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METHOD OF INCREASING THE CAPACITY OF FIBER OPTIC TRANSMISSION SYSTEMS USING Y-SPLITTER

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Abstract

The issue of increasing the capacity of fiber-optic transmission systems is relevant and has prospects for development in the future. The article discusses methods for increasing capacity and their scope of application, and also describes a method for increasing the capacity of fiber-optic transmission systems using Y-splitters.

Keywords: Mobile, information and communication, Y-splitters, fiber, attenuation, telecommunications, length of optical fiber.

Introduction

In the world in the field of information and communication technologies, close attention is paid to the development and optimization of methods and devices for improving mobile telecommunication networks and fiber-optic lines.

In the context of intensive improvement of modern information and communication systems, increasing the volume and flow of information, one of the pressing problems is increasing the capacity of mobile telecommunication networks. In this direction in the field of information and communication technologies in the leading countries of the world, the demand and need for methods and devices for increasing the capacity of mobile telecommunication networks and fiber optic lines is increasing.

One of the most important issues in the world is the study of methods to increase the capacity of mobile telecommunication networks, Development of methods for increasing the capacity of mobile telecommunication networks. In this area, targeted scientific research is being carried out, including close attention to the following areas:Development of the architecture of regional mobile telecommunication networks.

Formation of criteria for managing information flows in regional mobile telecommunication networks. Formation of criteria and development of methods for experimental assessment of the capacity of mobile telecommunication fiber-optic communication networks.

MAIN PART

Nowadays, telecommunication systems allow creating digital information transmission systems of various types – transfer of audio, video and data in various forms. From the point of view of TCS development, fiber-optic transmission systems are a promising solution for transmitting all types of traffic.

As a result, for the subsequent increase in productivity, the development of the architecture of the basis for the operation of devices, materials and technologies for the production of fiber-optic information transmission systems is important.

Scientists are positive about the possible future of using graphene as a base for fiber-optic paths. The material has demonstrated its properties, being quite flexible, durable and electrically conductive.

The positive properties of graphene do not end there; with the help of graphene it is possible to make a supercomputer in which the dimensions of the computing cells will be reduced by millions of times. As a result of this, again, the development of a basic manufacturing technology comes to the fore, which is largely guided by new ideas and the size of the invested funds. Despite significant advances in nanotechnology, the current limited resolutions (around 10 nm) do not yet allow the use of new computer technology.

One of the methods for moving to the next level of quality and transmission speed is considered to be the development of processing and transmission devices with the support of molecular electronics; the introduction of individual molecules of organic compounds as an elementary base. All possible configurations of molecules provide an unlimited range for encoding all states of elementary particles and information messages in them.

Increasing the capacity of fiber-optic communication lines is one of the key challenges in the face of growing traffic and the need for faster and more reliable connections. With the development of digital technologies and the increase in the number of Internet users, the load on the existing infrastructure is growing, which requires the modernization and optimization of networks.

WDM is a wave division technology that allows multiple signals to be transmitted over a single optical fiber at different wavelengths. This method allows for significant increases in bandwidth using existing infrastructure.

Advantages: Increased bandwidth without replacing cable, flexibility in traffic management.

Disadvantages: High cost of equipment and complexity of setup.

DWDM is a denser version of WDM that allows up to 80 or more channels to be used on a single fiber. This method is especially relevant for backbone networks and networks with high traffic density.

Advantages: Maximum efficiency of optical fiber use, support for large volumes of data.

Disadvantages: Requires complex and expensive equipment.

CWDM is a simplified version of WDM that uses fewer channels with greater spacing between wavelengths. This method is suitable for less congested networks and can be a more cost-effective solution.

Advantages: Reduced cost compared to DWDM, ease of implementation.

Disadvantages: Lower throughput compared to DWDM. Efficient routing and optimal traffic distribution can significantly relieve the network and improve its performance. The use of modern routers and traffic management systems helps to achieve these goals.

The introduction of 5G technologies opens up new opportunities to increase network capacity, especially in conditions of high user and device density. Optical networks play a key role in supporting 5G infrastructure, providing the necessary capacity and data transfer speed.

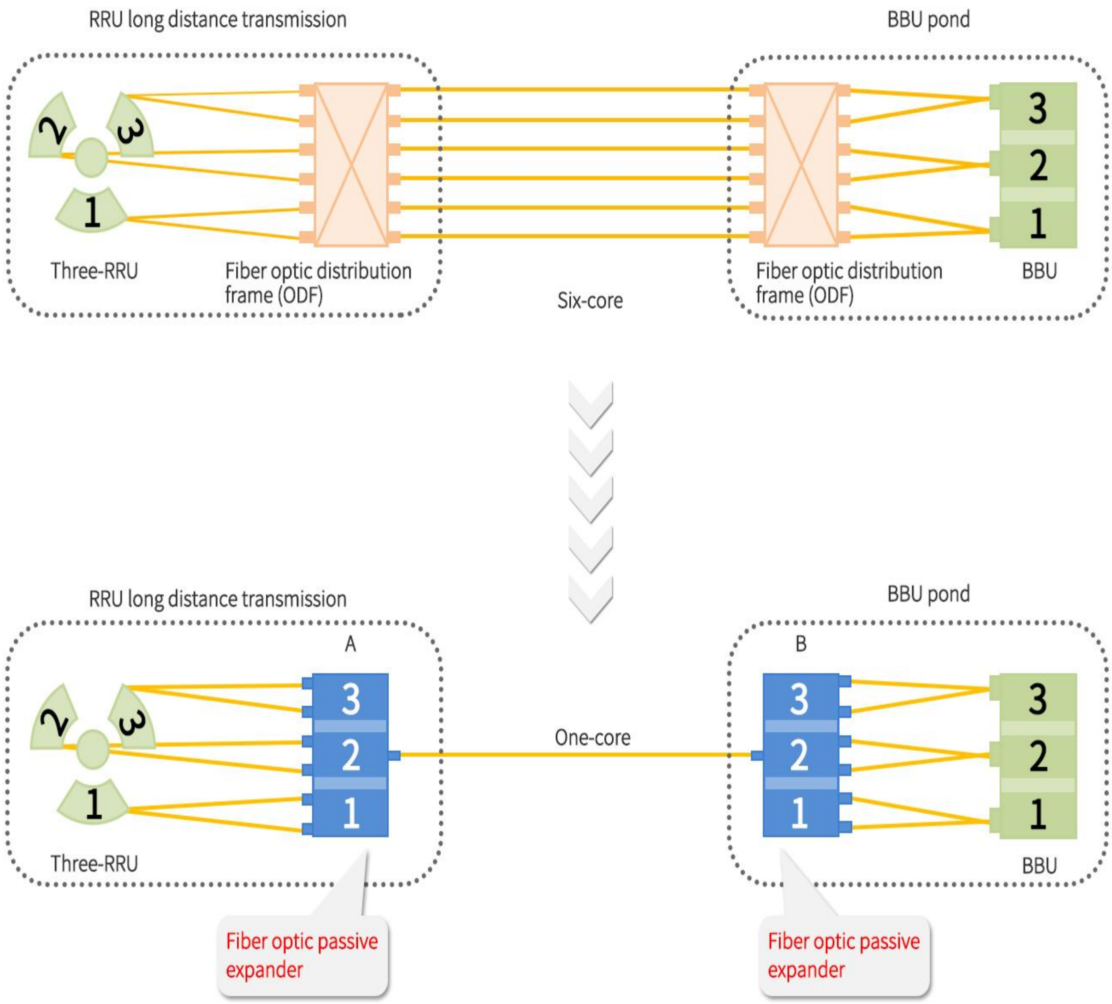
Each of the methods considered has its own advantages and limitations: WDM, DWDM, CWDM: Increased bandwidth without replacing cables, but high equipment cost. Channel Densification: Maximizes the use of existing infrastructure, but requires advanced modulation techniques.

Infrastructure Optimization: Improves network performance, but may require significant changes to network management. New Technologies (5G): Maximum throughput and support for new standards, but high implementation costs.

Today, every enterprise that has the ability to use fiber-optic communication lines strives to use the equipment to its full potential. To accomplish such a task, it is necessary to find optimal options that do not require large expenses and additional labor, but the solution to such a problem will not always be simple. In many facilities, due to the lack of fiber on fiber-optic communication lines, the possibility of organizing additional capacities is limited.

How to solve the problem of fiber resource shortage?

FCMS (full name - Fiber Capacity Multiplier Solution) is a WDM technology for the access layer of the metropolitan network. Since its commercialization in China around 2000, the industry chain has reached maturity and the cost and capacity can support large-scale commercial use. CWDM uses optical multiplexer to multiplex optical signals of different wavelengths into one fiber for hybrid transmission, and each color optical channel is physically isolated from each other, thereby realizing optical fiber channel multiplexing. FCMS is designed to address the serious cable resource consumption problem caused by the trend of centralized ISP BBU construction. It is mainly located between the C-RAN interfaces between remote base stations BBU-RRU and terminates the transmission of C-RAN interface services for multiple pairs of optical cables. Multiplexing and can be extended for use in multiple scenarios such as BBU backhaul, OLT backhaul and access to integrated services of the access segment. In this solution, service signals of different wavelengths are provided using matched optical modules at the BBU and RRU (Radio Remote Unit). Optical fibers carrying service signals of corresponding wavelengths are respectively connected to fiber optic extenders on the BBU side and the RRU (Radio Remote Unit) side. Fiber optic extenders on both sides transmit signals of different wavelengths through one fiber on the line side, which saves a lot of fiber resources. The system is a passive solution with waterproof, dustproof, high and low temperature resistance, and high reliability. There is no need for a power source, and the device is small in size, easy to install and use. The device does not require large expenses and special places for mounting and can ensure the delivery of the signal without changes and maintaining the best quality between the BBU and RRU (Radio Remote Unit)



This method is very effective and economical and can be applied at a distance from the station to the RRU (Radio Remote Unit).

Thus, to increase the capacity of fiber-optic lines depending on the economic and technical conditions of the operating enterprises, and on the number of communication consumers and many similar factors, all the above methods that ensure an increase in the capacity of fiber-optic communication lines can be applied in the required objects and areas. Currently, in many facilities, equipment operates on previously constructed fiber-optic lines where all the fibers of the fiber-optic line have already been used and there is no possibility of laying a new fiber-optic communication line, but expansion is required at the expense of existing fiber-optic communication lines.

The demand for higher data speeds and the exponential growth of Internet traffic have placed fiber optic networks at the forefront of telecommunications infrastructure development. Optical fiber, with its unprecedented bandwidth and low transmission loss, has become the backbone of global communications, providing everything from high-speed Internet access to backbone connections to the world's data centers. However, as digital data consumption continues to grow, driven by cloud computing, streaming services and an ever-growing number of connected

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devices, the challenge of scaling network capacity to meet this demand becomes increasingly pressing.

The drive to increase the capacity of fiber optic networks requires a multifaceted approach that includes advances in physical layer technologies, network architecture optimization, and innovative modulation schemes. At the core of these efforts is the goal of maximizing the amount of data that can be transmitted over a single fiber, thereby reducing the cost per bit and increasing the efficiency of network resources. This involves not only making more efficient use of existing infrastructure, but also introducing new technologies that push the boundaries of what is currently possible.

This dissertation research provides a solution to the problem of efficient use of fiber in fiber-optic communication lines and proves the possibility of using one fiber instead of two using Y-splitters

As you know, in mobile communication networks, fiber optic communication lines are used to increase network capacity in densely populated areas, in this case, the connection between the switch and each station is carried out according to a ring scheme

Fiber optic lines come in eight-fiber, sixteen-fiber, and other types, If the number of stations exceeds the number of fibers, then an additional fiber-optic line must be laid or look for other ways to launch all existing stations. In this dissertation, the optimal solution to this problem was selected using Y splitters.

In this paper, a more acceptable option for increasing the throughput of fiber-optic transmission systems using Y-splitters is determined.

The general scheme for converting optical transmission systems to single-fiber operation mode using optical Y-splitters is shown in Fig. 1

The transmitting optical modules (ПОМ) of multiplexers A and B are connected to the optical connectors 1 of the Y-splitters, and receiving optical modules (ПрОМ)

– to optical connectors 2. Connectors 3 are connected to the working fiber of the elementary cable section fiber optic transmission line via optical cross ports.

To compensate for the decrease in signal-to-noise ratio in single-fiber mode, it is necessary to reduce the attenuation of the elementary cable section by $\Delta a_{\text{эку}}$, and for this it is necessary to reduce the nominal length of the elementary cable section

$L_{\text{ном}1} = L_{\text{ном}2} - (\Delta a_{\text{эку}}/(\alpha + \Delta\alpha))$,

$L_{\text{ном}2}$ – nominal length of the ECU in dual-fiber mode, α – attenuation coefficient of optical fiber at the operating wavelength of optical transmission systems, dB/km;

Δα – increase in the attenuation coefficient due to welded joints in couplings.

If the calculated Lnom1 is equal to or exceeds the actual length of the optical fiber on the elementary cable section, then it is possible to transfer the existing optical transmission system to single-fiber mode.

To study the features of the transfer of existing fiber-optic transmission systems to a single-fiber mode, experiments were conducted to select a network section of suitable length.

The sections are selected in which Lnom1 is equal to or exceeds the actual length of the optical fiber in the regeneration section.

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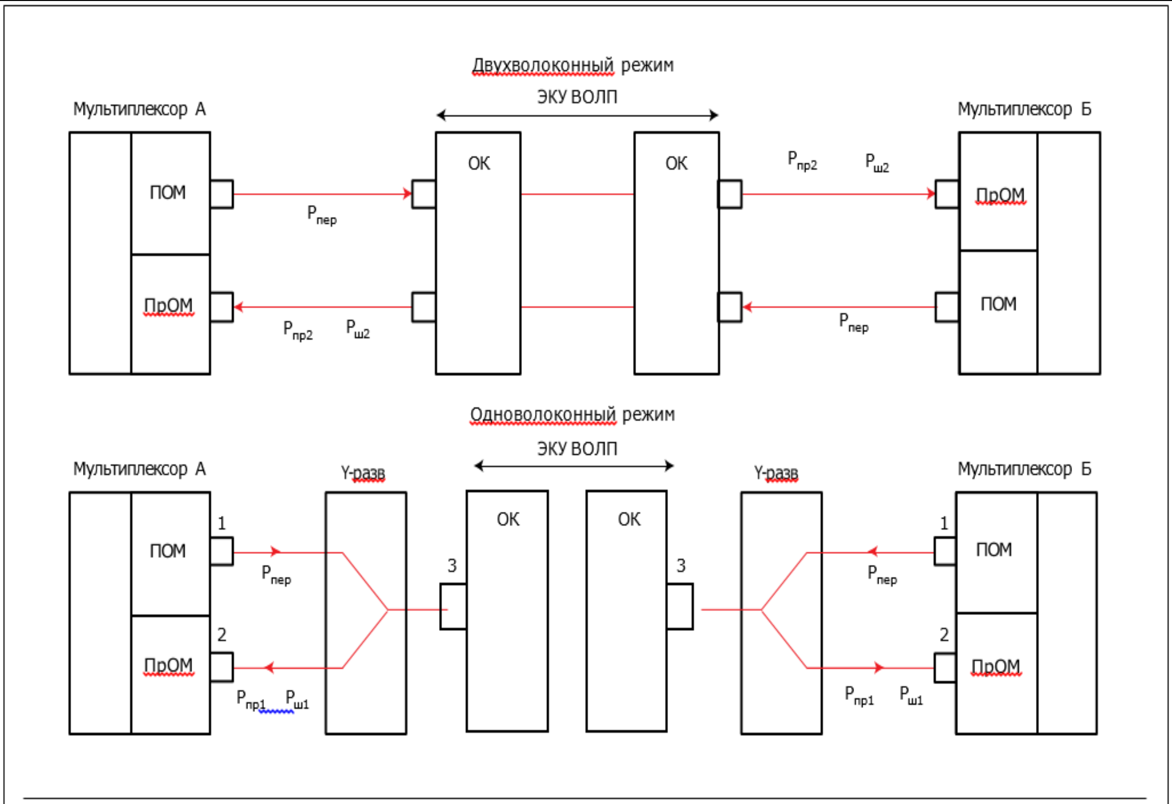

Рис.1. Схема организации одноволоконного режима работы ОСП

Fig. 1 shows the use of Y-splitters in single-fiber and dual-fiber mode.

CONCLUSION

Improving the capacity of fiber optic networks requires a comprehensive approach that includes both the selection of the appropriate type of optical fiber and the use of advanced multiplexing technologies. The method of increasing the capacity of fiber-optic transmission systems using Y-splitters allows for the most efficient use of existing infrastructure, increasing the number of fibers without additional cabling.

Thus, this method can be used on regeneration sections of fiber-optic communication lines, where the length of the section is so much shorter that when using Y-splitters to switch to single-fiber mode, the attenuation of the regeneration section, including the Y-splitter, should not exceed the norm.

The proposed methodology for organizing a single-fiber mode of operation of the OSP and examples of calculations of the main indicators of such a mode can be useful for the engineering and technical personnel of communication operators.

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