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ISSUES OF TRANSMITTING INFORMATION VIA COMMUNICATION SYSTEMS

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ABSTRACT

This article discusses the problems of data transmission through communication systems, such as: signal attenuation, shadow zones, multipath propagation of signals, signal fading. The characteristic features of signals transmitted through the connecting channels are highlighted and described. Such systems are affected as: MIMO technologies — a method of spatial signal encoding that allows increasing the bandwidth of a channel in which data transmission and data reception are carried out by systems from several antennas, the GSM standard.

1 Introduction

A person receives information from everything that surrounds him with the help of the main senses: hearing, sight, smell, touch, taste. He receives the greatest amount of information through hearing and vision. Audio messages are perceived by sound acoustic signals in a continuous environment. The eyes perceive light signals that transmit images of objects. Information can pass through, as with the help of natural channels (atmospheric air through which sound waves pass, light the sun reflected from the

observed objects), and with the help of artificially created ones. In the second case, we are talking about technical means of communication.

2 Technical information transmission systems

Since time immemorial, mankind has used various primitive types of signaling and communication for the purpose of ultrafast transmission of important information. Bonfires lit on high ground or smoke from bonfires should signal the approach of enemies or an impending natural disaster. By this method so far people who get lost in the taiga or tourists experiencing a natural disaster use it. Some tribes and peoples used certain combinations of sound signals from the drum and wind instruments for this purpose musical instruments, while others have learned to transmit certain messages by manipulating, reflecting sunlight with using arrays of mirrors. The first technical means of transmitting information over a distance was the telegraph, invented in 1837. On the basis of the discovery of electromagnetic waves by the German physicist Heinrich Hertz (1886), A. S. Popov in Russia in 1895 and almost simultaneously with him in 1896, G. Marconi in Italy invented radio. Television and the Internet appeared in the twentieth century. All these technical methods of transmitting information are based on the transmission of a physical signal remotely and obey some general law. So what is a signal?

3 Types of signals

A signal is a code created and transmitted to space via a communication channel by one system, or that arose during the interaction of several systems. [4]. Signals can be subdivided: periodic and non-periodic. A periodic signal is a signal whose values are repeated at certain regular intervals, called the signal repetition period or simply the period. This condition is not met for a non-periodic signal. [2] The simplest periodic signal is a harmonic oscillation.

$s(t)=S*sin(wt)$ (1)

where S, w are the amplitude and angular frequency of the oscillation. Another example of a periodic signal is a sequence of rectangular pulses. What do you think this pulse sequence consists of? It turns out to be from sinusoids. As the initial sinusoid, select the one whose oscillation period coincides with the period T of rectangular pulses

$s(t)=S_1*sin(w_1t)$ (2)

where. S_1 is the amplitude of the sine wave, and w_1:

$w=2\pi/T$, (3)

The oscillations of a given frequency $w1$ and amplitude S_1 can be represented in as a graph: mark the value of $w1$ on the frequency axis and draw a vertical line with a height equal to the amplitude of the signal S_1 . The next sine wave has a frequency 3 times higher, and the amplitude is 3 times less.

$S_1*\sin(w_1t)+ (S_1/3)*\sin(3w_1t)$, (4)

The sum of these two sinusoids formula (4) still bears little resemblance to rectangular pulses. But if we add to them sinusoids with an oscillation frequency of 5, 7, 9, 11, etc. times more and amplitudes of 5, 7, 9, 11, etc . times less, then the sum of all these oscillations:

$S=S_1*sin(w_1t)+ (S_1/3)*sin(3w_1t) + (S_1/5)*sin(5w_1t)+\ldots\ldots$ (5)

$S1=(\pi/4)*U=1.27*U$, (6)

where formula (6) will not differ so much from rectangular pulses. Thus, the degree of "squareness" of the pulses is determined by how many sinusoids with increasingly higher oscillatory frequencies we

sum up. There is another classification of signals: constant, discrete or analog.

An analog signal is a signal that can be represented by a continuous line of different values defined at all times by relative to the time axis. [3]. If a certain signal takes arbitrary values only at a certain time, then such a signal is called discrete. Most often in practice, discrete signals are used, located in a homogeneous time scale, the step of which is called the sampling interval. When a discrete signal takes only some fixed values so that they can be represented as a number of quantum quantities, such a discrete signal is called digital. That is, a digital signal is a discrete signal that is quantified not only by time intervals, but also by the level.

4 Problems of signal transmission

The following main problems that arise during signal transmission can be distinguished: signal attenuation, shadow zones, multipath propagation of signals, signal fading. Let's look at them in more detail.

4.1 Signal attenuation

For the transmission of telecommunication signals are used various environments: electrical or optical communication cable,airspace, etc. Regardless of the chosen transmission method, the initial signal energy that was at the output of the transmitter will gradually decrease. In other words, the signal will disappear. There are several causes of attenuation for a radio signal. The main one is the dissipation of signal energy into heat, that is , the radio transmitter "heats" the surrounding space. However, this type of loss is quite predictable and has the property of linearity. Thus, knowing that the attenuation of the signal for a certain frequency per unit length, it is possible to calculate in advance the required radiation power of the transmitter to transmit the signal over a given distance.

4.2 Shadow zones

With the propagation of signals from the cellular base station (BTS)

on its way, it faces various obstacles of artificial and natural origin. Obstacles

of artificial origin are apartment buildings, industrial buildings, wide bridges and viaducts, and others. Obstacles natural origin: mountains, hills, rocks, high forests, etc. Thus, any less wide object towering above the surface The ground at least a few meters can create a barrier. Depending on the size of the barrier, several options are possible: the signal can simply bypass the barrier, or a so-called

parietal zone with a very low signal level is formed behind the object, or the signal will generally be be absent. Usually, the objects that can become an obstacle are known even before the deployment of the communication network and the design is carried out from the very beginning, taking into account possible obstacles. There are many solutions to this problem. Firstly, to close large parietal areas with a large an additional base station can be installed by the number of potential subscribers in this area

. In this case, it can be in a low-capacity configuration. If we are talking about a sparsely populated parietal zone, then the most reasonable solution is to install repeater. The principle of its operation is that the repeater accepts

the capacity of another base station and emits a cell signal in a given field.

4.3 Multipath propagation of signals

The signal can be absorbed by an obstacle or reflected from it. After that, this signal can again be

reflected towards the receiver. In this case, this signal will arrive at the receiver, but it will happen with a delay. On the other hand, the rest of the signal energy can reach the receiver without re-reflection for a shorter time. time or skip more reflections, which will lead to even more delay. This effect occurs when there are several ways of delivering a signal between the source and receiver. In this case, the signal energy will be distributed unevenly between the signal samples , which may eventually lead to a situation where the receiver cannot receive sufficient energy, at least in one of the copies for one signal reception. However, this problem has another advantage that does not lie on the surface. With multipath propagation of the signal, the receiver receives several copies of the signal at once. By comparing these copies with each other, you can detect and even correct errors that occur during signal propagation. This principle is based on the operation of the Rake receiver in the mobile equipment of the UMTS (Universal Mobile Telecommunications System) cellular communication network. The energy from these receivers is then compared and added. Thus, for a Rake receiver, the best environment is simply multipath signal propagation, not unobstructed. In MIMO (Multiple Input Multiple Output) technology, multipath propagation is a necessary element of the transceiver operation. The principle of this technology is based on the fact that the flow of information from one source is divided between several transceivers. There is also a set of the same number of transceivers on the receiving side. Thus, not one is organized, but there are many communication channels, and it is desirable for them to have different ways of passing signals. Practical tests have shown that the fewer obstacles between MIMO transceivers, the lower the overall data transfer rate in the toga was achieved. This technology has become widespread in UMTS (Universal Mobile) networks Telecommunications System) and LTE (Long Term Evolution).

4.4 Signal fading

The signal on the radio interface of the cellular system rarely spreads in a straight line. There are usually various obstacles on the propagation path that lead to the reflection of the signal and a change in its path. As a result, a situation may occur when the receiver does not receive one, but several temporary copies of the original signal with different amplitudes. And the energy of the original signal will be distributed unevenly between copies. This is the so-called phenomenon of multiple distribution the signal. By itself, this phenomenon does not lead to big problems, there are quite effective methods of struggle. However, a situation may arise when two copies of the signal fall into the opposite phase. This means that a copy of the signal can be stored over a time interval of several signal periods. In this case , the receiver may develop two signal beams and neutralize each other. If it turns out that these two the beams in total carry significant signal energy, this can lead to an increase in the number of errors and a decrease in the quality of the communication channel. This the phenomenon is called "fading" of the signal, i.e. the signal seems to stop coming between the source and receiver for a while. There are two main types of fading, depending on the effect they have and their cause: fast and slow fading. Slow fading is caused, as a rule, by bad weather conditions and there are quite effective methods to combat them.

Fast fading is caused mainly by the movement of the receiver or obstacles closely related to the receiver of the signal. This type the attenuation frequency is selective, that is, the change in frequency, by which it is transmitted to, can either reduce this effect, or completely remove it. Thus, signal fading is one of the most important problems in cellular communication. However, many years of experience

and a large number of developments in this area currently allow us to deal with fading quite effectively.

5 Conclusion

Some of these problems manifest themselves in almost any system radio communications (signal attenuation, shadow zones), and therefore there are already solutions to these problems. But others (fading, multipath propagation of signals) required the developers of standards to introduce new methods of struggle. The problem is still that, that the voice transmitted in real-time communication systems cannot allow transmission with long delays.

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