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SUBSTANTIATION OF TECHNICAL CHARACTERISTICS OF PROMISING HIGH-SPEED MULTI-BAND BROADBAND MILITARY RADIO STATIONS

The issue of improving the technical characteristics of promising high-speed multi-band broadband military radios is an important issue. It happens because of the increase in the number of devices of communication in information and telecommunication networks, as well as the growing requirements for the level of technical characteristics of these devices. Given the above, the object of the research is a promising high-speed multi-band broadband military radios. The subject of the research is the technical characteristics of promising high-speed multi-band broadband military radios. In the course of the research, classical methods of analysis and synthesis were used. The research analyzes global trends in the construction and development of wireless access networks, which allows concluding on the prospects of development (purchase) and implementation of high-speed multi-band broadband military radios for the Armed Forces of Ukraine. The results of the analysis of characteristics and parameters of high-speed multi-band broadband radio stations of the world-'s leading countries allow to determine the main features and requirements for promising radios, as well as to substantiate the use of high-speed radio stations in the Armed Forces of Ukraine. The conditions and factors influencing the possibilities of using promising broadband radio stations in the conditions of modern wars and armed conflicts are determined. The analysis allows to conclude that broadband radio access systems will be used to organize access to information resources in the information and telecommunications environments of network-centric and information wars.

Keywords: *radioelectronic environment, network-centric war, multi-band radio stations, technical characteristics.*

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1. Introduction

Already today in developed countries, focused, in particular, on broadband wireless access, in networks covering all categories of customers, the speed of subscriber channels is offered 25–50 Mbps from operator to subscriber. And also more than 10 Mbit/s for the ascending traffic (the USA, the countries of the Asia-Pacific region, Europe). The same bandwidth requirements for new networks appear in Ukraine, which demonstrates the proposals of alternative telecommunications operators.

Today, the vast majority of mobile networks in the world are networks of the second and third generations (2G, 2.5G, 3G), GSM standards, CDMA-Is95, WCDMA, CDMA-2000, UMTS. All these network standards provide speech transmission as well as data transmission. The most significant difference between them, in terms of opportunities for the implementation of certain services, is the different value of the maximum achievable data rate at the level of access equipment (AE). The characteristics of a number of standards in terms of data transmission (DT) are given in Table 1.

Table 1

Characteristics of a number of standards in terms of data rate

Characteristics	Standard	DT technology	The maximum speed of DR at the level of AE
Technology 2G–2.75G	GSM	CSD HSCSD GPRS EGPRS (EDGE)	9.6 kbit/s 28.8 kbit/s 43.2 kbit/s 236.8 kbit/s
	CDMA–Is95	–	115200 kbit/s
Technology 3G	WCDMA	HSDPA	3.6 Mbit/s
	CDMA–2000	EV–DO	3.1 Mbit/s
	UMTS	–	8 Mbit/s
Radio access	DECT	–	552 kbit/s
Radio technologies designed for data transmission	WiMax	IEEE 802.16 IEEE 802.20 IEEE 802.22	70 Mbit/s
	LTE	–	more than 570 Mbit/s
Personal PAN networks	Bluetooth	IEEE 802.15.1	3 Mbit/s
Wireless networks (WSN)	ZigBee	IEEE 802.15.4	250 kbit/s

Note: the table is based on data [1–5]

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As can be seen from Table 1, existing technologies that have reached the peak of development (2G) and relatively new (3G), differ significantly in the ability to provide data services. Potentially possible DT speeds in third-generation network technologies are an order of magnitude higher than similar characteristics of previous-generation networks.

Therefore, it is important to substantiate the technical characteristics of promising high-speed multi-band broadband military radios.

Thus, *the object of the research* is promising high-speed multi-band broadband military radio. *The subject of the research* is the technical characteristics of promising high-speed multi-band broadband military radios. And *the aim of the research* is to increase the level of technical characteristics of promising high-speed multi-band broadband military radios.

2. Research methodology

In the course of the research let's use:
– classical methods of analysis to solve the problem of analysis of technical characteristics of promising high-speed multi-band broadband military radios;
– synthesis methods to substantiate ways to increase the technological level of characteristics of promising high-speed multi-band broadband military radio stations.

3. Research results and discussion

The maximum achievable DT speed for this class of technologies is only their qualitative characteristic. In practice, the speed of DT for wireless technologies significantly depends on the conditions of radio wave propagation and subscriber traffic because the spectral resource in this case, in contrast to wired technologies, is common to a large number of users.

GSM networks use technologies based on the principle of time division multiplexing (TDM). Next-generation mobile networks use the principle of code division multiplexing (CDM), which has the potential to increase the efficiency of radio frequency spectrum.

In addition to the technologies used in mobile networks, wireless access technologies have been developed for communication with fixed subscribers or for use within a subscriber terminal (radio extension cord). The most common today is DECT technology. This technology provides speech or data transmission with a potentially achievable data rate of 552 kbit/s. In addition, this technology is used in telephones to connect the base unit to the handset, in the PBX, etc.

The second class of wireless technologies includes access technologies designed directly for the implementation of data services. The most common in this class are WiFi, WiMax and LTE technologies.

WiFi technology is used today in almost all local wireless broadband networks. It includes the IEEE 802.11a/b/d/e/f/g/h/i/n/p/r/s/t/u/v/w family of standards. The main distinguishing features of WiFi technology from others are [6–8]:
– providing communication in a small area (in an area with a radius of 100–150 m) and indoors;
– providing high-speed (up to 300 Mbps) data transmission;
– simplicity of the principles of construction and operation of the network.

These properties of WiFi technology in combination with other factors (available equipment, accepted in many countries the principle of unlicensed use of the 2.4 GHz radio frequency band, widespread support by leading equipment manufacturers, etc.) allowed it to become widespread in a relatively short time. This was facilitated by the active work of the international organization WiFi Alliance, which to date has managed to ensure a high level of interoperability of WiFi equipment from different manufacturers. Currently, work is underway to further increase the data rate of more than 300 Mbps. Mechanisms for information security and adaptation to the electromagnetic environment in the areas of access points and the introduction of mesh technology are being improved.

WiMax technology is an IEEE 802.16 standard that defines the principle of local-level wireless broadband access (BWA) (Wireless Metropolitan Area Networks, WMAN). The successful deployment of WLANs over the past five years has demonstrated the market's readiness to deploy wireless Internet anywhere to expand the range of Internet services, including broadband. WiMax technology allows providing broadband access over a larger area than WLAN technology, while the latter is typically used to provide broadband access indoors and quite limited outside buildings. Given the principle of construction of IEEE 802.16 networks, similar to GSM/3G cellular networks. IEEE 802.16 has high channel bandwidth. It is already anticipated that the standard will be able to enter the communications services market fairly quickly and find the required number of users for a relatively short payback period. One of the significant strategic improvements of IEEE 802.16 technology over other IEEE 802 family technologies is the initial focus on traffic delivery with different Quality of Service (QoS) requirements. Later, with the release of the IP protocol in commercial use in the form of the Internet, a number of algorithms, architectures and protocols were developed to ensure the quality of service in wired networks. However, with the introduction of the Internet in wireless networks, it turned out that the dynamics of the wireless channel affects the probability of packet loss and to provide commercial access to real-time services. For example, Premium VoIP, it is necessary to provide guarantees on a number of key parameters, such as the probability of packet loss, delay, jitter delay.

LTE technology was carefully analyzed by 3GPP, and the conducted system approach showed that LTE access meets the formulated requirements and accordingly provides the necessary spectrum flexibility. The spectrum efficiency is 1.7–2.7 bit/s/Hz per cell in the downlink channel and 0.7 bit/s/Hz per cell in the uplink channel at a distance between stations of 500 m. The bandwidth of user traffic at the cell boundary is 0.18–0.28 bit/s/Hz per cell in the downlink channel and 0.022–0.05 bit/s/Hz per cell in the uplink channel, while simulating work with 10 users and completely filled buffers of each cell.

LTE technology is capable of providing transmission speeds exceeding a specified 100 Mbps for downlink and 50 Mbps for uplink. In practice, while allocating a bandwidth of 20 MHz, a speed greater than 325 Mbps for the downlink and 80 Mbps for the uplink is achieved. The approximate response delay in the network is 7 ms; one-way delay is 3.5 ms, and the network response delay value for HARQ is 5 ms.

Thus, after analyzing the different specifications of WiMax and LTE technology, it is possible to conclude that they are designed to implement wireless high-speed data transmission at different distances (tens of kilometers)

from objects that can move. The maximum achievable speeds depend on the speed of movement of the moving object and the distance to the object. These technologies can be used both for communication with mobile data terminals and for the organization of the transport environment. For example, to make a phone call to a group of geographically located subscribers. The cost of accessing LTE technology at this time is significantly higher than WiFi and WiMax, so its use is limited to cases where it is impossible to use cheaper technology.

The analysis and determination of the characteristics of promising radio devices in the implementation of methods of high-speed broadband radio access allows determining the following main advantages of their use in the Armed Forces of Ukraine [8–10]:

1. Ensuring reliable communication in cases of limited visibility or its absence (work on reflections) through the use of OFDM technology, which simplifies and reduces the cost of installation, increases the stability of communication in multi-beam propagation.

2. Modulation schemes up to QAM 64 allow achieving high efficiency of radio frequency spectrum use (up to 5 bits/s/Hz). The transmission speed is up to 37.7 Mbps in the 10 MHz band. The type of modulation can vary adaptively from BPSK to QAM64, depending on the distance of the subscriber and the conditions of signal propagation. To increase noise immunity, cascade coding is used – Reed-Solomon/convolutional with different speeds.

3. High user capacity – more than 1000 subscribers per base station (6 sectors).

4. The ability to change the bandwidth used (1.75; 3.5; 7; 10 MHz). This allows to more efficiently perform frequency-spatial planning of the network.

5. The use of multiple access with time method of division of subscriber channels (TDMA) eliminates the occurrence of collisions and helps to maintain high system bandwidth.

6. Due to the use of OFDM-256 technology and adaptive modulation methods, the service area is expanded.

7. Support for the quality of service (QoS) system, while the bandwidth of the system is distributed taking into account the required quality of service of each subscriber.

8. Support for the interface of the Ethernet subscriber device (10/100 Base-T), which is widespread, easy to use, allows to easily integrate different types of services (TDMoIP, VoIP, video surveillance, etc.).

9. Ensuring comprehensive protection of information, while performing data encryption on the air, authorization of subscriber devices and verification of certificates. As an extension, Ukrainian DSTU 28147-2009 is supported for data encryption and authentication.

10. Implementation of centralized network management. The network management system is based on the SNMP protocol and has a wide range of capabilities (configuration, emergency diagnostics, performance monitoring, QoS and security management, operation logging, etc.).

The limitations of this research are a review of only the main technical characteristics of high-speed multi-band broadband military radios for the Armed Forces of Ukraine.

The direction of further research is to expand the list of technical characteristics of high-speed multi-band broadband military radio stations for the Armed Forces of Ukraine. It will deepen the quality of the analysis and improve its quality.

4. Conclusions

Analysis of global trends in the construction and development of military wireless access networks allows concluding on the prospects of development (purchase) and implementation of high-speed multi-band broadband military radio stations for the Armed Forces of Ukraine.

The results of the analysis of characteristics and parameters of high-speed multi-band broadband radio stations of the world's leading countries allow to determine the main features and requirements for promising radios, as well as to substantiate the use of high-speed radio stations in the Armed Forces of Ukraine.

The conditions and factors influencing the possibilities of using promising broadband radio stations in the conditions of modern wars and armed conflicts are determined.

The analysis allows saying that broadband radio access systems:

– will be used to organize access to information resources;
– will play an important role in the implementation of the latest concepts of combat operations in the information and telecommunication environments of network-centric and information wars.

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