METHOD FOR INCREASING THE ACCURACY OF INFORMATION EXCHANGE IN COMMUNICATION NETWORKS

Gunay Khasmammadova[1], Sevinj Bakhshaliyeva[2], Javanshir Zeynalov[3]

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[1]Azerbaijan Technical University, Baku, Azerbaijan
[2]Azerbaijan State Oil and Industry University, Baku, Azerbaijan
[3]Nakhchivan State University, Nakhchivan, Azerbaijan
gunay.xasmemmedova@aztu.edu.az, sevinj.quliyeba@asoiu.edu.az, cavansirzeynaov@ndu.edu.az

Abstract

The presented article is devoted to the issue reducing losses in the information exchange channel. Satisfactory results have been obtained from the conducted research: calculations show that the implementation of the evolution of wireless communication network control center increases the performance of the network. It is based on G technology and its generations. Research shows that the LTE (4G) architecture is the way to improve mobile devices and data based on GSM/EDGE and UMTS/HSPA standards in the field of telecommunications. Ensuring the accuracy of information in wireless networks was thoroughly investigated, and for this, corrective filtering was proposed for receiving data in the processing process, and a positive result was obtained without filtering. Modeling of LTE was carried out in the OPNET modeling software package. During the research, simulation modeling was carried out in the Matlab environment, and satisfactory results were obtained.

Keywords: Information exchange, communication network, exchange channel, wireless communication, LTE technology.

I. Introduction

When considering the term wireless, it is clear that this term can be given different definitions. That is, the concept of wireless communication (or simply wireless when the context allows) is the transfer of information between two or more points that do not use an electrical conductor as a means of transmission [1, 2].

The most common and widely used wireless technologies use radio waves. The distances covered by radio waves can be short or long, for example a few meters for Bluetooth or up to millions of kilometers for deep space radio communication. It covers a wide variety of fixed, mobile and portable applications, including two-way radios, mobile phones, personal digital assistants (PDAs) and wireless networking [3, 4, 5]. Other examples of applications of radio wireless technology include GPS devices, garage door openers, wireless computer mice, keyboards and headsets, headphones, radio receivers, radio transmitters as well as satellite television, broadcast television and cordless telephones, etc. includes Somewhat less common methods of achieving wireless communication include the use of light, magnetic or electric fields, or other electromagnetic wireless technologies such as the use of sound.

The term wireless has been used twice in the history of communication, with slightly different meanings. It was first used from 1890 for early radio transmitter and receiver technology, such as wireless telegraphy, until around 1920 when the new word radio replaced it [6]. In countries around the world, non-portable radios in the UK continued to be called wireless sets into the 1960s. The term was revived in the 1980s and 1990s, mainly to distinguish digital devices that communicate wirelessly from those that require wires or cables, such as the examples listed in the previous sections. This became its primary use in the 2000s with the advent of technologies such as mobile broadband, Wi-Fi, and Bluetooth, allowing it to become more widespread [6, 7].

Wireless operations allow services such as cellular and interplanetary communications, i.e. global communications, that are impossible to implement with the use of wires [7, 8, 9]. The term is generally used in the telecommunications industry to refer to telecommunications systems (such as radio transmitters and receivers, remote controls, etc.) that use some form of energy (such as radio waves and acoustic energy) to transmit data without using wires. Information is transmitted in this way over both short and long distances.

The first wireless telephone conversation took place in 1880 when Alexander Graham Bell and Charles Sumner Tainter invented the photophone, which sent sound over a beam of light. Sunlight and a clear line of sight between the transmitter and receiver were required for that process to work. These factors greatly reduce the viability of the photophone in any practical experiment. It took several decades before the principles of the photophone found their first practical application in military communications and later in fiber-optic communications [9, 10, 11].

A number of wireless electrical signaling schemes, including sending electric currents through water and earth using the laws of electrostatics and electromagnetic induction, were explored for the telegraph in the late 19th century before practical radio systems became available.

These include Thomas Edison's patented induction system, William Preece's induction telegraph system for sending messages between water bodies, and several operational and proposed telegraphs, etc. includes In 1894, Guglielmo Marconi began to develop a wireless telegraph system using radio waves, which had been known since their existence in 1888 by Heinrich Hertz.

Soon Marconi developed a system that transmitted signals over a great distance that anyone could guess [12, 13, 14]. Marconi and Carl Ferdinand Braun were awarded the Nobel Prize in Physics in 1909 for their contributions to this form of wireless telegraphy. Millimeter wave communication was first studied by J. Chandra Bose in 1894-1896. He achieved a very high frequency of up to 60 GHz in his experiments. He also proposed the use of semiconductor compounds to detect radio waves when he patented the radio crystal detector in 1901 [1, 15, 16].

II. Connection of LTE technology with previous generation technologies and distinctive features

Nowadays, communication technologies are extremely important. We are surrounded by many telecommunication technologies, especially mobile phones, internet, satellite, wireless communication. 4G service provides faster and better transmission of data, internet and call services. For example, through this service, subscribers can open web pages in the blink of an eye, instantly upload photos to social networks, and watch HD movies online without interruption.

Data transfer speed in mobile networks reaches 326.4 Mbit/s through LTE technology, which belongs to the fourth generation technologies [15, 16, 17]. This allows providing mobile television, mobile finance, education, healthcare and other social services easily and with high quality. This technology also creates great opportunities for users operating in the corporate sector. So, they can carry out tasks requiring the exchange large volumes of files anywhere in the world through their mobile devices and participate in video conferences.

On average, a 5-minute song is downloaded in 100 seconds from mobile networks, 10 seconds with HSPA, and 0.38 seconds with 4G technology. In addition, a 1-hour movie in HD quality can be downloaded to our computer in 3 days from mobile networks, 8 hours with HSPA, and 17 minutes with 4G. These facts clearly demonstrate with visual evidence how much more powerful technology 4G is than its predecessors. In general, the connection speed in this technology is 100 mps in mobile phones and 1 Gbps in Wi-Fi networks [3, 17, 18]. At the same time, it is the same size as Wimax bandwidth. This is 10 times faster than 3G technology.

In general, more than half 4G connections worldwide are in North America (thanks to large-scale LTE networks established in the USA), 39% in developed Asia-Pacific countries (the largest networks are established in Japan and South Korea). If we look at the world trends, we will see that despite the active development of the fourth generation networks, international organizations, equipment manufacturers, operators and research centers are already working on the creation of the next telecommunication networks.

However, according to the research of "J'son & Partners Consulting" company, the golden age of using LTE networks was observed in 2012. Since that year, the 4G network has been available to local subscribers. Azercell Telekom was the first company to offer 4G services in Azerbaijan. Thus, in 2012, the company introduced the LTE service, which is the 4th generation network. With this, "Azercell" became the first company to introduce 4G technology for commercial use to customers not only in Azerbaijan, but also in the entire region [5, 8, 9].

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Ericsson company equipment is used to provide the network. "Azercell" is intensively developing the 4G network, taking into account the demand for fast mobile Internet of its subscribers [6, 9, 10]. During the first 5 months of 2016 alone, the company installed 177 new LTE stations in Baku and the Absheron Peninsula, and by the end of June, the number of stations increased to 220. Currently, the number of 4G stations in the mentioned area has reached 480.

With this, the level of 4G coverage of Baku and Absheron, which has the highest demand for high-speed mobile internet, reached 79%, and subscribers were able to use high-speed internet up to 100 Mb.s in the 4G network.

Good results on 4G coverage have already been achieved in Baku and Absheron Peninsula. The next target is other big cities of Azerbaijan. Already in 2017, the company aims to achieve 4G coverage in the regions [11, 14]. During this year alone, the investment made by "Azercell" in the 4G network amounted to 8 million manats.

III. IP Multimedia Subsystem VoLTE

The IP Multimedia Subsystem or IP Multimedia Core Network Subsystem (IMS) is a standardized architectural framework for delivering IP multimedia services. Historically, mobile phones have provided voice calling services over a circuit-switched network rather than strictly over an IP packet-switched network.

Alternative methods of delivering voice (VoIP) or other multimedia services have become available on smartphones, but they have not been standardized across the industry. IMS is an architectural framework that enables such standardization. IMS was originally designed by the wireless standards body the 3rd Generation Partnership Project (3GPP) as part of a vision for mobile networks evolving beyond GSM.

Its original formulation (3GPP Rel-5) was an approach for delivering Internet services over GPRS. This vision was later updated by 3GPP, 3GPP2 and ETSI TISPAN to require support for networks other than GPRS such as Wireless LAN, CDMA2000 and fixed lines [1, 2].

IMS uses IETF protocols whenever possible, such as Session Initiation Protocol (SIP). According to 3GPP, IMS is not designed to standardize applications, but to facilitate access to multimedia and voice applications from wireless and wired terminals, i.e. to create a form of fixed mobile convergence (FMC). This is done by having a horizontal management layer that isolates the access network from the service layer.

From a logical architecture perspective, services do not need to have their own management functions because the management layer is a common horizontal layer. However, this does not necessarily mean more reduced cost and complexity in implementation. Alternative and overlapping technologies for accessing and providing services over wired and wireless networks include Public Access Network, soft switches, and "bare-open" SIP connections.

IMS is widely adopted as it becomes increasingly easy to access content and contacts using mechanisms beyond the control of traditional wireless/fixed carriers.

Examples of IMS-based global standards include Voice over LTE (VoLTE), Wi-Fi Calling (VoWIFI), Video over LTE (ViLTE), SMS/MMS over WiFi and LTE, USSD over LTE, and MMTel, which is the basis for Rich. Communication Services (RCS), also known as Joyn or Advanced Messaging, RCS is a carrier application. RCS also performs Presence/EAB (enhanced address book) functionality.

IV. LTE network model in the OPNET modeling software package

OPNET Network simulator is a tool for simulating the behavior and performance of any type of network. The main difference between Opnet Network Simulator and other simulators is its power and versatility.

IT Guru provides pre-built models of protocols and devices. It allows you to create and simulate different network topologies. General Purpose Modeling (GPM) languages (eg UML, Southbeach Notation, IDEF) or Domain Specific Modeling (DSM) languages (eg SysML). Visual modeling in computer science had no standards before the 90s.

These include proprietary standards such as languages related to industry open standards (eg UML, SysML, Modelica), VisSim, MATLAB and Simulink, OPNET, NetSim, NI Multisim, and Reactive Blocks. Both VisSim and Reactive Blocks provide a downloadable viewer that allows anyone to simulate their models openly and interactively. Community publishing of Reactive Blocks also allows for full editing and building of models as long as the work is published under it. Eclipse Public License.

Visual modeling languages are an active area research that continues to develop, as evidenced by the growing interest in DSM languages. In the OPNET modeling software package, the LTE network model is three-tiered.

Three-tier OPNET hierarchy [2, 8, 11, 15]:

- Three domains: network, node and process
- The Node model defines an object in the network domain
- A process model specifies an object in the node domain.

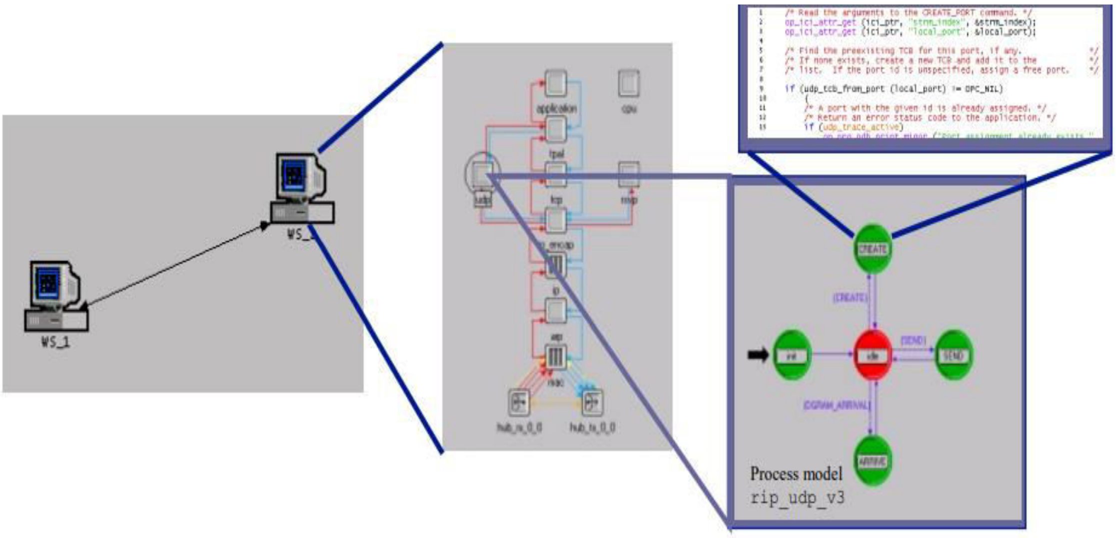


Figure 1: *OPNET model hierarchy*

V. Corrective filtering to increase accuracy

Filtering generally means separating the useful signal from other environmental noises that affect it. Since the measured signal is a tuned signal, solving this problem involves certain problems. The device that implements the filtering algorithm is called a "filter". Any node or processing operator operating during measurement information exchange in measurement systems should have any filtering property.

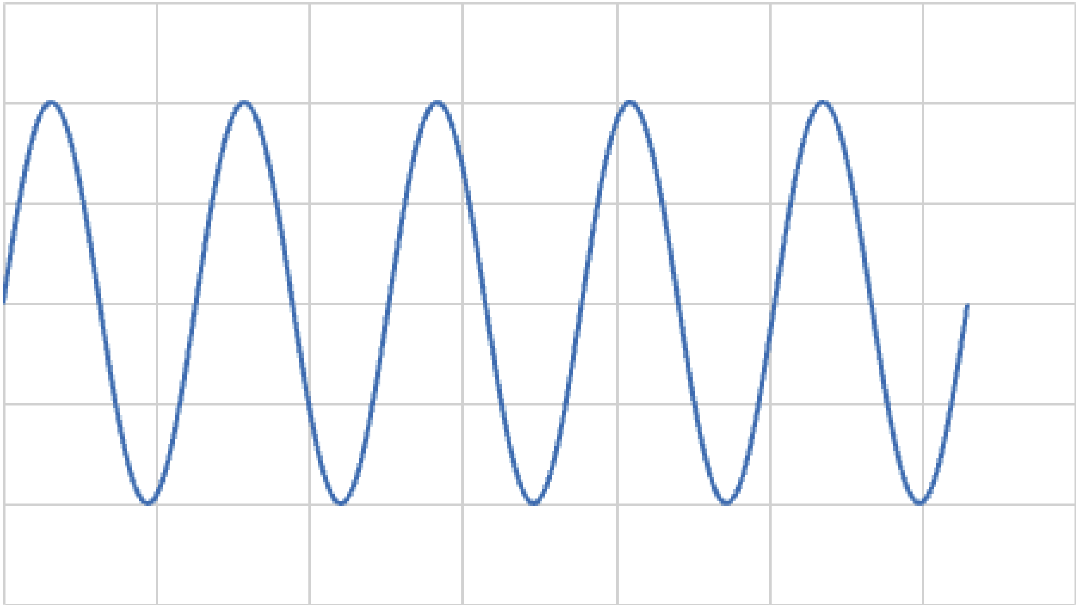
Selective filtering means the method of processing the useful signal and the error signal (noise) together with the aim of estimating the informative (current value) parameter of the measurement signal with the highest possible accuracy. Selective filtering is an indication of the level of accuracy that measurement systems can provide. Accuracy is the most objective efficiency indicator of any measuring tool [1, 16, 18]. Measurement information correction methods and tools are divided into 2 main classes, depending on the nature of the measurement signals processed in the measurement-processing exchange and the nature of the information exchange processes performed, that is, whether they are analog or discrete:

1) structure; 2) algorithmic.

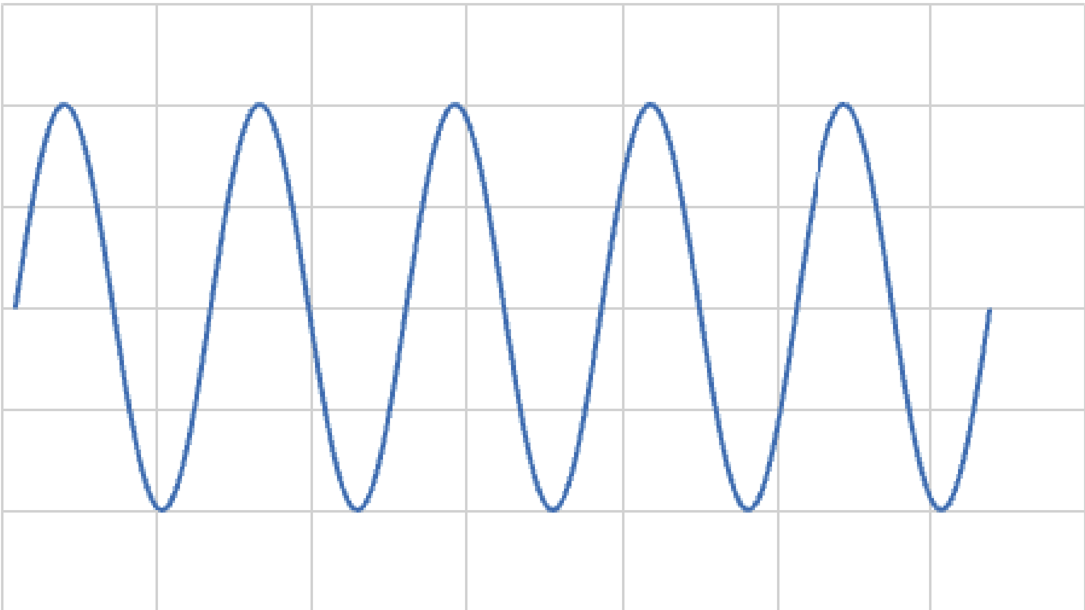
Structural methods and tools serve to increase the accuracy and stability of measuring tools by including additional elements and blocks in the structure of the created functional node. The algorithmic method is implemented with software tools, their implementation is oriented towards classical and modern filtering algorithms. The most widely used of these modern filtering algorithms is the digital filtering algorithm.

VI. Results and discussion

Many filters are used nowadays. To increase the measurement accuracy, the most widely used types of correction filters can be listed - Butterdort, Bessel, Chebyshev, Raised-Cosine, Cauer. There are a number of parameters that distinguish these filters from each other: system function, frequency transfer coefficient, dispersion and damping coefficient. The structural schemes and parameters of each can be determined using the MATLAB software package [7, 10]. Based on the used input signals, it is possible to determine the attenuation coefficient of the filters and compare the values found to choose the most suitable filter. After completing the process, the most appropriate filter was selected based on the extinction coefficient, Chebyshev filter. Figure 2 shows the model of the Chebyshev filter created in the Matlab program.



a)



b)

Figure 2: *a) filter input, b) output signals*

VII. Conclusion

1. The presented article is devoted to the issue reducing losses in the information exchange channel. Satisfactory results have been obtained from the conducted research: calculations show that the implementation of the evolution wireless communication network control center increases the performance of the network.

2. It is based on G technology and its generations. Research shows that the LTE architecture is the way to improve mobile devices and data based on GSM/EDGE and UMTS/HSPA standards in the field of telecommunications.

3. Ensuring the accuracy of information in wireless networks was thoroughly investigated, and for this, corrective filtering was proposed for receiving data in the processing process, and a positive result was obtained without filtering. Modeling of LTE was carried out in the OPNET modeling software package.

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