

BLOCKCHAIN INTEGRATION MODEL IN RAIL TRANSPORT TO INCREASE SAFETY

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Abstract: Railway companies that were established for traffic and transport face challenges in the market. In order to remain competitive, they must implement new business models. Today, in order to achieve higher revenues, they apply computer technologies in their businesses, which are represented among employees as well as among current and potential users. In connection with the above, all participants in electronic business processes expect safety and security of digital transactions. In this paper, a model based on the blockchain is presented. The model includes the most powerful protection and security mechanism that is increasingly in use. The architecture and infrastructure based on the available computer network on the company's territory are also presented.

Key words: Digital transaction security, blockchain technology, electronic business, infrastructure and model architecture, security mechanism

1. INTRODUCTION

The safety and security of people, their property, employees in transport and transportation companies, infrastructure capacities and facilities, and digital assets can be considered a primary goal. All transport and transportation companies, in accordance with their policy, vision, and mission, must ensure the safety of both users and employees. Modernization of rail transport and transportation improves business and trust in the carrier. Modernization includes rolling stock and infrastructure capacities that are essential to the rails enabling speeds of up to 200 km/h. The second part includes the invisible part of business that takes place via computers, computing devices, networks, and the Internet. In this part, the role of people is reduced to a minimum because their work of organizing and regulating activities is taken over by computers. Today, a large number of researchers are trying to improve and ensure the security of digital processes through the application of various models based on advanced Internet technologies [1],[2].

Blockchain technology is today a protection mechanism that can improve the security of digital processes in a railway company. Based on the analyzed and presented literature, this paper presents a model for the application of advanced Internet technology blockchain, which should encompass all digital processes that are implemented between computers and devices in a railway company.

2. RELATED RESEARCH

Due to urbanization and the increase in people's lifestyles, the number of vehicles is increasing. Efficient transportation and traffic management systems are becoming increasingly prominent. In recent years, progress has been made in the field of Internet of Vehicles applications. This has paved the way for the development of Intelligent Transportation Systems (ITS). Advances in communication systems, the Internet of Things, and cybersecurity have made it possible to achieve in-vehicle communication. With the introduction of smart cities, smart vehicles, and technology, the development of a suitable environment for ITS has become more efficient. However, the existing system is centralized and poses security and privacy risks for communication. Blockchain technology has been proposed to overcome security and privacy problems. Blockchain brings features such as decentralization, transparency, security, and immutability, and cannot be tampered with [3].

Although modern maritime transport systems have greatly benefited from the Internet of Things (IoT) technology, the risks and challenges in terms of security and reliability have increased significantly. The involvement of various maritime parties in the planning and management of maritime transport flows further escalates these challenges. Therefore, we need an IoT-based collaborative processing system that unifies a modular structure and integrates multiple modules involved in maritime transport. Moreover, the need for a common and controlled access mechanism

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that cannot be manipulated or tampered with by unauthorized parties is also an essential requirement for maritime transport. Blockchain, as an emerging technology, has become a key tool in data protection due to its anti-tampering and anti-counterfeiting characteristics [4].

The aim is to explore how blockchain can solve the security problems in Intelligent Autonomous Transportation Systems (IATS) and the intelligent development of logistics transportation. Regarding the lack of trust and concentration of rights caused by the centralized structure of traditional logistics information systems, a blockchain-based IATS is proposed. The system uses Ethereum as the underlying blockchain to record sensitive information such as system orders, cargo and personnel information on the blockchain, ensuring unauthorized modification and data authenticity. At the same time, order management modules, warehouse management module, transportation management module, transaction management module and system management module are established [5].

Fifth-generation (5G) wireless communication technology enables high-reliability and low-latency communication for Intelligent Transportation Systems (ITS). However, increasingly sophisticated attacks on 5G-ITS may cause serious damage to valuable data generated by various ITS applications. Therefore, establishing a secure 5G-ITS through trust assessment against potential threats has become a key goal. Moreover, as a distributed shared ledger and database, Blockchain has the characteristics of non-interference, traceability, openness, and transparency, and can support both trust storage and trust verification for trust assessment. This paper proposes a heterogeneous blockchain-based hierarchical trust assessment strategy, called BHTE, which uses federated deep learning technology for 5G-ITS [6].

Intelligent transportation systems have made transportation more efficient. With available traffic information and 5G technology, cars can efficiently transmit relevant information to other road users, such as congestion, environmental forecasting, and accidents. This information is vital for designing fast and efficient transportation. However, many people do not participate in information sharing, even if they have the opportunity, because this means that a lot of personal information about the car and its owner must be provided. The information systems used so far have not been able to solve these problems. However, in the case of vehicles authenticated in the blockchain, the personal information of the car owner will remain secret and will not be published. Due to decentralization, trust is based on blockchain technology, not on personal and sensitive data. To this end, the research goal is to create a blockchain where ITS data can be stored securely [7].

The concept of Intelligent Transport System (ITS) aims to improve the performance of transport networks, which is receiving more and more attention in both academic and commercial circles. ITS is a constantly evolving vision that combines state-of-the-art approaches to transport with new information, communication, computing and other technologies. ITS should detect routes of consequences to improve the sustainability, safety and reliability of the entire transport system using new technologies. The paper proposes a sustainable framework for managing the safety of connected vehicles by integrating blockchain. It introduces a smart transportation equipment called a smart vehicle device with AI (for vehicle communication) [8].

The integrated space-air-ground network as an efficient new integration network could provide more comprehensive network services to meet diverse service quality requirements in different intelligent transportation systems (ITS). By taking advantage of space-air-ground integrated vehicle crowd testing (VCT), there would be great potential and ITS-related services could be facilitated. However, centralized systems are usually vulnerable to malicious attacks and trust issues are one of the main reasons hindering their further development. Blockchain as a distributed hyperledger shows vital potential to solve the trust problem of multiple participants who do not trust each other and to solve security problems [9].

Blockchain technology is gaining its popularity in many fields with tremendous success, which ultimately attracts all researchers to study this technology. And the result of this shows more and more research to be conducted. Which makes blockchain technology relevant in the field of transportation systems. It is expected that in the near future their integration will reach greater heights, compared to other technologies, blockchain is still new and many unknown things are yet to be discovered. The aim of the study is to find out how blockchain benefits autonomous vehicles. Blockchain integrated

autonomous vehicle systems are compared to get a picture of the current environment and future challenges for this integration. The potential of blockchain applications that will help improve this particular part of the industry will be studied. Finally, their limitations and challenges are related to this integration [10].

Data-driven applications play an important role in modern maritime transport systems, for example, in facilitating decision-making related to communication and security. One example of an application is the sharing of position data between vessels in the context of the maritime Internet of Things (IoT). When designing such applications, one must also consider how to ensure data accuracy as well as privacy in large-scale applications. This paper demonstrates the potential of using blockchain to facilitate privacy-preserving data sharing. Specifically, a zero-knowledge scheme is developed to protect vessel identities while enabling data sharing, and a commitment-based approach is developed to ensure privacy related to data trading relationships between participants. Our security and performance evaluations demonstrate the utility of the proposed approach [11].

Transportation and logistics management play a vital role in the development of a country. With the advancement of Internet of Things (IoT) devices, smart transportation is becoming a reality. However, these numerous connected IoT devices are vulnerable to security attacks. Blockchain has recently emerged as one of the most widely adopted technologies for reliable, secure, and decentralized intelligent transportation systems. This research study aims to contribute to the field of logistics and transportation by exploring the potential of IoT and blockchain technology in smart logistics and transportation. We propose a layered framework for smart logistics and transportation that integrates IoT and Blockchain to provide an intelligent logistics and transportation system. Finally, we present two real-world case studies based on IoT and blockchain to highlight the contributions of IoT and Blockchain in logistics and transportation [12].

3. INFRASTRUCTURE AND ARCHITECTURE OF AN INNOVATIVE MODEL BASED ON BLOCKCHAIN TECHNOLOGY

Considering that traffic and transportation are complex in a railway company, involving a large number of digital processes that are implemented in parallel at the same time, it is necessary to implement such a protection mechanism that ensures all elements. At the beginning, it was said that all processes and activities that occur in the business tasks of employees, as well as various user needs, meet their needs via computers and networks. At one point, a route may be required for a train to leave the station, or a train to enter the station at the same time where it is also necessary to set a route, or issue train tickets at the ticket office, or issue train tickets at a ticket machine and an automatic machine with train attendants, or purchase train tickets online from their homes, or stop the train at another station, and so on.

For such a complex system consisting of computers, devices, and networks, it is necessary to secure all digital processes with blockchain for the safety and security of data exchanged in a large number of activities. In order to ensure the security of the data that is exchanged and which also represents orders on what and how to implement the process in any segment of electronic business within the railway company and outside with interested users, the following parameters must be implemented and enabled to function (Figure 1):

- Confidentiality – when data protection is applied to transactions carried out in electronic business from any unauthorized person, such as the use of certain passwords that are known only to authorized persons.
- Integrity – which refers to the stability and accuracy of data that regulate activities in the electronic business process, as well as that unauthorized persons cannot access the data and simultaneously change the data.
- Availability – which refers to access and use of data at any time, but only by authorized persons.



Figure 1 – Information security elements

3.1. Blockchain architecture in an innovative model

Blockchain is a technology that was created for the needs of digital banking and is defined as a distributed and decentralized system where a large database, or, in other words, a ledger is created. It stores all transactions that have occurred in electronic business processes. It is defined as a series of chronological records that are stored in blocks. Connecting such blocks creates a chain of blocks or a blockchain. In addition to the hash algorithm, which is also a code, it also contains a time stamp and information about the transaction performed in electronic business.

The basic architecture of the blockchain is shown in Figure 2. The first initial block is also called the genesis block, which is created when the blockchain is first applied for security in a railway company. Connecting blocks is enabled by consensus protocols. Each newly created block, contains the hash code of the previous block and they are automatically connected. In this way, a chain of blocks is created that cannot be interrupted, or the content of the message in digital transactions can be seen.

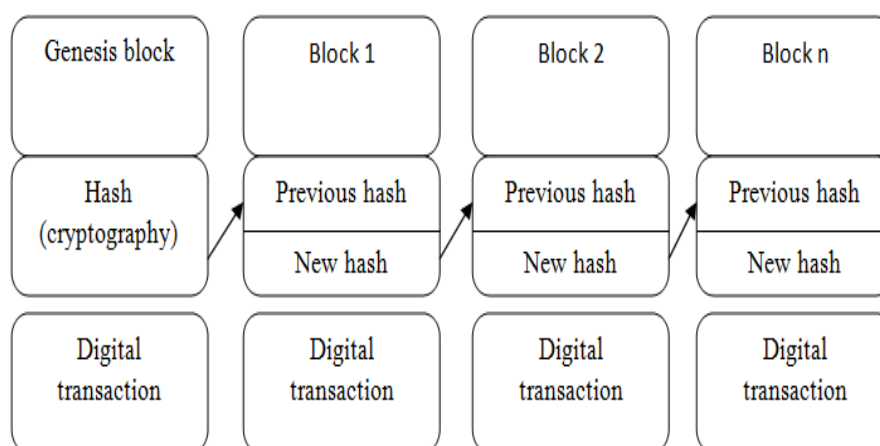


Figure 2 – Information security elements [2]

Now the questions arise: How does blockchain work?, How are blocks created?, What needs to be done to ensure that the technology applied in the railway company meets all security requirements in the railway company (Figure 3)?.

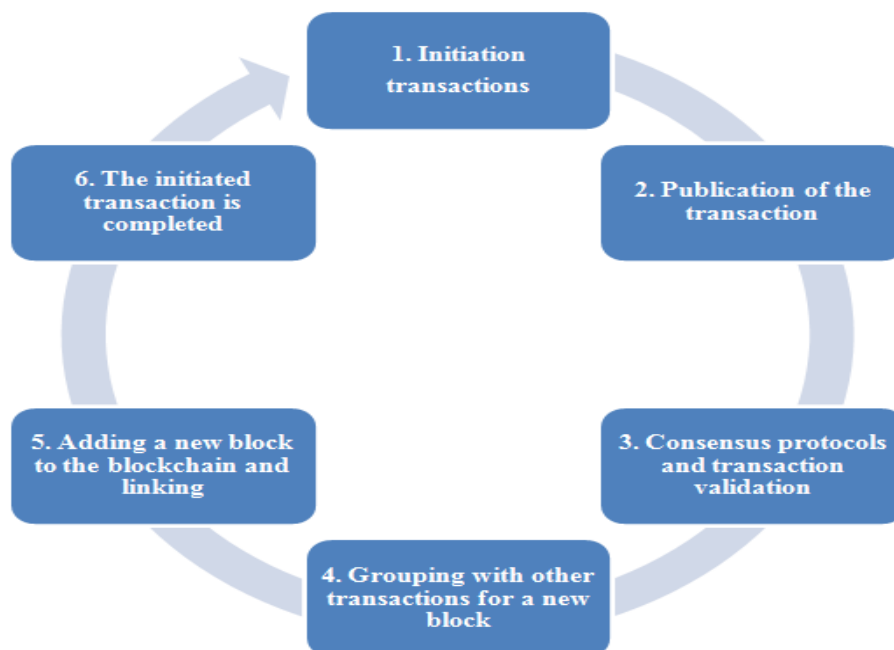


Figure 3 – Steps required to create a block in the blockchain

3.2. Blockchain infrastructure in an innovative model

The blockchain infrastructure in a railway company should be decentralized and include all computers, devices and networks. In this type of protection mechanism, there is no single entity responsible for maintaining the processes in electronic business. Electronic transactions are publicly published where verification and validation are openly performed in all processes that take place within the company as well as in processes outside the company initiated by users (Figure 4).

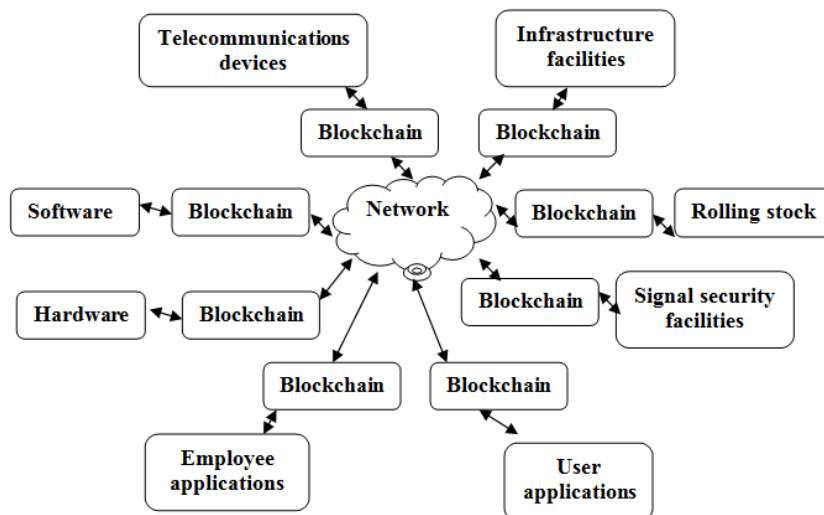


Figure 4 – Model of block chain infrastructure in a railway company

4. CONCLUSION

This paper presents a model of advanced Internet technologies based on the blockchain with the possibility of integration into the existing computer system of the railway company. In the analyzed literature, one can see the potential of blockchain in the exchange of digital transactions with the basic purpose of increasing security in electronic business processes. The creation of a block and then a chain of blocks creates a database - a book of all transactions that cannot be changed. The paper presents possible potential problems that may arise in the railway company due to changes in the

content of messages (orders) when it comes to regulating train traffic and even digital money transactions. Violation of the above can cause major material and financial consequences.

In future research, special attention should be focused on the integration of services related to other types of traffic (road, river) and transport for more efficient safety.

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