Application of Blockchain in the Railway Company

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***Abstract*—The development of traffic and transport in a railway company implies quality service. Modernization that is in accordance with the business plan can lead to increased profits but can also create inconveniences. Employees and service users want to have trust and security in all business activities. In order to save time and speed up processes, the application of innovative technologies for the implementation of their and business obligations has been imposed. This paper presents a model for the application of block chain in a railway company to increase the security of digital transactions and thus increase the quality of service. The basics of how block chain works, the architecture of the innovative model, as well as the layers required for the implementation of digital transactions, are presented.**

Keywords—security, block chain, digital transaction, advanced technologies, quality of service,

I. INTRODUCTION

Today, in the era of advanced internet technologies, it is necessary to create good conditions for survival in the transport market. The quality of service factor as well as the organization of traffic regulation and management depends on the safety and security of all components in the transport system [1, 2]. In practice, a large number of scientific approaches are applied that encompass available resources, employed in both passenger and heavy traffic [3, 4]. Modern approaches oblige the railway company, in addition to modernizing its infrastructure capacities, to also implement advanced internet technologies for the purpose of safety and security. Considering that the railway company owns computer equipment in its operations, it has the basic prerequisites for upgrading [5, 6]. This paper presents an innovative model for increasing security in a railway company based on block chain.

II. RELATED RESEARCH

The quality of service of a system such as ticket sales in public transport can be one of the criteria and an important factor. The authors in [7] note that current online payment systems (credit/debit cards, PayPal, etc.) do not satisfy the processing of micropayment transactions because the minimum amounts are not cost-effective for transport companies. In connection with the above, it is necessary to introduce a new acceptable micro transaction model for micropayments. Block chain technology does not facilitate transactions through third-party intermediaries, but rather reduces micropayment fees by a large percentage. By applying the block chain concept, fees are further reduced when the transaction process is completed with proof of work. The model also includes micro transactions based on Ethereum, which is the basis for implementation in the public transport sector, as well as the sale of transport tickets in the system. The Ethereum platform is programmed and includes smart contracts to manage the distribution of payments for the purpose of purchasing a transport ticket. Block chain technology includes regulated bodies (nodes) that are designed to verify and prove the work of transactions. When the entire transaction process is completed, digital currency codes are embedded in it. Also, the authors [7] present three stages in the methodology that are important for the implementation of the model:

- In the first, interviews are conducted with relevant stakeholders to identify the real-time state of the system as well as its limitations.
- In the second stage, problems, limitations and shortcomings related to the design of the new architecture are identified.
- Finally, in the third stage, it is necessary to develop a prototype of the model architecture that should meet user expectations.

In urban metropolitan areas, communication-based train control (CBTC) has become of interest to both transportation companies and the scientific community. The hardware and software management and control logic in the CBTC system are intended to monitor the movement of the train in railway transport where the possibility of failure of the safety of the entire system should be prevented. In the paper [8], the authors present the process of research, development and testing of such a system, which includes the existing hardware and software, where the emphasis is placed on the implementation of principles that can be critical for the safety of traffic activities. The initial basis for CBTC testing can be patent analysis, which is already used in transport companies. In this way, practitioners can better understand the various testing processes and how to test the innovative technology in this model. An example can be the transportation signal system design company Thales Shanghai Electric Group Company (SEC) which has great R&D potential and experience with a large market share [8].

Today, the European Union (EU) applies smart devices, which includes mobility as one of the factors where it is considered as a service of the future. The core concept includes the ability to offer passenger mobility as well as cargo transportation solutions in line with travel needs. In the paper [9], the authors analyze and propose a unique method of payment, intermodal tickets, passenger transport services, goods transport services and the like. This way of doing business involves the introduction and integration of a large number of Internet of Things (IoT) sensors. Then attention

should be paid to the safety of all actors in the railway company. Special attention should be focused on the environment where the sensor data that is registered in various events is monitored. The system detects possible anomalies in order to carry out subsequent analyses. The authors [9] propose a system based on Ethereum block chain technology as an efficient storage mechanism, where all railway entities are equal in the network, where entity security and information privacy are ensured.

Railway systems in the world are increasingly applying digital technologies to improve their business. The integration of multiple services containing railway data as well as other carrier transport carriers is a new generation of digital transport systems. The integration of the service and database that arises must be safe. Block the front is an innovative technology that has potential for such a system that implies the same integration of data in a safe and secure level. The authors in the work [10] are considering the current potential of block chain technology that can be implemented in railway companies. After the analysis, the block chain technology can provide numerous benefits related to safety and decentralism as well as the level of adoption of innovative technology until the necessary levels are required to transform current business models. Existing barriers for easier adoption of innovative models in railway traffic and transport Authors [10] presented an interface based on speech and mobility recognition in various transport companies. At the same time, data collected can be the starting point for accepting innovative technology block chain.

Traffic signal control and flow management play a key role in maintaining the structured flow and order of urban life. Such challenges, inherently complex in nature, are becoming increasingly demanding with rapid urbanization and urban growth. Solving this mixed integer nonlinear programming problem requires advanced optimization techniques. The generalized Benders decomposition (GBD) algorithm emerges as a potential solution, providing a more efficient means to achieve optimal outcomes. Delving into the dynamics of urban transportation, a comprehensive linear mixed integer programming model is developed. This model aims to optimize the organization of urban rail transit, ensuring that it is in line with the actual traffic demands. Moreover, the Benders decomposition algorithm is carefully tailored to efficiently decipher and solve the presented model. Using MATLAB, a co-simulation experiment was conducted, the results of which strongly confirm the algorithm's efficiency and superior performance [11].

The need to apply smart signaling in the economy, an effort to establish the principles of sustainable energy, the introduction of innovative technologies that the Sun and the disposal, development and introduction of innovative environmental sustainability surely leads to marketing activities. Such activities directly affect energy consumption. The authors in work [12] study of implementation of digital marketing communication technologies, where smart networks by service companies dealing with energy supply for city traffic. The vehicles that use alternative fuels are also highlighted. Prerequisites for the application of innovative access to cyclic infrastructure management are considered. They represent a model of marketing communication between organic transport beneficiaries and companies in charge of energy supply to increase sustainable transport where the environmental impacts are reduced.

The main task of concept Synchromodality and Synchromodal transport enables optimal integration of different transport lines and its infrastructure where the transition from road to navigable routes and railways are emphasized. In this way, integration contributes to the possibility of modal election, the synchronization of deposits and available capacities are more dynamic, more flexible and acceptable when it comes to costs and delivery times. The authors in the work [13] notes that new technologies with non-time inputs must interact with cargo models in support of the decision maker. They also propose symbiosis between a virtual environment and a physical environment where models are closer to end users. The concept involves connecting data sources in real time from the physical system into a virtual GIS environment for use and delivery in real time.

The Industrial Internet is applicable across a wide range of industries including manufacturing, aerospace, road and rail transport, power, oil and gas, healthcare, smart cities and buildings. Some of the major impacts of the Industrial Internet include the development of new and innovative services and products, which in turn also have economic benefits. The purpose of this special issue is to bring together research studies that propose new techniques, algorithms, models and solutions to address challenges such as interoperability, security and privacy related to the Industrial Internet, block chain and cyber-physical systems [14].

III. Development of a Digital Railway Model Based on Blockchain Technology

A. Model Components

In all large companies, enterprises and even on the railway, the basic building blocks are data that are implemented in everyday business. The main task of the company is to collect and exchange data in an efficient manner. Today, in the era of computing, data standardization and the possibility of connectivity is facilitated through a large number of applications. This approach to business provides data utilization, which simultaneously increases productivity in the railway company as well as the quality of service, namely:

- A large number of data in electronic form within the railway, which are intended for quick processing when making business decisions and
- Web-oriented portals, sites, applications that are intended for the user with the main purpose of better communication with the service provider - the railway company, which leads to greater satisfaction of current and potential users.

In accordance with the above, a railway company must have such an electronic business system, which contains advanced Internet technologies for transparent, immutable and distributed data storage and sharing. This technology is block chain, which can completely replace existing data protection and security systems and thus improve the quality that is the primary goal of a railway company as well as user expectations.

Now the following questions arise: How does block chain work? What is the sequence of operations? How can it be implemented in a railway company?

The functioning of the block chain involves the use of the Ethereum software platform, which is open source. In the railway company, it is used as a platform that provides the

creation of decentralized applications for employees and users, as well as the creation of smart contracts. This platform is not used on a single central computer, but on a large number in various territories around the world. These computers are called nodes, where each node has a copy of that computer. When a digital transaction is initiated in electronic business, each transaction must be verified, entered into a block in the block chain, and then a copy is updated on each node.

The procedure for the functioning of the block chain in the railway company includes the following steps (Figure 1):

- Internet wired or wireless connection (the user or employee must have an Internet connection to implement a digital transaction that involves data exchange);
- The transaction is initiated (in accordance with the needs and instructions of the railway company);
- The transaction is published on the network;
- The nodes that execute the consensus protocol and validate the initiated transaction are activated;
- When valid, the initiated transaction is automatically grouped with other transactions to form a new block in the main register;
- The resulting new block is added to the block chain and is linked by a hash algorithm to the previous block where one of the transactions has already been implemented;
- The last step includes a notification that the initiated transaction has been completed.

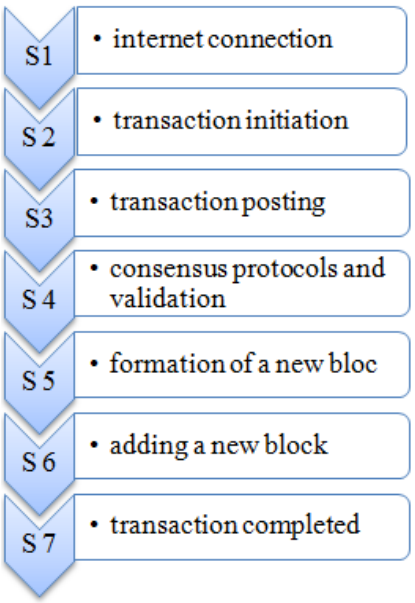

Fig. 1. Realization of blockchain

B. Creating a Block and Blockchain

Each digital transaction represents a single record. A blockchain is a sequence of chronologically sorted records that are organized into blocks and linked and protected by cryptography. Each block is formed in the same way and contains a cryptographic hash code, a timestamp, and information about the transaction itself. A hash code is the result of a mathematical function that transforms an arbitrary-length input into a fixed-length encrypted output and is the basic tool of modern cryptography. This function is one-way, or in other words, there is no reverse algorithm that can be used to get from the hash code to the output of the original input data. Cryptographic hash functions are widely used in applications in the domain of security and digital data signing, so their implementation in blockchain platforms is one of the foundations of transaction security and immutability. In addition to its own hash, each block also contains the hash code of the previous block, which guarantees data integrity, since any subsequent modification of data in the blockchain would require modification of all previous blocks. Figure 2 shows the basic architecture of the block chain network [15].

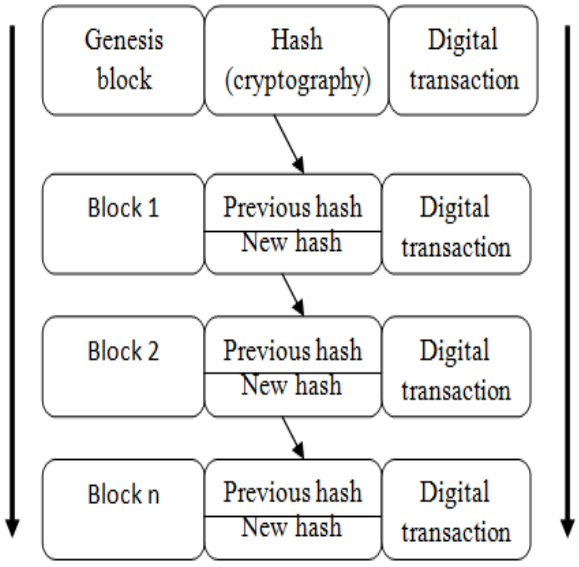

Fig. 2. Creating a block

C. Blockchain Architecture

Innovative technologies in the railway enterprise based on block chain in terms of system architecture consist of four layers, as follows (Figure 3):

- The railway enterprise data layer, which includes infrastructure capacities and devices, signaling and security systems, and all other information that is realized in the exchange and communication between them, as well as the block chain system;
- The block chain layer, which provides the system of the aforementioned architecture;
- The block chain application layer for data management intended for employees of the railway enterprise;
- The user layer for whom cyber security using block chain is intended, which includes all interested parties who wish to realize their needs in the railway enterprise or the Republic Statistical Office or scientific and research institutions, etc.

The multi-layer architecture of the innovative model based on block chain in the railway enterprise is presented in the figure 3.

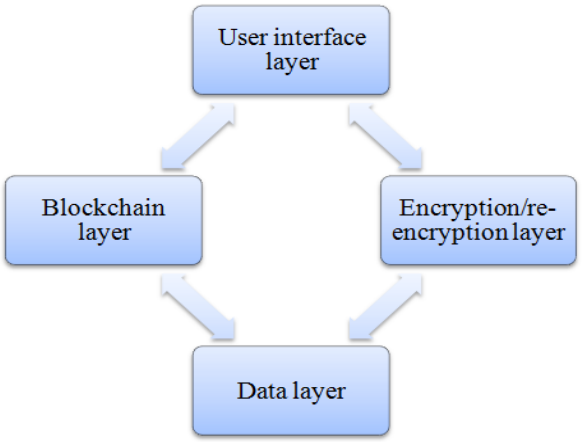

Fig. 3. Multi-layer architecture of an innovative blockchain-based model

IV. Conclusion and Future Research

This paper presents a real need for the application of block chain technology to increase security. Considering that a large number of transactions take place via the network of all networks, users to realize their needs, as well as employees in this example of a railway company, must feel safe. If a railway company is ready to provide various services in order to increase profits and competitiveness in the transport market, it must also ensure the security of the process that is implemented through digital transactions. Block chain is currently the most secure protection mechanism because it creates blocks and connects them with the previous ones, applying a hash algorithm where each new block contains the hash of the previous one. A protection system arranged in this way ensures a large number of computers that are interconnected and a chain of blocks is created through validation. In this way of modern business based on block chain, a large database is created that cannot be changed. The paper describes the procedure for one activity, which can be, at one point, an order for a train to enter a station, an order for a train to pass simultaneously without stopping, a prohibition on further travel, purchasing a ticket at a ticket office or ticket machine, or purchasing an online ticket or ordering freight wagons, filling out an online waybill, and so on. This means that a large number of possible digital transactions must be protected against possible changes in content that could cause unwanted consequences.

Future research must be directed towards practical application with additional education of railway company employees as well as providing information to users that their transactions will be secure in order to increase the quality of service.

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