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New methods of train traffic control

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Abstract. This article is written about a new concept of train traffic control. A topic of significant relevance in the field of organisational and safety aspects of train traffic.

The existing system of train traffic control is based on the principles of application of field devices railway automation, and depending on their state driver provides movement or stopping of the train. Also on the monitoring panels, which are located in the control center, describes the state of floor devices, by them train dispatcher keeps track only the approximate location of the train.

ETCS is based on the idea of continuous monitoring of the transport process using a combination of various technical means, thereby achieving a safe reduction in the transit interval, which means an increase in throughput. The ETCS is based on determining the location of the train, calculating the distance between trains, controlling the maximum permissible speed on the section, calculating the braking curve (depending on the speed over the distance traveled), comparing route data with the technical characteristics of the train.

The requirements for ETCS devices are strict parameters of the accuracy of the navigation system: the error in determining the location of the eurobalance should not exceed ± 1 m, and the error of the odometers should not exceed $\pm 5\%$ of the distance traveled.

Keywords: transport, management, traffic control, infrastructure, automatics.

1. Introduction

This system can determine the exact location of the train, and also provide information to the driver about of the train`s location and speed of the route of the previous train. In addition, the existing system does not allow for the remote stop of the train in the acute necessity of it (for example, if something happens to the locomotive driver or at any possibility of an emergency situation). Thus, under the current system, controlled the field devices, not the train, that does not give possibility to provide sufficient security and efficiency of the organization of movement of trains, and also restrict the use of the throughput of the railway stations and speed route of the mobile units. Such a principle of train traffic control, until recently, was applied on the railway transport of almost all countries. And in connection with the fact that in general, each state uses its technology and equipment, operating in various standards that are not compatible between themselves, there are border issues, which are important for the organization of international and transit traffic.

It is known that one of the important indicators of railway transport is the capacity of the backbone network, which in turn depends on the applied system of the interval regulation of the traffic. And when the throughput of the railway reached its maximum use, there is a necessity of construction of the second ways. Specialists know that the regulation of movement of trains on a particular division carries out the train dispatcher with the help of various means of railway automatics, telemechanics and communication, technical opportunities which largely determine the carrying capacity of the site. Today on the railways of Kazakhstan for this purpose is used the technique and technology were developed in 50-60 years of the last century. In this case, even introduced in 2007 in the areas of the backbone network of new technology of production of the CIS countries is no different in principle of their action on the existing, except for the advanced element bases of individual nodes.

2. Methods

In this regard it should be noted that the current system of the management of train traffic has reached its limit opportunities, and further increase of throughput of the railway sections, security level, speed of movement of trains, as well as the efficiency of the rolling stock usage becomes impossible without a radical revision of the existing system of train traffic control. In addition, the integration of the economies of different countries, the rapidly growing volume of transportations of cargoes and passengers, traveling in interstate communication, developing competition in the market of transport services, forcing the railway administrations of the different States to rethink methods of work in all areas of the railway transport and require the building of a unified system of control of movement of trains within the borders of many States [1].

3. Results and discussions

The solution of these problems has become one of the most important tasks of the International Council of Railway transport (UIC) in the framework of which has carried out certain work with allowance for the mobilization of the potentials of the leading companies and scientists of the world in the field of railway transport on the search for the answer on these issues.

As a result, was developed a new concept of train traffic control, which fundamentally differs from the present and corresponds to the requirements put forward by the Commission of the UIC. Today, more than 30 countries, including China, support this concept. And member states of the European Union define concrete terms, during which they will need to build a unified system of control of movement of trains. Work is carried out in the framework of the project for the creation of the European system of control of transportation process on the Railways (ERTMS), initiated in 1995 by the European Commission. The basis of this project is the system of management and safety of movement of trains ERTMS/ETCS. In this regard, countries such as Germany, Belgium, Spain, Finland, Norway and others already have concrete results, and countries such as China, India, Turkey and Russia are doing some work [2].

The proposed concept is based on the principles of the direct control of a moving object (without the use of traditional floor devices). The question of transition to the organization of the movement of trains through the onboard system of mobile units instead of the traffic management system through the floor of the device, stood before the world community for a long time. This problem were occupied by the scientists of many countries. One of the most important aspect in the decision of this task was to find ways to install a reliable and secure connection with the moving object regardless of the speed of its movement, which could ensure permanent monitoring and management of the object. Solution of the problem became possible only with the advent of modern telecommunications technology.

After a thorough study, research and comparative analyses in the field of telecommunication technologies, the most suitable for the organization of communication with moving objects, experts agreed the standard GSM, on the basis of which was developed specialized for railway transport system of mobile communication - GSM-R (here «R» means railway from the German word - Railways).

GSM-R is a complex system with wide range of possibilities and a set of the specialized for railway transport applications, implementation of which will allow to raise to a new level of quality, both the organization of the transportation process, and in the whole system of management of the company. Today, the Commission recommends that the UIC system GSM-R as an international standard system for the implementation of transition of Railways to the new principle of train traffic control.



Figure 1 ETCS floor devices: eurobalises (between rails) and wheelset counting device (fixed on rail), Erfurt — Leipzig line, Germany

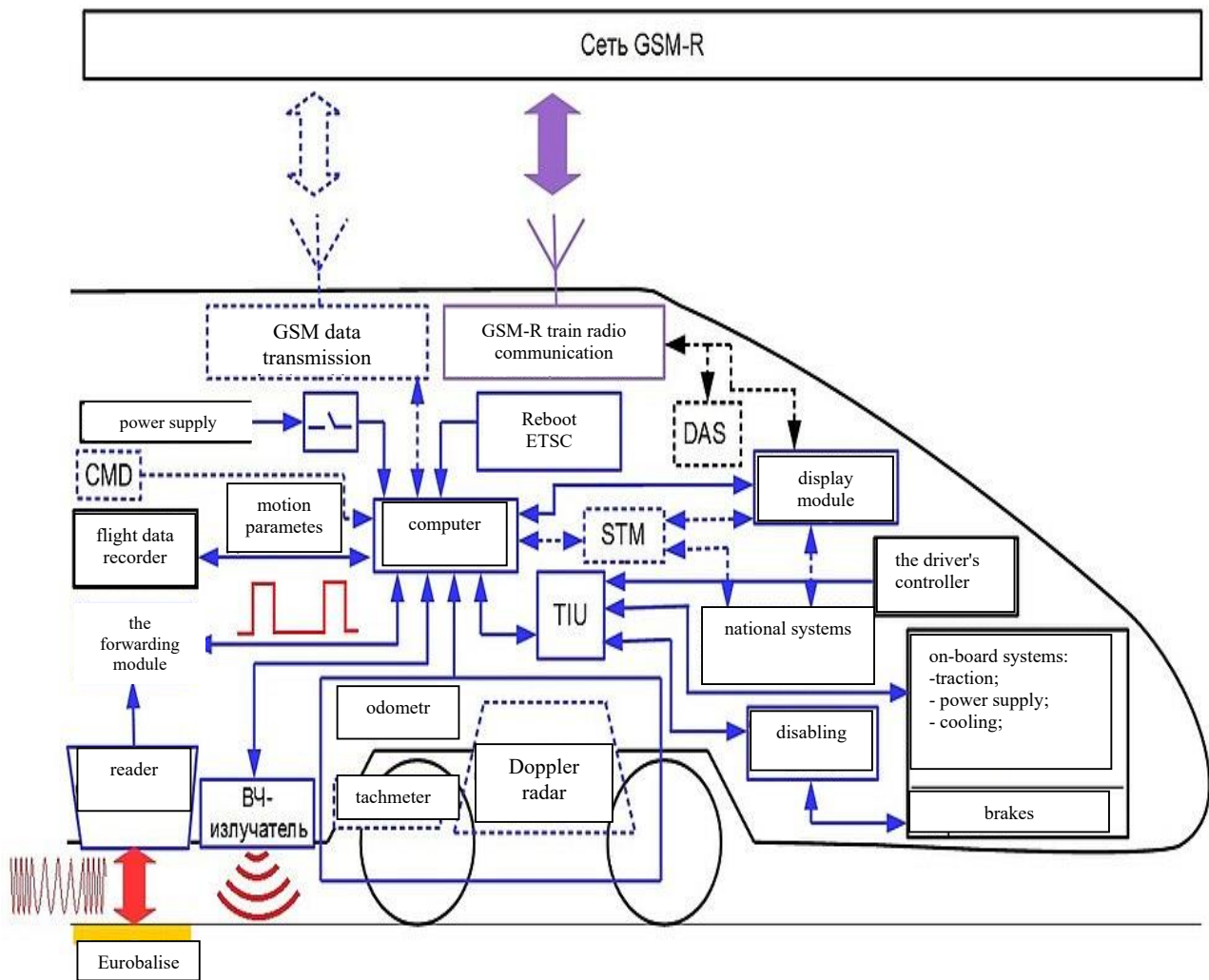


Figure 2 Block diagram of elements of on-board equipment of rolling stock equipped with ETCS

Implementation of the new concept of train traffic control demanded the solution of another important problem which related to the development of a universal international alarm system and a safety of movement of trains (ETCS).

Thus, we can stress that in order to realize a new concept of train traffic control is necessary to construct a system of GSM-R and implement a system to ensure the safety of movement of trains, stipulated by the project ETCS.

It is necessary to note, that the transition to the new principle of organization of movement of trains will in order to increase throughput of the railway lines and to revise the expediency of the construction or extension of second tracks and longitudinal transmission lines in some areas of the backbone network. And this, in turn, will contribute to the reduction of capital investments in the infrastructure of the backbone network of the railway transport and reduce the cost of transportation.

Given that the Commission recommends that the UIC developed the concept in the quality of the international and Kazakhstan strives to join the composition of the UIC, it will be necessary for this question to determine its position and our Republic, which has a specific policy of reforming of railway transport of the country [3].

In addition, the geographical position of Kazakhstan in the center of Asia attaches great importance to occupy the best positions in the market of cargo and passenger traffic. All of this obliges railway administrations of Kazakhstan to take the necessary measures, aimed at improving the safety, reliability, and commercial attractiveness of the railway transport.

It is clear that the successful solution of these problems will largely depend on the proper technical policy and the degree of compliance with international standards and norms in the selection of new equipment and technologies for implementation in the industrial economy of railway transport.

4. Conclusions

The specialists of JSC «NC «Kazakhstan Temir zholy» studied the details of the above mentioned systems and developed the possible options for implementing projects in the conditions of JSC «NC «Kazakhstan Temir zholy». In addition, meetings were organized with the developers of the systems and the leaders of projects for the implementation of GSM-R on the German Railways.

Back in March 2017, a working meeting of the management of JSC NC "Kazakhstan Temir Zholy" with representatives of the International Union of Railways (UIC) took place. The parties discussed the interest of JSC NC KTZ in the use of automatic wheelset width change systems at border crossings and the project of equipping locomotives with diagnostic devices for track infrastructure and contact network. In addition, the participation of JSC "NC "KTZ" in UIC research projects and the development of unified railway standards, as well as the experience of operating railway transport in difficult climatic conditions and improving its energy efficiency were considered.

Author contribution:

A.A. Aitkhozhina – concept, methodology, resources, data collection.

A.B. Orazalina – interpretation, editing.

G.N. Baiguzhina – modeling, analysis, visualization.

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Новые методы управления движением поездов

Аннотация. Тема данной статьи о новой концепции управления движением поездов очень актуальна в области организации, безопасности движения поездов.

Существующая система управления движением поездов основана на принципах применения напольных устройств железнодорожной автоматики, и в зависимости от их состояния машинист осуществляет движение или остановку поезда. Также на контрольных приборах, находящихся в диспетчерском центре, отражается состояние напольных устройств, по которым поездной диспетчер отслеживает только ориентировочное место нахождения поезда.

В основу работы ETCS положена идея непрерывного контроля перевозочного процесса с помощью совокупности различных технических средств, благодаря чему достигается безопасное уменьшение интервала попутного следования, а значит, увеличение пропускной способности. Действие ETCS основано на определении местоположения поезда, вычислении расстояния между составами, контроле максимально разрешённой скорости на участке, расчёте кривой торможения (зависимости скорости от пройденного пути), сопоставлении данных о маршруте с техническими характеристиками поезда.

К устройствам ETCS предъявляются строгие параметры точности работы системы навигации: погрешность определения местоположения евробализы не должна превышать ± 1 м, а погрешность одометров не должна превышать ± 5 % от пройденного пути.

Ключевые слова: транспорт, менеджмент, управление дорожным движением, инфраструктура, автоматика.

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Пойыз қозғалысын басқарудың жаңа әдістері

Аңдатпа. Мақала пойыз қауіпсіздігі саласында өзекті болып табылатын негізгі мәселелерді талдап, көлік қозғалысын басқарудың жаңа тұжырымдамасын ұсынады.

Қолданыстағы пойыздардың қозғалысын басқару жүйесі теміржол автоматикасының едендік құрылғыларын қолдану принциптеріне негізделген және олардың жағдайына байланысты машинист пойыздың қозғалысын немесе аялдауын жүзеге асырады. Сондай-ақ, диспетчерлік орталықтағы бақылау аспаптарында поезд диспетчерінің поездың болжамды орналасқан жерін қадағалайтын еден құрылғыларының жай-күйі көрсетіледі.

ETCS жұмысының негізі әртүрлі техникалық құралдардың жиынтығы арқылы тасымалдау процесін үздіксіз бақылауына негізделген. Соның нәтижесінде жол жүру аралығы қауіпсіздігін азайтуға, яғни өткізу қабілетін арттыруға қол жеткізіледі. ETCS әрекеті пойыздың орналасқан жерін анықтауға, құрамдар арасындағы қашықтықты есептеуге, учаскеде рұқсат етілген ең жоғары жылдамдықты бақылауға, тежеу сызығын есептеуге (жылдамдықтың өткен жолға тәуелділігі), маршрут туралы мәліметтерді пойыздың техникалық сипаттамаларына сәйкестендіруге негізделген.

ETCS құрылғыларына қойылатын талаптар, навигация жүйесі жұмыс дәлдігінің қатаң параметрлері бар: еуробализдің орналасу қателігі ± 1 м-ден аспауы керек, ал одометрлердің қателігі өткен жолдың $\pm 5\%$ - нан жоғарыламауы тиіс.

Түйін сөздер: көлік, менеджмент, жол қозғалысын басқару, инфрақұрылым, автоматика.

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