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Zhanmuratov A.
Academy of Transport and Communications named after M.Tynyshpaev
Almaty, Kazakhstan
Scientific superviser: K. Sansyzbay

ENSURING INFORMATION SECURITY OF TRAIN TRAFFIC BY IMPLEMENTING THE NATIONAL SYSTEM KTCS ON RAILWAYS LINES

Abstract. *This article highlights the need to develop a national KTCS system for the safe and efficient management of train traffic based on modern technical solutions. The work lists the main components of the national KTCS system, considers the operating principle of the system, gives digital radio communication standard TETRA.Ensuring information security train of traffic implementing by the national system KTCS railways lines*

Keywords: *KTCS, standard TETRA, rail transport, Direct Mode Operation, Trunked Mode Operation.*

As is known in the world, the development of the digital railway and high-speed railways, as a connected system of the transport network, has entered the digitalization stage. Currently, the railway sector is an integral part of all industrial progress, pushing the boundaries of digitization and technology, acting as a locomotive of the digital economy.

Rail transport for the Republic of Kazakhstan is of strategic importance. Information technology has become an active participant in the activities of enterprises in the world, ensuring their efficient operation and streamlining processes. Message [1] poses a comprehensive task for the development of traditional basic industries, such as logistics, through the widespread introduction of elements of the Fourth Industrial Revolution. As a result, the task is to develop a set of measures for the technological re-equipment of basic industries until 2025, which has become the initiator of the State program «Digital Kazakhstan» [2]. Within the framework of Digital Kazakhstan, the technologies of the Fourth Industrial Revolution will be actively introduced: automation, robotics, artificial intelligence, the exchange of «big data» and others.

Currently, the JSC «National company «Kazakhstan temir zholy» (JSC «NC «KTZ») railway network transmits significant amounts of sensitive confidential information using various data transmission systems. Logistic information on the schedule and location of trains is of high commercial value. The basis for ensuring the safety of train traffic are railway automation and telemechanics systems [3].

The methods of transmitting data to locomotive devices and their diversity on railway networks in Europe and Asia complicate locomotive airborne systems and make them more expensive. Various approaches to the organization of train traffic and railway automation systems significantly complicate through railway traffic across the national borders of Europe: they lead to a decrease in speed and additional transport costs. In addition, with an increase in average rail speeds (the development of high-speed rail), the efficiency of existing signal systems decreases.

To reduce the costs of various locomotive signaling systems and increase train speed in international traffic, a proposal was put forward to create a single standard for the development of signaling, blocking and centralization systems for railway transport in Europe. The project for the creation of the European Rail Transport Management System (ERTMS) was initiated in 1995 by the European Commission. The basis of the project is the ERTMS / ETCS train control and safety system (ERTMS - European Rail Traffic Management System; ETCS - European Train Control System) [4].

Recently, the specialists of JSC «NC «KTZ» developed the national system Kazakhstan Train Control System (KTCS) for the safe and efficient control of train traffic based on modern technical solutions.

The KTCS system is a single set of security systems and train traffic control systems on stages and stations and consists of the following main components:

- a microprocessor-based centralization system (including control systems for the movement of trains on stages, as well as equipment for a transportation control center);
- a radio blocking center (including the workstation of the center dispatcher to enter speed limits, as well as outdoor equipment to determine the location of the train);
- an on-board computer for monitoring and controlling the movement of the EVC train and related peripheral devices;
- subsystems of outdoor devices are connected via Ethernet. The connection between the on-board computer and the radio lock center is via the TETRA radio channel. The block diagram of the link between the main components of the KTCS system is presented in Figure 1.

This solution does not require laying a signal-blocking cable between stations, which significantly saves not only the cost of equipment, but also the cost of laying a copper cable, its maintenance and repair.

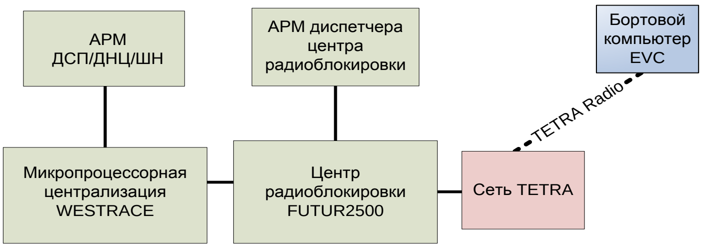

Figure 1 – The main components of the national KTCS system

Train routes are established and controlled by a microprocessor-based centralization system. Information about the state of floor devices is transmitted from the microprocessor centralization system to the radio blocking center. Centralization sends the information necessary for the radio blocking center to issue a permit for the train to proceed. When the signal is opened by microprocessor centralization, the radio blocking center generates permission to trace this signal and sends this information via the TETRA radio communication system to the on-board computer of the train, which approaches the signal or stands in front of it. The transmitted command contains the distance to the place of the speed limit or stop and the line characteristics. The on-board computer issues permission to proceed to the driver's display. After that, the driver can follow the signal.

During the movement of the train, the on-board computer controls the permissible speed, warning the driver if it is exceeded. If the driver does not respond to the warning and does not reduce speed, the on-board computer automatically stops the train. The train cyclically (at least every 6 seconds) transmits information about its location to the center of the radio blocking. To correct the odometry error, transponders with fixed data are used, which are installed on the line after a certain distance. Train location reports are used by the radio blocking center to correctly correlate trains with track elements. The principle of operation of the system is illustrated in Figure 2.

In the future, it will be possible to use the end of the train sensor on secondary and then on trunk lines, which will eliminate the device for monitoring the track vacancy on the stages. The sensor will be installed on the last car of the train and transmit to the locomotive a signal of integrity through the internal radio channel. Upon receipt of information about a malfunction of the devices or the disengagement of the train, movement along the busy stage will be carried out by order [5].

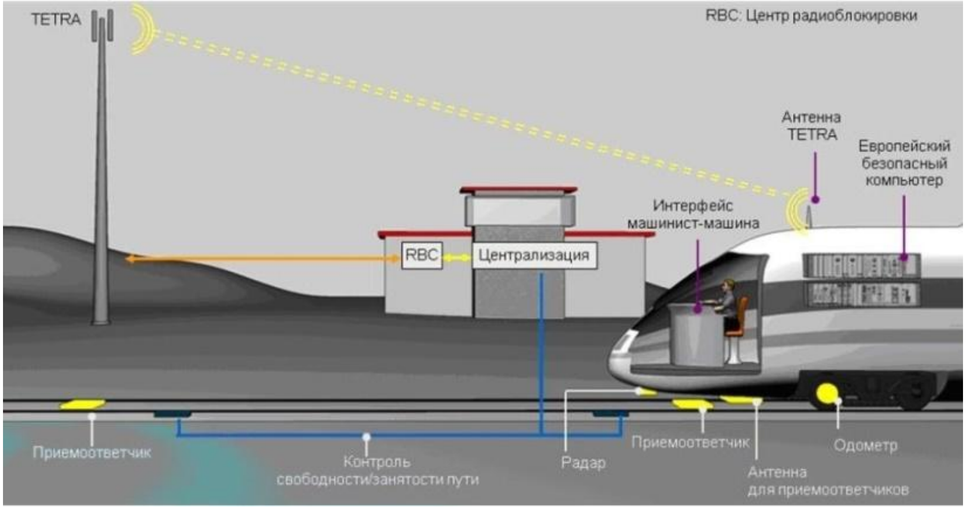

Figure 2 – The principle of operation of the KTCS system

The KTCS system uses TETRA (Trans-European Trunked Radio) standard digital radio communications, both for data exchange between a traffic control center and rolling stock, and between a control center and outdoor equipment. It is intended to use a double-coated radio network.

The main elements of the TETRA trunking communication system are:

- Infrastructure management and switching. The TETRA infrastructure includes equipment that provides radio coverage and the necessary modes of functioning of the TETRA network: switching / routing center; base stations; dispatching consoles; system control center; gateways to other networks; application servers, etc.

- Subscriber terminals. The TETRA standard supports two modes of operation of subscriber equipment (radio stations):

- Trunked Mode Operation (TMO). The TMT mode is possible when the subscriber is in the coverage area of the base station. TMO mode can provide the subscriber with all the TETRA capabilities and is optimized for the following tasks: a) simultaneous voice and data transmission (V + D), b) packet data transmission (Packet data optimized).

- Direct Mode Operation (DMO). DMO mode is designed for group interaction between subscribers outside the coverage area of TETRA base stations. Communication between subscribers is carried out in half-duplex mode, but at the same time it remains possible to make an individual or group call.

The TETRA standard implements the maximum possible frequency efficiency in mobile radio communication systems - 4 logical channels occupy 25 kHz.

The TETRA standard uses Time Division Multiple Access (TDMA) technology in conjunction with the Frequency Division Duplex (FDD) technology. The type of radio channel modulation is relative differential phase shift keying with a multiple of π / 4 (π / 4 DQPSK).

The TETRA standard provides for network security aimed at eliminating unauthorized use of system resources and ensuring the confidentiality of transmitted information on the network.

This is ensured by the following mechanisms:

- authentication of both subscribers and infrastructure;
- encryption of information;
- ensuring the privacy of subscriber parameters.

Subscriber authentication is based on the master key (K-key) and a unique TEI number. A subscriber terminal with an incorrect identifier is not allowed to the TETRA system resources.

Information encryption is an optional feature of each specific TETRA system. The TETRA radio interface is a priori protected. But other encryption options are possible:

- E2E (End-to-End) - encryption of individual calls radio station-radio station (the length of the encryption key can be 128 bits);
- encryption of group calls;
- encryption of the radio interface using the algorithms TEA1, TEA2, TEA3 (TETRA Encryption Algorithm) [6].

The secrecy of the subscriber's parameters is ensured by means of code protection for the configuration of the subscriber terminal and the assignment of identifiers-aliases.

Thus, the national KTCS system can be applied to ensure information security of the railway network of the Republic of Kazakhstan.

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Жанмуратов А.

Научный руководитель: Сансызбай К.

Обеспечение информационной безопасности движения поездов путем внедрения национальной системы КТХП на железнодорожных линиях

Аннотация. В данной статье расмотрена необходимость разработки национальной системы KTCS для безопасного и эффективного управления движением поездов на базе современных технических решений. В работе перечислены основные компоненты национальной системы KTCS, рассмотрен принцип работы данной системы, приводится цифровая радиосвязь стандарта TETRA.

Ключевые слова: KTCS, стандарт TETRA, rail transport, Direct Mode Operation, Trunked Mode Operation.

Жанмуратов А.
Ғылыми жетекші: Сансызбай К.

Теміржол желілерінде ТҚП ұлттық жүйесін енгізу жолымен поездар қозғалысының ақпараттық қауіпсіздігін қамтамасыз ету

Аңдатпа. Бұл мақалада заманауи техникалық шешімдер негізінде пойыздар қозғалысын қауіпсіз және тиімді басқару үшін ұлттық KTCS жүйесін құру қажеттілігі талқыланады. Мақалада ұлттық KTCS жүйесінің негізгі компоненттері көрсетілген, осы жүйенің жұмыс принципі қарастырылған, TETRA стандартының сандық радио байланысы қамтамасыз етілген.

Кілт сөздер. KTCS, стандарт TETRA, rail transport, Direct Mode Operation, Trunked Mode Operation.

About authors:

Zhanmuratov Azat, student, Academy of Transport and Communications named after M.Tynyshpaev.

Sansyzbay K.M., senior-lector, Academy of Transport and Communications named after M.Tynyshpaev.

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Аликулов А.Ж.[1], Серікбай А.М.[2], Молдахан И.[3]
[1,2]Казахский национальный университет имени аль-Фараби
Алматы, Казахстан
[3]Алматинский университет энергетики и связи им. Г. Даукеева
Алматы, Казахстан
Научный руководитель: Г.А. Мун

ПРОБЛЕМЫ МАКРОСКОПИЧЕСКОЙ ЗАПИСИ ИНФОРМАЦИИ В НАНОРАЗМЕРНЫХ СТРУКТУРАХ

Аннотация. *В работе показан подход с использованием нейронов, обладающим двумя входами, которые отвечают двум различным термодинамическим переменным. Отработаны макромолекулярные системы, которые действительно представляют собой аналог нейронной сети и которые позволяют записывать информацию на молекулярном уровне.*

Ключевые слова: *инфокоммуникационные технологии, нейронные сети, нанотехнологии, макромолекулярные системы.*

В литературе, посвящённой инфокоммуникационным технологиям уже продолжительное время обсуждается так называемый закон Мура. Этот закон фактически представляет собой аппроксимацию данных, отражающих количество логических элементов, которые располагаются на отдельной микросхеме. Данная аппроксимация показывает, что в обозримой перспективе логические элементы должны стать сопоставимыми с размерами отдельных макромолекул. Это соображение говорит о том, что для того, чтобы инфокоммуникационные технологии развивались дальше в том же русле, в котором они развиваются сейчас, необходимо перейти к логическим элементам, имеющим не просто наноразмеры, но и размеры, сопоставимые с отдельными фрагментами макромолекул. Подчеркиваем ещё раз, что тенденция на уменьшение размеров отдельного логического элемента связана далеко не только с миниатюризацией компьютерной техники, но и с их вычислительными возмож-