Verification and analysis of mobile communication network simulation method based on reverse coverage test

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Abstract: The common mobile communication network simulation method is to use the terminal to measure the downlink data of the base station and carry out the coverage simulation analysis of the mobile communication network. The test workload is large, the labor cost is high, and the accuracy deviation is large. The distributed base station is used to test the uplink data of the terminal, and the wireless link algorithm is used to carry out the coverage simulation analysis of the mobile communication network, so as to collect big data and high precision. Combined with the high-speed distribution processing capacity of the new generation of mobile communication network, the network test, simulation and analysis can be completed. Through verification and comparison, this method has many data sampling points, good real-time performance and high accuracy, and provides technical support for future automatic network planning and intelligent network optimization.

1. Introduction
Mobile communication network coverage is very important to the promotion of network users perception now, good coverage is the guarantee of the quality of the mobile communication network and grasp the real coverage situation of the network is the basis of network planning and network optimization work. The traditional test method adopts the technology of the road test, through frequency sweep meter and mobile terminals such as measurement of the base station downlink signal data, requires a large amount of manpower and material resources, often cannot as all-round full time measuring network, therefore, traditional methods have certain limitations. Based on the principle that the same frequency of uplink and downlink can be replaced, if use the distributed base station in the mobile communication network to reverse terminal of the uplink test, combined with the new generation of mobile communication network the distributed processing capacity, will be able to obtain full time reverse uplink coverage data automatically, complete cell propagation model adjust and simulation, and instead of traditional method.

2. Implementation of reverse coverage test system
The acquisition of the uplink signal of mobile transmitting station is different from the traditional acquisition of the downlink signal of base station, so it is called reverse coverage test. Reverse coverage
test system can be divided into three parts: transmitting system, receiving system and data processing system. The transmitting system uses a specific frequency point and a specified time slot to transmit uplink signals along the test route at a fixed power using a mobile transmitting station. The receiving system uses the surrounding base station to measure the signal and obtain the equal measurement data of signal reception. The data processing system is to summarize, store and analyze the measured data reported by all base stations on the network side according to the cell ID index. The reverse coverage test system is shown in figure 1.

![Figure 1. the diagram of reverse coverage test system](image)

The equipment of reverse coverage test system is shown in table 1:

| system                  | equipment                                                   |
|-------------------------|-------------------------------------------------------------|
| Transmitting system     | Mobile transmitter, electronic map, GPS receiver, inverter, test vehicle |
| Receiving system        | Base-Stations                                               |
| Data processing system  | Network management software, ZXPOS-CNA analysis software, ACP simulation software |

Specific methods are as follows:

1) transmitting system: the test vehicle is loaded with a mobile terminal and tested along a preset route. The mobile terminal transmits upline signals and obtains longitude, latitude and time synchronization information through GPS receiver. The test is scheduled to take place during idle hours (in the night or early morning) on the test route.

2) receiving system: select a test area in which 13 base stations are deployed, as shown in figure 2. The base station receives uplinked signals, firstly configure the measurement task through the network management system, manually adjust the parameters of the test frequency point in the region as the cell of the main carrier, and then report the measurement data and summarize and store them according to the cell ID as the index.
(3) data processing system: the system records uplinking measurement data, time stamp information and transmission power configuration of the cell, and combines the longitude and latitude information, time stamp information and transmission power uploaded by the mobile terminal through the air interface. At the same time, the background processing software carried out data processing, and finally used the test data in the planning software, corrected and processed by the propagation model at the cell level, and finally obtained the cell coverage level distribution map of all base stations in the test area.

In order to obtain the comparative data, the downlink data was tested with a frequency sweeper at the same time during the test. The antenna of the reverse coverage test equipment and the antenna of the frequency sweeper were placed outside the test vehicle, and the test route was consistent. The cell coverage level test was conducted, and the network parameter Settings were restored after the test.

3. Validation of reverse coverage tests

3.1 comparison and verification of test data with the current network

The first step is to compare the reverse coverage test with the current network test to confirm the feasibility of the reverse coverage test results.

(1) based on the reverse coverage test data, considering the influence of the antenna used in the test, wireless parameters (orientation, antenna height) and transmitting power, obtain the coverage information of road loss of each cell;

(2) combined with the planning scheme, verify and test the influence of antenna, wireless parameters and transmitting power corresponding to the actual network, and obtain the RSCP of PCCPCH road coverage prediction results of each cell;

(3) based on Best Server, the RSCP of PCCPCH is obtained.

The second step is to compare the test data of reverse coverage with the test data of the current network based on BIN.

For reverse coverage testing data from the distributed base station and a frequency sweep meter acquisition of network test data, in order to avoid has mutual interference signal, respectively, to test, at the same time to eliminate the difference between the two tests route, so compare the reverse coverage testing data and current network testing data, to compare the result is Arg Dif: 0.786dB, Std.Dev: 6.414dB, Total Bin Number: 1142, MaxDif Higher: 29.895dB, MaxDifLower: -19.641dB. As shown in figure 3.
It can be seen that the road coverage results obtained from the reverse coverage test data are basically consistent with the results from the current network test data, and the reverse coverage test data can be used. In order to further verify the reliability of the data, the experimental data is applied to the network simulation.

3.2 comparison with traditional simulation results

The first step is to carry out network simulation of traditional mode, that is, the traditional model of network planning is used for simulation, and then the simulation results and road test data are analyzed for deviation. The deviation distribution is shown in figure 4.

Mean difference: -2.18dB, maximum difference: 43.25dB, minimum difference: -56.60dB, standard deviation: 12.92dB, mean square deviation: 13.11dB, correlation coefficient: 0.34.
In the second step, the reverse coverage test data is used in network planning, and the propagation model is corrected and simulated based on the reverse coverage test data. Among them, each cell independently corrects the model, and RSCP based on PCCPCH is compared to obtain the simulation results. Analyze the deviation between simulation results and road test data, and the deviation distribution is shown in figure 5.

Mean difference: 0.29dB, maximum difference: 17.95dB, minimum difference: -15.55dB, standard deviation: 8.71dB, mean square deviation: 8.71dB, correlation coefficient: 0.13.

The third step is to compare and analyze the network simulation results between the two modes. As can be seen from the comparison figure above, the simulation result of reverse coverage mode is closer to the real situation of the network. Further comparison between the two groups of simulation data shows that the average deviation between the traditional simulation mode and the road test data is -2.18dB, and the mean variance is 13.11dB; the average deviation between the reverse coverage simulation mode and the road test data is only 0.29dB and the mean square deviation is 8.71dB. The statistical comparison data are shown in table 2:

| Comparing values      | Traditional simulation model | Reverse override simulation mode |
|-----------------------|------------------------------|---------------------------------|
| average deviation     | 2.18 dB                      | 0.29 dB                         |
| mean square deviation | 13.11 dB                     | 8.71 dB                         |

It can be seen from the comparison that the reverse coverage simulation mode is superior to the traditional simulation mode.

4. Validity analysis of reverse coverage test

The verification work mainly completed the analysis and comparison of reverse coverage test data and frequency sweeper test data. The realization method of reverse coverage test system is to turn on the special measurement function by means of software upgrade in the base station side of the system, which has no impact on the current network equipment. Mobile terminal fundamentally to avoid the main road test tools more traditional mode at the receiving end compared with limited frequency measuring sensitivity problem, from the point of view of comparative data, reverse coverage testing
technology in the aspect of data completeness is superior to the traditional road test tools, at the same time avoid the upward due to insufficient mobile transmission power constrained problem, can really reflect the network coverage, for network simulation and optimization provides accurate and effective data and methods.

5. summary
Reverse coverage testing can more truly reflect the comprehensive network coverage, through the analysis of the reverse coverage data of site, the cell level propagation model calibration and path coverage can find network coverage problem, in view of the weak coverage analysis the rationality of the construction of site. At the same time, the application of reverse coverage test data provides a foundation for automatic network planning. Test data can be applied in automatic planning tools. Combined with engineering parameters and high-precision map, interference matrix can be constructed to complete the optimization of neighbor cells, frequencies and scramblers, greatly improving the efficiency and accuracy of coverage optimization. Reverse coverage testing technology also provides a technical basis for AINO (artificial intelligence network optimization). In the future, network optimization work will realize automatic, fast and accurate output of network optimization solutions.

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