiles may be overlaid.

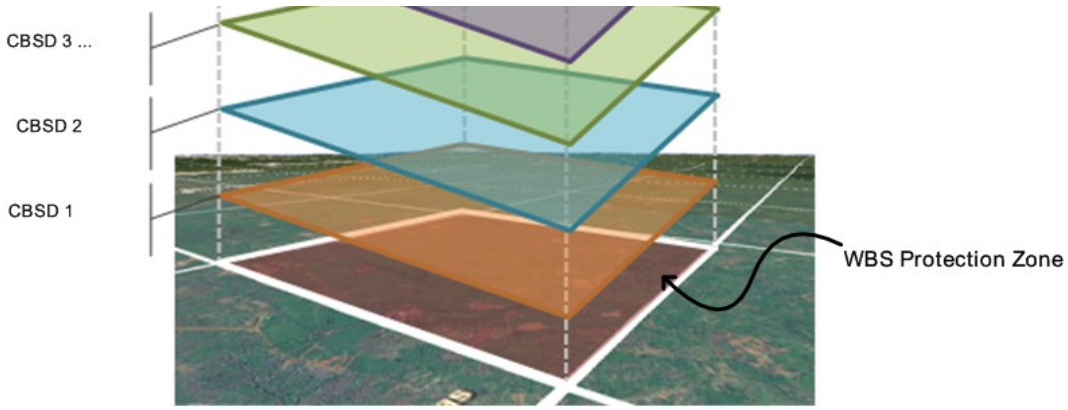

Illustration 4: Aggregate received interference power is the sum of each tile.

Each cell within the summed coverage grid identifies the aggregate received interference power level, in dBW, at the cell's respective geographic position.

2.6 Implement interference mediation techniques (if required)

Interference mediation techniques are implemented by the CBSD controlling / responsible SAS.

If any cell in the WBS receives a interference power level from a single CBSD calculated in Step 4 is above the thresholds identified in the *Grandfathered Licensee Methodology PN* then the immediate CBSD will be instructed to reduce its transmission to an acceptable level, to change its operating channel, or to cease operation.[4]

If the calculated aggregate received interference power level is above the thresholds identified in the *Grandfathered Licensee Methodology PN* then a aggregate CBSD power reduction technique will be effected.

Presently the Key Bridge SAS will implement the following iterative procedure to identify and reduce transmit power of the "most interfering" CBSDs. The procedure is repeated until the aggregate received interference power level is below the required thresholds as every point within the WBS Protection Zone. After executing each step the aggregate received interference power level is recalculated.

1. Calculate a normalized distribution of interfering CBSDs
2. Reduce the transmit power by 0.5 dB for the top 5% of CBSDs in the normalized distribution
3. Repeat at Step 1 until the aggregate received interference power level is acceptable for all grid coverage cells

4 See *Grandfathered Licensee Methodology PN* at 12. The "aggregate power of co-channel CBSDs must be no greater than -80 dBm/10 MHz at any point inside the Grandfathered Wireless Protected Zone."

2.6.1 Calculating the Normalized Distribution

Calculating the normalized distribution of CBSDs to receive interference mediation instruction from the SAS is implemented according to a “weighted influence” metric, determined as follows:

1. First, identify the average received interference power level across the entire WBS Protected Zone; this is the average aggregate received interference power level divided by the number of contributing CBSDs
2. Then, for each cell in a CBSD calculated coverage grid, sum the product of the difference above or below the average receive interference power level calculated in Step 1

The result is a single scalar value, centered on zero, that indicates the strength or weakness of the CBSD’s signal within the WBS Protection Zone relative to other CBSDs in the candidate set.

2.6.2 Other Fairness Algorithms

Other aggregate power reduction methods that include sophisticated ranking and fairness algorithms may be developed in the future by a multi-stakeholder body and/or recommended by the Commission. The Key Bridge SAS can readily accommodate other interference mediation techniques, and Key Bridge will implement these techniques as appropriate.

3 Discussion

3.1 Radiowave Propagation Loss

The model supports three similar options to compute the radiowave propagation loss, with selection based upon the preference of the implementor. These are, in order of preference:

1. ITU Recommendation P.2001-2
2. ITU Recommendation P.452-16
3. Irregular Terrain Model (ITM) (Longley-Rice)

The first (preferred) option is ITU-R P.2001-2, a general purpose, wide-range model for terrestrial propagation that predicts path loss due to both signal enhancements and fading. The model covers the frequency range from 30 MHz to 50 GHz, and distances from 3 km to at least 1 000 km.[5] P.2001-2 is a generalization of the path loss methodologies described in the P452-16 and ITM models.

5 See *P.2001 : A general purpose wide-range terrestrial propagation model in the frequency range 30 MHz to 50 GHz* (2015) (available through agency at https://www.itu.int)

The second option is ITU-R P.452-16, a prediction procedure for the evaluation of interference between stations on the surface of the Earth at frequencies above about 0.1 GHz range 30 MHz to 50 GHz and accounting for both clear-air and hydrometeor scattering interference mechanisms.[6]

The third option is ITM / Longley-Rice, a general purpose model based on electromagnetic theory and on statistical analyses of both terrain features and radio measurements for frequencies between 20 MHz and 20 GHz.[7]

The Key Bridge SAS will implement and use the ITU Recommendation P.2001-2 model for radiowave propagation loss.

3.2 Raster Library Selection

All three candidate radiowave propagation loss models are dependent upon a terrain profile raster library giving heights above sea level of the Earth's surface.

A SAS may select raster library coverage with resolutions based upon availability and suitability for the task. Typical practice for raster library selection is to choose a raster with cell spacing in the range 50 to 250m, depending on the source data and the nature of terrain.[8]

Within the United States, the Key Bridge SAS will employ bare-earth elevation raster libraries from the United States Geological Survey National Elevation Dataset (NED) as 1/3, 1 and 2 arc-seconds resolution, depending upon the region of coverage.

3.3 Data Availability in the ULS Database

As the Commission discussed in the Grandfathered Licensee Comment PN, the FCC's ULS database already contains much of the data necessary to calculate WBS Protection Zones, including location, operating parameters, antenna configurations, etc.

Operations in the 3,650 – 3,700 MHz band are identified in ULS by the radio service code "NN". A survey of candidate "NN" stations reveals the following data availability issues, which generally confirms the Commission's own findings in the Grandfathered Licensee Comment PN. Namely that the FCC's ULS database already contains much of the necessary data but also lack details required to implement the Commission's Grandfathered Wireless Broadband Services protection procedures. Specifically:

6 See *P.452 : Prediction procedure for the evaluation of interference between stations on the surface of the Earth at frequencies above about 0.1 GHz* (2015) (available through agency at https://www.itu.int)

7 See Technical Note TN-101 vol. I Transmission Loss Predictions for Tropospheric Communication Circuits: Volume I (Publication #2726) and Volume II (Publications 2727) (1967) (available through agency at http://www.its.bldrdoc.gov). The original reports are referenced here instead of their later software implementations as the software includes various engineering shortcuts and empirical constants.

8 See P.2001 at Page 4.

- Issue: NN-services do not identify actual operating frequency

Presently all “NN” frequency records generally report using the entire 3650-3700 MHz band, with some records indicating whether the station will operate in the upper or lower 25 MHz. Referencing FCC Form 601 Schedule M instructions, 3650 – 3700 MHz services are presently not required to complete item 36 (Transmitter Frequency).

Absent further guidance the Key Bridge SAS will protect the ULS-reported operating frequency range. The Key Bridge SAS will update and narrow the protected frequency range for each station if and when its actual operating frequency range is configured in ULS.

- Issue: NN-services do not include CPE information.

Presently all “NN” stations are identified as “Fixed” type. Referencing FCC Form 601 Schedule M instructions, 3650 – 3700 MHz services are presently not required to register the geographic coordinates of their receiver CPE location(s).

Absent further guidance, the Key Bridge SAS will interpret all NN Fixed-type stations as base stations for the purposes of calculating a protection zone.

Presently the FCC Form 601 Schedule M is designed for a single, point-to-point link and does not require nor accommodate the registration of CPE locations for NN-type services.

Absent further guidance the Key Bridge SAS will assume that each Fixed base station sector contains un-registered CPE and calculate a protected contour accordingly.

3.4 Suggestions for ULS database recordkeeping

The Grandfathered Licensee Methodology PN protection scheme makes no distinction between a sector containing one or many registered CPE: only the furthest CPE is inspected and used to establish a fixed radius for the entire sector. Key Bridge therefore recommends that the Commission not require registration of grandfathered CPE *per se* but rather allow grandfathered wireless operators to register the maximum distance of their CPE distributions.

To be clear, Key Bridge does not suggest a change in the licensing strategy for NN-type services. We instead propose a clerical technique to conveniently record CPE operating information for the purpose of implementing the Commission’s Grandfathered Licensee Methodology.

The ULS database already includes the ability to associate parent-child locations, and Key Bridge believes necessary information about NN-type CPE can be recorded by supplementing existing NN service records with a similar approach for Land Mobile Radio Services. For example, in Form 601 Schedule H registrants identify a base station and fixed or mobile CPE operating within a radius around the base station.

CPE operating range information may be readily recorded by supplementing existing ULS NN-service records with additional location records (“LO” table) that identify the maximum operating radius around the NN-service fixed base station for all CPE within a already-defined antenna sector (“AN” table).

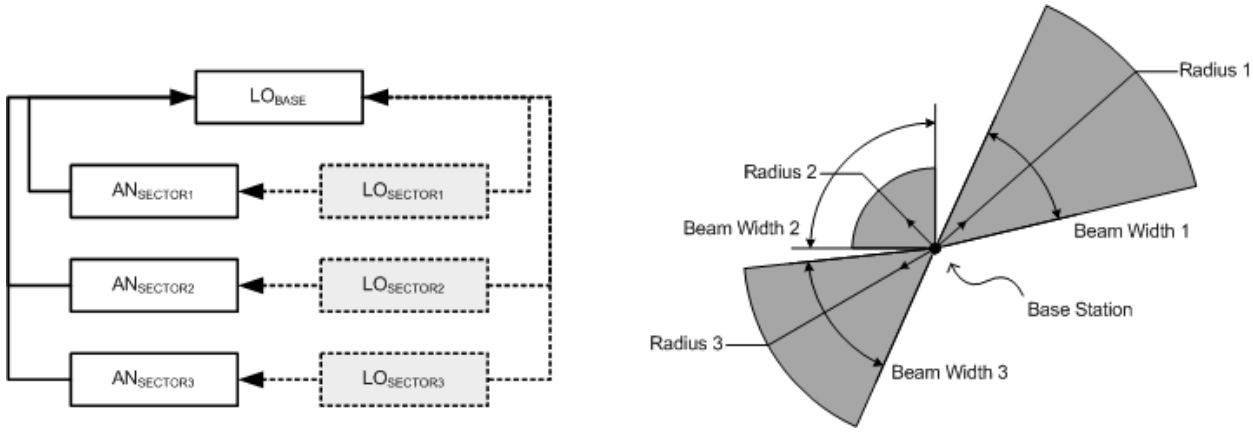

Illustration 5: Cectorized CPE radius can be stored in the ULS location table.

An example NN-service record configuration is shown in Illustration 5 that would include a new (sector) location record identifying the maximum CPE radius for each existing (sector) antenna record. In Illustration 5 the following labels are used:

> LO_{BASE} is the existing (fixed) base station location record.
>
> $AN_{SECTORI}$ is the existing Ith sectorized antenna record associated with the existing (fixed) base station location record.
>
> $LO_{SECTORI}$ is the proposed Ith location record recording the CPE count and maximum operating radius from the existing (fixed) base station location.

A existing NN-service location (LO) record could be supplemented with new sector location records that include the following configuration information:

Location Table Field	**Value**	**Description**
radius_of_operation	R_{MAX}	The maximum radius of operation for CPE served by the parent fixed station in the sector represented by this Location. (km)
area_of_operation_code	“A”	Enumerated code “A”, indicating kilometer radius (KMRA) around a fixed location.
units_mobile	CPE_{COUNT}	The number of CPE units operating in the indicated sector. (Information only.)

4 Sunsetting of Grandfathered Protection

The Key Bridge SAS will remove protection for Grandfathered Wireless Broadband Service records as each respective service record in the ULS database expires, as indicated by the “HD” table *expired_date* and *license_status* fields. This process will occur automatically through the normal course of updating records in the SAS to reflect the most recent status in the FCC ULS database.