

## PREDICTION AND ASSESSMENT ON ENVIRONMENTS OF URBAN HIGH-POWER ELECTROMAGNETIC RADIANT POINT

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**Abstract:** The paper discusses prediction and assessment of urban electromagnetic environments. Take the electromagnetic radiant point environment of TV2 image which carrier frequency is 57.75MHz for an instance, curves compared with measuring results, which applies several mathematics models, are analyzed and assessed. Okumura-Hata model has many advantages, such as easy to obtain parameters, more modified factors, broad of frequency band, high accuracy and easy to use, and most suitable to predict urban electromagnetic environment. Urban prediction for assumption of edge model is more accurate by Walfisch-Ikegami model. Egli model and CCIR-370 model, which have modified factors, may be applied to predict electromagnetic environments. Measures discussed in the paper may be applied to predict, assess and format urban electromagnetic environments.

**Key words:** Urban Prediction Assessment ,  
Electromagnetic , environment

### 1. INTRODUCTION

In order to avoid the pollution caused by the electromagnetic radiation , it is necessary to predict the electromagnetic environment. Prediction accuracy may be improved by applying suitable model to prediction and simulation. The paper discusses prediction and assessment of urban electromagnetic environment.

### 2. PREDICTION RBNHIGH-POWER RADIANTPOINT ELECTRO-MAGNETIC ENVIRONMENT

Approaches in urban electromagnetic environment prediction are as follow.

**2.1** Determining the main electromagnetic radiant points and their related information in prediction area High-power radiant points in prediction extent, television broadcast tower and mobile station etc, are determined mainly according to concrete circumstances. Parameters, such as radiant power, frequency, antenna characteristics, height and polarization, are listed in proper proportion map.

**2.2** Electric wave propagation relies on concrete environments such as circumstances of topography, circumstances of vegetation, density of construction, average height and width of streets.

**2.3** Determining the model according to environment information of prediction area

Each model takes effect only in its effective extension. For example, Egli model can be used only when distance is from 1Km to range of visibility and frequency is between 40 and 400 MHz. Accordingly, models should accord with parameters.

**2.4** Calculation of prediction electric field intensity of settled frequency

Electric field intensity of settled frequency, which is caused by each main electromagnetic radiant point in prediction spot, may be calculated according to prediction formulas, and gross electric field intensity of prediction spot also may be calculated when they superpose together.

$$E = \sqrt{\sum_{i=1}^n E_i^2} (V / m) \quad (1)$$

**2.5** Appending modified factors through measures in crucial spot

\* This work is supported by National Science Foundation of China (No: 60272069)

In prediction area, modified factors can be derived by measuring some typical spots compared with prediction. Some of the reported experiences are as follow. According to density of construction, height of construction and other circumstance, district is divided into small area, in which typical spots are going to be measured. In addition, complicated spots need to be measured.

The paper predicts the signal of CCTV1 channel carried frequency.

**3. PREDICTION, MEASURE AND ASSESSMENT OF BEIJING CENTRAL TELEVISION TOWER ELECTRIC FIELD INTENSITY**

Theory of electric wave propagation is the basis of utilizing wireless frequency spectrum effectively, design of system engineering and analysis of EMC. The authors study models of current international land mobile communication electric wave propagation carefully and analyze their characteristics, effective extension and limitation by synthesizing many relative documents, and then discover Okumura- Hata model, Egli model, plane ground model, CCIR-370 model and COST-Walfisch-Ikegami (WIM) model are typically applied to international VHF/UHF frequency band. The paper discusses application of these models in Beijing.

**3.1 Specific propagation environment**

China central broadcast tower is located on west of the West Three Loop, north of Jing-mi Penstock, east of Cui-wei Road and is 15.4ha. in area and 405m in height. Reinforcing steel bar concrete is below 322m while steel mast is above 322m. Circumstances within 2km of east of China Central Broadcast Television Tower are shown in Fig. 1. .

**3.2 Electromagnetic radiant points and their relative parameter**

Height of China Central Broadcast Television Tower is 405m, gross power of transmitter is 240kW, height of antenna is between 275~378m, horizontal polarization wave is radiated, designed radius of service is between 70m~60km and covering radius is between 108m~120km. TV2, whose frequency band is between 57.75 and 64.25MHz, transmitter power is 30kW, antenna height is 274.75m and antenna gain is 9.3dB, broadcasts

CCTV1. Parameters to predict TV2 are as follows.  $f_c=57.75$ ; frequency (MHz)



Fig.1. Map within 2km of east of China Central Broadcast Television Tower

- $h_m=4$ ; antenna height of measuring platform (m)
- $h_b=274.75$ ; transmittable antenna height (m)
- $d$ ; distance from transmittable antenna to mobile antenna (km), measuring spots are every 50m within 2Km and are 2、3、4、5、10、15、20、25、30km within 2~30km.
- $p=30$ ; transmitter wattage rating (kW)
- $P_t=10*\log_{10}(1000*p)$ ; transmitter power export (dB)
- $G_t=9.3$ ; transmittable antenna gain (dB)
- $L_t=6$ ; wastage of feedback line (dB)
- $w=20$ ; width of street
- $h_r=15$ ; height of structure
- $b=35$ ; distance between buildings

**3.3 Converting average wastage value in receiving spot into electric field intensity**

$$E(dB) = 107.27 + P_t + G_t + 20 \lg f - L_t - L_b \quad (2)$$

- $P_t$ : transmitter power export (dBw);
- $G_t$ : transmittable antenna gain (dB);
- $L_t$ : wastage of feedback line (dB),
- $f$ : frequency (MHz);
- $L_b$ : transferred wastage of model;
- $E$ : electric field intensity of receiving antenna

**3.4 Measure Apparatus to measure electric field intensity of settled frequency**

- 1) Digital electric field intensity apparatus of DS9, frequency band is 46~860MHz and measuring extension is 20~130dBuV
- 2) British GPR4003 electric field intensity apparatus, frequencyband is 26~1000MHz and measuring extension is -20~124dBuV
- 3) Height of measuring antenna is 4m

**3.5 Distribution of measuring spot**

- 1) Distribution of ground horizontal electric field

intensity is within 2km of east. Measuring spots are every 50m from broadcast television tower to 2km of east (east door of Guibin Hotel).

2)Distribution of remote ground horizontal electric field intensity. Measuring spots are 3, 4, 5, 10, 15, 20, 25, 30km from 2km (30km is east edge of Tong City) . Measuring spots are as follows (Fig.2).

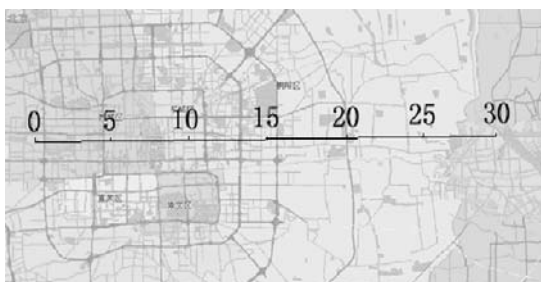


Fig. 2. Measuring spots are from 2~30km, east of central television tower

**4. Comparison of measured and predicted results**

The paper compares measuring results with prediction results of models in two segments(50m~2km(chart1.) and 2~30km(chart2)). The authors plot the curves according to the two charts and analyze them. Curves of free space wastage (Fig.3.) decline gently and approximate to measuring results. Okumura – Hata ( Fig.3. Broken line , effective distance more than 1km ) and Walfisch-Ikegami model visible mode formula (Fig.4. Dash dotted, effective cistance more than 20m) approximate to measuring results. Error between the two curves of prediction and measuring results is less than 1dB. Prediction of Walfisch-Ikegami model visible mode approximate measuring results. Curves of Egli model (Fig.3. Real line with macula), plane ground model (Fig.3. Plus line), and CCIR—370model(Fig.4. Plus-line) are almost identical, in which they exceed measuring results within 2km, while they approximate it with distance increasing.

**5. CHARTS OF PREDICTION RESULTS AND MEASURING RESULTS BETWEEN 2~30Km**

Okumura – Hata (Fig.3. Dash dotted) and Walfisch-Ikegami model visible mode formula (Fig.4. Dash dotted) approximate to measuring results within effective area. But there are two exceptional

spots, 2km and 3km. Error at 2km spot between prediction results (Egli model, plane ground model and CCIR—370 model) is more than 10dB, which is 11.5, 13.4 and 14.7dB respectively, and error at 3Km between prediction results (Okumura—Hata model, Walfisch-Ikegami model visible mode) and measuring results is also more than 10dB, which is -13.1 and -11.7. Error at the other spots is less than 10dB.

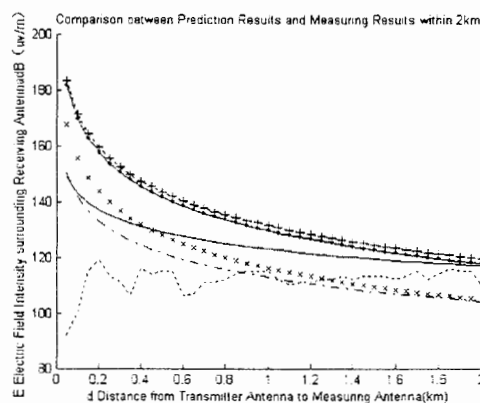


Fig.3. Curves of following models within 2Km  
Real line-----free space propagation  
Broken line-----measuring result  
Starriness line-----modified Egli model in Beijing  
Plus line-----plane ground model  
Real line with macula ----- Egli model  
Dash dotted----- Hata model

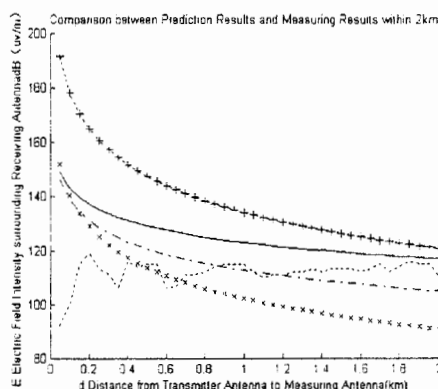


Fig.4. Curves of following models within 2Km  
Plus line-----CCIR-370 model  
Dash dotted----- WIM model visible mode  
Broken line-----measuring results  
Starriness line-----WIM model invisible mode  
Real line-----free space propagation

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Okumura-Hata Model and Walfisch-Ikegami model visible mode best approximate to measuring results

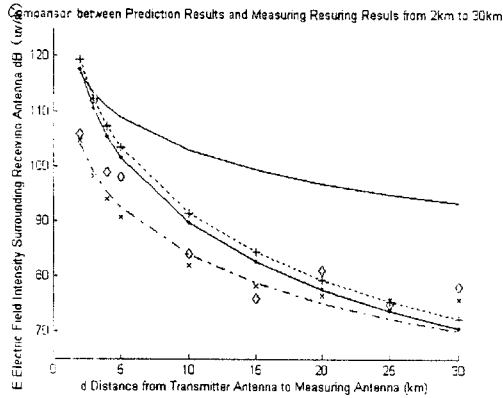


Fig.5. Curves of following models between 2~30km  
 Real line with macula----- Egli mode  
 Starriness line --- modified Egli model in Beijing  
 Diamond line-----measuring results  
 Real line-----free space propagation  
 Dash dotted-----Hata model  
 Plus line-----plane ground model

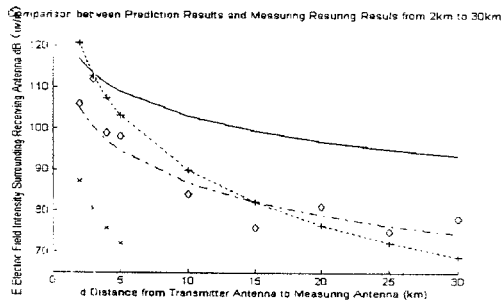


Fig.6. Curves of following models between 2~30km  
 Diamond line-----measuring results  
 Dash dotted----- WIM model visible mode  
 Plus line-----CCIR-370 model  
 Real line-----free space propagation  
 Starriness line-----WIM mode invisible mode  
 visible mode best approximate to measuring results within 30km. Egli model, plane ground model and CCIR--370 model adapt to prediction of remote distance. Prediction of Walfisch-Ikegami model invisible mode fails in all segments.

## 6. SUMMARY

As Okumura-Hata model has these dvantages, such as facility of obtaining parameters and more modified factors, curve of Okumura-Hata model approximates

to measuring results within 30km. Egli model, plane ground model and CCIR--370 model adapt to prediction of remote distance. Prediction of Walfisch-Ikegami model invisible mode fails in all segments.

- Plane ground model and Egli model with some extent of theory basis are accurate by overload antenna while predicting electric field intensity of significant signal. But less modified factors are available, error of prediction in complicated topography often exceeds the limitation.
- Walfisch-Ikegami model Within range of visibility of overload antenna, its visual mode approximates measuring results. Error in the paper is caused by complicated topography.
- With communication distance within 5Km and station antenna tall, computational route wastage may be less than free space wastage, but reference wastage should be free space wastage.
- Users need to test accuracy and reliability of models and rectify modified factors according to topography during the course of application.

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