

COMPREHENSIVE USE OF 6G CELLULAR TECHNOLOGY ACCOUNTING ACTIVITY COSTS AND CYBER SECURITY

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Submission: 2/21/2022

Revision: 2/23/2022

Accept: 4/20/2022

ABSTRACT

The purpose of this study was in the research of prospects for simultaneous use of 6G generation cellular communications for the purposes of automatization of cost accounting of the activity of enterprises of various branches and cybersecurity of accounting information. The theoretical and methodological aspects of the use of 6G cellular network technologies for accounting and cybersecurity purposes have been studied on the basis of general research methods – institutional and innovative; economic and mathematical methods of analysis using Excel spreadsheets were used to predict the pace of implementation of cellular communication of new generations; to determine perspective areas of use of 6G technology – methods of bibliographic and comparative analysis using the information resource "ResearchGate". The methods of permanent collection and transmission of accounting data about the production process and the procedure for monitoring the stay of employees or outsiders at the workplace using production equipment connected to the 6G cellular network has been developed. The procedure for combining the functional abilities of Global Positioning System (GPS) and

cellular positioning (mobile subscribers) for accounting of transport costs and control over the movement and economic use of vehicles has been proposed. The procedure for combining unmanned aerial vehicles in a cluster on the basis of 6G communication with the purpose of aerovisual surveillance of agricultural and construction activities for automated accounting of production costs and prevention of unauthorized getting into an enterprise of persons (drones). The methods for determining the cost of rental space from the lessor based on counting the popularity among visitors and identifying offenders (thieves of information and material resources) through automated monitoring of the location of 6G cellular subscribers. The practical implementation of the developments presented in the article on the use of 6G cellular technologies will contribute to reliable costing and accounting of production costs of production, agricultural, construction, trade activities in combination with effective cyber protection of enterprises in preventing and detecting violators of information and territorial security. Further research is needed on the methods of management of business entities on the basis of accounting information obtained with the use of 6G cellular network technology.

Keywords: *accounting, cybersecurity, 5G and 6G cellular communication, pricing, cost accounting.*

1. INTRODUCTION

Increasing of the population mobility and remote performance of official duties during the COVID-19 pandemic are creating new requirements for data transfer speed on the Internet. Modern technologies of the Internet of Things, blockchain, adaptive audio and video streaming are based on the use of high-speed wireless electronic communications.

Support of wireless cellular communication is implemented in modern wearable, household and industrial technological devices. Data collection and management of functional processes takes place remotely in a permanent mode via the Internet. Modern technologies of 4G cellular networks are not able to meet the needs of users in large data sets with a minimum time lag, which hinders the digitalization of social and economic processes.

Theoretical research and applied developments on the use of the fifth generation cellular networks are being actively conducted. 5G cellular technology enables full broadcasting of social and economic calculations in the cloud environment, use of blockchain technology on all technical devices, integration of technological equipment into a single production information network, etc. Instead, the economic use of developments in the field of artificial

intelligence, total virtualization of communications, unmanned aerial vehicles and autopilot of vehicles, connection to the Internet of all technical devices determines the achievable horizon of the new sixth generation of cellular communication, the operation of which is threatened by fundamentally new cyber risks.

2. LITERATURE REVIEW

The range of problems of providing effective cyber security in conditions of the use of 6G cellular communications is the subject of scientific research of many scientists. Yang (2020) studied the historical development of cyber threats from cellular communications from 1G to 5G, which allowed to identify the trends in cyber security in terms of 6G technology.

The research was continued by Porambage et al. (2021), who predicted problematic aspects of the use of potential technologies in 6G cellular networks, such as: distributed ledger technology (DLT), physical layer protection, distributed artificial intelligence, THz and quantum computing, and suggested ways to ensure enterprise cybersecurity.

Huang et al. (2020) explored the UK's experience in providing cybersecurity from Huawei's corporation information espionage using 5G cellular technology and predicted possible 6G threats to cybersecurity.

Zhang et al. (2021) developed a scheme of decentralized information exchange using 6G cellular communication for the implementation of crowdsourcing (transfer of production and information functions to an indefinite number of people), which creates new requirements for cybersecurity.

Considerable attention is paid to improving the conceptual apparatus of scientific research in terms of providing cyber security in the field of 6G.

Popovski et al. (2021) in particular conducted in-depth research on the development of 6G cellular networks and related concepts of “simultaneousness”, “presence” and “causality”, which are the basic categories in ensuring the information security of users of telecommunications services.

Terminological research was also conducted by Ylianttila et al. (2020) and Wang et al. (2020), who justified the positioning of the concepts of “trust”, “security” and “confidentiality” in the context of creating a reliable 6G cellular connection, which involves the development of multidisciplinary technologies, regulatory techniques, techno economics, policy and ethics.

In the scientific space, there are diverse studies of the subject use of 6G cellular technologies in combination with cybersecurity of business entities.

For example, Siriwardhana et al. (2021) substantiated the significant level of penetration of artificial intelligence mechanisms into the operation of 6G, which creates significant cyber risks in the activities of operators and users of cellular communications. At the same time, scientists point out that artificial intelligence is able to avoid and prevent the manifestation of cyber threats in the functioning of economic entities.

The integration of blockchain and 6G technologies, in the opinion of Khan et al. (2021), creates opportunities for effective information protection through decentralization of cellular networks and distributed access to databases. Researchers have explored different ways of combining blockchain technology with the use of 6G cellular communications, which helps to optimize cybersecurity.

Hoschek (2021) explained the impact of quantum cybersecurity on the operation of critical infrastructure based on the use of 5G and, in the long run, 6G. Similar studies were conducted by Al-Mohammed et al. (2021) on the prospects for the development of Internet of Things technology in the era of 6G cellular communications, which requires the use of quantum computing and communications.

The generalization of the authors' scientific achievements makes it possible to identify cyber risks that threaten 6G cellular networks: attacks with the use of artificial intelligence, previously unknown "Zero Day", risks based on quantum calculations, attacks with the use of fast (Tera Hertz) equipment etc., physical attacks to wiretap on telephony, etc., which requires improvements in cybersecurity methods and micro-levels (Figure 1).

In previous generations of cellular networks, telecommunication companies are responsible for cybersecurity. Cellular network operators are investing heavily in software and hardware for cybersecurity systems, increasing the number of security personnel, and investigating cyber incidents. In the conditions of implementation of 6G technology at the micro level, the functions of cyber security are partially transferred to the management of economic entities.

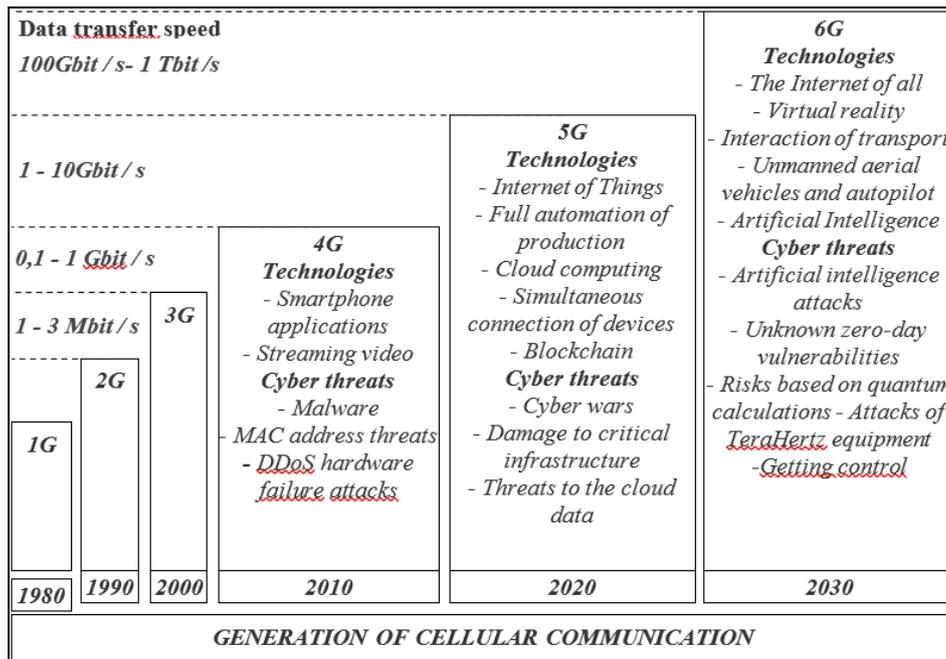


Figure 1: Development of cellular networks of mobile communications

Source: generated by the author based on (Yang (2020))

In management the need for ensuring cybersecurity of telecommunications equipment installed in the premises (on the territory) of an enterprise arise. The direct exchange of information within the 6G cellular communication is the full responsibility of employees of an enterprise, and therefore it requires additional measures for implementing effective cyber security.

The presence of significant cyber risks of using the technology of cellular communication of new generations is an obstacle to their widespread use, which can be seen in Figure 2.

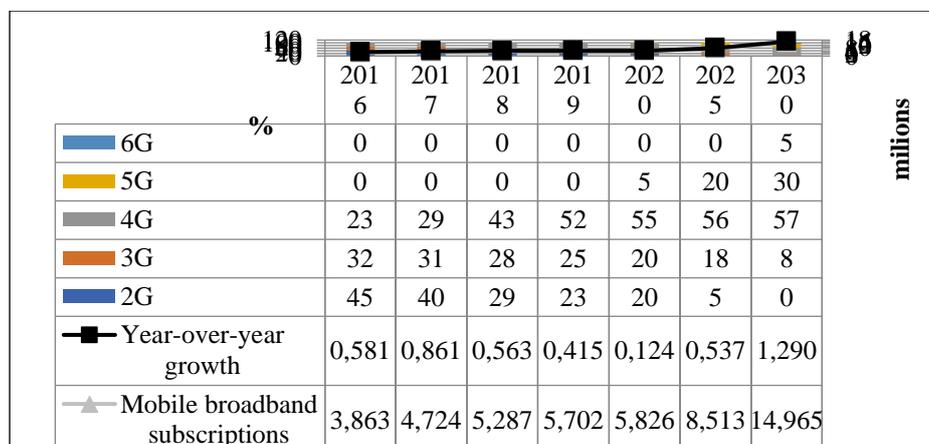


Figure 2: The rate of distribution of cellular devices by generation (2G-6G)

Source: determined on the basis of (Mobile broadband subscriptions worldwide 2007-2020; Mobile technology share by generation 2016-2025; Global 5G subscription forecast 2019-2025); the figure for 2030 is calculated based on data forecasting using Excel spreadsheets

The number of devices connected to cellular communication is increasing every year (from 3.863 million in 2016 to 5.826 million in 2020). The permanent growth of the popularity of cellular devices is partly explained by the development of new generations of cellular 4G communications (share in 2020 comprised 55%) and 5G (share in 2020 comprised 5%). However, it is necessary to take into account the insufficient future pace of introduction of the fifth and sixth generation cellular communications.

In particular, if the share of 4G popularity has increased by 32% during 5 years, then the projected growth in the use of 5G technology in 2020-2025 is only 15% against the background of the popularization of the Internet of Things technology connected to the cellular Internet. Similar figures are expected and for the use of 6G technology.

An obstacle to the forced introduction of 5G and 6G technologies is the significant payback period of investment projects for cellular network operators (Table 1).

Table 1: Financial indicators of 5G technology implementation by one cellular network operator for 2022-2030 (million USD)

Indicator	Pessimistic scenario	Optimistic scenario
Basic direction of socio-economic development		
Capital costs for the introduction of technology	492,5	340,9
Increase in operating costs after the introduction of technology	923,1	650,3
Net discounted income	596,7	975,5
Internal rate of return, %	21	23
Payback period, years	11,3	4,4
Conservative direction of socio-economic development		
Capital costs for the introduction of technology	505,1	353,5
Increase in operating costs after the introduction of technology	934,5	657,9
Net discounted income	571,4	959,5
Internal rate of return, %	20	25
Payback period, years	12,6	4,2

Source: calculated on the basis of (Concept of creation and development of 5G / IMT-2020 networks)

According to the forecast study, the payback period of the 5G project for one average cellular network operator in Eurasia is 4.2 years under an optimistic scenario in the context of conservative development of global socio-economic conditions. In the conditions of unstable financial and economic condition of cellular network operators activity payback period according to pessimistic estimates is as high as 12.6 years. This trend is relevant also for 6G technology for the period 2030-2038.

Improper tempos of implementation of 5G and 6G technology is explained by the lack of thorough complex research on the applied application of the cellular networks of new generation in combination with cybersecurity of economic (including accounting) information, which is also an obstacle to the widespread use of innovative technologies.

The purpose of the article lies in studding the prospects of complex use of 6G generation cellular communications for the purposes of automization of cost accounting of enterprises' activity of various branches and cybersecurity of accounting information.

3. DATA AND METHODOLOGY

To achieve the established goal of the scientific work, the institutional approach was used and the concept of institutional changes to ground the feasibility of transforming accounting methods in the use of 6G cellular communications in the context of cybersecurity of enterprises in particular. Into the basis of innovative approach to the theoretical and methodological foundations of accounting, the idea of its important social and economic role and importance for cyber protection of enterprises has been assigned. An innovative approach has been used for opening the prospects for the use of sixth-generation cellular technologies in the process of collecting, processing, transmission and cybersecurity of accounting information.

The methodical toolkit of the study was the methods of bibliographic and comparative analysis. The empirical study was conducted using a bibliometric approach known as «the common words analysis» using the information resource "ResearchGate". It was determined that only during the last two years (2020-2021) there had been a scientific papers on the development of 6G technology.

The hypothesis on the expediency of a combined research of the prospects for the use of 6G cellular technologies combined for accounting and cybersecurity purposes has been formed, which will contribute to the intensification of the pace of applied introduction of cellular communications of new generations.

The methodological tools of research were cross-tabulation analysis to analyze the research hypothesis and graphical analysis to present the research results. During the research of statistical indicators of the spread of cellular communication of different generations, the emphasis has been chosen on the use of methods of economic and mathematical modeling through the mechanisms of Excel spreadsheets.

Based on construction of a polynomial trend line using approximate and predicted data, the indicators of the popularity of new generation cellular communications and the number of devices connected to cellular networks in 2030 have been determined. The forecast of comprehensive use of 6G technology for accounting and cybersecurity purposes in production, trade, construction, agriculture, transport and rental services has been developed.

4. RESULTS

The key characteristics of 5G and 6G technologies is the reliable location of the cellular subscriber. Similarly, global satellite positioning (GPS) technology can identify the spatial location of a smartphone and, consequently, its owner. If GPS navigation provides two-dimensional information about the location and movement of the controlled object, then cellular networks promote three-dimensional positioning. In other words, based on 5G and 6G technologies, it is possible to determine the height of the cell phone in the open space or on top of the building – indoors.

Another important possibility of next-generation cellular networks is the direct exchange of information between technical devices. Without the involvement of base stations, smartphones are able to exchange data with other devices that have access to cellular communications. Direct communications provide operational and complete data, which is a valuable information resource for accounting and management purposes. Functional abilities of using 6G technology in terms of automation of processing and cyber protection of accounting information are shown in Figure 3.

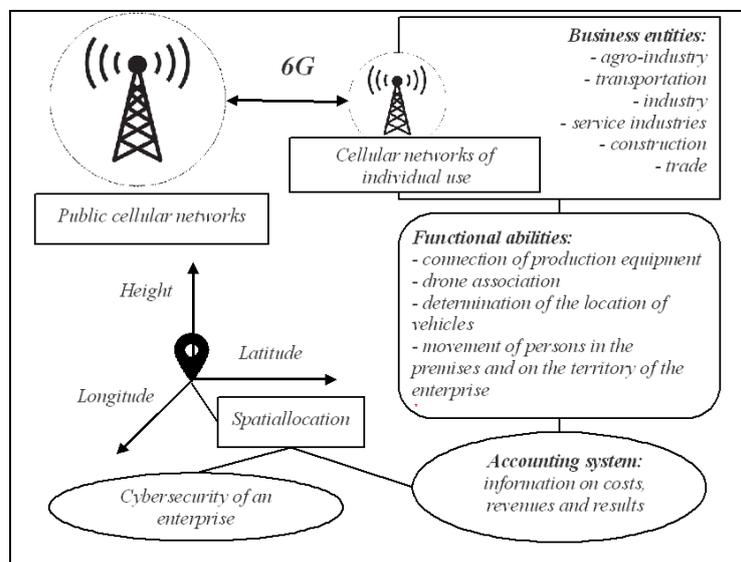


Figure 3: The use of 6G cellular networks for accounting and cybersecurity of enterprises

Source: generated by the author

The use of 6G cellular communication expands the functional abilities of GPS technology in monitoring the commercial operation of vehicles. In addition to information on routes and stops of vehicles, based on 6G technology it is possible to obtain information on fuel consumption, loading (unloading), unproductive stoppage, breakages, the need for technical maintenance or repair, traffic violations, etc., which may be useful for accounting purposes and cybersecurity.

In particular, after finishing the trip, it is advisable to use the data obtained using 6G technology to account for fuels and lubricants. For each fact of moving the vehicle, it is recommended to determine the consumption of fuel (electricity) in order to reliably identify the cost of transport services. Information on the distance traveled by road in kilometers is not very informative for efficient and reliable accounting of transport costs. Different driving styles, terrain and road conditions, weight of the transported cargo significantly affect fuel consumption and, especially, electricity for electric vehicles. Therefore, only the actual fuel consumption (electricity) provided using 6G technology, and not the information on the mileage of vehicles, it is advisable to focus on the automation of accounting for transport services.

Information on timely detected facts of unproductive use of vehicles should be used for accounting and control of transport enterprises. After the identification of improper use or unplanned stoppage of vehicles during working hours, receiving fines for violations of traffic rules, it is possible to simultaneously determine those responsible for violations of employees, reflecting in the compensation for damages.

In addition to the traditional protection against vehicle theft, 6G cellular communication can be used to organize autopilot traffic. Through instant communication mechanisms based on 6G cellular networks, vehicles can avoid collisions and comply with traffic rules. In this case, it is important to ensure proper cybersecurity of vehicles for preventing unauthorized access by intruders. Using cellular networks, third parties can gain remote control of vehicles to commit further wrongdoings. Therefore, it is recommended to develop the latest protocols for cyber protection of cellular communications in combination with permanent monitoring of compliance with established routes of vehicles and traffic rules.

Together with the organization of autopilot transport of vehicles using 6G cellular communication, it is possible to provide information communication with unmanned aerial vehicles (drones). With the use of systems of artificial intelligence systems, it is advisable to

combine drones in a swarm for collecting information for the purposes of accounting and cybersecurity of construction and agricultural enterprises. Associations (swarms) of unmanned aerial vehicles are able to monitor business activities around the clock regime without the direct participation of employees. After receiving a signal from the drone about the low battery level, a new unmanned aerial vehicle is sent for replacement. The previous drone is returned to renew the power supply, which is the basis for the permanent rotational operation of unmanned aerial vehicles.

On the basis of data on the status of construction works, it is advisable to carry out automated accounting of costs and income in accordance with the degree of completion of construction, which is justified by the construction contract. On the basis of aerovisual identification of the degree of construction works (construction of the whole building, a separate part or floor (section)) it is possible to reliably determine the cost of construction services provided. The customer of the construction of certain objects may be notified of its intermediate cost in accordance with the construction contract.

Accordingly, in the accounting system it is advisable to automatically record the costs incurred, income received and the determined financial result from the provision of construction services for any period of time. Upon completion of a certain stage of construction on the basis of drone monitoring of construction works, all accounting procedures can be performed daily, which ensures the timeliness and efficiency of accounting and control.

Similarly, drones controlled via the 6G cellular network are capable of aerial visual monitoring of the process of agricultural work. The collected information on tillage, sowing process, biological transformations of plants, harvesting should be used to account for the costs of agricultural enterprises. On the basis of photos and videos it is possible to automatically determine the need for fuel and stocks, seeds, plant protection products, mineral fertilizers, etc. with automated recording in accounting. Operational accounting of material costs in an additive way ensures the formation of the intermediate cost of agricultural products.

Accordingly, with the growing popularity of certain places of outdoor advertising or products (goods) may increase the cost of renting advertising and retail space. For customers of advertising signs, the cost of the service is determined individually with a clear link to the potential number of people who may be consumers of marketing activities.

Unmanned aerial vehicles are capable of automatically detecting violators of the perimeter of the territory and airspace. Based on the visual recognition of faces and comparison with the database of images of the company's staff, it is possible to identify outsiders who do not have the right to be in the security control zone. In addition to full-time employees, visual images of the faces of third parties who perform periodic work (provide services) or are visitors who receive one-time access rights are entered into the personal information database.

Unmanned aerial vehicles can also detect the presence of other third-party drones. With the massive development of small (personal) aviation, the means of air-visual espionage appear at the disposal of criminals, competitors, the media and other persons. In case of detection of violators of territorial and airspace, drones are notified by the security units of the enterprise to suspend illegal actions.

6G cellular communication can be implemented in any production equipment with the purpose of active transmission of production information. Regardless of the spatial location of the means of production, automated collection of production process parameters is possible. Technological data from sensors, which are equipped with fixed assets of an enterprise, it is advisable to use for automated accounting of production costs. Production equipment is able to record the quantity and quality of consumed material values and electricity (water, gas, etc.) in the process of production (works, services).

All the facts of the use of objects of labor should be automatically recorded in accounting. With the use of methods of incomplete costing, it is advisable to determine quickly all direct production costs. Calculation takes place on a permanent basis, when for each unit of finished product it is possible to determine reliably the cost. The company's management has the opportunity to determine accurately the cost of production, which allows you to simultaneously adjust the cost of sales for each individual order and customer.

In the operation of production equipment, it is advisable to provide a mechanism for identifying persons who are nearby. A person who visited the workplace and is not a full-time employee may be identified as a violator of the security regime. In the case of defective products, theft of raw materials, excessive consumption of resources, it is possible to identify suspects. All facts of violations are automatically reported to the security department of an enterprise.

Based on information on visits to certain types of premises, it is also recommended to determine reliably the rent for retail space for operators. Depending on the number of people who visited the trading halls of a tenant, the amount of rent changes. At the end of the month, it is advisable to calculate and reflect in accounting the rent, which is set in proportion to the number of visitors and the area given to a tenant. Quantitative pricing option is useful for rental operators, which allows you to effectively take into account the cost of customer service not only retail space, but also areas of common use. Such premises include corridors, toilets, stairs, escalators, lounge areas, etc.

Maintenance costs of general purpose premises (heating, air conditioning, cleaning, current repairs, etc.) are mainly included in the cost of rent by retail space operators, which violates fundamental accounting principles. Instead, pricing based on the number of visitors ensures a fair distribution of such costs. In addition to commercial establishments, cost accounting based on the number of visitors should be used for catering, tourism, passenger transport services.

According to a similar method, it is possible to determine the effectiveness of outdoor advertising and the operation of shop windows in commercial establishments. Using 6G technology, the company's management receives information about popular routes of movement of visitors of trade establishments. It is recommended to determine the popularity and effectiveness of marketing activities on the basis of information about the number and duration of visitors' stops at an advertising sign or shop window. Accordingly, with the growing popularity of certain places of outdoor advertising or products (goods), the cost of renting advertising and retail spacemay increase. For customers of advertising signs, the cost of the service is determined individually with a clear link to the potential number of people who may be consumers of marketing activities.

On the other hand, it is advisable to monitor the popularity of a particular type or kind of product (goods) that are of interest to buyers, but for unknown reasons are not sold. In other words, clarification requires increasing attention to material values, which does not end with the fact of their realization. Such products (goods) require a change in pricing, sales or merchandising policy.

Quite often it is organizationally difficult to provide video surveillance and automated control of the admission of workers to the territory in the conditions of a significant flow of people or a large area of monitoring. With the use of 6G technology, it is possible to control

the movement of persons through the enterprise. In the cybersecurity system of the enterprise, it is advisable to record the facts of entry of unauthorized persons using cellular communications in the premises or certain areas of the restricted area. If the violator of the information or territorial regime is promptly identified by the cybersecurity system, it is possible to prevent cybercrime.

In case of late detection of lost material or information resources, it is advisable to identify the persons involved in the offense. Based on the identification of the list of persons who were territorially near the scene of the incident for a certain period of time, it is possible to identify the offenders on the basis of identifying an individual cellular number. In the course of further investigative actions, the involvement of cellular subscribers in the cyber incident is proved. The generalized possibilities investigated in the article and the challenges of the sixth generation cellular communication technology are given in Table 2.

Table 2: Opportunities and challenges of realized on the basis of 6G cellular technologies for cybersecurity

6G technologies	Opportunities for cyber defense	Challenges for cyber defense
Positioning	Monitoring the movement of persons through the territory, premises of an enterprise. Identification of trespassers of information regime.	The ethics of excessive control over the movement of cellular subscribers. Prevention of getting of personal data of subscribers to third parties.
Autopilot / unmanned aerial vehicles	Control over the movement and operation of commercial vehicles. Coordination of unmanned aerial vehicles in the process of aerial surveillance.	Protection against obtaining physical control over vehicles or drones by third parties.
Internet of Things	Connection of all production equipment to the Internet on the principles of Internet of Things technology for operational automatic (without employees) data collection and transmission.	Prevention of distortion and theft of information at the time of its collection and transmission.
Blockchain	Providing distributed access and data storage.	Impossibility of control by state institutions.
Quantum security	Unbreakable data encryption during transmission	Lack of the existing computing power for cellular operators. The complexity of standardization.
Artificial intelligence	Autonomous management of security system. Optimized provision of security.	Problemscalability. The difficulty of automatic identification of trespassers and informing the cybersecurity service. The need for protecting computing infrastructure at the micro level.

Source: systematized by the authors

The practical implementation of the developments presented in the article on the use of 6G cellular communication technologies (automated identification of positioning, autopilot / unmanned vehicles, Internet of Things, blockchain, quantum computing, artificial intelligence, etc.) will contribute to reliable calculation of products (works, services) and production costs

of production, agricultural, construction, trade activities in combination with ensuring effective cyber protection of enterprises in terms of prevention and detection of violators of information and territorial security regime.

5. CONCLUSIONS

The progressive development of communication technologies creates new requirements for data transfer speeds. The use of 4G cellular communication and the new generation of 5G is not able to meet the information needs of users of artificial intelligence technologies, total virtualization of communications, unmanned and autopilot vehicles, connection to the Internet of all technical devices, which requires the concept of 6G mobile communications.

An important advantage of the sixth generation of cellular communication is the three-dimensional reliable determination of the subscriber's location and direct information connection between the elements of the cellular network, which allows transformation of accounting of enterprises in various fields. In particular, fundamental changes are made to the accounting of costs with the use of: production equipment connected to the information system of an enterprise, for permanent timely determination of the cost of industrial products; vehicles with controlled movement by agreed routes and preventive identification of the cost of providing transport services; swarms of unmanned aerial vehicles for aerovisual observation of agricultural and construction works with reliable definition and distribution of income and expenses; technologies for counting the number of visitors to the company's premises to determine the popularity of retail space and advertising in order to inform customers about their value.

At the same time, the information system of enterprises using 6G cellular networks is threatened by significant cyber risks: attacks using artificial intelligence, previously unknown vulnerabilities of "Zero Day", risks based on quantum calculations, attacks using fast (TeraHertz) equipment, hybrid wars etc. To ensure cyber security, it is necessary to use 6G cellular networks to monitor: the location of employees on the territory or premises of an enterprise; routes of movement and performance of works by vehicles; access of persons to production equipment, construction sites or places of agricultural work; the presence of criminals at the scene of offenses in order to prevent the loss of material and information resources of economic entities.

Further research is needed for the methods of management of business entities based on accounting information obtained using 6G cellular network technology.

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