

**BEFORE THE
FEDERAL COMMUNICATIONS DIVISION
WASHINGTON, D.C. 20554**

In the Matter of:

Unlicensed Operation in the TV Broadcast
Bands

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ET Docket No. 04-186

Response to TV Whitespace Database Administrators Group Submission for the Record

Dear Ms. Dortch,

Key Bridge submits the following response to the “Channel Calculations for White Space Guidelines” document recently submitted for the record by the TV Whitespace Database Administrators Group (WSDBA).¹ In this response we address the WSDBA proposed method for reading, interpreting and re-sampling the Government's digital elevation data.

The WSDBA proposed method diverges from Commission guidance and does not implement best current practice. It also produces different elevation values from the source data. The WSDBA proposed method should not be accepted as normal practice for white space operation without a suitable justification from the proponents. At minimum the Commission should require a basic validation that the novel methods proposed by the WSDBA generate a mathematically meaningful result.

¹ See Whitespace Database Administrators Group, *Channel Calculations for White Space Guidelines* at <http://apps.fcc.gov/ecfs/document/view?id=7022134609>

As the WSDBA method for reading, interpreting and re-sampling the Government's digital elevation data is non-standard and not in conformance with Commission guidance the white space database systems that implement this technique should also be updated to conform with best current standard practice.

The National Elevation Dataset is a blended elevation data product

At the second white space workshop the Commission issued guidance that white space database systems must use the 1-arc second resolution U.S. Geological Survey (USGS) National Elevation Dataset (NED) for all elevation measurements and calculations.²

As background: The NED is derived from an inventory of other USGS Digital Elevation Models (DEMs) and also from a number of project or agency-specific datasets. These various source data are processed in to a common coordinate system and unit of vertical measure.

NED data is distributed in units of decimal degrees and conforms with the North American Datum of 1983 (NAD 83). NED elevation values are in meters and are referenced to the North American Vertical Datum of 1988 (NAVD 88) over the conterminous United States but may vary in other areas.

NED horizontal and vertical spatial accuracy can vary by location because of the variable quality of the source DEMs. Each NED data file therefore inherits the accuracy of its respective source models.³

White Space administration requires consistent elevation data

A principle characteristic of database-mediated spectrum sharing is the use of radio propagation models to predictably calculate protected geographic service areas. The FCC's white space strategy depends

2 See Presentations given at the TV bands device database manager workshop on April 20, 2011, FCC Presentation (updated 02/27/12), Slide 25 at <http://transition.fcc.gov/bureaus/oet/whitespace/TVWS-Workshop2-Presentations-4-20-12update.ppt>

3 See USGS National Elevation Dataset at <http://ned.usgs.gov/index.asp>, USGS NED *Frequency Asked Questions* at <http://ned.usgs.gov/faq.asp> and USGS *NED Spatial Metadata Field Definitions* at http://ned.usgs.gov/downloads/documents/NED_DataDictionary.pdf.

upon accurate and uniform implementation of the Commission's FM and TV Propagation Curves model (CURVES) to calculate a protected contour distance for licensed broadcast stations. Both unlicensed spectrum availability for FIXED-type white space devices and CURVES calculations depend upon the accurate calculation of height above average terrain (HAAT): itself dependent upon accurate and consistent readings of digital terrain data.

A characteristic of the CURVES model when used to calculate distance for a given field strength is its sensitivity to small variances in HAAT.⁴ It is therefore important that white space database systems calculate consistent HAAT values when using the CURVES propagation model.

On November 11, 2011, the Wireless Innovation Forum DSA-White Space Interoperability Work Group, chaired by Key Bridge and representing over 50 industry experts from more than 40 companies, submitted a draft “Geographic Contour Calculation Guidelines” document and requested the Commission's “... advice, input, guidance and commentary on the document to assure that its interpretations and intentions match those of the Commission.” This document does not anticipate a digital elevation processing algorithm but does provide a detailed recipe for calculating height above average terrain (HAAT).⁵

On March 25, 2013 the TV Whitespace Database Administrators Group (self referenced as the “WSDBA”) submitted a revised version of their “Channel Calculations for White Space Guidelines” document.⁶ Sections 3.7 and 3.8 of this document briefly describe a similar HAAT calculation method but Section 2.3.2 describes a novel scheme for post-processing digital terrain elevation data whereby neighboring grid sample points are interpolated to calculate a blended elevation value instead of

4 The HAAT to distance relationship is generally 1:100. e.g. a +/- 1 meter variance in HAAT typically corresponds to approximately +/- 100 meter change in calculated contour distance.

5 See Wireless Innovation Forum, *Geographic Contour Calculation Guidelines* at <http://apps.fcc.gov/ecfs/document/view?id=7021746733> at 3.1.3.1.

6 See Whitespace Database Administrators Group, *Channel Calculations for White Space Guidelines* at <http://apps.fcc.gov/ecfs/document/view?id=7022134609>

directly reading from the digital elevation data file.

Industry standard practice is direct data sampling

While developing our own White Space System Key Bridge consulted with our partners and with various U.S. Geological Survey customer service and technical support personnel to better understand the source data behind the National Elevation Dataset, to receive their advice on how to correctly read the NED data files and to discuss best practices for data processing and manipulation. The results of our consultations were:

- While not a substitute for GPS-based elevation measurement the current National Elevation Dataset represents the USGS best available public data and may be treated as generally authoritative.
- USGS elevation data is derived from diverse sources that are extensively processed prior to incorporation into the National Elevation Dataset: each source data file elevation value ('pixel') is the product of a variable combination of DEM sources.
- Any post processing of the NED should account for the variances in source file resolution and corresponding horizontal plus vertical accuracy.
- Best current practice for identifying the elevation of a given location is to directly sample the corresponding NED source data file 'pixel' value.
- Direct data sampling is the standard data method used in commercial GIS products and systems (in agreement with USGS advice)

The WSDBA strategy is non-standard

The Wireless Innovation Forum and WSDBA document's HAAT calculation methods are substantively

identical. However the WSDBA interpolation scheme is non-standard and does not represent best current practice in a geographic information system. The WSDBA scheme also produces different elevation values and correspondingly different HAAT values than are calculated when using the actual source data.⁷

The WSDBA's purpose for implementing an interpolation scheme is ostensibly to increase the NED data file resolution and to enable sub-pixel sampling. Data grid re-sampling is a commonly used technique when creating pretty-print maps and imagery but must be carefully applied when adjusting source elevation data for measurements. USGS advice agrees with the literature and commercial product implementations on this topic: a mathematically rigorous resampling algorithm should be employed.^{8 9}

The WSDBA scheme does not appear to be either a deterministic or geostastical interpolation; nor does it appear to be a method recommended by the USGS. It does not account for the variable horizontal and vertical accuracy of the source data and it does not accommodate the NED's variable data source file resolutions.¹⁰ The WSDBA scheme also diverges from Commission guidance to use the 1-arc second resolution U.S. Geological Survey (USGS) National Elevation Dataset (NED) for all elevation calculations.

7 During the testing and quality assurance phase of our White Space database we verified that direct sampling of the NED source files match the USGS web service elevation data for over one million random coordinates throughout the United States.

8 GIS interpolation strategies are generally divided into deterministic and geostatistical methods and typically used to create a mathematical contour over a raster dataset. Deterministic methods such as inverse distance weighted (IDW) and spline predict elevation values based on nearby empirical measurement and a mathematical description of their smoothness. Geostatistical methods are based on more computationally intensive statistical models but can provide increased accuracy of their predictions.

9 The USGS recommends either Cubic Convolution and Bilinear Interpolation as the preferred methods to resample digital elevation data. See National Elevation Dataset Frequency Asked Questions: "When resampling NED...." at <http://ned.usgs.gov/faq.asp#RESAMPLE>

10 See USGS *Vertical Accuracy of the National Elevation Dataset* at http://ned.usgs.gov/downloads/documents/NED_Accuracy.pdf and National Digital Elevation Program, *Guidelines for digital elevation data*, Sections 1.5 (Data Quality) at http://www.ndep.gov/NDEP_Elevation_Guidelines_Ver1_10May2004.pdf

Conclusion

Certain practices identified within the WSDBA “Channel Calculations for White Space Guidelines” document do not represent best current practice. The WSDBA's proposed strategy to re-sample and interpolate USGS elevation data does not adhere to USGS recommendations nor conform with Commission guidance. Should the Commission wish to update its guidance then the Commission should at least require a rigorous analysis and proof that the WSDBA proposed strategy produces a mathematically meaningful result.

Until such an analysis is proffered and the WSDBA strategy is approved by the Commission all white space database systems utilizing this WSDBA technique should be made to conform with current guidance and with the best current practice of treating the Government's elevation data as authoritative.

Respectfully submitted,

/s/

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