Scientific and Practical Cyber Security Journal (SPCSJ) 2(1):29-36
Scientific Cyber Security Association (SCSA), 2018 ISSN: 2587-4667

FREE DIRECT ACCESS CHANNEL FOR THE SECURITY COMPLEXES OF THE DETECTED OBJECTS

V.Saiko, **V.Nakonechnyi**, **S.Toliupa**, **M.Brailovskyi**
Taras Shevchenko National University of Kyiv

The article presents the results of the analysis of the technical aspects of the construction of a broadband access channel terahertz range for security complexes in the systems for detecting hidden objects. The technical solution of the radio access channel in the terahertz range with increased information efficiency and a generalized algorithm for forecasting channel and time resources of such a network are proposed.

ABSTRACT: One of the promising areas of terahertz technology application is the wireless communication system. In particular, it is planned to create fundamentally new in size, impedance and energy efficiency, devices of the submillimeter and terahertz range for high-speed video transmission, for radio-relay systems of direct visibility, for fifth generation mobile communication networks and radars for high-precision detection and recognition of small-scale speed targets, and also for radiometric detection systems for hidden objects.
Nowadays, for such wireless research systems, the focus is on increasing the bandwidth of the communication channel when using ultra-wideband signals that occupy the entire terahertz range. However, it should be noted that in many promising applications for networks of a new generation, the range of communication plays a more significant role than the speed of data transmission.

The aim of the article is to increase the information efficiency of the communication node by developing an innovative solution for constructing a channel of wireless broadband subscriber access to information resources using the terahertz channel, which results in better system efficiency in terms of communication distance and channel throughput.

Keywords: Terahertz wireless technologies, systems of protection, increase of efficiency

One of the promising areas of terahertz technology is the wireless communication system [1]. In particular, the creation of fundamentally new in size, noise immunity and energy efficiency of submillimeter and terahertz range devices for high-speed video transmission, for radio-relay systems of direct visibility, for fifth generation (5G) mobile communication networks (5G) and radar for high-precision detection and recognition of small-scale high-speed goals, as well as for detecting hidden objects radiometric systems, is expected. The development of new types of sensors based on terahertz technologies will provide more accurate and detailed operational information about the state of the controlled object or terrain. Such developments are conducted in the USA under the auspices of DARPA, in England, Germany and China for use in military and civilian purposes. The development of the elemental base of radio electronic devices, the widespread introduction of digital technology for

the formation and processing of signals allows a new approach to the solution of many problems that previously held back the implementation of the development of telecommunication systems sub-and terahertz ranges.

These circumstances make this range unique for the construction of telecommunication systems and networks, including for the detection of hidden objects by radiometric systems. In recent years, the trend of using terahertz radio waves has become steady, unlike in previous years. This is due to the successes in the development of technically advanced devices and systems [1]. Their most important advantage is the wide working frequency range. Narrow antenna pattern diagrams in this range contribute to increasing the secrecy of communication and suppression.

Today, for such wireless research systems, the focus is on increasing the bandwidth of the communication channel when using ultra-wideband signals that occupy the entire terahertz range [1]. However, it should be noted that in many promising applications for networks of the 5th generation, the range of communication plays a more significant role than the speed of data transmission. Thus, the development of methods and technical solutions for increasing the radius of the individual node of the terahertz range is an important scientific and technical task. *In order to increase the information efficiency of the communication node a technical solution for constructing a channel for wireless broadband subscriber access to information resources using the terahertz channel is proposed in the article, which results in better system efficiency in terms of communication distance and channel throughput.*

2. Analysis of technical aspects of the construction of a broadband access channel terahertz range

The exhaustion of licensed frequency resources and the rapid increase in the population's need for access to information networks require the study of the use of unlicensed frequency resources in access networks, in particular, the terahertz frequency range. At present, many studies on the distribution of millimeter, partly submillimeter and terahertz waves have been obtained in a large number of papers [2-7]. The main features of terahertz radiation, which distinguish it from the microwave and optical, appear mainly during its interaction with the substance. In particular, in the terahertz range there are resonances of the rotational and oscillatory transitions of molecules of many substances, which allow to identify the dielectric medium of different aggregate states. The most suitable for development under the mobile telecommunication systems are the windows of transparency, which can be determined at a certain level of attenuation. According to [7], this threshold level may be 100 dB / km. Then we have five windows of transparency, and the bandwidth in the strips of the terahertz window range can reach hundreds of Gbps. Moreover, the smaller the distance radio paths, the less the impact of external factors and the greater the bandwidth can be achieved. But the coverage of the services of a significant

territory by the network of channels of the terahertz range is complicated by the lack of current transmission lines of affordable value and the required capacity and low noise receiving tracks. In cities of oblast centers there is a sufficiently developed fiber optic network, which usually accesses information resources, whereas in small cities, in district centers, and in adjacent rural settlements where there is a small density of potential subscribers, fiber optic networks that can be implemented a quality access to information resources, are usually absent. Exhaustion of the licensed frequency resource significantly complicates the provision of such services in the above-mentioned territories. Therefore, it is proposed to use unlicensed frequency resource for subscriber access in backhaul network channels (mobile fixed radio channel). In the actual case - the terahertz range (140GHz). Significant energy losses of the signal of such a frequency range on the propagation path require the use of antennas with an amplification factor of up to 50dB, in the range of about 140GHz, and the angle of inclination of the diagram is less than 1^0.

In [8], the implementation of access in the format according to IEEE 802.11n standard and subsequent transfer of the working range, which uses software-hardware Wi-Fi, in the terahertz range - 140 GHz, is proposed. Receive and transmission linear paths provide a frequency transfer of about 2.7GHz in the ≈140GHz band when transmitting signals and lower the frequency from ≈ 140 GHz to ≈2.7 GHz when receiving a signal. Central (CA) and subscriber stations (AC) are connected by channels of the backhaul network in the terahertz range (in this case, ≈ 140 GHz). As the AU uses a Wi-Fi access node, which includes receiving transceivers and linear AC circuits. The technical solution [9] for extending the service area (QO) of the access point is realized by creating a peer-to-peer Mesh network accessed through a hub, which may be part of the AU. The disadvantage of such a technical solution is the insufficient size of the CA. The increase in the length of the backhaul network channel is implemented in the broadband system [10]. In [11], the proposed information streamformer consists of 8 receiving and 8 transmitting paths based on Mikrotik R52nM chips which are frequency-multiplexed and uses 64 GHz / 64-KM modulation when using a 1.2 Gbit / s data stream in 802.11.n format. Processing of the receiving and transmitting streams by linear paths allows us to create a channel for the terahertz range transmission in which the above formator is used as a modem. Connecting such a modem to both ends of the data transmission can create a span of the radio relay line with an information speed of 1.2 Gbit / s. Such a channel was developed for the terahertz range (in the range of 140 GHz) [12-14]. It consists of receiving and transmitting antennas, linear paths and signal processing units on the basis of the central station shaper. At the same time, the transmitter and receiver antennas serving the corresponding areas of the coverage area have been introduced into the formation of the information flow of the central station, and the composition of the nodes of the subscriber network corresponds to the composition and

parameters of the corresponding parts of the central station. The information resource on a single port is connected to the receiving and transmitting antenna, which is directed to the corresponding area of coverage. Information flows in the format IEEE 802.11n in the number of up to 8 are transmitted on the route distribution to the receiving node of the corresponding station. To more effectively use the information resource for the provision of subscriber access services as a subscriber station access node on the basis of the chip Mikrotik R52nM.

3. Channel of broadband radio access in terahertz range with high informational efficiency

When implementing broadband access of subscribers to information resources, the information rate on average per subscriber will be about 3 ... 4 Mbps. That is, the number of simultaneously working in the network will be ≈40 subscribers. Increasing the number of subscribers requires or increase the provided information resource, or reduce the information flow rate provided to the subscriber. Reducing the information flow rate provided to the subscriber is a reduction in the quality of the transfer. The increase of the total informational resource in the present case is limited by the parameters of the backhaul path, in particular the level of output power of the transmitter amplifier. The absence of a transmission path (output amplifier) at present of an acceptable value and a level of output power in the terahertz range (140 GHz) and a low-noise input amplifier of the receiving path significantly limits the implementation of the desired size of the backhaul network channel when one channel transmits several information flows.

3.1 Technical aspects of the construction of the terahertz channel range.

The implementation of broadband access requires the provision of a significant information resource for each subscriber, which, in case of insufficient resources provided, causes a decrease in the system's efficiency in terms of providing services. The absence of hardware at the receiving and transmitting paths of an acceptable cost at the time of use in the backhaul network channels of the unlicensed terahertz frequency range results in a significant decrease in the length of the backhaul network channel, that is, in reducing the size of the network area. Therefore, in order to eliminate these shortcomings, a new technical solution is proposed to increase the speed of the information flow, which is provided on average to each subscriber, increase the number of subscribers in the territory covered by the access point and the possibility of extending the territory of service.

As is known, deploying a MESH network in the Wi-Fi access point service area does not solve the problem primarily because of the inadequate channel information resource when using the Mikrotik R52nM chip modem in the IEEE 802.11n (150Mbps) standard. Its increase by connecting additional information flows in One

channel leads to a decrease in the length of the backhaul network and inadequate power supply due to the lack of hardware paths. In addition, the MESH network deployed mainly to expand the service area, which is not the subject of this article.

In this technical solution, it is proposed not to create a MESH peer network, but a server in which backhaul channels are created for additional information streams that connect to individual access points. Coverage areas with such access points overlap. The size and location of the enclosed territory is determined by the results of the study of the service area.

As stated above, the technical solution [9] proposes to connect to different access points from one or more information flows. The disadvantages of this technical solution are the inadequate information resource when connecting one stream and reducing the length of the transmission channel when feeding multiple streams. These disadvantages associated with insufficient energy resources significantly restrict the use of the peer-to-peer MESH network.

Therefore, it is proposed to compensate for the supply of various information flows to different access points. Management of such a system can be performed on the principle of a server network.

Territorial dislocation of access points allows:

- to increase the information resource provided to the subscribers of the serviced territory;
- to ensure the maintenance of energy resources (energy per bit), ie backhaul channel length is stored;
- to ensure the expansion of the size of the service area.

Figure 1 shows the principle of servicing such a system, where

1 – central station;

2 – the coverage area with the main stream;

3 – coverage area by an additional flow, that is, the territory of expansion of the service area;

4 – the territory of improving the quality of information services.

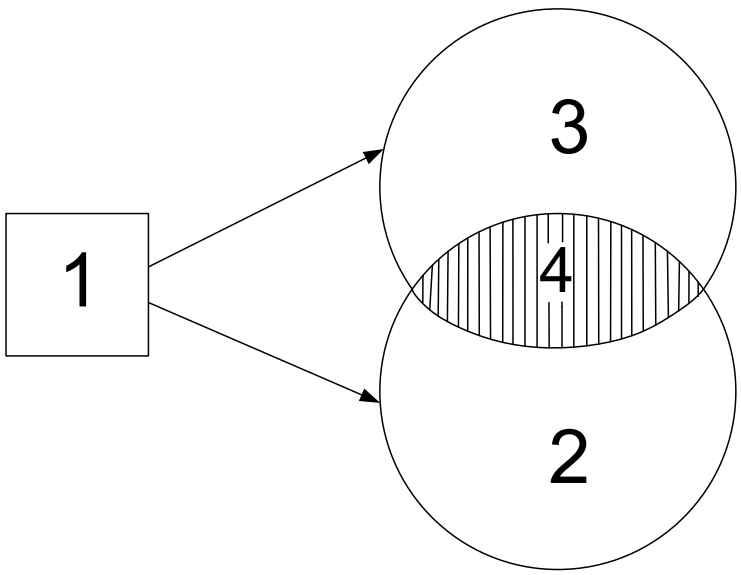

Fig.1 Structure of the principle of customer service developed by the system

An increase in the crossing of territories 2 and 3 leads to a decrease in the total territory of service (i.e., the size of territory 4 increases due to the reduction of territory 3). This leads to an increase in the information flow in the main zone. That is, part of the information resource of the stream 1-3 is transmitted to zone 2 and increases the total informational resource in the main zone (zone 2).

3.2 A generalized algorithm for forecasting channel and time resources of an innovative technical solution.

In the process of deploying the system of transmission channels terahertz range one of the main places is the distribution of channel and time resources between the individual sectors (directions) of the wireless communication system, due to changes in the qualitative and quantitative characteristics of traffic. Once again, it should be noted that the feature of such radio systems is that access to the transmission channels is organized on request transmitted by the transmitting party in the service announcement. In other words, the router subscriber access point generates a schedule of possible transmissions, ie produces channel-time forecasting of the resource, which leads to the following negative consequences:

- adversary in the transfer of data between individual directions;
- non-optimal use of channel-time resource.

Consequently, there is a problem of optimizing the forecasting channel-time resource in systems of this type. The need to save the channel-time resource provides an increase in the qualitative characteristics of the transmission and reception of signals.

However, the complexity of the solution of such a task, which is due to the lack of sufficiently effective algorithms for its solution, should be noted as well. The most effective way of forecasting channel-time resources is the algorithms of the theory of sequential solutions [15], Bellman's dynamic programming [17], and the approximate "heuristic" method of Boxing [16]. The main disadvantage of the latter lies in the little study of the convergence of the proposed algorithm. The first two methods do not always allow you to get the exact solution that is provided to carry out the forecasting of the wireless network, built by this type. Therefore, it is proposed to solve the problem of forecasting channel-time resources as an optimization problem involving the mathematical apparatus of the method of linear programming [18].

Conclusion:

The proposed innovative solution can increase the efficiency of using the network resource for radiometric detection systems of hidden objects, increase the distance to a remote subscriber network several times depending on the ratio of information flows at the network access node input, increase the number of radio access points.

REFERENCES

1. Han C., Akyildiz I.F. Terahertz band: Next frontier for wireless communications / in Proc. IEEE International Conferenceon Communications. AcceptedtoICC. – 2014.
2. БыстровР. П. Дальность действия миллиметровых радиолокационных станций в дождях / Р. П. Быстров, А. В. Соколов, Р. Н. Чеканов // М.: Радиотехника. –2005. – № 1. – С. 19–23.
3. Быстров Р.П., Соколов А.В. Распространение короткой части миллиметровых и субмиллиметровых волн: возможные области их применения. // М.: Радиотехника, - № 5, - 2006. — с. 11-18.
4. Preissner F.J. // Symp. Millimeter and Submillimeter Wave Propagation and Circuits. AGARD Conf. Proc. 1972. № 245. P. 48/1.
5. Yujiri L., Shoucri M.M., Moffa P. // IEEE Microwave Magaz. 2003. V. 4. № 3. P. 39.
6. Малышенко Ю.И. Оценка воздействия дождей на параметры радиолокационных станций микроволнового диапазона с учетом метеостатистических сведений о продолжительности выпадения дождей / Ю. И. Малышенко, Ю. В. Левадный // ИРЭ НАН Украины. – Радиофизика и электроника. – 2012. – т. 3(17), № 1. – с. 36-40.
7. Link budget considerations for THz Fixed Wireless links/ M. Grigat // IEEE Trans. on Terahertz science and technology. – 2012. – vol. 2, NO. 2. – p.567-572.
8. Патент України на корисну модель №109005 Україна, H 04 B 7/00. Мікрохвильова система широкосмугового бездротового доступу з підвищеною щільністю покриття зони обслуговування UMDS-TH / Наритник Т.М., Казіміренко В.Я., Сайко В.Г., Бреславський В.О., Єрмаков А.В. Заявник і патентовласник НТУУ «КПІ»; заявл.05.02.2016; опубл. 10.08.2016 // Бюл. № 15.
9. Патент України на корисну модель №110181 Україна, H 04 B 7/165. Мікрохвильова система широкосмугового безпроводового доступу UMDS-Mesh /Наритник Т.М., Сайко В.Г., Казіміренко В.Я., Поршнєв В.Л., Лисенко Д.О., Єрмаков А.В. Заявник і патентовласник НТУУ «КПІ»; заявл.08.04.2016; опубл. 26.09.2016 // Бюл. № 18.
10. Патент України на корисну модель №114590 Україна, H 04 B 7/165. Мікрохвильова система широкосмугового доступу UMDS-PP /Наритник Т.М., Сайко В.Г., Казіміренко В.Я., Дакова Л.В., Єрмаков А.В. Заявник і патентовласник НТУУ «КПІ»; заявл.30.09.2016; опубл. 10.03.2017 // Бюл. № 5.
11.Патент на корисну модель 84923Україна, H 04 B 7/165. Приймально-передавальнийформувачінформаційного потоку для каналу

зв’язкуізпідвищеною спектральною ефективністю та пропускною здатністю / Ільченко М.Ю.,Наритник Т.М., Казіміренко В.Я. Заявник і патентовласник НТУУ «КПІ»; заявл.11.05.2013; опубл. 25.11.2013 // Бюл. № 21.
12.Сайко В.Г. Використання розподілених транспортних радіомереж терагерцового діапазону в рамках побудови мереж мобільного зв'язку нового покоління / Сайко В.Г., Наритник Т.М., Казіміренко В.Я., Дакова Л.В., Грищенко Л.М., Кравченко В.І.// Зв’язок. -- № 6. – 2016. – с.16-21.
13. Патент на корисну модель 104299 Україна, Н 04 В 7/165. Канал безпроводного широкосмугового абонентського доступу до інформаційних ресурсів із використанням каналу терагерцового діапазону / Сайко В.Г., Наритник Т.М., Казіміренко В.Я., Лутчак О.В. Заявник і патентовласник НТУУ «КПІ»; заявл.25.06.2015; опубл. 25.01.2016 // Бюл. № 2.
14. Сайко В.Г. Радиорелейные системы терагерцового диапазона для радиометрических систем обнаружения скрытых объектов /Сайко В.Г., Казимиренко В.Я. // II Науково-практична конференція «Проблеми кібербезпеки інформаційно-телекомунікаційних систем». – Київ, КНУ імені Тараса Шевченка: 23-24 березня 2017 р. – С. 190-193.
15. Сосулин Ю.Г., Фишман М.М. Теория последовательных решений и ее приложения. – М.: Радио и связь, 1986. – 272 с.
16. Беллман Р. Прикладные задачи динамического проектирования. Под редакцией А. А. Первозванского. — М.: Наука. Главная редакция Физико-математической литературы, 1965. — 460 с.
17. Box F. A heuristic Technique for Assigning Frequencies to Mobile radio Networks // IEEE Transaction on Vehicular Technology, VT-27(2). -- 1978. -- p. 57-64.
18. Вентцель Е.С. Исследование операций: задачи, принципы, методология. – М.: Дрофа, 2006. – 206 с.