Research Article

Researching of spreading of radio waves from base stations of mobile communication inside of buildings

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Abstrakt- The purpose of this article is to analyze the research devoted to propagation of radio waves inside the building, as well as conducting calculations radio channels located between the transmitting and receiving antenna. The approaches to determining the signal level radio channels inside and outside the buildings allow for a sufficient engineering calculations accurately calculate the attenuation of radio waves. The main objective in this case is the choice of an adequate model propagation in each case. at choice It affects a lot of factors: the frequency range, the distance mobile station from the base, the relief areas and parameters building. Most of the methods of calculation of the field inside the buildings is based on the a large number of experimental measurements in different buildings type, with different views of the walls of the material, floors, degree clutter furniture and equipment.

Keywords: communication, propagation, receiver

1. Introduction

The quality and reliability of communication is the main criterion for work any communication system. In communication systems using radio wave information as vectors, proper prediction signal attenuation along the path from the transmitter to the receiver lets you efficiently and cost-effectively solve the problem ensure the reliability of the radio channel. There fore analysis of the propagation of radio waves in communication systems. It is an urgent task.

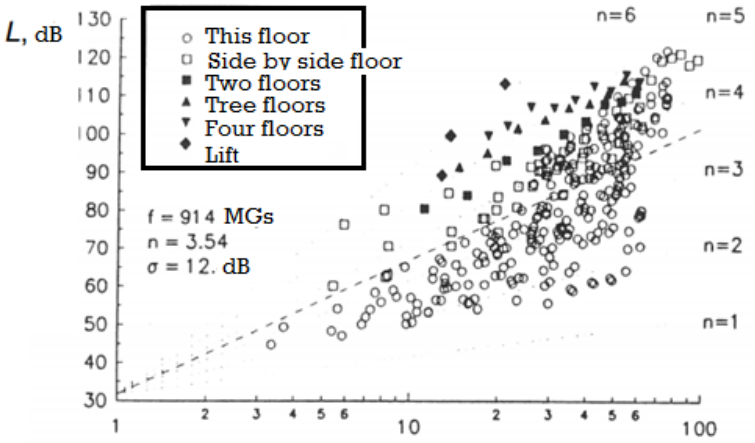
2. Main part

Propagation inside the buildings has its own features. For example, in the corridors observed effect waveguide propagation even with the weakening less in comparison with the open space. At signal attenuation is no direct visibility significantly increases. It is necessary to take into account the passage of radio waves through walls, floors, interior partitions. It has the value of the presence and movement of people inside buildings. Must be take into account the range of operating frequencies of the communication system. Time delays due to multipath propagation usually very small.

Most of the methods of calculation of the field inside the buildings is based on the a large number of experimental measurements in different buildings type, with different views of the walls of the material, floors, degree clutter furniture and equipment.

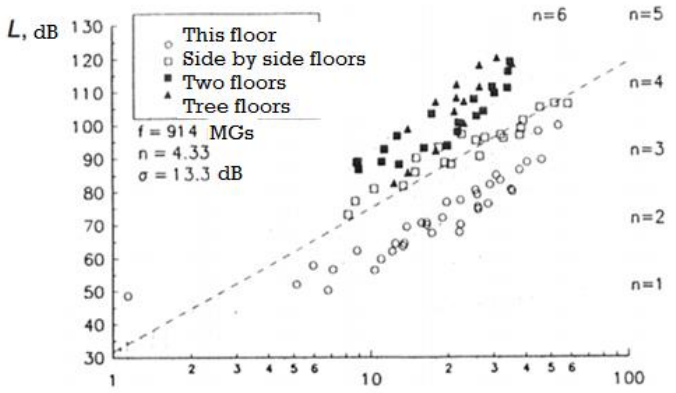
The results of the measurement of signal attenuation as a function of the distance between the transmitting station and mobile receiver for different propagation conditions for the two typical office buildings are shown in Fig. 1, 2. The transmission like radio waves on the same floor, and through the inner lining overlap [1].

It should be noted that the attenuation value depends nonlinearly the number of floors. This is due to the phenomena of diffraction and radio waves Radio Wave Propagation through the windows outside the building.



The distance from the transmitter to the receiver, m

Fig. 1. The results of the experimental measurements of the signal attenuation when propagation inside the building number 1.



The distance from the transmitter to the receiver, m

Fig. 2. The results of the experimental measurements of the signal attenuation at propagation inside the building number 2.

Approximately attenuation level in the channel inside buildings It can be calculated by formulas (1) and (2) with the corresponding values of attenuation coefficients n, given in the Table. 1.

Table 1:The results of experimental measurements attenuation coefficient and its standard deviation for radio links inside buildings.

Building	*f, MGs*	*n*	*y, dB*
Shop retail	914	2,2	8,7
gastronomer	914	1,8	5,2
Office with solid partitions	1500	3,0	7,0
Office soft partitions	900	2,4	9,6
Office soft partitions	1900	2,6	14,1
The company with the line of sight:			
textile / chemical	1300	2,0	3,0
textile / chemical	4000	2,1	7,0
papermaking / grain processing	1300	1,8	6,0
metalworking	1300	1,6	5,8
out of the house to the street in a city house	900	3,0	7,0
Companies with no line of sight:			
textile / chemical	4000	2,1	9,7
metalworking	1300	3,3	6,8

The signal level when propagation inside buildings taking into account the partitions and intermediate floors can be approximately defined as follows:

$$P(d) = P(d_0) + 10nlg\frac{d}{d_0} + FAF(q) + \sum_{p=1}^{p} WAF(p) \qquad (1)$$

Where, FAF(q) – q interfloor attenuation, depending on the number of floors;

WAF(p) – attenuation during the passage of an electromagnetic wave wall
or partition;
p – the number of partitions.

Reference distance from the transmitting antenna for radio lines inside buildings d_0 often chosen equal to 1 m. Signal Level a reference distance

$P(d_0)$ is calculated based on the model Radio Wave Propagation in open space.

The level of attenuation of a wooden wall or ceiling It can be assumed approximately equal to 4 dB, concrete wall or overlap gives a signal attenuation at 10 - 20 dB [2].

Dependence of attenuation on the number of intermediate floors and the type of partitions, obtained in are shown in Table. 2 and 3 respectively.

Table 2:The dependence of the attenuation of the number of intermediate floors q

Let	FAF(q), дБ
Office building №1	
Passing through the 1st floor	12,9
Passing through 2 floors	18,7
Passing through 3 floors	24,4
Passing through 4 floors	27,0
Office building №2	
Passing through the 1st floor	16,2
Passing through 2 floors	27,5
Passing through 3 floors	31,6

Table 3:The dependence on the type of signal attenuation baffles

Partition	WAF, дБ
Rag partition	1,4
Wall, plastered on both sides	3,4
Concrete wall	13
Aluminum siding	20,4
Metal wall and ceiling	26

n a method for calculating attenuation level within Building on the basis of formula

$$L = 20lgf\,[MGs] + 10\,nlgd[m] + L_f n_f - 28,\ dB. \qquad (2)$$

In the formula (2) takes into account the attenuation L_f between floors using attenuation and the number of intermediate floors n_f.

The attenuation in a radio link on the same floor is calculated on the basis of appropriate selection of the attenuation coefficient of.

Table 4:The attenuation coefficient for the calculation of the attenuation in the radio channel inside buildings

Frequency, GGs	Radio wave propagation environment		
	Residential building	Office	manufacturing room
0,9	-	3,3	2,0
1,2-1,3	-	3,2	2,2
1,8-2,0	2,8	3,0	2,2
4,0	-	2,8	2,2

Table 5: Attenuation coefficient between floors L_f, dB.

	radio wave propagation environment

Frequency, GGs	Residential building	Office	manufacturing room
0,9	-	9 (Adjacent floors)	-
		19 (over 1 floor)	
		24 (over 2 floor)	
1,8-2,0	$4n_f$	$15 + 4(n_f - 1)$	$6 + 3(n_f - 1)$

In a method of calculating the attenuation in a communication channel IEEE 802.11 broadband access, working in a range of 2.45 GHz is used for wireless communication networks. On based on numerous measurements proposed at distances up to 8 m alculate attenuation by the formula from the antenna to the base station free space [3]. At distances greater than 8 m used formula

$$L = 58{,}3 + 33\lg\frac{d}{8} \qquad (3)$$

that is attenuation rate for the considered radio $n = 3{,}3$

If you wish to obtain more accurate information on the signal level inside the building, you can use ray tracing method or solve the problem of severely, for example, using a program electrodynamic HFSS simulation [4]. However, this substantially It increases the computation time.

Illustration of radio wave propagation simulation in facilities using Wireless In site program is shown in Fig. 1 - 4. The first modeled the building itself, or a fragment thereof.

Set the parameters of the material of the walls and ceilings (Fig. 1). Then It indicates the point at which it is desirable to calculate the tension field, in fact, is the sampling of the object. Program It calculates the possible ways of propagation

(Fig. 2 - 3).

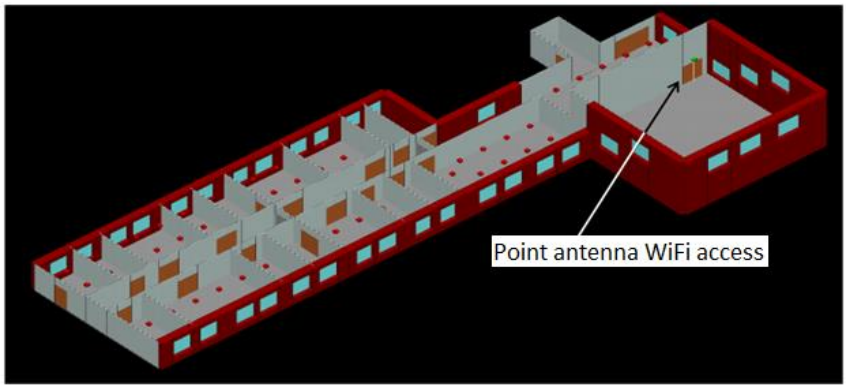


Fig. 1. Modeling of the building fragment Wireless Insite environment

Point antenna WiFi access

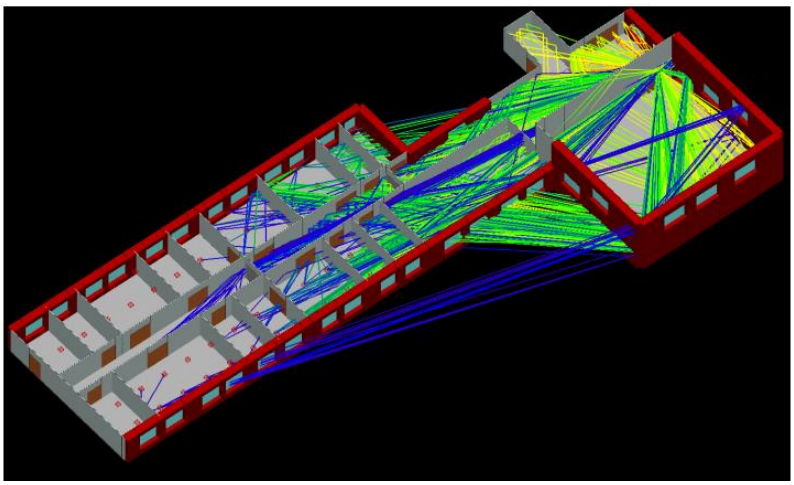


Fig. 2. The signal beam tracing method of calculation

The calculated signal strength distribution is shown in Fig. 4.

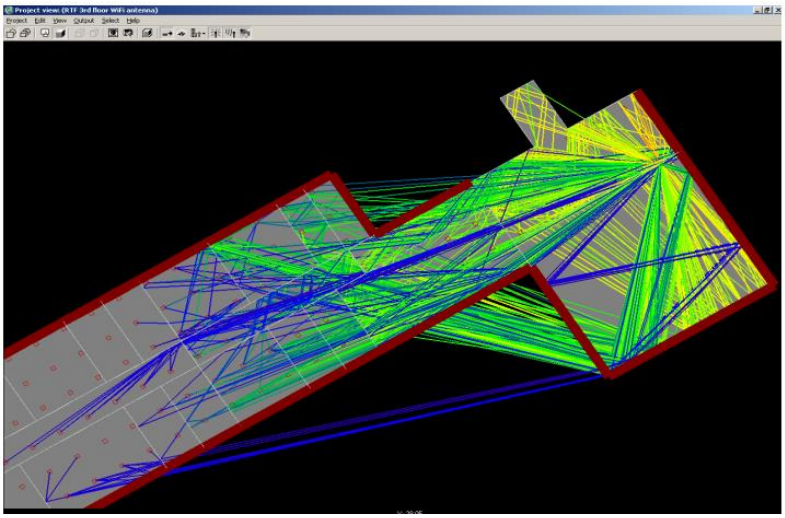


Fig. 3. The signal level calculation WiFi hotspot ray tracing method

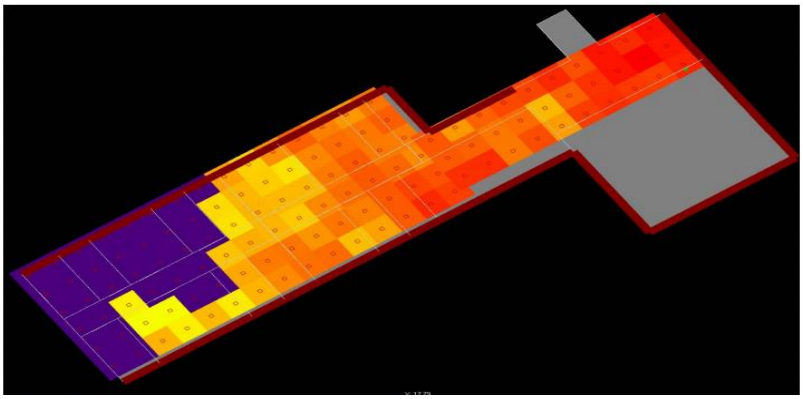


Fig. 4. The distribution level Wi-Fi hotspot signal Wireless Insite environment

The calculated distribution of the level of the transmitting station signal to determine the place of reliable reception. Knowing the minimum possible signal level in the system (receiver sensitivity), You can identify problem areas in terms of network organizations wireless access. This makes it possible to optimize the layout access points in the building to determine their required amount.

Once again it should be noted that the simulation beam propagation, and especially electrodynamic modeling, for example, in environments requires significant HFSS computer resources and memory speed. The calculations may require hours of CPU time, and may not place due to the limitations of computer technology.

3. Conclusion

The considered approaches to determining the signal level radio channels inside and outside the buildings allow for a sufficient engineering calculations accurately calculate the attenuation of radio waves. The main objective in this case is the choice of an adequate model propagation in each case. at choice It affects a lot of factors: the frequency range, the distance mobile station from the base, the relief areas and parameters building.

We hope that the material contained in this manual will help buy radio paths calculation skills and make the necessary calculations.

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