Research on Interference of LTE Wireless Network in Electric Power System

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Abstract. In view of the problems of electric power wireless communication and to serve the power consumer better, On the basis of the basic principles of TD-LTE's network structure, interference in the wireless network optimization of power system are analyzed in detail, and put forward a method of interference remediation for power system. Based on the actual, cases, the feasibility of interference remediation is verified by means of data processing and comparative analysis. The interference analysis provides a technology support for electric power communication access network construction and late operation and lays the foundations for popularization and application of LTE power wireless private network, and the security of the power network is guaranteed.

Keywords: TD-LTE · Barrage jamming · Intermodulation interference · Network security · Spurious emission · Network optimization

1 Introduction

As one of the important technologies of power communication network, wireless communication has been widely used in national network marketing, transportation inspection and other systems [1, 2]. At present, many provincial and municipal districts have carried out pilot applications of power private networks based on different wireless communication technologies, including WiMAX, McWILL, 230 MHz LTE, and data transmission stations [3]. Business applications include distribution automation, power information collection, monitoring of transmission and transformation status and so on [4]. At the same time, some problems in power wireless network are gradually exposed. The interference problem will affect the performance of the network, therefore, it is urgent to study the interference analysis of wireless network optimization technology in power system. In this paper, the interference in the power system is introduced in detail, and different kinds of interference is analyzed in detail.

Y. Tian et al. (Eds.): ICBDS 2019, CCIS 1210, pp. 309–318, 2020.
https://doi.org/10.1007/978-981-15-7530-3_23

2 Process for Interference Analysis

For wireless communication networks, the premise of ensuring service quality is to use a clean spectrum, this band is not used or interfered by other systems [5]. Otherwise, the performance of the interference system and the terminal will be affected negatively [6].

The screening of interference cells is to screen out the high interference cells that need to be dealt with according to certain conditions [7]. Interference analysis is the

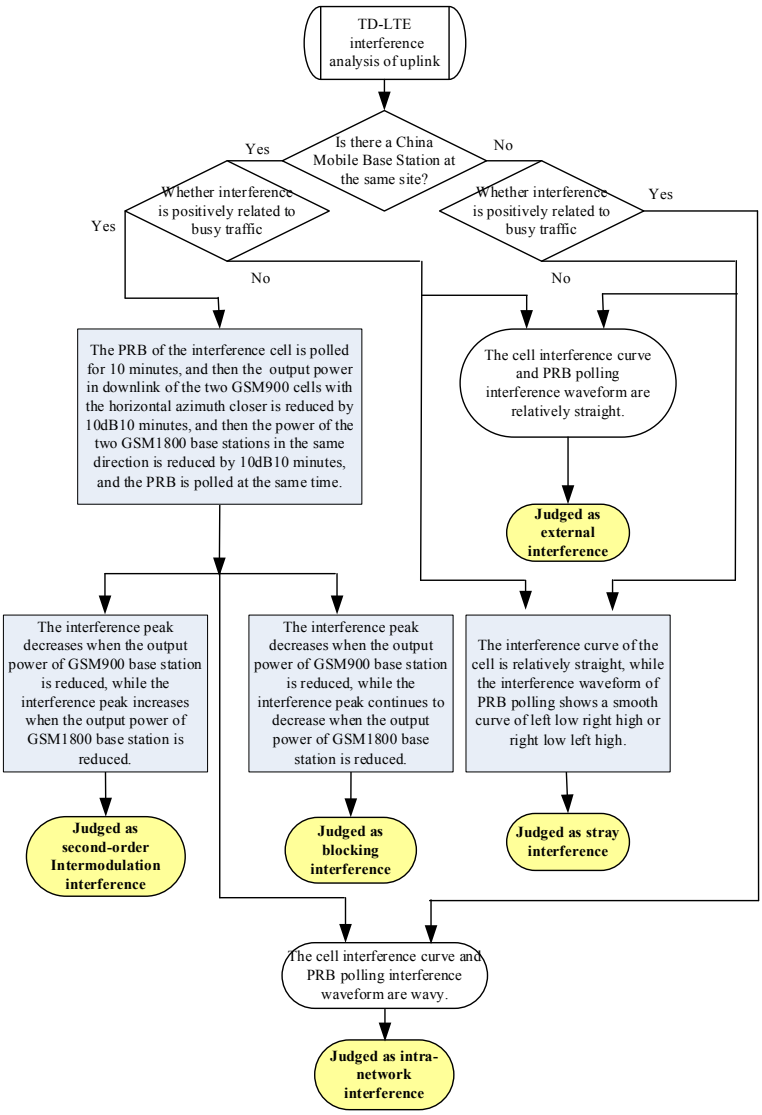

Fig. 1. Interference process of uplink in TD-LTE.

third step in the overall process of interference trouble shooting, and is a very important step. Interference analysis determines the next working direction of site interference detection [8]. Correct interference analysis is helpful to improve the overall efficiency of interference checking. The flow chart of interference analysis is shown in Fig. 1.

3 Analysis and Treatment of Intermodulation Interference

3.1 Analysis of Intermodulation Interference

Intermodulation interference is generally caused by the fact that the Intermodulation signal transmitted by nearby radio equipment falls into the frequency band received by the TD-LTE base station [9]. At present, the Intermodulation interference is mainly the second-order Intermodulation interference produced by China Mobile GSM900 system, which interferes with the F-band of TD-LTE. In addition, in other places, because the frequency band used in GSM1800 system reaches 1870 MHz, the third or fifth order Intermodulation interference will also fall in the F band of TD-LTE. The characteristics of interference are as follows.

The average interference level of the cell is closely related to the traffic of 2G. The busier the traffic of 2G is, the greater the interference of TD-LTE is. The smaller the isolation between the antenna of 2G cell and the antenna of TD-LTE cell, the more serious the interference is.

The interference curve of a cell is shown in the following figure (Fig. 2).

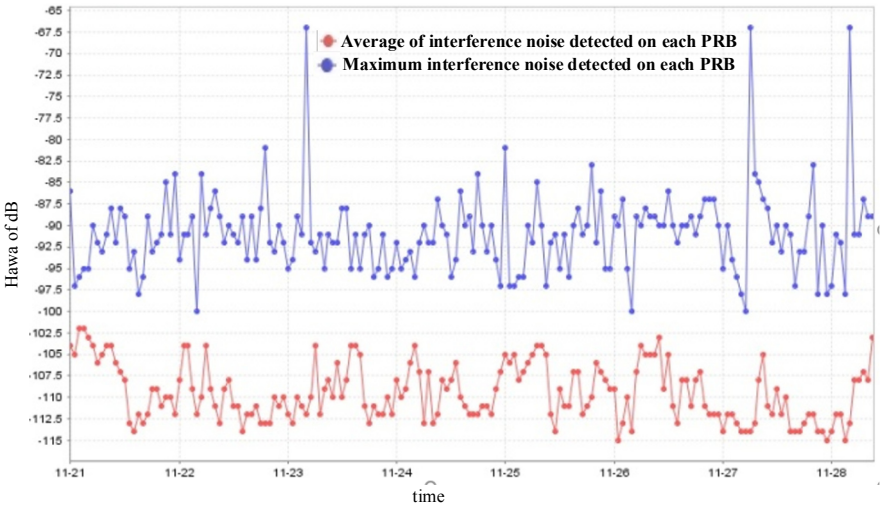

Fig. 2. Intermodulation interference curve.

The interference of PRB level is shown in the following figure (Fig. 3).

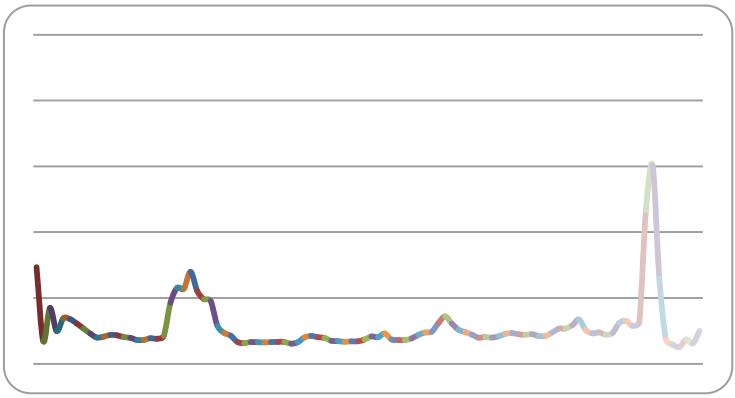

Fig. 3. Intermodulation interference in class PRB.

The characteristics of interference can be clearly seen from the interference of the cell. The interference in the early hours of the morning is the least, because traffic in the early hours of the morning is lower. According to the parameters of information, there are GSM900 base stations in the same sector of the site, and there are many frequency points. The frequency point of BCCH is 69, and the frequency point of TCH is 13/10. The calculated second order intermodulation and second harmonics are shown in the following table (Table 1).

Table 1. Two order intermodulation and two harmonic

Second order intermodulation & frequency point of second harmonic	Interference with the number of PRB in F band
Second-order Intermodulation generated by frequency points 69 and 10	PRB25 ~ 27
Second-order Intermodulation generated by frequency points 69 and 13	PRB28 ~ 31
Second harmonic produced by frequency point 69	PRB91 ~ 93

Therefore, it can be judged from the above table that the sector of TD-LTE is interfered by the second order Intermodulation of GSM900 cell.

Because the antenna is about the same height, the site can be initially determined to be subjected to blocking interference from the GSM900/1800 base station. And because of the frequent occurrence of BCCH frequency points, the second harmonic interference is the most obvious, which is of course related to the low traffic volume in the cell.

3.2 Treatment of Intermodulation Interference

There are two ways to regulate the interference of Intermodulation. First, the antenna of the interference source base station and the antenna of the interfered base station are transformed from horizontal isolation to vertical isolation, the isolation degree can generally be increased by more than 10 dB. Second, the horizontal distance between the antenna of interference source base station and the antenna of the interfered base station is more than 2 meters, or in the case of vertical isolation, the antenna of the interference source base station can be replaced with the antenna with higher second-order intermodulation suppression system. At present, the antenna with intermodulation index of 100 dBm and 43 dBm can be replaced.

4 Analysis and Treatment of Blocking Interference

4.1 Analysis of Blocking Interference

Blocking interference is generally caused by a strong signal transmitted by a nearby radio device received by the device of the TD-LTE. The blocking interference found at this stage is mainly caused by China Mobile GSM900 base station and closer base station. The characteristics of interference are as follows.

The average interference level of the cell is related to the traffic of the interference source, and the busier the traffic of the interference source is, the greater the interference is. The smaller the antenna isolation between the interference base station and the TD-LTE cell, the more serious the interference. Of course, it is impossible to know the isolation degree of the antenna between the systems only through the information of the working parameters, but the isolation degree of the antenna can be roughly understood

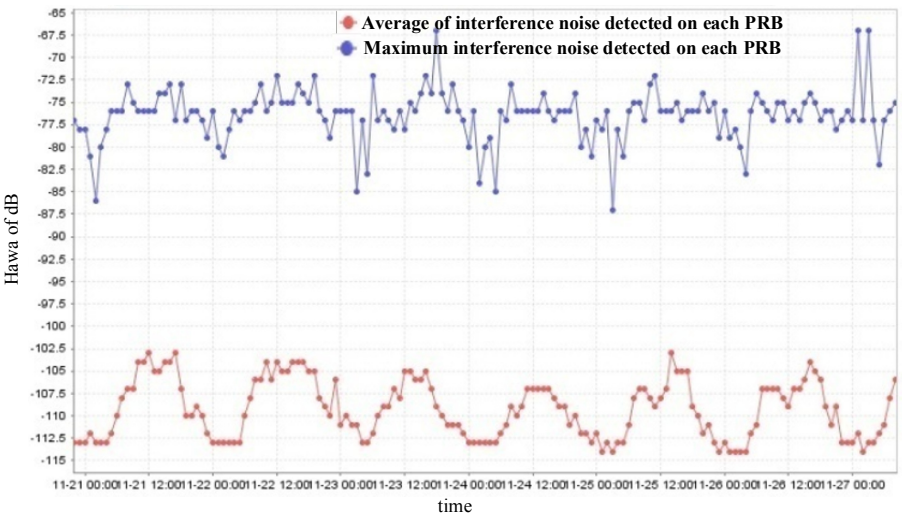

Fig. 4. Block interference curve.

from the antenna height and the horizontal azimuth angle of the antenna. The characteristic of PRB interference is that there is an obvious protruding before PRB10, and there is no obvious interference waveform behind the raised PRB (Fig. 4).

The interference of PRB level is shown in the following figure (Fig. 5).

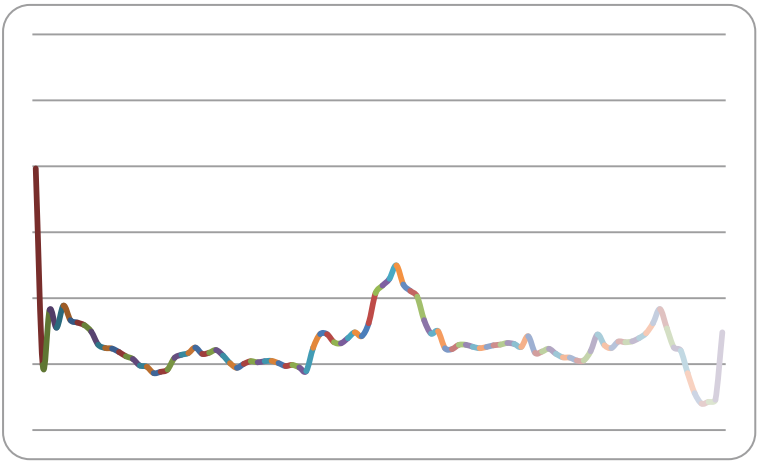

Fig. 5. Block interference in class PRB

The interference characteristics of the cell can be clearly seen from the interference of the cell. The interference in the early hours of the morning is the least, because traffic in the early hours of the morning is lower. From the interference of PRB, we can see that there is a large uplink interference in the cell around PRB1. According to the information of working parameters, there is a GSM900/1800 base station in the same sector, and the antenna of the base station is the same as that of the LTE base station. Therefore, the site can be initially determined to be subjected to blocking interference from the GSM900 base station.

4.2 Treatment of Blocking Interference

There are three ways to deal with blocking interference.

First, filters in the corresponding frequency band can be installed on interfered TD-LTE base stations. It should be noted that the filter installed in the RRU, common mode with the TD-SCDMA in the A band must be 2010–2025 MHz compatible.

Second, increase the isolation between the two systems, for example, raise the antenna height of the interference source base station or the interfered base station, change it from horizontal isolation to vertical isolation

Third, replace the interfered RRU with the RRU of more anti-blocking. For example, replace it with RRU produced after 2012, and its anti-blocking ability is developed and produced according to the latest 3GPP specification, compared with the

previous RRU, the resistance to stopper is obviously enhanced, so the number of blocking interference sites is small.

5 Analysis and Treatment of Stray Interference

5.1 Analysis of Stray Interference

Stray interference is the interference caused by stray transmission outside the transmission band of one system falling into the receiving band of another system. Stray interference directly affects the receiving sensitivity of the system. If the stray falls into the receiving frequency band of the system, the receiver system of the interfered system can not filter out the stray signal, therefore, the filter must be added to the input port of the transmitter to control the stray interference.

In the process of actual investigation, it is found that the stray interference mainly comes from three aspects. One is the stray interference from China Mobile GSM1800MHz base station, second, the 1G FDD-LTE base station of China Telecom at present, third, the TD-LTE base station in E band is vulnerable to the stray interference of WLAN AP.

The diagram of interference curve is as follows (Fig. 6).

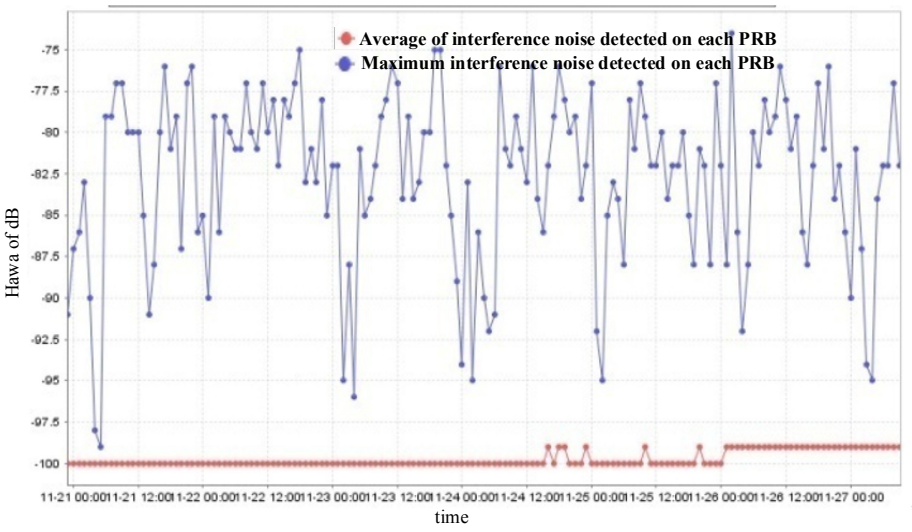

Fig. 6. Stray interference curve.

From the diagram, the interference curve of the cell affected by stray interference is relatively straight, and the fluctuation is generally about 1 dB.

The interference of PRB level is shown in the following figure.

From the interference curve, we can obviously see that the interference of the cell has obvious busy characteristics, and there are many interference peaks in the interference polling waveform of PRB (Fig. 7).

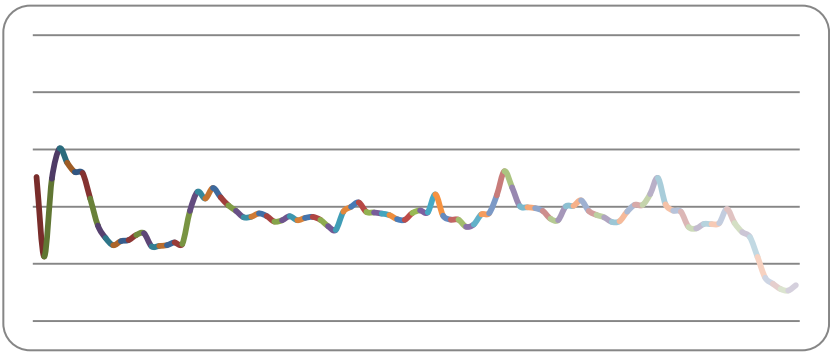

Fig. 7. Interference curve in class PRB

5.2 Treatment of Stray Interference

There are two kinds of treatment methods for stray interference.

First, by increasing the isolation between the antenna of the base station and the base station of the interference source, the purpose of reducing the interference can be achieved, horizontal isolation can generally be changed to vertical isolation. The second is to reduce stray interference by adding bandpass filter to the base station of interference source.

6 Interference Analysis of Power Wireless Private Network

There are two main ways to find interference. One is to statistics the uplink interference through the base station side, the other is to collect the downlink interference through the terminal side. Taking Y city as an example, the interference index in uplink of the last week is extracted, and the granularity is the one day. The uplink interference can only be extracted on the base station side, and the downlink interference can only be collected on the terminal side. Uplink interference is ideal when the low noise is below −120 dbm, and can be determined as interference when it is higher than −120 dbm. When the uplink interference is higher than-110dbm, it is considered that the interference begins to deteriorate, and when it is higher than-105 dbm, it is considered that the interference is more serious (Table 2 and Fig. 8).

Table 2. Uplink interference statistics

RSSI	Number of samples	Proportion
[0～−95)	891	85.84%
[−95～−105)	144	13.87%
[−105～−110)	3	0.29%
[−110～−115]	0	0.00%
[−115～−120]	0	0.00%

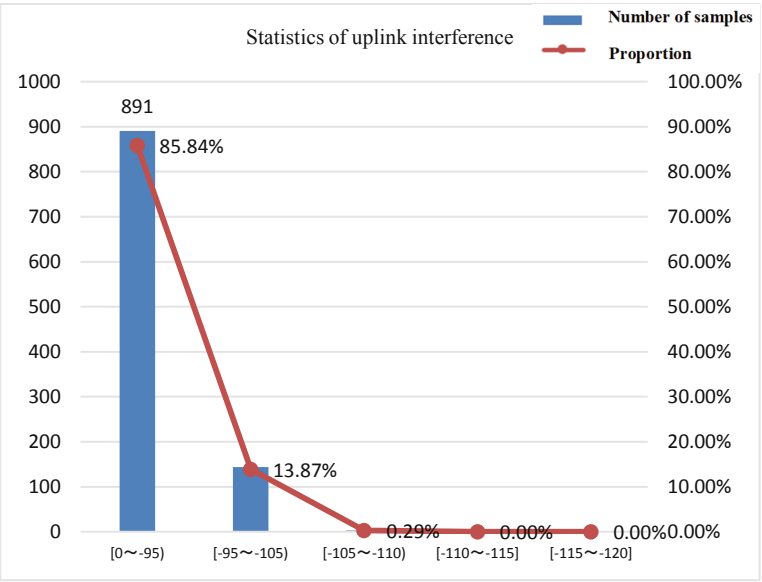

Fig. 8. Statistics of uplink interference.

From the above statistics, we can see that, the proportion of interference above −95 dbm is very high, reaching 85.84%, it shows that the interference in the frequency band is very serious and needs to be checked.

7 Conclusion

This paper is based on the basic principle of TD-LTE network structure, the frequency sweep test, interference analysis, alarm processing and coverage optimization in wireless network optimization of power system are analyzed in detail. In this paper, an

optimization method in TD-LTE wireless private network is proposed. The network optimization scheme provides technical support for the construction of power network, and lays a solid foundation for the popularization and application of power wireless private network.

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