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INFLUENCE OF TELECOMMUNICATION TECHNOLOGIES ON DECISION-MAKING FOR DYNAMIC TASKS USING BIG DATA IN THE AGRO-INDUSTRIAL COMPLEX

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To date, telecommunication technologies are used all over the world to obtain reliable information on the situations on the sown areas of farmers. Data is transmitted in real time, access to devices (sensors, drones, fixation equipment) must be provided on an ongoing basis. Information for dynamic tasks using big data consists of heavy content and requires data transmission at high speeds. One of the main components of modern information technologies is Internet access, which provides not only the entire process of data processing and analysis, but also timely management decision-making. As a rule, all information on objects (databases, knowledge) is placed on servers, access to which is possible only if there is a permanent service from potential customers in the area of operation of data fixation and transmission devices. The existing methods of visualizing objects using space satellites have disadvantages associated with limited residence time, image quality, and the need for manual processing. In this regard, the use of devices with Internet of Things technology support is relevant and timely, since data is captured in real time, data is relevant, the decision-making process can be carried out promptly and increases production efficiency and labor productivity. The article considers the possibilities of mobile communication networks of Kazakhstan to perform tasks related to obtaining data from Internet of Things devices, to analyze the data of forecast models on arable lands of grain-growing regions of the country, problems, possible solutions, principles of organization of an intelligent management decision-making system.

Keywords. Telecommunication technologies, big data analysis, dynamic tasks, intelligent management decision-making system, forecast

АГРОӨНЕРКӘСІПТІК КЕШЕНДЕ ҮЛКЕН ДЕРЕКТЕРДІ ПАЙДАЛАНА ОТЫРЫП, ДИНАМИКАЛЫҚ МІНДЕТТЕР БОЙЫНША ШЕШІМДЕР ҚАБЫЛДАУҒА ТЕЛЕКОММУНИКАЦИЯЛЫҚ ТЕХНОЛОГИЯЛАРДЫҢ ӘСЕРІ

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Бүгінгі таңда фермерлердің егіс алқаптарындағы жағдайлар туралы сенімді ақпарат алу үшін бүкіл әлемде телекоммуникациялық технологиялар қолданылады. Деректер нақты уақыт режимінде беріледі, құрылғыларға (датчиктер, дрондар, бекіту аппаратурасы) қол жеткізу тұрақты негізде қамтамасыз етілуі тиіс.

Үлкен деректерді пайдаланатын динамикалық тапсырмаларға арналған ақпарат ауыр мазмұннан тұрады және жоғары жылдамдықта деректерді беруді қажет етеді. Қазіргі заманғы ақпараттық технологиялардың негізгі компоненттерінің бірі интернетке қол жетімділік болып табылады, оның көмегімен деректерді өңдеу мен талдаудың бүкіл процесі ғана емес, сонымен қатар басқарушылық шешімдерді уақтылы қабылдау да қамтамасыз етіледі. Әдетте, объектілер (деректер базасы, білім) бойынша барлық ақпарат деректерді тіркеу және беру құрылғыларының жұмыс істеу ауданында әлеуетті клиенттерде тұрақты сервис болған жағдайда ғана қол жеткізуге болатын серверлерде орналастырылады. Ғарыштық спутниктер арқылы объектілерді визуализациялаудың қолданыстағы әдістерінің шектеулі болу уақытына, кескін сапасына, қолмен өңдеу қажеттілігіне байланысты кемшіліктері бар. Осыған байланысты Интернет заттары технологиясын қолдайтын құрылғыларды пайдалану өзекті және уақтылы, өйткені деректер нақты уақыт режимінде алынады, деректер өзекті, шешім қабылдау процесі жедел жүзеге асырылуы мүмкін және өндіріс тиімділігі мен еңбек өнімділігін арттырады. Мақалада еліміздің астық егетін өңірлерінің егістік жерлеріндегі болжамды модельдердің деректерін талдау үшін заттар интернеті құрылғыларынан деректерді алуға байланысты міндеттерді орындау бойынша Қазақстанның ұялы байланыс операторлары желілерінің мүмкіндіктері, проблемалар, шешудің мүмкін жолдары, басқарушылық шешімдер қабылдаудың зияткерлік жүйесін ұйымдастыру қағидаттары қарастырылған.

Түйінді сөздер:. Телекоммуникациялық технологиялар, үлкен деректерді талдау, динамикалық міндеттер, басқарушылық шешімдер қабылдаудың интеллектуалды жүйесі, болжам

ВЛИЯНИЕ ТЕЛЕКОММУНИКАЦИОННЫХ ТЕХНОЛОГИЙ НА ПРИНЯТИЕ РЕШЕНИЙ ДЛЯ ДИНАМИЧЕСКИХ ЗАДАЧ С ИСПОЛЬЗОВАНИЕМ БОЛЬШИХ ДАННЫХ В АГРОПРОМЫШЛЕННОМ КОМПЛЕКСЕ

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На сегодняшний для получения достоверной информации по ситуациям на посевных площадях аграриев, во всем мире используются телекоммуникационные технологии. Данные передаются, в режиме реального времени, доступ к устройствам (датчики, дроны, аппаратура фиксации) должен обеспечиваться на постоянной основе. Информация для динамических задач с использованием больших данных, состоит из тяжелого контента и требует передачи данных на высоких скоростях. Одной из основных составляющих современных информационных технологий является доступ в интернет, с помощью которого обеспечивается не только весь процесс обработки и анализа данных, но и своевременное принятие управленческих решений. Как правило, вся информация по объектам (базы данных, знаний) размещается на серверах, доступ к которым возможен только при наличии постоянного сервиса у потенциальных клиентов в районе функционирования устройств фиксации и передачи данных. Существующие способы визуализации объектов с помощью космических спутников имеют недостатки, связанные с ограниченностью времени пребывания, качеством изображения, необходимостью обработки в ручном режиме. В этой связи использование устройств с поддержкой технологии интернета вещей, актуально и своевременно, так как данные снимаются в режиме реального времени, данные актуальны, процесс принятия решений может осуществляться оперативно и повышает эффективность производства и производительность труда. В статье рассмотрены возможности сетей операторов мобильной связи Казахстана по выполнению задач связанных с получением данных с устройств интернета вещей, для анализа данных прогнозных моделей на пахотных землях зерносеющих регионов страны, проблемы, возможные пути решения, принципы организации интеллектуальной системы принятия управленческих решений.

Ключевые слова. Телекоммуникационные технологии, анализ больших данных, динамические задачи, интеллектуальная система принятия управленческих решений, прогноз.

Introduction. Modern possibilities of information technologies allow to introduce innovative approaches in various sectors of the economy of Kazakhstan, in particular in the agro-industrial complex (AIC).

Agro-industrial complex is the basis of the country's food security. Not only the general welfare of the population depends on the effectiveness of its work, but also the global challenges of our time in which Kazakhstan is involved, being part of the world community. The use and implementation of the latest achievements of science and information technology is a trend in the development of world powers for which it is not only a tribute to fashion, but also a vital necessity, as the world's population is approaching the 9 billion mark. And only effective and scientifically sound technologies will ensure the possibility of obtaining food to meet the needs of the inhabitants of the planet. Digital technologies, telecommunication technologies, and technical means for processing big data play an important role in this.

Over the last period in Kazakhstan, within the framework of the development and promotion of innovations, the documents ”Digital Kazakhstan” from 2017 [1], ”The State Program for the development of the agro-industrial complex of the Republic of Kazakhstan for the period 2021-2025” from 2021[2] were adopted.

At the same time , the main problems of the agro - industrial complex include:

- lack of a scientifically based plan for the diversification of the industry;

- the presence of a large number of old equipment;

- use of outdated cultivation technologies;

- lack of personnel capable of promoting innovative technologies;

- lack of software solutions for forecasting business processes;

- low production culture and productivity;

- large indebtedness of commodity producers;

- low level of information technology involvement.

To date, the most advanced countries in the use of information technologies in agriculture are China and the USA [3], which use modern technologies, including the Internet of Things, to introduce innovations, increase productivity and labor productivity.

In the most developed countries, telecommunication technologies are the drivers of the economy, on the basis of which related industries are developing.

In particular, the use of Star link as a provider allows US farmers to access data transmission at speeds up to 100 Mb / s throughout the country. I.e., processing big data of dynamic tasks is possible without difficulties related to the quality of the data transmission network. Thanks to this, data is accumulated, transmitted, and analyzed in real time 24 hours a day.

The purpose of the study. To evaluate the possibility of networks of mobile operators in Kazakhstan (using the example of Tele 2) to gain access to Internet of Things devices in real time, transfer and processing of big data for dynamic decision-making tasks in the agro-industrial complex.

Methods and materials. As a methodology, the research uses methods of system analysis, logical, statistical analysis, LTE 4G, GSM 3G technologies.

Discussion of the results. Working with large amounts of data requires the use of technical means with large amounts of RAM and processor performance, which in itself requires large financial costs for the purchase of such equipment.

Devices designed to store information and exchange it allow storing large amounts of data that increase non-linearly, which causes a quantitative transformation of the data array that is subsequently created - ”big data”. There may be problems here primarily related to:

- with data located on the Internet, to which there is no direct access;

- access to data is carried out according to an access scheme that is too complex;

- limiting the speed of data access due to unsatisfactory data transmission quality;

- insufficient number or congestion of channels.

For Kazakhstan's agro-industrial complex, it is important today to develop software tools that allow performing predictive calculations to assess risks that exclude the occurrence of force majeure situations associated with inefficient business processes by commodity producers.

The most popular data for forecasting today are:

1. Forecast models based on weather data;

2. Predictive models based on image processing;

3. Predictive models based on seed varieties;

4. Predictive models based on the soils used;

5. Predictive models based on the use of fertilizers;

6. Predictive models related to the disease of grain crops;

7. Forecast models related to grain sowing culture;

8. Forecast models of crop yields;

9. Predictive models based on various types of data coming from various heterogeneous sources.

For example, in Russia, Sberbank has developed a program ”Heat Map of the harvest forecast”, which uses data from the Global Environmental and Safety Monitoring (GMES/Copernicus), photos from the Sentinel-1 and Sentinel-2 satellites of the European Space Agency. Further, the information is processed by machine vision technology. Data is accessed via a browser, information can be provided both for the entire region and for individual districts or fields (see Fig.1) [3].

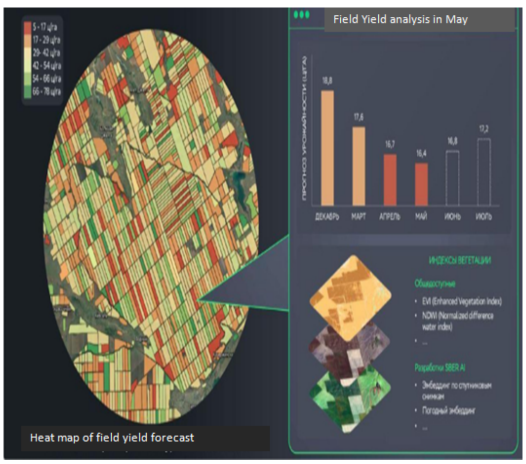

Fig. 1- Data from Sentinel-1,2 satellites

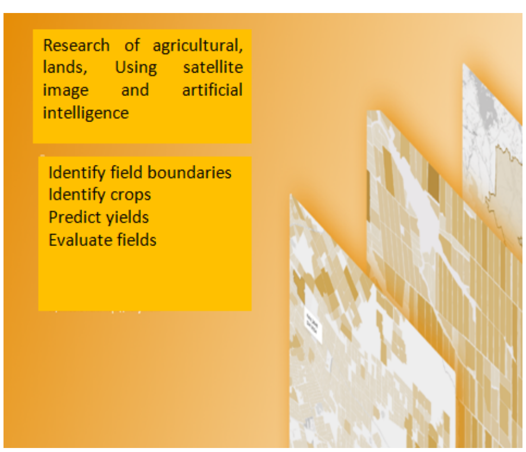

Fig.2- Potential capabilities of the program ”Agromonitoring”

The ability to obtain high-quality data, as well as access to the browser, depends on the speed and coverage area of both satellite and mobile Internet. In particular, I. Mask's company provides access via Starlink up to 100 Mgb / s (data obtained from open sources). As for the Sberbank product, the previously developed program ”Agromonitoring” allows you to receive data (see Fig.2).

The capabilities of a modern person, in particular his brain, are limited, and does not have the ability to predict situations with 3-5 independent factors assigned. In cases with AIC problems, there is a need to predict a sufficiently large number of predictive models. In this regard, there is a need to create an intelligent control system focused on the development of control solutions based on the analysis of predictive models and forecasting their development for the implementation of optimal control modes.In particular, today data warehouses (data centers) are being built all over the world, including in Kazakhstan, which provide reliable storage and processing of data with real-time access from anywhere in the country or the world. Nevertheless, it is necessary to take into account the potential capabilities of the operator of the telecommunications service provider, since not everywhere there is a coverage area, but even if there is a coverage area, the quality of data transmission may not be satisfactory.The possibilities of operational access to data for analyzing the current situation, comparison with real-state data, can be implemented by means of on-line analytical processing (OLAP) [4].

Currently, OLAP technologies are an effective tool for assessing situations for making managerial decisions Fig.3.

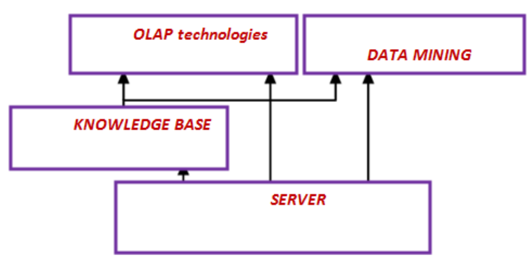

Fig.3 - OLAP technologies for situation assessment

One of the important components of DM is the transition from situation visualization technology to the use of applied mathematics methods in research.

To date, for the agro-industrial complex, the tasks of DM in managing dynamic processes are system analysis of situations, short- and long-term forecasts, their development and development of management decisions.

Analysis of current situations includes:

- detection and prediction of the development of observed processes;
- detection and recognition of influence factors (threats);
- detection and identification of relationships between dynamic parameters and influencing factors;
- analysis of the interaction of dynamic processes and prediction of changes in characteristics;
- development of optimization recommendations for dynamic process management;
- visual presentation of the results of the analysis, preparation of reports and proposals of scientifically based solutions with assessments of the reliability and effectiveness of possible implementations of the tasks.

The solution of forecasting problems can be performed in the following ways (see Fig.4).

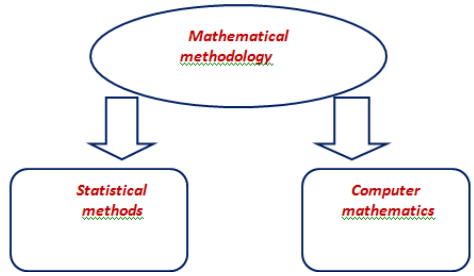

Fig. 4 - Big Data Tools

Statistical methods of data processing, provide 4 basic functions [4]:

- hypothesis testing (stationarity, normality, independence, homogeneity, evaluation of the type of distribution function);
- identification of relationships and patterns of processes (linear and nonlinear regression analysis, correlation analysis, etc.);
- statistical analysis;
- development of dynamic models, forecast based on time series.

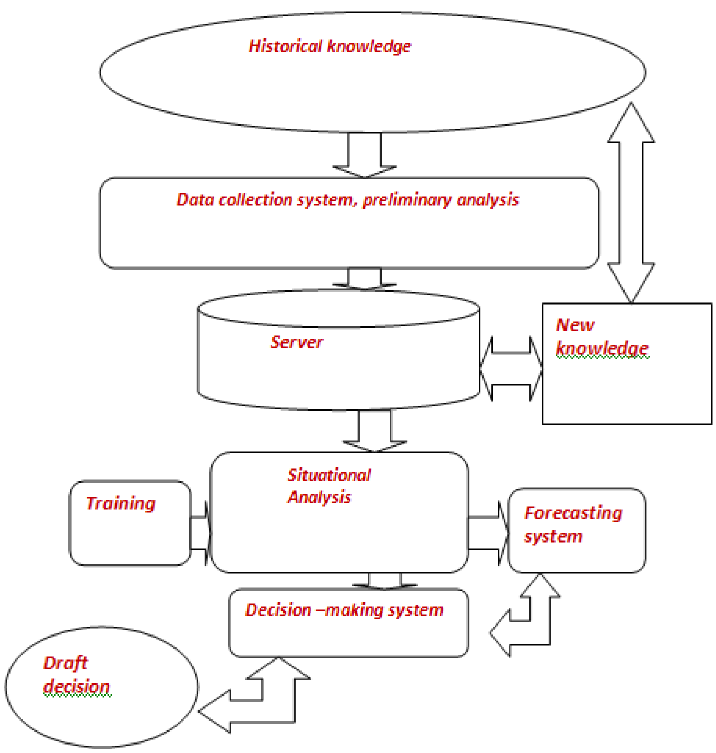

Fig. 5 - Block diagram of an intelligent management decision-making system

To date, the following software tools are actively used: Statistica, SPSS, Systat, Statgraphics, SAS, BMDP, TimeLab, ataDesk, S-Plus, Scenario (BI).

Computer methods are based on computer mathematics and the theory of artificial intelligence. These primarily include methods neural networks, evolutionary modeling, genetic algorithms, fuzzy logic methods.

To date, there is no clear methodology in assessing decision-making, nevertheless, it is possible to consider approaches for intelligent decision-making systems, in particular, Figure 5 shows a block diagram of an intelligent management decision-making system.

From Fig. 5, it can be seen that the main idea of using big data is to compare the results of monitoring processes in real time with the data preceding this event (with the historical past"), the data is stored on the server. Database (knowledge), creates the basis for

Displaying information "about the past" in a form that allows using this data for the subsequent search for analog situations and prototype situations (practical experience, associative memory) at the same time, templates ("patterns") of analogs begin to form, which can compare the "past" with the present situation, thereby being able to make a forecast development of dynamic processes.

It should be understood that it is the formation (justification) of a deliberate decision that is an important and key element of the analytical management system. Also, it is not a little important that such functions as collecting and pre-processing information are included in predicting the development of situations, storage, self-study, preparation of reports.

In practice, when using the big data methodology, the fundamental difference between which and data processing systems is the functionality of using knowledge of the "historical past" on the basis of which a forecast scenario is formed. In addition, it should be understood that a mathematical apparatus capable of processing a large amount of data is also used here. Sometimes the concept of "hybrid intelligence" is used in the scientific literature, when a person remains the final decision-making.

Returning to the topic of processing and analyzing a large amount of data that needs to be not only received, but also transferred to the server for storage, we understand that there is a need to implement a module that would provide data reception, including from the global network, which is practically impossible in practice, for various objective and subjective reasons. The meaning of this approach is that the availability of high-speed Internet access allows you to receive data in real time, regardless of the volume and format of the data.

Table 1. Harvesting area

Area	Harvesting area in thousand ga	
	2015	2016
Akmolinskaya	4180	4328
Aktubinskaya	320	340
Almaatinskaya	449.4	455.2
Zapadno-Kazhakhstanskaya	260.2	215.3
Zhambylskaya	260.9	266.3
Karagandinskaya	681.7	741.3
Kostonayskaya	4018	5215
Kizilordiskaya	86.6	86.9
Uzhno-Kazhakhstanskaya	255	260.4
Pavlodarskaya	663.9	673.9
Severo-Kazakhstanskaya	3210	3217.7
Vostochno-Kazakhstanskaya	579.5	573.4
Total	14966	15375.1

When working with big data, the following procedures are required to form the "Historical Past":

1. Getting data from the object. We receive data both from sensors operating on the Internet of Things technology, and, for example, from various tracking devices, satellites, and aircraft. At the same time, the

status ”ready to work” or on air is required. If the object is not ready to transmit data, the process can be initiated to the next object with the status ”ready to work”.

2. Connection to the object. Today in Kazakhstan, there is a possibility of obtaining a connection with the help of 3 mobile operators, which today have monopolized the entire mobile communications market.

At the same time, the process of working with big data itself can be difficult, since there is no possibility of obtaining high-quality data transfer services.

The main granaries of Kazakhstan are 3 regions of Akmola, Kostanay and North Kazakhstan regions [5-10], located in the north of the country. These regions are not densely populated themselves, moreover, the North Kazakhstan region, the smallest region in the republic, the area of arable land, these regions, is more than 81.5% of the total number in the country table 1.

When installing base stations, operators first of all put stations in settlements where at least 1000 people live.

To work with big data of predictive models, a stable and reliable, fault-free data transmission network is needed.

According to data from [11], today 90% of households are equipped with Internet access Fig.6.

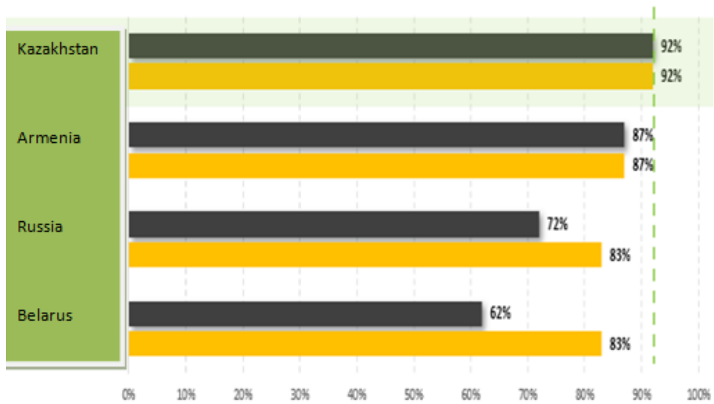

Fig. 6 - Share of Internet users by household

For example, Fig. 7 shows data on the number of base stations introduced by Tele2 in rural areas (data for 2022) [11].

Fig. 7 - Number of base stations introduced by Tele2 in rural areas

As part of the ”250+ Program”, all 3 mobile operators of Kazakhstan had to mount 928 base stations. To date, the base stations support the 2G, 3G standard, the data transfer rate for these technologies is no more than 2-4MB/sec [11].

The arable lands of the main grain-growing regions are located in places of compact residence of the population of the country or, correctly speaking, far from the places of permanent residence of residents of settlements.

As a rule, the height of the suspension of antenna-feeder devices of the base station of mobile operators is at least 16 m, to ensure normal coverage. There are no such high-rise buildings in rural areas. Accordingly, the AFU is placed on the roof of houses no higher than 6-8 meters or mast structures are being built Fig.8.

Fig.8 - Antenna-mast structure of the mobile operator

Fig. 9 - Antenna-mast structure

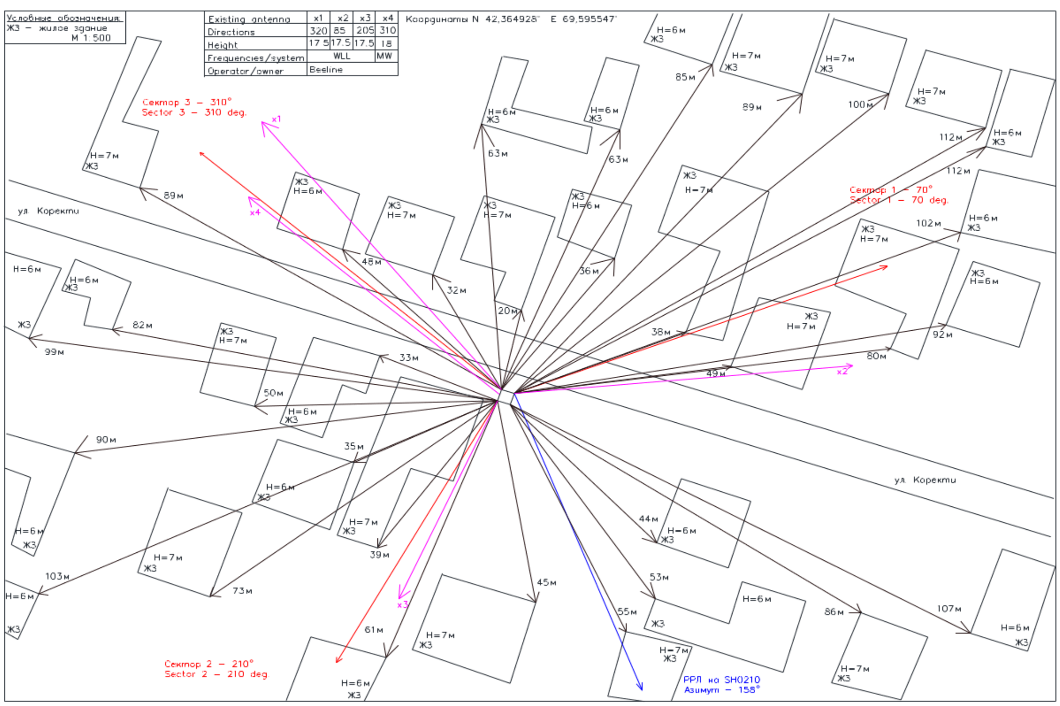

Fig. 10 - Situational plan of the base station

According to [12], the construction of high-rise AMS (see fig. 9) in the amount of 487 units on republican highways is expected by 2027.

The coverage of republican roads does not mean that there will be a high-quality coverage of arable land, in particular, the 3 regions presented above.

According to the situational plans (see fig.10-11) presented during the construction of mobile communication facilities, each antenna has a suspension height and an angle of inclination Fig.8, depending on these parameters and the number of subscribers, it is possible to determine the coverage radius of the base station. For example, the range of the GSM 3G base station (900 MHz) is 10 km, for unloaded sectors, similarly for 4 LTE, as for 5 G, then no more than 500 meters. The lower the frequency, no fewer stations need to be installed.

Fig. 11 - Placement of antennas on AMS

Fig. 12 - Location of base station sectors

According to the rules of installation and installation of antenna-feeder devices, each sector of the base station covers at least 120 ° (see Fig.12).

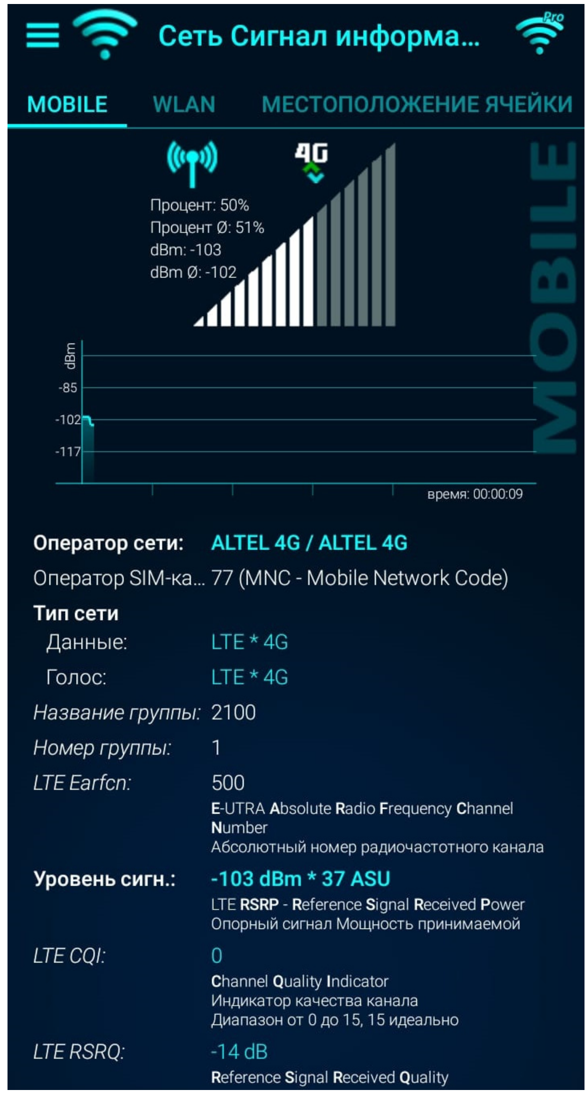

Fig. 13 - Measuring the signal level at the Tele 2 base station

Ideally, if we assume that the AMS will be installed every 30-40 km, for a high-quality hand off, but this does not solve the problems with covering the arable fields of the country with high-quality Internet access.

Conclusion. Fig. 13 shows a screenshot of the measurement of the signal level of the Tele2 base station. As can be seen from Fig.10, the signal strength is -103dBm, this indicator indicates that the base station provides not only low-quality services, but is also practically out of service.

With the existing coverage area of mobile operators' networks, as well as with a significant deterioration in the services provided by all mobile operators, today it is practically impossible to use telecommunication networks to solve problems related to forecasting, monitoring and processing of big data on dynamic tasks of the agro-industrial complex of Kazakhstan. Serious work is required to implement the President's.

Address, to quickly introduce information technologies into the decision-making process in the agricultural sector, to ensure high productivity, reduce the cost of agricultural products, and ensure the security of the country.

According to the source [13], the deployment of base stations in rural settlements is not efficient and impractical, nevertheless, it must be done, since we can stay out of the current trends in the processes of maintaining cultivated land.

As an alternative, consider the possibility of using the I. Mask satellite network, in the event of the appearance of the Star link company's service on the territory of Kazakhstan to solve the tasks of organizing intelligent forecasting systems and making management decisions in the agro-industrial complex of Kazakhstan.

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