A new method for the allocation of propagation model based on the cell environment

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Abstract

For a certain lack of the usual way for the allocation of propagation models used in the wireless network planning and simulations, a new method is introduced for the allocation of propagation model based on the cell environment and initially verified and compared with the traditional methods by using 110 cells of 40 sites CW data, which has an important practical significance and wide application prospect in the simulation and engineering.

Key words

Propagation model, Allocation of propagation model, Model calibration, Cell environment characteristic extraction, Clustering analysis, RMS error

1. Introduction

Propagation model is the basis of wireless network planning and simulation which directly influences the calculation of the cell range and further affects the evaluation of the scale of network and also influences the reliability of the coverage analysis and other related performance results.

However, for a certain lack of the usual way for the allocation of propagation models used in the wireless network planning and simulations, this paper brings a new method for the allocation of propagation model. It's initially verified and compared with the traditional method through the data of 110 cells of 40 CW (continuous wave) sites in the city of Zhengzhou.

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2. Requirement and principle of the new allocation method

2.1 Requirement and core idea

When engineers allocate the propagation models in the simulations, the usual way is to divide the whole area to four area types: dense urban、urban、suburban、rural and then choose some typical sites in each type of area and perform the propagation model drive test and calibration. The calibrated propagation models would be allocated to the mobile sites in the same area.

However, there are certain inadequacies:

1. It's no common rule to evaluate the area type of specific cities and different engineers may have different classification results;
2. The environment of each cell in one specific area type might have big difference, which probably cause prediction errors when we apply the same propagation model to all sites in the same area.

The ideal way of using propagation mode is to perform the propagation model calibration in each cell, however, this is impossible to be implemented in reality as the mobile network has a large scale and there is no sufficient time and money to do this.

A new method is to be considered. It's that we extract the characteristics of each cell environment through electronic map, then, classify the cells into several groups by clustering algorithm, choose some typical cells to perform propagation model drive test and calibrations and finally allocate the specific calibrated model to the cells of the same clustering group. There are three benefits:

1. The way of site classification are more reasonable, especially based on cell environment and using the clustering algorithm;
2. The accuracy of coverage prediction and network planning would be improved;
3. The value of the calibrated propagation models could be highly utilized by establishing the database of calibrated propagation models which would both improve the accuracy of simulation and highly reduce the workload of engineers and save time and cost.

2.2 Flow chart of the new allocation method

Flow chart of the new allocation method is illustrated in figures.1.

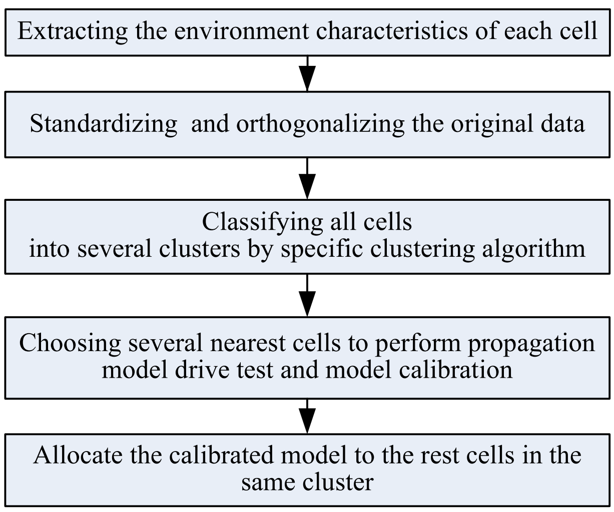

Figure 1: Flow chart of the new method of propagation model allocation

Based on our research,40 characteristics are selected to represent the cell environment and the hierarchical clustering algorithm is chosen to make further clustering[1][2].

3. Verifications and comparisons

We verify the new method and compare with the traditional method of propagation model allocation by 110 cells of 40 sites CW data, in the city of Zhengzhou. Firstly, we apply the new method to all 110 cells and get the final propagation model of each cell. Then we compare the effect with traditional and new method through 24 cells of 9 sites data. Figure 2 is the 9 sites locations and info and the coverage area is urban environment in the city of ZhengZhou.

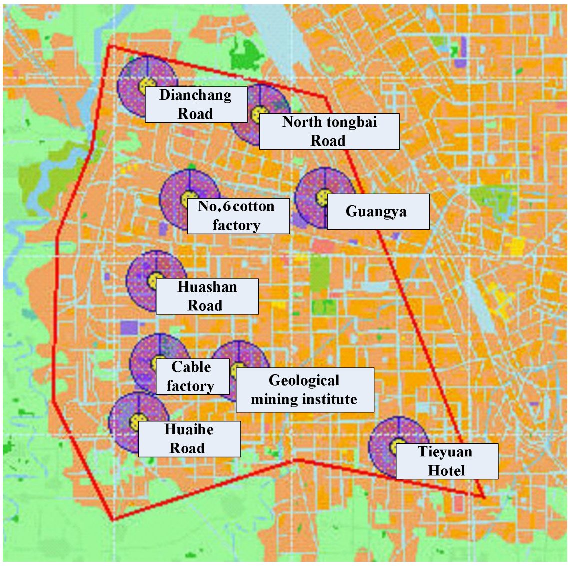

Figure 2: 9 CW sites in urban environment in the city of Zhengzhou

The traditional way is to choose huashan road site or guangya site as the typical site of urban area and then perform model calibration and allocate to calibrated model to all the other sites in urban area. The new method is to using the cluster results and apply the calibrated cluster models to other cells in each cluster.

We compare the prediction results with the two methods which are included in table 1.

Table 1: Prediction results of the two methods

Cell name	Cluster Model RMS Error	Huashan Road Model RMS Error	Guangya Model RMS Error
Geological mining institute -2	12.2163	17.9632	15.3684
Geological mining institute -3	9.4383	9.3552	9.7397
Dianchang Road-1	9.9244	27.2377	20.4835
Dianchang Road-2	10.0713	13.6130	13.3863
Dianchang Road-3	7.8531	17.3638	17.5726
Cabel factory – 1	8.6251	9.2443	7.4162
Cabel factory – 2	6.3763	10.7645	7.5840
Cabel factory – 3	12.1494	10.7064	10.8188
Guangya – 1	8.3465	6.4896	N/A

Guangya – 2	6.7384	9.5654	N/A
Guangya – 3	9.0078	9.5259	N/A
No.6 cotton factory -2	14.7951	7.9864	8.0820
No.6 cotton factory -3	10.4756	9.9834	9.1441
Huashan road -1	9.3055	N/A	7.4664
Huashan road -2	10.6904	N/A	6.4673
Huashan road -3	7.5505	N/A	7.3857
Huaihe road – 1	9.5839	10.6954	9.2315
Huaihe road – 2	29.9236	15.9574	15.2952
Huaihe road – 3	18.5342	10.4919	13.8756
Tieyuan hotel – 1	8.2319	12.8247	10.9899
Tieyuan hotel – 3	5.4494	12.0187	11.2308
North tongbai road – 1	5.0927	7.7937	7.1752
North tongbai road – 2	6.8469	8.3960	8.6782
North tongbai road – 3	13.5288	24.2075	17.8578
Total（RMS Error below 10dB）	62.50%	42.86%	52.38%

Notes: RMS Error means the mean square deviation between prediction value and real drive test data, assuming $x1_i$ is the prediction value of location i,and $x2_i$ is the real drive test data,then,assuming $y_i = x1_i - x2_i$,then RMS Error= $\sqrt{\frac{\sum y_t^2}{N}}$ (N equals to the total number of effective test data).

4. Conclusion

From the results, it's seen that the Cluster Model has the best prediction results compared with the traditional two models. It is about 10% to 20% improvement than the traditional methods regarding the percentage of RMS Error below 10dB.

Besides, we could further form a database of calibrated models and environment attributes which would not only improve the prediction accuracy but also reduce the heavy load to perform propagation drive test, calibration and save much time and cost. It has a strong and wide application prospect.

However, it's seen that the percentage of RMS Error below 10dB is about 62-65% when using the new method and it's still a room to be further improved. We still have to do more research on the characteristics extraction and trying more of the clustering algorithm. Besides, collecting more samples of propagation model drive test is also very important. All the above considerations would be our future key research points.

References

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