Application of WiMAX technology in difficult geographical conditions: Perspectives for mountain environment

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Abstract. WiMAX (Worldwide Interoperability for Microwave Access) is a telecommunications technology designed to provide universal wireless communication over long distances for a wide range of devices (from workstations and notebook computers to mobile phones). It is based on IEEE 802.16 standard called Wireless MAN. The name "WiMAX" was coined by the WiMAX Forum, which was established in June 2001 to promote and develop WiMAX technology. The forum describes WiMAX as "a standards-based technology that provides high-speed wireless network access as an alternative to leased lines and DSL." WiMAX allows you to access the wireless Internet at high speed with a wider coverage than Wi-Fi networks. This allows the technology to be used as "backbones", a continuation of traditional DSL and leased lines, as well as local networks. As a result, this approach makes it possible to create high-speed networks that expand across cities. In recent years, the development of network technologies has led to a significant expansion of the list of possible ways of connecting personal computers to the network and the types of connections to the global Internet. From a server to a pocket computer, almost any personal device that has enough computing power to process text and graphic information is equipped with one or another network interface, from a modem to WiMAX. This article examines the application of WiMAX technology in mountainous conditions, and analyzes the technical solutions used to create a continuous and high-quality connection despite topographical and environmental challenges. The advantages of wireless communication technologies are shown in mountainous areas where the population is small and the infrastructure is limited. The article presents strategies for configuring WiMAX networks, installing base stations, and expanding network coverage. As a result, WiMAX is proving to be an effective solution for meeting broadband communication needs in mountain environments.

1 Introduction

Wireless technologies - belong to the subclass of information technologies that serve to transfer information between two or more points without connecting them. Information transmission in various ways, including wireless, has existed since ancient times. In different eras, the technologies of information transmission and reception have changed and developed, but the essence of wireless transmission or reception of information from one address to another within a certain period of time has not changed [1, 2].

Electrical communication systems have an important role in the information society and people's lives for organizing the exchange of information between one address and another by means of wired or wireless technologies. Modern telecommunication systems and networks are a single complex of technical means that ensure the transmission and reception of various types of electrical communication signals (data) at any distance with the required quality parameters.

Communication systems and networks differ from each other according to data exchange technologies, transmission speed, used communication channels, frequency band width and other characteristics. Among the modern information communication technologies, wireless communication technologies are one of the most extensive and rapidly developing communication systems and technologies in the information society [3, 4, 7]. As a result of the emergence of a new stage in communication technologies - the stage of information processing by digital methods, practically all information (voice, documentary information, video images, television images, etc.) before being exchanged, is converted into discrete signals of information carrier signals, that is, 0 (zero) and 1.

The foundation of digital communication technologies was laid by converting and processing into (one) stream.

Currently, without modern information and telecommunication technologies, the Internet, e-mail, fax communication, telephone communication, obtaining the necessary information including access to remote databases, access to news services, distance education, telehealth, teleconference, telemarkets, telestores and it is not possible to arrange other types of communication services.

Finally, the end of the 20th century and the beginning of the 21st century gave impetus to the development of new information technologies, the development of wireless communication technologies as well as the type of wired communication service [5, 6]. As a result of the rapid development of wireless communication technologies over the past 25-30 years, opportunities for rapid exchange of information between one address and another have been created. In general, wireless communication technologies are based on two groups - a set (combination) of wireless information transmission and network interconnection technologies [8, 9].

2 Problem statement

This technology does not have deep roots like GSM or CDMA. It appeared relatively recently: the first standard for WiMAX was released in 2004, and it is only now entering our everyday world.

Initially, it was positioned as 4G due to its innovation and transmission speed, but in 2008 it clearly took its place among the third generation technologies. However, this fact did not prevent sellers, informants and other unscrupulous people from advertising it with the slogan "4G Internet" (what are they talking about?)

First, I will briefly tell those who are far from telecommunications about the generations of communication technologies. In the beginning there was AMPS (Advanced Mobile Phone Service) - the analogue standard could be listened to simply by having a receiver. Not even

a few years old, he lost his hand to the technology known as GSM (Global System for Mobile Communications).

This is the 2nd generation. Along with this, CDMA One (Code Division Multiple Access) also appeared. These two branches gave birth to GPRS (General Packet Radio Service, later EDGE - Enhanced Data rates for GSM Evolution), WCDMA (Wideband CDMA aka UMTS) and CDMA 2000 1x, respectively, which are usually classified as intermediate generation 2.5G. WCDMA was reborn in HSDPA (High Speed Downlink Packet Access, later HSUPA - High Speed Uplink Packet Access) and CDMA 2000 1x CDMA EVDO. This is, roughly speaking, the third generation approached by WiMAX from the IP network side. As you can see by now, comparing WiMAX and 3G is somewhat incorrect.

In 2004, the 802.16d specification describing fixed WiMAX appeared. Subscriber devices cannot move over long distances, they are not handed over, but at the same time long-distance operation is ensured (up to 50 km from the BS according to the specification). A hopeless branch in my opinion.

802.16e was released in 2005. This is the Mobile WiMAX you hear about regularly. He was predicted to have a great future. The technology works in the 2-6 GHz frequency range. The most convenient frequencies for mobility are 2.3-2.7 GHz, but it is quite difficult to get permission for them [11, 12]. The following range used in the equipment: 3.4-3.6 GHz is the golden mean. At frequencies close to 6 GHz, the so-called preWiMAX subscriber devices must be in the line of sight of the base station, because the penetration of these frequency waves and the prevention of obstacles are very weak. In this regard, the same GSM networks (800-1900 MHz) and more CDMA (450 MHz) are easier.

WiMAX networks consist of several components - base and subscriber stations, as well as equipment that connects base stations to each other, to the service provider and to the Internet. The high-frequency radio wave range from 1.5 to 11 GHz is used to connect the subscriber equipment to the base station, and the data exchange rate can reach 70 Mbit/s without the need for line of sight [14, 15].

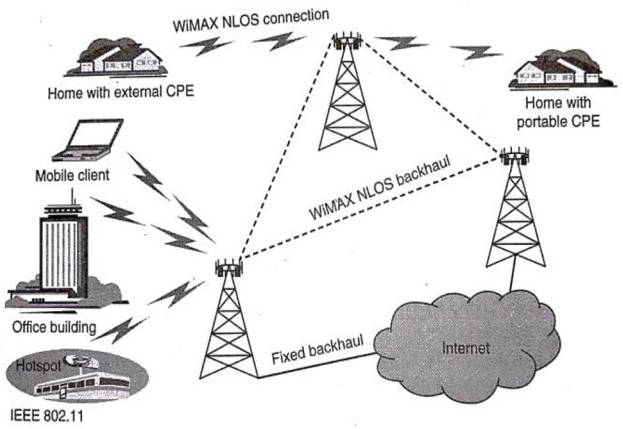

Fig. 1. Graphical representation of base stations.

Line-of-sight connections are established between base stations and use the 10 - 66 GHz frequency range. In this case, the data exchange speed reaches 120 Mbit/s. At least one base station connects to the provider's network via a wired connection, and then transmits data wirelessly to other towers.

It should be noted that the structure of WiMAX networks is similar to traditional GSM networks: base stations operate at a distance of several tens of kilometers, and direct visibility between stations is required.

The scheme of connecting to the Internet at home using WiMAX technology is similar to other wireless methods - satellite or 4G Internet. The provider installs the receiving equipment outside the building - usually a flat antenna is sufficient.

Inside the room there is a modem, from which it is connected to the end devices with a copper cable: a desktop computer, a Wi-Fi router, a TV. Internet speed usually reaches 20 Mbit/s, which is enough for comfortable use, and also, as a rule, low ping is provided, which allows you to play online games without problems.

3 Problem solution

Flow size distribution information can be useful in a number of applications in network metering and monitoring. First, traffic size distribution information can allow Internet service providers to infer the usage pattern of their networks, such as the approximate number of users with dial-up or broadband access.

Such information about usage patterns can be important for pricing, billing, infrastructure engineering, and resource planning. In addition, network operators can infer the type of applications running on a network connection, such as how many customers are using streaming music, streaming video, and voice over IP, without looking at traffic details.

Over the years, more and more network applications have become known through streaming data [10, 13].

Second, flow size distribution information can help detect locally the presence of an event that causes the global network dynamics to switch from one regime to another. An example of such a mode transition is a sudden increase in the number of large flows (ie, elephants) in a transition. Possible events that could cause this include link failure or route crashes. Just looking at the link's total load may not reveal such a link, since the link may be heavily used consistently anyway. Third, stream size distribution data can help detect different types of Internet security attacks, such as DDoS and Internet worms.

In the case of DDoS attacks, if the attackers use fake IP addresses, we will see a significant increase in 1-dimensional flows. In the case of Internet worms, we can suddenly find many streams of a certain size on the Internet.

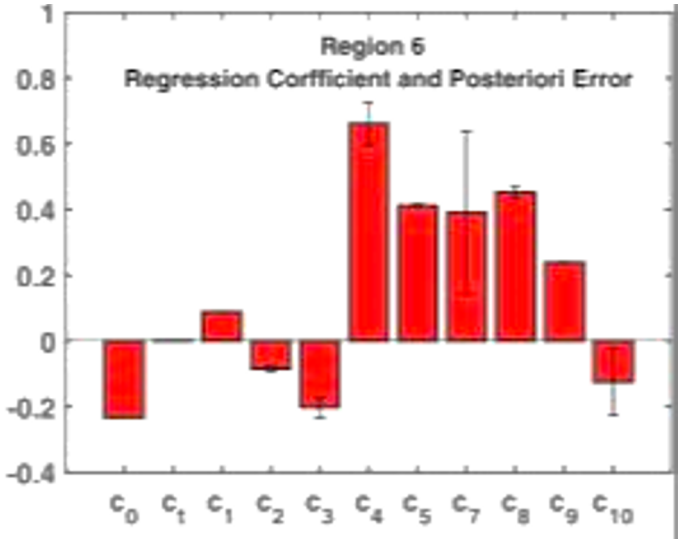

Fig. 2. Errors in the plot of the regression equation.

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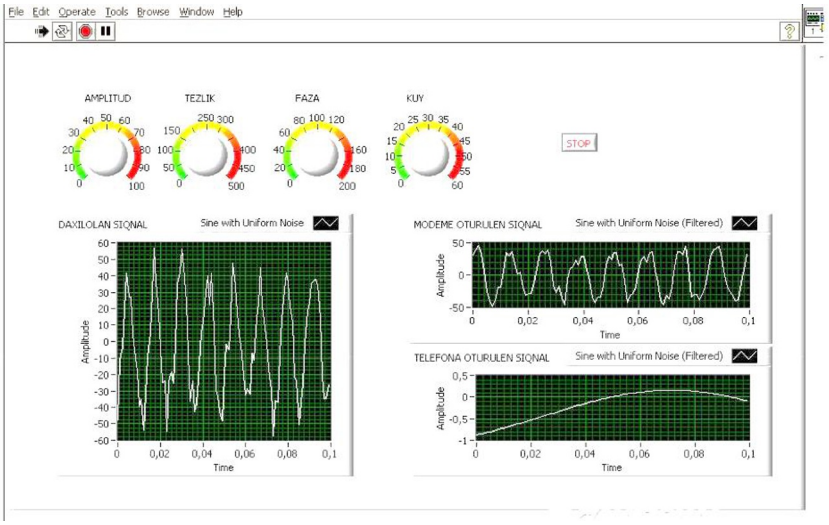
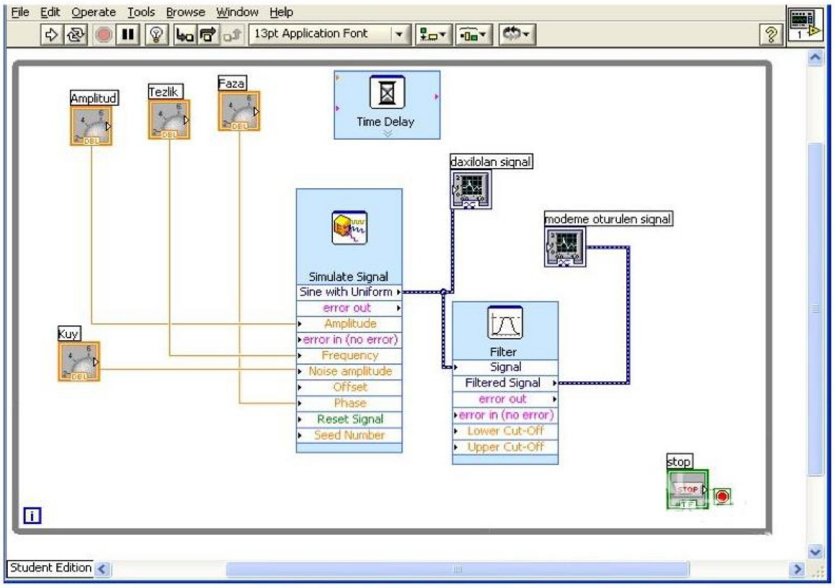
The simulation model of the virtual data distributor was created using the LabVIEW software package. LabVIEW is a specialized flexible programming environment used to create unique utilities and applications for devices. LabVIEW is a data analysis system that includes powerful tools for visualizing results. These LabVIEW features were used in the study. A simulation model of signal distribution was developed and studied. The purpose of these studies was to provide populations in mountainous areas, where organizing Internet access is a difficult task (Figure 3 a, b).



a)



b)

Fig. 3. A simulation model of a signal distributor in the LabVIEW software package.
a) "front panel", b) "block diagram".

4 Conclusions

Numerous studies have been conducted on the principles of telecommunication information exchange, technical requirements, and information distribution devices in the field of control systems, yielding successful results: Based on the measurement results, errors in the digital processing process have been detected; Studies have been conducted based on the possibilities of minimizing the methodological errors of existing works, the importance of reducing instrumental errors in order to minimize errors and other problems of the integrand has been substantiated; A simulation model of a virtual data distributor has been built using the LabVIEW software package.

As a result of the article, several advantages and prospects for using WiMAX technology in mountainous areas have been identified. Despite topographic obstacles, high-speed wireless communication can be achieved by deploying suitable base stations and using advanced antenna technologies. This significantly increases the availability of the Internet and other communication services in rural and mountainous areas, especially in areas where it is difficult to build infrastructure. WiMAX technology plays an important role in creating modern communication networks in these areas, offering flexible, cost-effective and technically effective solutions.

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