INFLUENCE OF INTERFERENCE IN GSM NETWORK AND OPTIMUM SOLUTIONS

I.V. Kashtanov and O.D. Arkhelyuk

Department of Correlation Optics, Chernivtsi National University, Chernivtsi, Ukraine
E-mail: ikashtanov@yahoo.com

Abstract

The frequency band used in GSM network is mostly overload. For required network access traffic surface the channels inside the network are repeatedly used. It increases the negative interference processes. As a result the quality of service and the network capacity become lower. The effective optimisation methods decreases the interference influence and guarantees the comfort signal to noise ratio.

Keywords: interfernce, BS, power control, antenna height.

INTRODUCTION

Interference is a limiting factor in the performance and capacity characteristics of the cellular systems. The sources of interference are the mobile station in a cell, base stations with the same frequency, or any other nonlinear systems that inadvertently affect the frequency range of cellular systems. Interference on voice channels is cross-noise, in consequence of which the quality of transmission of voice traffic. Interference leads to increase «blocked» traffic due to the increase of errors in digital signaling. Interference factor particularly relevant to urban areas, where the density of mobile users and base stations is much higher than outside of the city. In GSM the main limiting factor for bandwidth is co-channel interference from cell, that using the same frequency.

Our further interest will be focused on the basic techniques which allow significantly reduce interference levels in the mobile communications system. We will consider downlink communication, from the base station equipment to the mobile terminal. Effect of the power control setting changes is presented in Section 1. Reduction of interference by changing the antenna height is presented in Section 2. Effect of base station antenna titlted on intrference reduction is presented in Section 4. Section 5 summarizes our work.

SECTION 1

Influence of the power control parameter changes on interference level.

Introduction.

Main objective of the power control is adapting of base station transmitter power to the mobile station's reciever and contrariwise.

For example, a mobile station 1, that is located near BTS can use a lower transmit power than mobile station 2, that is located on the edge of a cell. The main advantages of the given method are interference level reducing and power consumptions of the mobile station.

The primary power control measures.

For the power control manage are used the received signal power level, signal to noise ratio and forthcoming errors bit frequency in the receiving signal. The measured values RXLEV_FULL (power level of received signal) and RXQUAL_FULL (signal to noise ratio) handle in BTS for the further decisions about power level correct.

Power Control Decision.

For the power control decision, RXLEV and RXQUAL are compared with fixed tresholds L_RXLEV/U_RXLEV – L_RXQUAL/U_RXQUAL. Power control decision is mainly based on the forthcoming errors bit frequency of the received signal, rather than on the power level. If the controlled variables are within acceptable limits, the power control decision is not applied.

Conclusion.

Mobile operators very often used the power control function. Such regulation is implemented as follows [1]:

- Power control on the open-loop cycle
- Power control on the close-loop cycle.

Also, the combination of the power control function and another technics, sometimes is used in the real networks, but this ussue is beyond the limits of this article.

SECTION 2

Antenna height influence on interference reduction.

One of the most effective strategies for interference level reduction is to change the height of the antenna hanging. According to [2] there are a few methods for determining the effective height of the base station antenna:

- method that determining the effective height of antennas as the sum of the height of the base station and the difference between the mobile station and base station. The difference is added in case of positive values (Fig. 1).

- alternative method is based on the height of the line above the ground. Effective antenna height is two sizes larger than the distance between the beam and the land divided by distance. In case of hard relief, directly line replaced on series of segments that are connected to each other at the highest point of relief (Fig. 2)

SECTION 3

Another method to reduce interference level is a method for base station antenna tilting.

To optimize the coverage of mobile networks and reduce the impact of interference is used new director tilt angle change with the fixed base station antenna height.

Since the attenuation multiplier has interference nature (in a receiving point apart from direct waves can come a few waves from the multiple reflections such as Earth's surfacetion and other obstacles), it is necessary to determine the point of reflection. In practice, the point of reflection is convenient to define on a method of the mirror reflections [3]. The attenuation multiplier module is determined by the interference formulas

$$V = \sqrt{1 + \Phi^2 + 2\Phi\cos\gamma} \qquad (1)$$

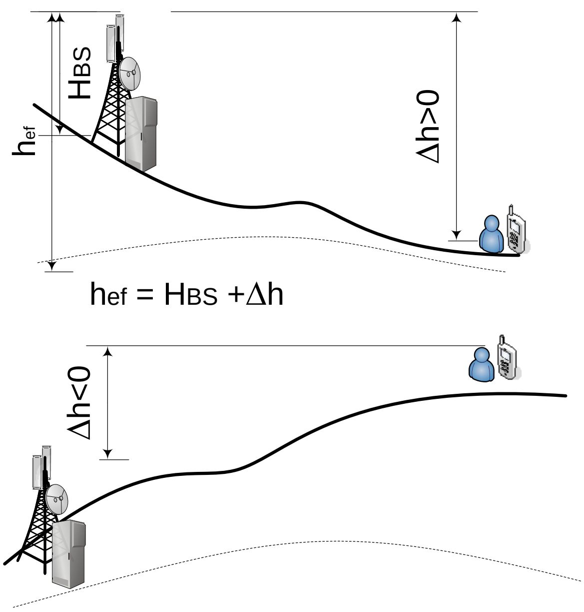

Fig. 1. Determination of the effective base station antenna height.

and in case of the one reflected wave determination of the module reflection factor is a complex task, particularly in the urban conditions. In practice, therefore, are used average values. This approach allows to optimize the angle of the vertical direction of the antennas director to reduce interference effects in the subscriber clusters.

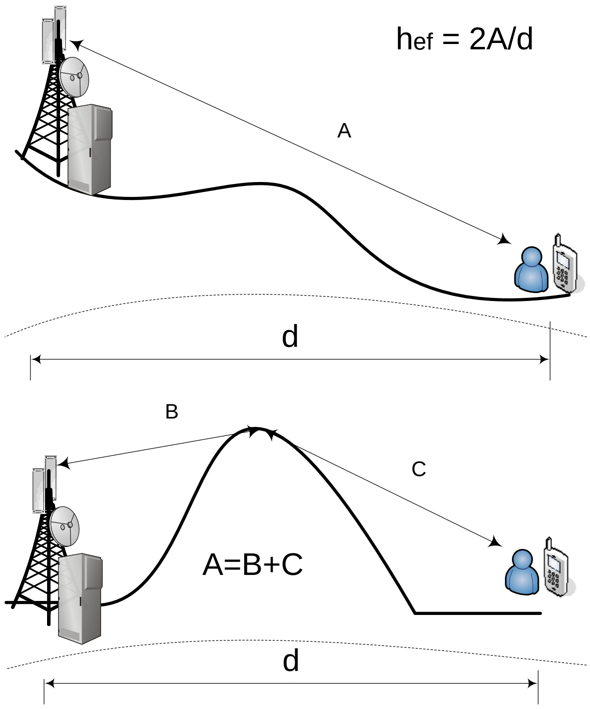

Fig. 2. Determination of the effective base station antenna height .

In [4] analised relation between antenna height and antenna tilted. The following outcome had obtained as a result of the simulation: at the height of the antenna at 25 m, vertical width of the beam 6^0 and the cell size 1.5 km optimal values of antenna tilt angle is 4^0. At the same time, at the antenna height at 45 m, the best antenna tilt angle is 7^0 (fig. 3) . In these cases, management of the antenna tilt can provide interference reduce because of two factors:

- concentration and retention of the signal power within the cell, preventing its spread outside of the cell. This helps to keep the level of interference in this cell in acceptable boundaries and to ensure the required handover level from the neighboring base stations.
- Provide clear cell boundaries to minimize interference with neighboring cells and reducing, thereby, handover zones.

In [5] the authors concluded that with increasing of the antenna tilt angle relative to horizon's line, speaking traffic on the cell is increasing. Also, as mobile operators practice shows, increase the antenna tilt angle in the complex terrain (Fig. 4) allows to limit the influence of the "parasitic" signalling traffic from the subscribers that located on the border of the cell. This technique allows to improve the statistics in problematic places.

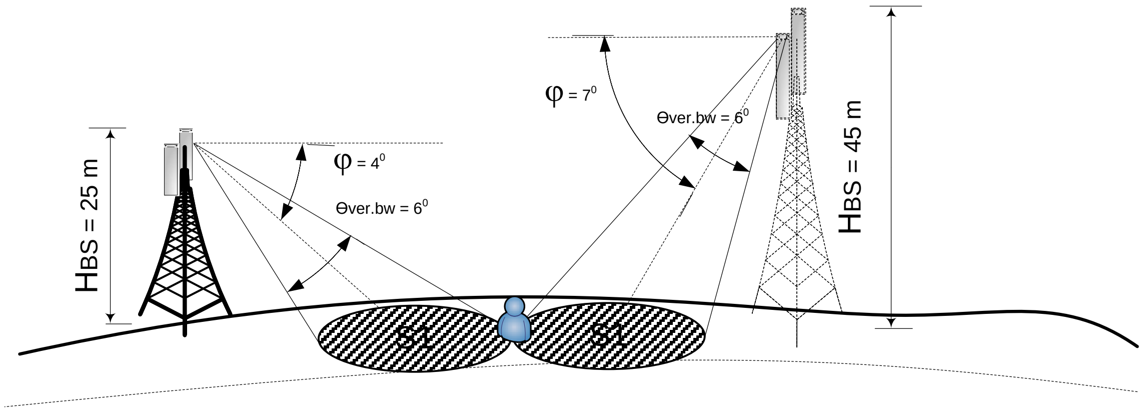

Fig. 3. The optimal value of antenna tilt angle .

CONCLUSION

Thereby, to reduce the interference effects in the GSM-systems the following methods are used:

- Power control on both cycle, close-loop and open-loop;
- A method of antenna height correction in real condition;
- Change of an antenna tilt angle, that especially effective affect on traffic statistic in the difficult relief conditions.

In practice, in GSM-networks, mobile operators use all mentioned methods with this or that efficiency.

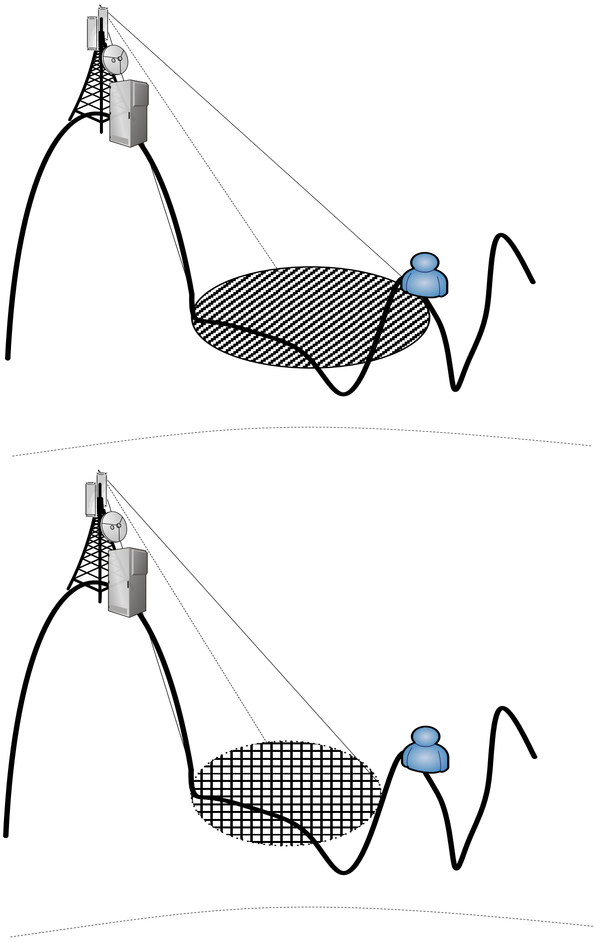

Fig. 4. “Parasitic” signalling traffic limitation.

REFERENCES

1. Stallings W., 2003, ‘Wireless communications and networking’, Prentice Hall, New Jersey.
2. Jukka Lempiäinen, Matti Manninen, 2002, ‘Radio interface system planning for GSM/GPRS/UMTS’, Kluwer Academic Publishers.
3. Каменский Н.Н., Модель А.М., Надененско Б.С., 1981, ‘Справочник по радиорелейной связи’, М.: Радио и связь, с.121
4. T. Isotalo, J. Niemelä, and J. Lempiäinen, 2004, ‘Electrical antenna downtilt in UMTS network’, in Proc. 5th European Wireless Conference (EW'04), pp. 265-271, Spain.
5. Forkel I., Kemper A., Pabst R., Hermans R., 2002, ‘The effect of electrical and mechanical antenna down-tilting in UMTS networks’, International conference on 3G mobile communication technologies N°3, vol. 489, pp. 86-90.