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FEATURES OF THE SIGNAL PROPAGATION IN HIGH-SPEED RADIO RELAY COMMUNICATION LINKS

Abstract. *The article is devoted to modern high-speed radio-relay communication lines. In particular, the features of the transmission and distribution of signal signals in radio relay communications. This type of communication can be considered one of the most stable types of communication with wireless data transmission, where free space (airspace) is used as a transmission medium, as well as an alternative to fiber-optic communication lines (FOCL). At the moment, the tasks are to simultaneously increase the throughput, resistance to various factors of the data transmission medium, as well as the communication range and profitability.*

Keywords: *Data transmission, Communication systems, Radio relay communication, Bandwidth, Signal propagation, Adaptive modulation.*

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ОСОБЕННОСТИ РАСПРОСТРАНЕНИЯ СИГНАЛОВ В ВЫСОКОСКОРОСТНЫХ РАДИОРЕЛЕЙНЫХ ЛИНИЯХ СВЯЗИ

Аннотация. *Статья посвящена современным высокоскоростным радиорелейным линиям связи. В частности, особенностям передачи и распространения сигналов в радиорелейной связи. Данный вид связи можно считать одним из самых стабильных с беспроводной передачей данных, где в качестве среды передачи используется свободное пространство (воздушное пространство), а также альтернативой волоконно-оптических линий связи (ВОЛС). В данный момент стоят задачи одновременного повышения пропускной способности, устойчивости к различным факторам среды передачи данных, а также дальности связи и рентабельности.*

Ключевые слова: *Передача данных, Системы связи, Радиорелейная связь, Пропускная способность, Распространение сигнала, Адаптивная модуляция.*

Introduction

To implement the information transfer process, various radio engineering devices are currently used, which form a kind of information transfer system. An information transfer system (ST) is a set of technical means combined into a single technological chain. It uses the general physical principle of signal processing and transmission, as well as a certain order of interaction of individual elements with each other (satellite, cellular, microwave radio relay, etc.) [1].

Possibilities of modern radio relay communication

Radio relay communication is one of the types of terrestrial radio communication based on multiple relaying of radio signals. For many wireless routes, especially in suburban areas, the range of 10 Gbit/s magistral radio relay links (RRL) in the 71-76/ 81-86 GHz range is a critical factor if it is required to cover a distance with restrictions on the installation of a repeater (water, forest, etc.). In the climatic conditions of Russia, the typical RRL range of the 70-80 GHz range is within 3-6 km. For civilian systems in this range, the transmitter output power is limited to 0.15W, therefore, overcoming the range above 10 km is a difficult technological task [2].

Signal propagation features

As the carrier frequency increases, the signal attenuation in the atmosphere increases too [3]. Figure 1 shows the dependence of the signal attenuation in the atmosphere on the frequency.

The potential of the radio link, as well as the signal attenuation on the path, is indicated in dBm. (dBm) - decibels to milliwatts, i.e. by how many decibels the given power is more than 1 mW. Path attenuation includes 3 components – attenuation in vacuum, in air and in rain [4]. The first two components are the same for any region. But the rain in different regions goes differently - in some it almost does not happen all year round, while in other regions it can be very intense in certain months.

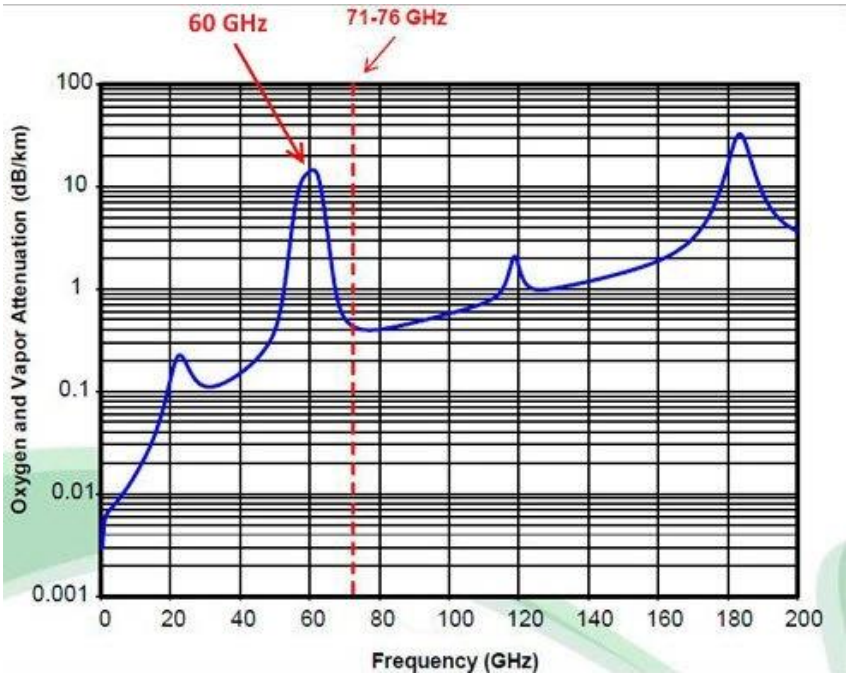

Fig. 1 – Dependence between signal attenuation and frequency.

As the frequency increases, precipitation also has a greater effect on the signal. In the 2-8 GHz range, their influence on the powerful radio relay channel is practically unnoticeable, and in the ranges above 40 GHz, rain becomes a serious obstacle. For example, in the 71-76 / 81-86 GHz range, the attenuation will be about 3 – 60 dB/km depending on rain intensity (Fig. 2).

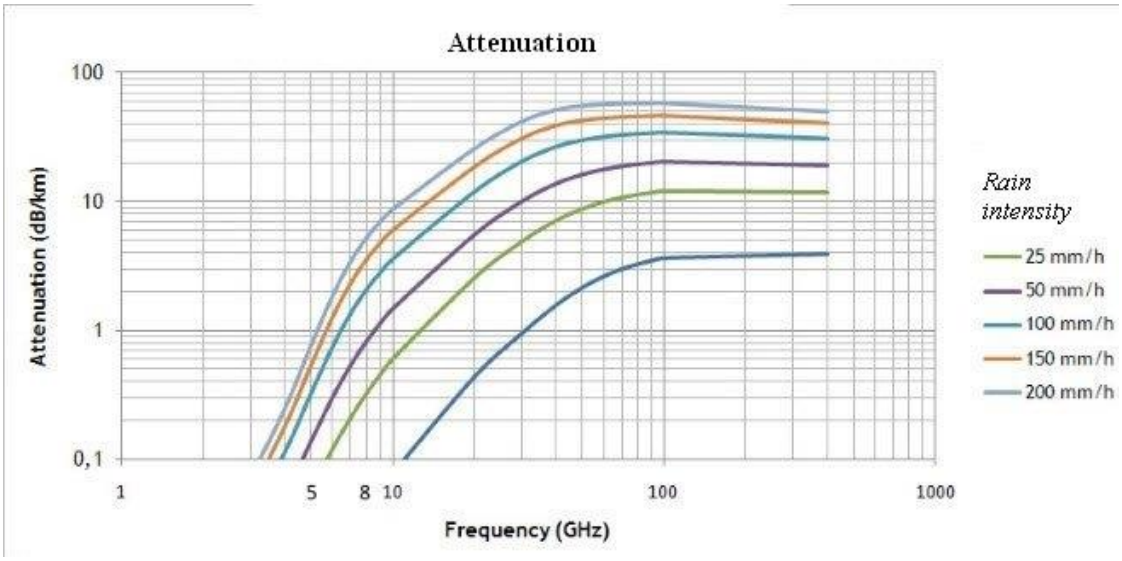

Fig. 2 – Dependence between signal attenuation and frequency in the rain

Therefore, it is important to calculate the energy balance of the radio relay line at different precipitation levels, typical for the area where the radio bridge is installed [4].

To reduce the effect of rain, almost all modern trunk-class radio relay lines have an adaptive modulation function, which changes the type of modulation from complex types (256 QAM, 128 QAM, 64 QAM) to simpler ones (QPSK, BPSK) to improve the energy reserve of the radio relay link depending on the rain intensity. The purpose of adaptive modulation is to avoid dropping the connection at the cost of reducing the transmission rate. After the rain ends, the RRL automatically restores the maximum bandwidth (Fig. 3).

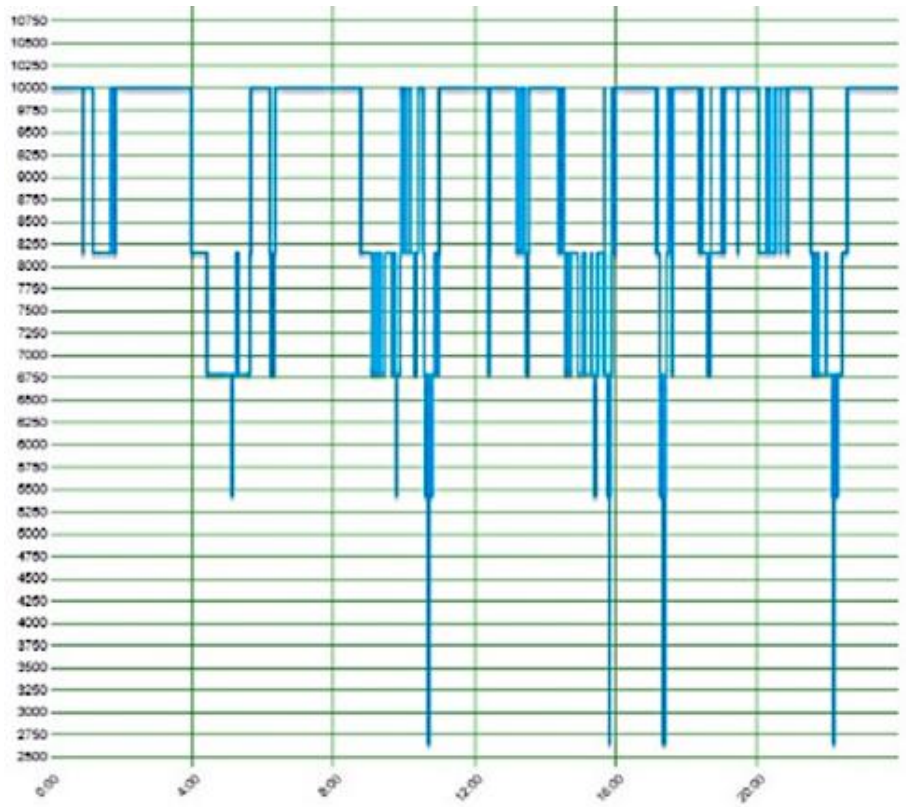

Fig. 3 – 10-Gigabit RRL throughput graph in the rain.

Figure 3 shows the daily bandwidth statistics of the PPC-10G-E-60 70-80 GHz radio bridge [4]. This graph shows the principle of adaptive modulation: the type of modulation changes and the transmission rate is reduced, but the connection does not break.

Thus, the use of adaptive modulation in wireless networks, in particular, in radio relay lines, significantly improves the performance of the information transmission system and allows you to work stably under the influence of various interferences [5].

Conclusion

The features of signal propagation in high-speed radio relay links considered in the article play an essential role in the design of radio relay routes, the calculation of the energy budget and the choice of equipment. The performance of the communication system will also depend on this, i.e. bandwidth, stability of work, communication range, etc.

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