Via Electronic Filing
August 24, 2010

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

In the Matter of

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Establishment of an Improved Model for	{	ET Docket No. 00-11
Predicting the Broadcast Television Field	{	
Strength Received at Individual Locations	{	
	{	
Establishment of a Model for Predicting	{	ET Docket No. 10-152
Digital Broadcast Television Field	{	
Strength Received at Individual Locations	{	

PETITION FOR RULEMAKING
AND
COMMENT

Dear Ms. Dortch:

I, Sidney E. Shumate, as President of Givens & Bell, Inc., hereby submit this Petition for Rulemaking, authorized to be submitted, at any time, under ET Docket No. 00-11, Paragraph 21, and as required to be reauthorized and extended by The Satellite Television Extension and Localism Act of 2010, (STELA).

This is also submitted as Comment with regard to the Notice of Proposed Rulemaking (NPRM) adopted on July 28, 2010 in ET Docket No. 10-152, and under the continuing authority to submit this Petition described in paragraph 31 of the NPRM.

This Petition proposes to support changes that would correct and complete the ILLR model in order to make it comply with the requirements of Section 204 of STELA. We also submit this as Comment with regard to ET Docket No. 10-152.

Contents:

Background: What is the Individual Location Longley-Rice Model? 2

Why does STELA present a quandary to the Commission? 3

Why is it not possible for the Commission to completely rely on the ITM? 3

The ITM is NOT a point-to-point model. 3

The ITM results do not improve when used with better data. 5

The ITM is incapable of supporting interference analysis. 6

The NTIA_ITS will not change or correct the ITM. 6

How can Givens & Bell's ITWOM be used to solve this quandary? 6

Now is the best time to introduce the ITWOM Model. 7

Test Results using the ILLR test bed; ITM vs. ITWOM: 7

Givens & Bell's Petition re: the ITWOM. 8

Additional Comment, regarding Docket 10-152: 9

Background: What is the Individual Location Longley-Rice Model?

In OET Bulletin OET-72, it states:

> "This bulletin publishes the detailed definition of the ILLR computer program as established in the First Report and Order adopted May 22, 2000."

And a few lines later, it states:

> "Computer code for the Longley-Rice radio propagation prediction model is published in an appendix to NTIA Report 82-100, *A Guide to the Use of the ITS Irregular Terrain Model in the Area Prediction Mode*. Some modifications to the code were described by G.A. Hufford in a memorandum dated January 30, 1985. With these modifications, the code is referred to as Version 1.2.2 of the Longley-Rice model."

So it is a very specific, and, since 1985, an essentially unchanged reference benchmark set of software subroutines.

Why does STELA present a quandary to the Commission?

Section 204 of STELA requires that:

a. "In prescribing such model, the Commission shall rely on the Individual Location Longley-Rice model set forth by the Commission in CS Docket No. 98-201, as previously revised with respect to analog signals, and as recommended by the Commission with respect to digital signals in its Report to Congress in ET Docket No. 05-182, FCC 05-199 (released December 9, 2005)". As discussed in the Background section above, this means that the Commission shall rely on the NTIA-ITS ITM.

But Section 204 also requires that:

b. "the Commission shall develop and prescribe by rule a point-to-point predictive model"

And that:

c. "The Commission shall establish procedures for the continued refinement in the application of the model by the use of additional data as it becomes available."

And here the legislation presents the Commission with a quandary. Total reliance on the ITM is impossible, as the ITM is neither a point-to-point model, nor does it improve with the application of additional data.

The ITM is NOT a point-to-point model.

The ITM, and therefore the ILLR, is a point-to-averaged-radial model, not a true individual point-to-point model. The ITWOM, by comparison, is a true individual point-to-point model.

The ITM reports out that it is operating in a point-to-point mode, and, in the original 1985 ITM source code, the subroutine making the report is called the "point-to-point" subroutine, but the rest of the program was never updated from the older methodology found in the original "Irregular Terrain" software model, which can be found in the annex in an older 1968 NTIA report,[1] to actually be able to compute a point-to-point result. This is due to:

a. The ITM methodology's inability to calculate diffraction loss close to an obstacle, or leading up to and following a pair of obstacles[2], and:

[1] ESSA Technical Report ERL 79-ITS 67,"Prediction of Tropospheric Radio Transmission Loss Over Irregular Terrain, A Computer Method-1968" A.G. Longley, P.L. Rice, NTIA-ITS, July 1968.
[2] NTIA-ITS Technical Note 101, "Transmission Loss Predictions for Tropospheric Communications Circuits, Volume I" P.L. Rice, A.G. Longley, K.A. Norton,, A.P. Barsis, January 1967. In Section 7.3, it is

b. The lack of a scientific explanation or basis to explain the additional losses occurring in the line of sight range above and beyond the Free Space Loss and Two-Ray loss.

To work around these difficulties, the ITM uses a radial averaging system, combined with a now-discredited[3] empirical calculation that predicts additional "diffraction" losses in the line-of-sight range based on diffraction occurring past the horizon, to predict losses at a selected location.

For example, in the line-of-sight range, the ITM averaging system calculates the loss at three separate points on the radial, two in the line of sight range (selected to avoid the un-calculable locations) and one a short distance past the horizon. Based on a weighted averaging of the two-ray and "diffraction" losses, a curved line solution formula is created based on the results from these three widely-separated points, and the formula is then solved for the location selected on the radial to produce the "point" result. The point to be solved for is rarely one of the three points selected, and even when it is one of the three, the calculated result is averaged with the other two unrelated points. So the ITM is, in fact, a point-to-averaged radial system.

Givens & Bell's ITWOM replaces the discredited line-of-sight diffraction loss, and calculates the losses close to obstructions, with a scientifically-based system using Snell's Law, Beer's Law, and as set of approximations of the Radiative Engine Transfer Functions[4] to properly estimate clutter loss. Clutter loss is the correct source of the losses previously unexplained in Tech Note 101 and the ITM methodology. In doing so, it allows calculation of all the signal attenuation at all points along a radial, and eliminates the averaging system, instead calculating accurately the losses to single, individual locations.

Since the latest effort of the International Telecommunications Union, the new ITU-R P. 1814 terrain-sensitive methodology, describes itself as a point-to-area system, and the TIREM, the Military-Industrial restricted-access methodology, started out as a fraternal twin of the ITM (both having been derived from the ITS-67 model), we have reason to believe that the ITWOM, Givens & Bell's corrected and completed version of the Longley-Rice-Shumate model, is the only true point-to-point model now available.

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noted that for diffraction calculations to be valid, "the components α_o and β_o, of the angle θ are less than 0.175 radians." The components α_o and β_o are the transmitter and receiver look-up angles, respectively.

[3] "Fixed Broadband Wireless System Design", by Harry R. Anderson, PhD, P.E., founder of EDX Engineering. 2003, Wiley & Sons,Ltd. In Section 3.5.3, in describing the Longley-Rice model, he states: "Having the path loss to a receiver location be affected by terrain obstacles beyond that receiver location is clearly noncausal and violates physical reasoning for a single path two-dimensional model."

[4] "Deterministic Equations for Computer Approximation of ITU-R P.1546-2", Sid Shumate, Proceedings of the International Symposium on Advanced Radio Technologies (ISART), June 2-4, 2008, Boulder, Colorado.

The ITM results do not improve when used with better data.

The ITM is designed to be used only with a 30-arc-second database. This shows up in the calculation of the delta-h coefficient, the terrain roughness factor, in the ITM subroutine *dlthx*. The calculation methodology for delta-h in the ITM is similar to that found in the FCC rules[5], except that the consideration of terrain extends up to 800 km (500 miles) in the ITM to include consideration of diffraction over mountainous obstacles at a far distance in the diffraction range. In subroutine *dlthx,* the starting point for the section on the radial used for calculating the delta-h, starts at a maximum of 25 intervals. The end point is at 10 times the starting point distance, less 5 intervals, so the end point is at 245 intervals. An interval is the distance between terrain points in the database. For an interval of a 30-arc-second database, the distance represented by 245 intervals is a maximum, at the equator, of 111 meters/sec, times 30 arc-sec, times 245 intervals, or 815850 meters. This is 816 kilometers, or 507 miles, the intended maximum distance in the ITM.

For a 3 arc-second database, as used by the Commission with the ILLM, this limits the maximum consideration distance to be limited to one tenth as far, or 82 kilometers, only sufficient for the line-of-sight range. For a one-arc second database, this shrinks the maximum distance considered to only 24 kilometers, and for a 1/3 arc-second database, to 7 kilometers. At the latitude of the mid-continent U.S., for example, at Washington, DC, this distance can shrink by 1/3, as the length of a degree of latitude shrinks as it travels north from the equator.

Our tests show that this can cause the delta-h calculation to miscalculate in the diffraction range for a 3-arc-second database. The delta-h coefficient is used to set the weighting of two-ray vs. diffraction loss in the line-of –sight range, and the ratio of rounded-edge to knife-edge diffraction in the diffraction range. So as the terrain database used becomes more detailed, the ITM attenuation results become less accurate overall. This was not the only location where we found such terrain database limitation built into the ITM. The ITWOM bases its calculation range on a number of intervals derived from a percentage of the path distance, and therefore avoids this limitation.

In addition, the averaging system prevents the higher detail from significantly improving the determination of the actual height and nature of the individual points the Commission is attempting to calculate for. So improving the detail of the terrain database alone cannot significantly improve the accuracy of the individual location calculation!

Therefore, better data alone does not produce better results, and the Congressional mandate to improve the ILLR with better data is not possible, unless the ITM core software is replaced or supplemented.

[5] 47CFR73.684(h) and Figure 10d of 47CFR73.699.

The NTIA itself has determined that the ITM is not capable of supporting interference analysis.

The NTIA-ITS, as documented in its 2008 annual report, and continuing through the current project status reports on the NTIA-ITS website, has determined that the ITM is not capable of supporting mobile interference analysis[6] such as is necessary for analyzing mobile DTV and vehicular FM radio reception. The Commission has been attempting to do DTV interference analysis with the ITM for DTV allocation analysis with great difficulty and limited results. The Commission needs the higher accuracy provided by the ITWOM in order to develop higher quality interference analysis. In fact, it was because of the need to do more sophisticated interference analysis, that Givens & Bell found it necessary to correct and complete the ITM by developing the ITWOM, as it was discovered several years ago that the ITM did not provide true point-to-point prediction as needed to support sophisticated interference analysis.

The NTIA-ITS will not correct or complete the ITM.

Givens & Bell have found several other mathematical and minor technical errors in the ITM, which have been documented in a continuing series of articles I have authored in the IEEE Broadcast Technology Newsletter. These corrections have been addressed in the ITWOM. In our discussions with the NTIA-ITS staff who provide technical support for the ITM, we found the assistance of the staff very helpful in identifying and verifying the problems found. But when the discussion turned to including corrections in the ITM, the correspondence from the ITS made it clear that no suggestions to correct the ITM model as it stands would be considered. This is understandable in that the ITM is a reference benchmark used worldwide, and to change it now would raise liability and political issues that would not be welcome. So the ITM can only be relied on for what it is; a 25-year old reference benchmark, essentially unchanged since 1985, in which no further improvement or development can be expected.

How can Givens & Bell's ITWOM be used to solve this quandary?

The ITWOM software source code will be supplied to the Commission with a dual core configuration; the source code will have both the original, unmodified version of the ITM source code, as used by the Commission, and the new subroutines that comprise the ITWOM source code, so that either one can be called by the wrap-around software. Therefore, the ITM can be relied on as a reference, or when International agreements call for its use, and the ITWOM can be called on for better results.

[6] NTIA-ITS 2008 Technical Progress Report, Telecommunications Engineering, Analysis, and Modeling Section, Short Range Mobile-to-Mobile Propagation Model Development and Measurements Subsection.

Now is the best time to introduce the ITWOM Model.

In the NPRM, Section III (A.)(12), the Commission mentions it is expected that the predictive model will be used far less frequently than in previous years, hinting that little effort should be expended to further improve the model. We offer an alternative view; that this makes this the ideal time and application on which to try out an improved model. This model, once the Commission's engineering staff has had time to become accustomed to its use and advanced capabilities, can then be applied to the design and analysis of new wireless applications as well as Distributed Transmission Systems, Mobile DTV, and complex interference analysis, which was either not possible or far less accurate with the ITM model.

Test Results using the ILLR test bed; ITM vs. ITWOM:

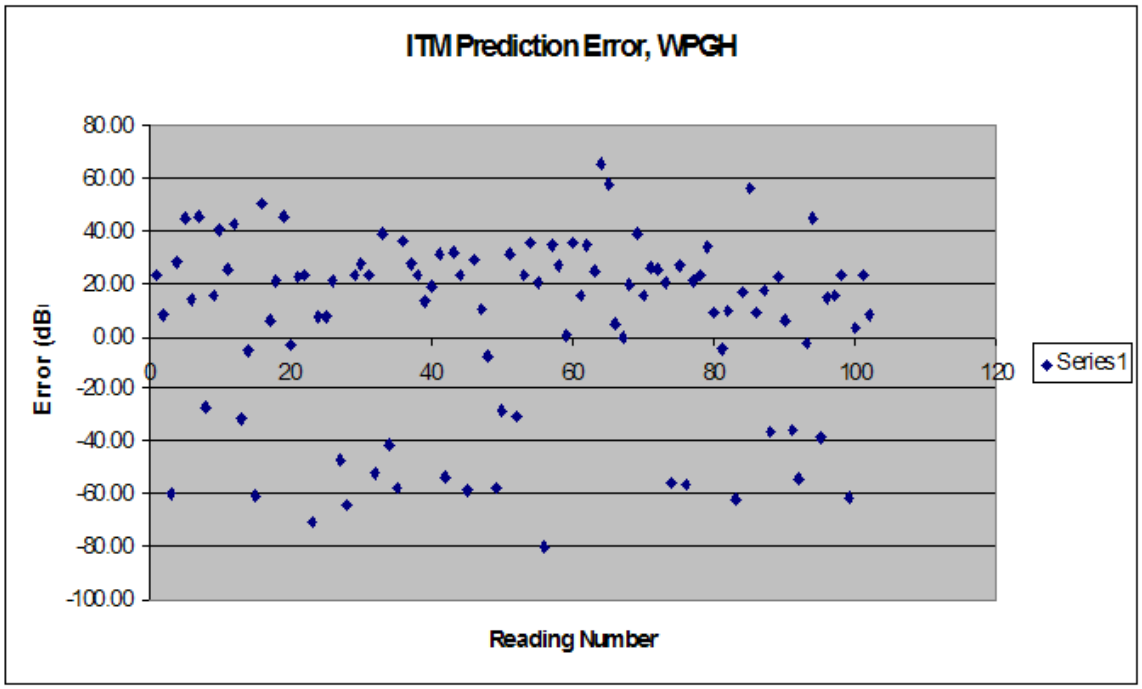
The ITWOM model has been tested and compared to the ILLR results using the ILLR test measurements and predictions published on Feb. 10, 1996 in proceeding 87-268, and identified in the ECFS as "ADVANCED TELEVISION TEST" in 34 separate .pdf files.

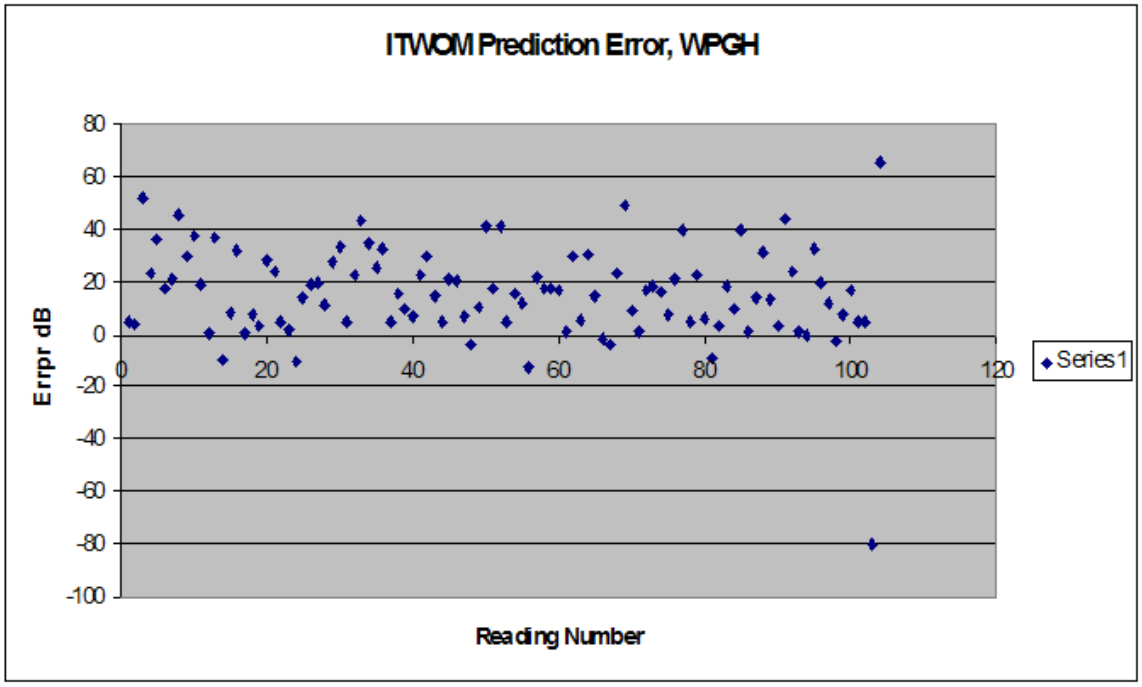
For the entire test set of 1069 readings, the average error of the ITM-based ILLR predictions was only 6.61 dBu above the actual readings. However, the radial averaging system used in the ITM produced a wide variance in the error values.

For the ITWOM, the test shows an average error of +1.93 dBu, for the 1069 field measurements.

Of the tests, the original test results identified the WPGH-TV series of 102 readings as being the most challenging; the one for which the ITM showed the lowest "C" score. The charts on the following page visually compare the variance of the ITM prediction errors versus the ITWOM prediction errors, as referenced against the WPGH-TV field measurements. Note that the last two readings on the ITWOM chart are for scale calibration, added to force the scale of the two charts to match.

Both were generated with 3-arc-second terrain databases; however, the database preferred for use with the ITWOM, and used here, is the Satellite Radar Terrain Mission data, SRTM3 version2. Full test results in spreadsheet form will be provided with the software, along with installation documentation.





<u>Givens & Bell's Petition re: the ITWOM.</u>

G&B hereby Petitions the Commission to accept its offer of a dual software core package that allows a smooth transition to a true point-to-point predictive model. The software core, to be provided in both Fortran and c++ versions, will contain both the unmodified original ITM and the new ITWOM; either version can be called from the package once

compiled with the appropriate wrap-around software. Since Congress did not provide funding for this mandate, we are offering the source code as copyrighted, open source software with no charge for internal and individual use.

At the Commission's convenience, when requested, we will present the software source code ex-parte, at any time after the end of the reply comment period. Final porting of the c++ original version to the Fortran version, and final testing, are currently in progress.

Public distribution of the software source code is scheduled to start during presentations at professional conferences held or co-sponsored by the IEEE; including the IEEE-Vehicular Technology Society Fall Conference on Sept. 9, 2010, and during the week of Oct. 18-22, 2010 in Alexandria, VA.

Additional Comment, regarding Docket 10-152:

The LULC data needs to be applied by introducing clutter height and density factors into the clutter calculations, not by adding preset values of attenuation to the ITM results. The clutter calculations developed for the ITWOM, as presented before the NTIA-ITS and ITU working groups at the 2008 ISART Conference, recognize that the attenuating effect of the clutter varies with distance from the transmitter and the terrain location. For example, clutter loss increases as a reception antenna located below the foliage clutter canopy moves away from the transmitting antenna. The clutter loss varies with the height of the foliage canopy approaching and above the receive antenna, and with the average density of the clutter approaching the receive antenna. However, as the receive site, moving along the radial, starts to climb a gently sloped mountain, the clutter loss becomes less, even if the ground cover stays approximately the same, as the signal takes a more direct path through the clutter to reach the antenna climbing the mountain, when compared to the longer, angled path it took through the clutter to the antenna as it approached the base of the mountain.

Therefore, the proper application of land cover factors is within the calculations in the core software. The ITM has no such provision, and the NTIA-ITS ITM 1.2.2 version never will. Initially, with the first, "drop-in" version of the software to be supplied, the ITWOM is preset to calculate the average clutter height and density found in the ITU-R P.1546 data; therefore, we initially recommend modifying the existing LULC computations, if used with the "drop-in" software version, to only reduce attenuation in areas of low or no clutter, reducing the attenuation by 5 dB for treeless plains, and by 10 dB for desert conditions. The second set of ITWOM source code, also to be provided in both Fortran and c++ languages, requires modification of the wrap-around software to properly input clutter height and foliage density values into the core software clutter attenuation calculations, in order to further improve the predicted values.

I hereby certify that I performed or supervised the testing procedures and ITWOM prediction results reported in this Petition, and that I am authorized to present this petition.

Sincerely yours,

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