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FORMALIZATION OF TASKS OF SYNTHESIS OF INTELLECTUAL CONTROL SYSTEMS OF TECHNOLOGICAL PROCESSES OF HIGH-SPEED RAILWAY TRANSPORT

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Abstract. The article describes the stages of development of high-speed rail on the Railways of Uzbekistan, peculiarities of electronic document management of technical documentation of railway automatics and telemechanics. The considered problem of synthesis of mathematical descriptions of electronic document management of technical documentation of railway automatics and telemechanics. The article describes the formalized representation of electronic document management of technical documentation of railway automatics and telemechanics.

Keywords: high-speed traffic, railway automatics and telemechanics, electronic document management, technical documentation, formal methods and models, model electronic document management of technical documentation.

Introduction

In the Republic of Uzbekistan embarked on the modernization of its Railways, where the priority is to increase speeds of passenger trains. In this direction have already been put into operation high-speed line at the site Tashkent-Samarkand with a train speed of 150-250 km/h. Was carried out a number of measures to ensure traffic safety of high-speed trains such as the strengthening of railway lines, renewal of the dimensions of the structures, reconfiguration of switches.

Development plan of high-speed traffic

The timing of the implementation of the basic measures for the organization of high-speed movement on the Railways of Uzbekistan is divided into 4 stages [1]:

1. **2010-2015.** Initial phase associated with the preparation and introduction of high-speed electric trains Talgo-250 to the direction of the station Tashkent - Samarkand station.

2. **2016-2020.** The stage is characterized by the expansion of the area of operation of high-speed movement on the direction of Railways Tashkent - Karshi with intensive passenger flow. Expert evaluation of the implementation of this step involves organizing the high-speed passenger trains at speeds up to 160 km/h on the existing road, which needs to be reconstructed in accordance with the technical requirements. In addition, the recorded expenditure on construction of objects of security.

3. **2021-2025.** At this stage, the coverage of high-speed rail will be expanded at the expense of railroads with massive passenger traffic high-speed traffic on the section of Tashkent – Bukhara; high-speed traffic on the commuter movements Tashkent Chinar and the Tashkent - Angren. Expert evaluation phase envisages the reconstruction of Railways, including devices of signaling, centralization and blocking and communication structures, as well as the electrification of the tunnels and stations. In accordance with the requirements of security of the

railway involves the construction of objects of protection and fencing.

4. **Until 2035.** Further development of high-speed traffic on the grounds of Tashkent - Navoi-Tashkent - Urgench (Nukus), Tashkent - Andijan. At this stage are envisaged:- construction and commissioning of new electrified railway Angren - Pap; the formation of the highway Tashkent – Andijan.

In connection with growth of volumes of construction and modernization in areas of high-speed traffic in front of the Uzbekistan Railways are reducing the time and cost of design, construction and pre-commissioning when commissioning systems of railway automatics and telemechanics (RAT).

Statement of the problem

In modern conditions, expanding the functionality of the latest systems of automation and telemechanics, grow the amount and quality of information provided by the railway automatics and telemechanics systems for traffic management, monitoring of train location and state of infrastructure. With further development of these systems, their design, process Troubleshooting of failures becomes more difficult; increase the number of subcontractors participating in the design, construction and supply of equipment, constructs and components; lengthened periods of verification systems in commissioning.

Unfortunately, with the establishment of railway automatics and telemechanics systems do not always use modern design techniques, the organization of interaction of involved organizations, quality control of work execution, automation, input and retrieve information. The result increases the duration of design, construction and commissioning of the systems, waste of time, more difficult scheduling of deadlines, it is impossible to take timely corrective management decisions and, consequently, significantly raise the price of supplies work.

Today in world practice in the field of automation occupies a leading position in developing highly efficient systems of control of technological processes with the involvement of intelligent technologies. Further development of intelligent control technology in rail transport allows you to implement advanced technical systems with high performance and enhanced functionality.

Intelligent technologies are allocated by the developed systems of monitoring and diagnostics. In modern conditions in the railway automatics and telemechanics systems of the ability of a monitoring system organised on the basis of document workflow technical and other regulatory documents.

In this regard, the establishment of an integrated monitoring and control the design, construction, commissioning works, supply of devices, materials, and equipment, as well as analysis of the quality of work performed on the basis of electronic document work flow of technical documentation (EDTD) is relevant.

Formal method

The use of electronic document management [2,3] due to the increasing complexity of systems and, as a consequence, huge amounts of transmitted and processed information. For example, a test project of electric centralization of station visual method without the use of technical means at the time can be comparable with the time of system design. Thus, without the use of means of complex automation of processes of obtaining information and information exchange impossible to reduce time and increase efficiency of production work.

Formally, the process EDTD is submitted in the form of three finite sets and relations of the elements of these sets among themselves [4]. Mathematical notation of this process is presented in the form

$$Д_T = \{У, П, Ф\}$$

where $Д_T$ – is a formal model of electronic document management of technical documentation; $У$ – a plurality of participants; $П$ – the set of processes; $Ф$ – the set of states of the technical documentation (TD), which valid fields values.

A set $У$ is defined as a finite set of actual participants in the workflow, $П$ – as a finite set of

processes, the implementation of which is within the system of workflow participants from many $У$. $Ф$ – is a nite set of states, which can take a TD after executing processes of the plurality of $П$ members from the set $У$.

Graph model

Logical level formal model document TD is implemented using the theory of graphs. When building a graph model of the circulation of TD are encouraged to use the following method to display workflow graphs of TD [5]. To set the vertex set of a graph we use the number of possible states of edges of $Ф$. Edges of the graph define a through many processes $П$. Install this according so as to fulfill the following rules:

− one node of the graph corresponds to one and only one element of a set $Ф$;

− one edge of the graph corresponds to one and only one element of a set $П$;

− one element of the set $Ф$ corresponds to one and only one node of the graph;

− one element of the set $П$ corresponds to one and only one graph edge.

As a basis consider the overall technological process of doing custom specs railway automation and telemechanics (Fig.1), presented in [6].

The process consists of the following steps:

1) project organization is to customer specifications on the basis of the project under construction or renovation projects.

2) drafted specifications according to the service automation and remote control.

3) then, the specification should apply to the head of capital construction. Based on these data, determines which equipment must be ordered manufacturers. As in the specification of several hundreds of items of equipment and devices, the likelihood that their releases only one plant is very small. The capital construction Department shares the equipment specified in the specifications between suppliers.

4) Suppliers, in turn, give the order to the factory to fulfill the order.

Upon completion of the work, the plant sends equipment to the warehouse signaling
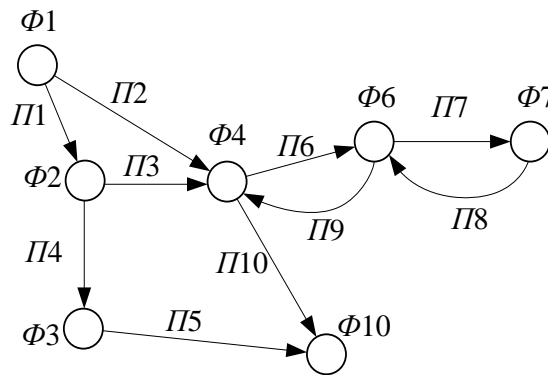

Fig.1. The count of technological process of doing custom-made specifications of railway automatics and telemechanics.

To denote model parameters used legend:

− documents denoted with a multitude of forms used in the simulated process – $Ф1…Ф10$.

− the processes performed on the documents for the state transitions - $П1…П10$.

− executor processes – $У1…У10$.

Consider the logical scheme of algorithms of process management custom spec algorithm A11:

$$A11 = b_{111} \downarrow^{111} b_{112}\alpha_{111} \uparrow^{111}\downarrow^{117} d_{111}\alpha_{112} \uparrow^{112} \alpha_{113} \uparrow^{113} \upsilon_{119}b_{113}\omega \uparrow^{116}\downarrow^{113} \upsilon_{111} \downarrow^{116} \upsilon_{112}\upsilon_{113} \times$$

$$\times \upsilon_{114}\upsilon_{115}\upsilon_{116}\upsilon_{117}\upsilon_{118}\alpha_{114} \uparrow^{114}\downarrow^{114} b_{115}b_{116}b_{117}\upsilon_{1111}\upsilon_{1112} \downarrow^{112} \upsilon_{1110}b_{114}\alpha_{115} \uparrow^{115} \upsilon_{+}\omega \uparrow^{117}\downarrow^{115} \upsilon_{J}$$
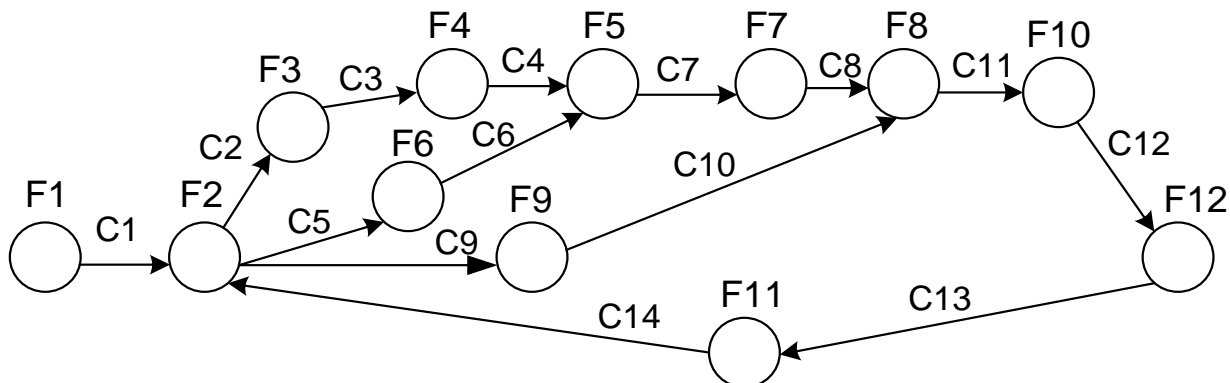
Fig.2. **The graph model of algorithmic descriptions A11**

To display the transition process, the algorithmic description by using the graph theory [7], construct the transition graph (Fig.2).

In the graph model following symbols have been used:

− changed as the documents used in simulated process – F1,…,F12.

− algorithms performed on the documents to change the conditions – C1,…,C14.

Possible chains (Ц) passing algorithm A11 in graph model:

Ц1=F1C1-F2C2-F3C3-F4C4-F5C7-F7C8-F8C11-F10C12-F12

Ц2=F1C1-F2C5-F6C6-F5C7-F7C8-F8C11-F10C12-F12

Ц3=F1C1-F2C9-F9C10- F8C11-F10C12-F12

Ц4=Ц1-Ц2-Ц3-C13F11C14-Ц1-Ц2-Ц3

Software module

The proposed formal model EDTD implemented in the software module "Automated system of accounting and control devices of railway automatics and telemechanics" (ASA-CRAT) (Fig.3), which is registered in the state register.
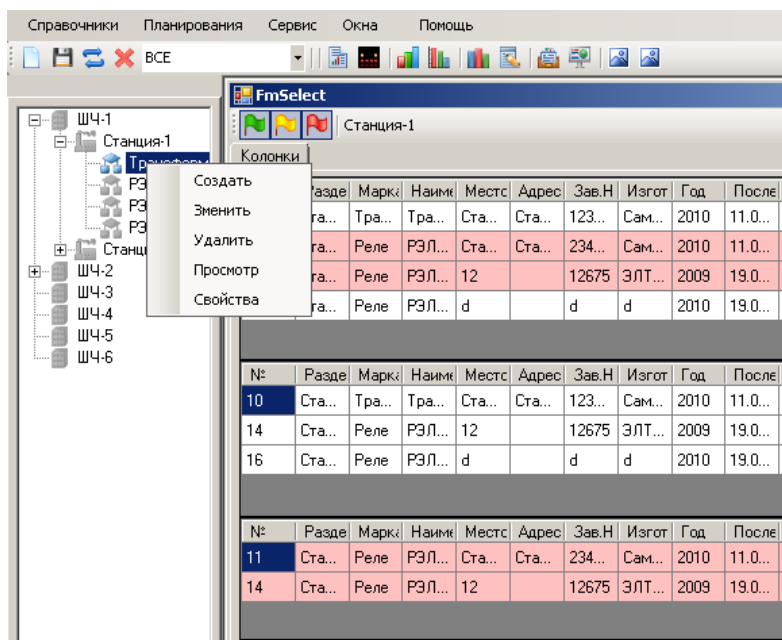

Fig.3. **Interface software module**

A fragment of the database structure of ASA-CRAT shown in Fig.4. In the logical model of the database represented by database tables and their relationship.
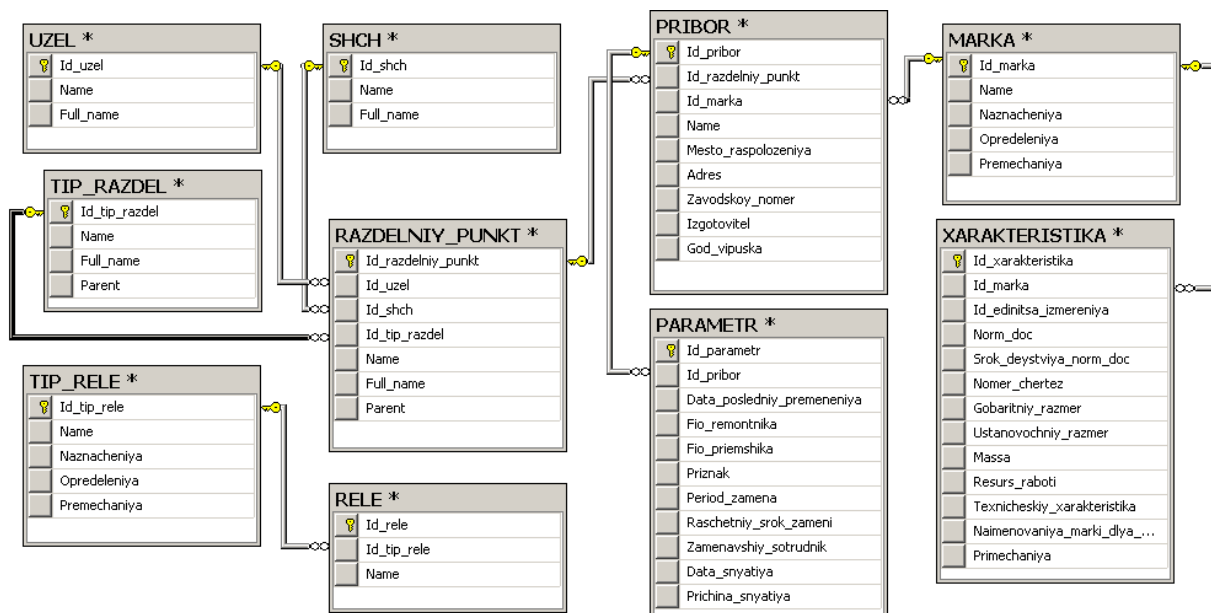
Fig.4. The Fragment of the logical model of the database

Electronic documentation for control and accounting of devices of railway automatics and telemechanics in the form of ASA-CRAT can significantly improve the efficiency of automation and telemechanics, and companies associated with this document [8].

Paperless information technology control and metering devices of railway automatics and telemechanics systems facilitate the management of all flows of the equipment. They form the basis of solutions that provide automated and centralized exchange of information about the hardware and extract only necessary information from all available sources.

From a technological point of view ASA-CRAT is an integrative system covering record keeping, control and metering devices of railway automatics and telemechanics, and linking them with the external environment of the electronic exchange.

Conclusion

Needs high-speed rail transport increase, which reveals the need to update and upgrade systems and devices of Railways, to develop modern information technologies in electronic document processing.

Based on the methodology of constructing a conceptual model of document management systems technical documentation [3] and models of composite workflow [4] this paper presents a graph model of electronic document management of technical documentation, and implementation of the model in the software module.

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