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# Best base station location with a given area as an example

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***Abstract:*** *In the communication infrastructure construction, how to reasonably configure base station type and location according to different traffic volume areas, so as to improve the communication efficiency of base station coverage area and enhance the sharing of resources. The problem of communication bandwidth becomes bigger and bigger, but the coverage of BTS becomes smaller and smaller, which makes the number of BTS needing to cover the same area become more and more. We simplify the type of BTS into macro and micro BTS according to the requirements of the project, and use the CHARACTERISTICS of BTS given in the project to conduct mathematical modeling. In the actual construction process, we adopt effective site selection, which can not only improve the investment efficiency, but also reduce the construction and maintenance cost of base station. Therefore, it is of practical significance to study the site selection of base station. Genetic algorithm is used to analyze the optimal solution in simulation space and find the optimal method of station construction. The simulation software is used to simulate the coverage of the base station and verify the rationality of the site selection scheme.*

***Keywords:*** *Base station, communication bandwidth, Genetic algorithm*

## 1. Introduction

In recent years, with the rapid development of mobile communication industry, mobile communication technology has been widely penetrated into all walks of life[1-2]. At the same time, with the continuous development of 5G network and services, the dependence on mobile communication is gradually deepening. In the communication process, the requirements for speed, quality and safety are getting higher and higher[3]. The communication bandwidth is getting bigger and bigger, but the area that the base station can cover is getting smaller and smaller. Therefore, scientific and reasonable station location planning has become one of the research contents of network planning and construction[4]. In practical problems, there are many types of base stations with different coverage areas, so the construction cost and construction period need to be taken into account in the actual planning process.

## 2. Analysis of the problems

Site selection is an important part of communication network planning. Establish a network of communication base station in a certain position often depends on the environment and terrain, and then select the best combination of the terrain and the environment for the construction of the base station, communication network the final adjustment of the base station location selection according to the actual local conditions, rather than generate large area check the location of base station in a small area to adjust the location is more convenient and effective to determine the communication base station site location Therefore, we first need to determine the location of a communication base station, we first need to determine its general location range, and then fine-tune according to the local specific terrain and environmental characteristics, to determine the overall location.

## 3. Model establishment and solution

Macrocell refers to the type of equipment room composed of outdoor tower rooms, etc. For the construction of modern macro base stations in the outdoors, many factors influence the construction of macro base stations, and uneven terrain, tall floors, etc. will affect the signal coverage area of macro

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base stations, and the signal band used by TD-LTE is higher spatial propagation loss than 2G/3G, and the actual coverage area relative to the theoretical signal coverage area of macro stations is larger[5]. The area will appear regional weak signal area and signal blind area, based on the shantytown scenario, there are many problems in the mobile network construction of macro station.

Microstation The coverage area can reach up to 1-2.5 km. In the early stage, in order to make the macro station have a larger coverage area, the macro station with higher position is set to a lower pitch angle while the macro station with lower position is set to a high pitch angle, and the larger coverage area has the phenomenon of signal trans-area coverage, which causes the signal to disturb each other, and at the same time, the increase of signal coverage area also makes the weak signal area and signal blind area increase greatly.

The principle of polygon planning is to connect all adjacent base stations to form a colorbic triangle. For each side of these triangles, the area near each of these base stations will produce a polygon. Each vertex of this polygon is the planned location of the base station. See the following figure for details:

Model planning principle:The principle of polygon planning is to connect all adjacent base stations to form a colorbic triangle. For each side of these triangles, the area near each of these base stations will produce a polygon. Each vertex of this polygon is the planned location of the base station. See the following Figure 1 for details.

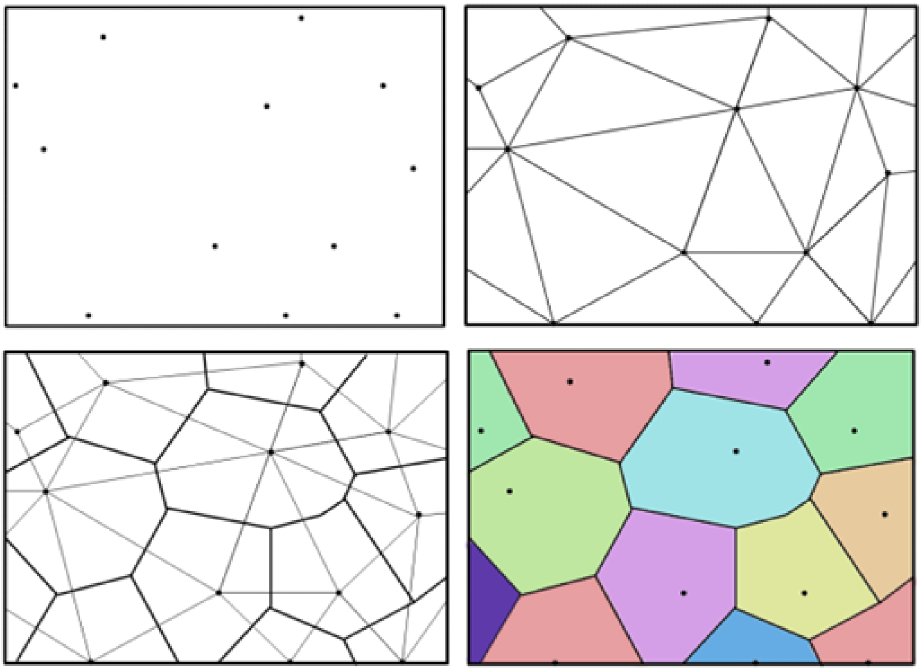

*Figure 1: Schematic diagram of the polygon planning*

Model planning steps:

Collect all base station information in a city, analyze and sort out, and build the status of base station network in a city.

According to the Vonornoi diagram, according to the spacing of network base station, the station location is preliminarily planned. The initially obtained sites were optimized.

Planning purpose: To maximize the area covered by each base station signal, there may be overlapping signal coverage areas between adjacent base stations, and there will be part of the network coverage area loss. In order to improve the effective coverage area of the signal system to the target area, theoretically, the signal coverage area of each base station is the same and determined, and the signal is blocked by obstacles, overlaps with the coverage area of other base stations, and meets the target area, which is a waste of the base station. It is assumed that the area of the overlapping area of the two base stations is; the area of the base station signal beyond the target area of the signal is the minimum loss of all base stations. The formula is as follows:

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$$\min f_1 = \sum_{q=1}^{n} S_q + \sum_{i=1}^{n} \sum_{j=i+1}^{n} S_{ij} \quad (i,j,q = 1,2,\dots,n) \tag{1}$$

Reduce the signal interruption distance. The signal interrupt distance is the distance at which the mobile terminal moves between the two signal coverage areas unable to receive the signal. The shortest distance for a mobile terminal to move from the base station signal coverage area directly to the base station signal coverage area is:

$$length_{ij} = \begin{cases} d_{ij} - 2D_0 & d_{ij} - 2D_0 > 0 \\ 0 & d_{ij} - 2D_0 \leqslant 0 \end{cases} \tag{2}$$

When the path through which the mobile terminal passes has multiple signal coverage areas, that is, to pass through multiple no signal areas, the path $path(s,t)$ through the no signal area in the shortest path from the starting point to the end point is

$$\cos t(s,t) = \sum_{b_i b_j \leqslant path(s,t)} length_{ij} \tag{3}$$

The above formula is the path formula through the signal zone, and the shortest is:

$$\min f_2 = \frac{2}{n(n-1)} \sum_{s=1}^{n} \sum_{t=s+1}^{n} \cos t(s,t) \tag{4}$$

The shortest path passing through the signal-less area during the terminal receiving the signal is the closer the distance between the areas covered by the base station signal, but the less overlapping between the two, the more conducive to improving the continuity of communication.

The result of the base station address planning is set in its corresponding sub-address area, that is, the position of all base stations in their sub-region is random and the transformation between any positions is continuous, and the position combination of all base stations will constitute the range of the target index. In the multi-objective optimized Pareto solution set, there are similar solutions with multiple subregions combining in the same way but with different offsets. After grouping the Pareto solution set according to the combined mode of the subregions, multiple schemes and the corresponding indexes of each scheme can be obtained. The following figure is used to determine the applicability and rationality of the planning scheme.

The standard layer consists of basic performance and adjustment ability, which is the area of the base station signal coverage area, and the interruption cost when moving between different signal coverage areas. Adjustment ability refers to the ability to adjust the network coverage in the required area. The final selected scheme is determined jointly by the evaluation index weight and the scheme index evaluation index. If the weight vector of the evaluation index should be as follows, according to the evaluation index obtained from the categorized data, the optimal solution of the scheme is:

$$E = \sum_{i=1}^{2} \sum_{j=1}^{2} w_{ij} a_{ij} \tag{5}$$

In all the schemes obtained, the resulting E-value maximum solution is the optimal solution and the optimal recommended solution.

From the data obtained, 182,808 data can be obtained, and the volume of all data is summed: 7056230.115

Ninety percent of the total volume of business is available: 6350607.1035

Regions with high business volume have priority to establishing base stations, so the given data should be screened as follows:

Due to the large amount of data given in the attachment, the too large amount of data will lead to the decrease of the accuracy in the recording process, and artificial subjective errors and computer

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objective errors may occur. Therefore, the obtained data should be screened to eliminate outliers. We decided to treat the outliers.

Equal precision measurement of all measured values yields that $x_1, x_2, \ldots x_n$ seek its mean $x$ , And calculate their remaining error $v = x_i - x \quad (i = 1, 2, 3 \ldots n)$ , through $Bessel\ formula$ the standard deviation was calculated, If a certain data is being tested $x_b$ residul error $v_b \ (1 \leqslant b \leqslant n)$ , that is to meet:

$$|v_b| = |x_b - x| > 3\delta \tag{6}$$

The value is the problem data with large error, which should be eliminated.

For these excluded unreasonable data, we believe that the error is caused by the input or the error of sampling, and these values should be modified or eliminated. We set the legitimate range of the target data as $x \pm 3\delta$ , so the data falling within $(x - 3\delta, x + 3\delta)$ the interval are reasonable data, and the values falling outside them are excluded. Box plots then identify the extreme exception obtained values and replace these extreme outliers with normal values.

The data given in the attachment after outliers processing, take part of the data to draw box plot, used to show the approximate distribution characteristics of the data given by the attachment, and replace the data used to compare the distribution of data between different groups using MATLAB plot as follows, the green part of the Figure 2 is low volume, to eliminate these data.

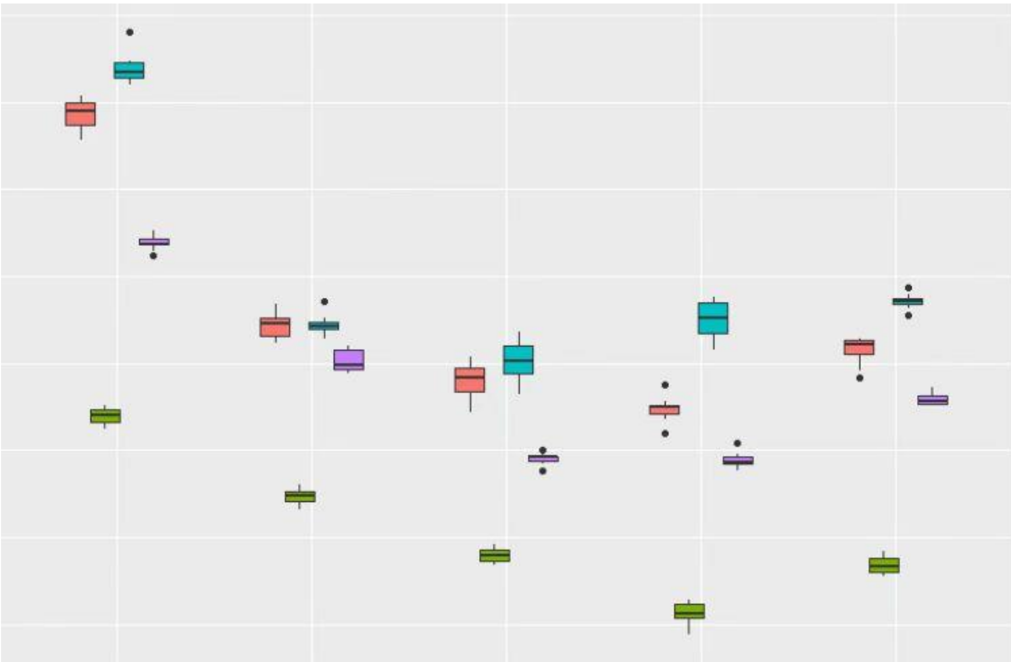

*Figure 2: Boxplot of the data distribution*

## 4. Conclusion

In this paper, through K-Means cluster analysis, through the preprocessing of the starting data, the base station that meet the coverage of 90%, and then the written coordinates are processed, calculated to select between macro and micro base stations according to its local characteristics, and the types and specific coordinates of the base station are given.

Finally, we calculated that there were 3213 and 209 micro base stations, and the total cost was 34125. The proportion of new base station business volume was 91.134%. The location of the base station was drawn as follows through Matlab, and the data was visually analyzed.

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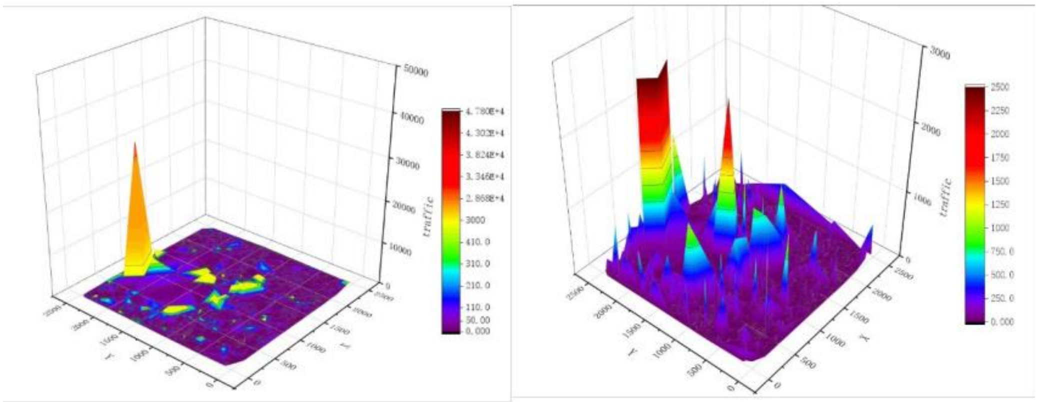

*Figure 3: Location distribution map of all base stations*

As can be seen from Figure 3, without the number of groups, the positions of all base stations can be displayed in the figure, because the data are processed as the coverage reaches 90%, so it can be determined in FIGS. 5-10 that all base station choices can meet the coverage.

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