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Usage of IBM Blockchain Technology to Improve Clearing and Settlement Processes in the Banking Sector

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ABSTRACT

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Title of the Publication: Usage of IBM Blockchain Technology to Improve Clearing and Settlement Processes in the Banking Sector

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The movement of money in the modern economy is carried out through the channels of the banking system. Therefore, it is necessary to clearly understand how payment systems work, how the banking system is regulated and how those processes can be improved. The clearing process was selected for the topic of the bachelor thesis. The current challenges of the modern clearing systems were outlined and discussed in the research and that helped to set a direction to the whole thesis.

The theoretical framework was created by studying the relevant case-studies, latest research articles and reports about recent technological solutions development. The qualitative interview was conducted with a representative of the Russian banking sector. The primary goal of the interview was to receive insights into the actual clearing processes, their challenges, blockchain-based systems and a necessity for improvement.

A solution for the improvement was determined – blockchain based clearing systems. To maintain the scale of the bachelor thesis, the primary technology was chosen – IBM Blockchain technology. The main research question was "Can IBM technology improve the process of clearing and settlement in the banking sector with the help of blockchain technologies?" The system allows banks either to make it public and open, or to have control over it. The successful case-studies were reviewed. Those presented a clear understanding of the possibilities of blockchain-based systems.

FORWARD

The author would like to thank everyone who helped in writing this thesis. Especially, it will be justified to give special thanks to the thesis supervisor for taking the thesis and working on it. In addition, the author's respect goes to people who work to improve and promote blockchain technology. Furthermore, the author is very grateful to his family and friends for their support.

CONTENTS

LIST OF SYMBOLS

DLT - Distributed Ledger Technology

CHIPS - Clearing House Interbank Payments System

CHAPS - Clearing House Automated Payment System

TARGET - Trans-European Automated Real-time Gross Settlement Express Transfer System

RTGS - Real Time Gross Settlement

DNS - Deferred Net Settlements

PoW – Proof of Work

PoS – Proof of Stake

BWW – Blockchain World Wire

SDK - Software Development Kit

DAH - Digital Asset Holdings

HLF - Hyperledger Fabric

CLS - Continuous Linked Settlement

AIG - American International Group

NTRS - Northern Trust Corporation

HSBC - Hongkong and Shanghai Banking Corporation

KBC - Kredietbank ABB Insurance CERA Bank

STR - Stellar

API - Application programming interface.

1 INTRODUCTION

1.1 Background

The movement of money in the modern economy is mostly conducted through the channels of the banking system. Therefore, it is necessary to clearly understand how payment systems work, how the banking system is regulated and how those processes can be improved. The clearing process was selected for the topic of the bachelor thesis.

1.1.1 The process of clearing and settlement

Clearing and settlement process is a method of regular non-cash payments, based on the definition and offset of mutual monetary claims and obligations of legal entities for goods, securities, services rendered with the subsequent transfer of the balance. As for banks, clearing is important for them, first of all, as a way to reduce expenses on means of payments and simplify the exchange of counter-payments. (Loader, 2002)

1.1.2 Blockchain technology

This thesis focuses on the Blockchain technology, namely on its applications in the banking sector. Blockchain technology has a wide resonance in the world and especially in the financial sector. Literally, blockchain is a "chain of blocks". The word itself accurately reflects the essence of the phenomenon. Blocks of information are collected in a serial circuit and protected by cryptographic encryption. Chains of information are not stored on a separate server but exist simultaneously on all computers connected to the network. (Credits, 2018) Blockchain is a perpetual digital distributed journal of economic transactions, which can be programmed to record not only financial transactions but almost everything that has value. (Wattenhofer, 2016)

1.1.3 IBM company

To narrow the thesis topic down, the Blockchain Technology by IBM was chosen. One of the innovative areas where IBM is actively working in the foreground of modern technology is Blockchain Technology. (Pugh, 2009) The technology allows banks to utilize blockchain functionality to set up more seamless clearing and settlement processes. (IBM Corporation, 2017)

1.2 Aim

The clearing and settlement process is imperfect and requires improvement. Blockchain technology is suitable for this purpose.

1.2.1 Difficulties of clearing and settlement processes

Increasing the efficiency of interbank transfer through the bank's own branch network of offices, agencies, subsidiaries or Central banks by optimizing clearing and settlement processes, has a great importance in modern conditions. Thus, the main directions of work in the improvement of bank connections are controlled in banks at special divisions which are engaged directly in the correspondent relations, the wide introduction of means of automation and computerization, control of rational use of means on bank accounts, and optimization of a correspondent network abroad and in the home country. The thesis focuses on the automation and computerization and will research a new approach to improve this direction. (Tompkins & Olivares, 2016)

1.2.2 Blockchain solution

The blockchain technology has some advantages compared to the work of traditional payment systems and its process. To begin with, it is worth noting that it is

decentralized. This term refers to the absence of a Central server or regulatory body responsible for storing all data on the network and supporting its operation.

This approach ensures that no user can gain control over the blockchain. The cost of transferring funds through such a network is much lower compared to bank fees. This makes it ideal for ordinary users when transferring small amounts and it can reduce the cost of banking services for large companies.

Third, the blockchain provides the ability to process transactions much faster. While banks usually do not operate on weekends and public holidays, the blockchain-based network operates around the clock. This process is beneficial both to the Bank and its customers. (Swan, 2015)

1.3 Open question – thesis statement

The question is how IBM technology can improve the process of clearing and settlement in the banking sector with the help of blockchain technologies. This should allow to consider the use of blockchain technologies in the financial sector by an international company. In addition, it allows to get acquainted with the technology and find out what is happening in the field of clearing and settlements at the moment. Thus, the role of research is much more than it seems first.

2 RESEARCH METHOD

2.1 Qualitative method

In this work, the qualitative data was gathered from an interview and through case studies. They are used to fully explain why people think and behave in a certain way. This type of research is best used to answer how and why questions. The qualitative study was used to make the results more reliable. (Mason, 2002)

2.1.1 Interview

To confirm the validity of the hypothesis, an interview was conducted with the person responsible for clearing and settlement processes in a Russian Bank. Qualitative data obtained by the survey method is better suited to answer the question of Why than others. This conclusion can be drawn from the fact that the interview usually provides rich data, details, insights into participant's experiences, behavior, and opinions. (Mason, 2002) That is why the interview was conducted to fully describe why the clearing and settlement processes are ineffective at the moment.

This method fits perfectly into the concept of this work, complementing and strengthening it. The respondent is a competent expert in the matter. Having knowledge of the specific aspects of the phenomenon under study, he expressed a valuable opinion and contributed significantly to the research paper. Thus, it gave confirmation of the hypothesis of this study. (Mason, 2002)

The interview had the perfect balance to solve the problem identified for it. To improve the validity of the answer to the question, several criteria for the effective operation of the clearing and settlement processes were discussed. In addition, the reliability of the information provided is supported by economic education, multiple pieces of training and experience in the banking sector. This interview is reliable research as it intersects directly with the materials provided in the theoretical part of the research. From this interaction and the information provided by the respondent, it became possible to draw certain conclusions and assumptions on the

topic of the study, and after reading all the work it was able to understand how important is as it seems at the first glance. (Steinar Kvale, 2009)

This interview also had several drawbacks. One of the disadvantages was the confidentiality of the respondent in connection with the position, duties, and contract, which did not allow to reveal all the small details that could help the study. Only one interview was conducted, which could affect the accuracy of the answers because everyone has an opinion on a particular phenomenon. However, the information provided by the respondent was enough to confirm the hypothesis, and the data only confirmed the previously specified information from reliable sources. Therefore, confidentiality and personal opinion did not interfere with the purpose of the method and the result was achieved.

2.1.2 Case study

The case provided a complete picture of how this solution is used in the real world. This is since these cases are particularly useful for complex or sensitive subjects. Having considered this, it became clear whether the IBM solution is useful for clearing and settlement processes in the banking sector.

Case analysis was perfect for a deeper consideration of the problem, its support, and clarification. The essence of this research was to study one case in detail, to reveal the content of the processes occurring in this technology, to better understand the phenomenon under study and to offer a diverse interpretation. The key methodological point of the case study was the reliance on qualitative methods of collecting and analyzing empirical material. Based on the above information, it became clear that this type was suitable since it best showed the implementation of the solution proposed by the blockchain technology in this work. (Stake, 1995)

This is due to the fact that this example showed how the solution is implemented in the real world in order to cope with the task. The purpose of this case analysis was to evaluate and examine the implementation of the solution in the currently existing workflow and saw how effective it is. To do this, several approaches were used to better reveal the picture of what is happening. To begin with, the work

solution was explained and each advantage of them was demonstrated directly. So, although only one of the processes was used to clarify the situation described, it concisely consolidated everything that was indicated in the research work.

Based on these facts, this part described one of the most successful and the most recent examples at the moment, which perfectly described the success of the implementation of the solution in general. To do this, all the information was summarized and presented in an easy to understand form. Since this implementation of the solution is at the initial level and the situation with it is still developing, it will be possible to learn many more interesting topics in the future. Information was collected from various resources that are currently available, including the official website of the organization that provides this implementation. This made it possible to clearly, reliably and fully describe the whole situation on a unique example. (Yin, 2012)

Only one case has been used, which has not yet been fully disclosed. There will be many other examples of technology implementation. It will be shown excellent results and all benefits of the solution, asking an important question about what else this technology is capable of.

Analysis of the case has perfectly shown each advantage of the blockchain system together and separately. Many different resources were studied and only the most qualitative and necessary for this question were chosen, such as articles, textbooks, case studies, reports, etc. Thus, this method is ideal for answering the causal question in this study. (Yin, 2012)

3 THEORETICAL BACKGROUND

3.1 Settlement and Clearing

Clearing and settlement process is a financial procedure in which a clearing company is a buyer and seller of two parties, in order to secure orders between the parties and to establish netting based on the terms of the balance of payments. In other words, clearing is the procedure of exchange of goods or securities between two interested parties. (Bank for International Settlements, 2003) The clearing and settlement process can be applied in various fields of activity. They are described in more detail below.

3.2 Types of clearing

1. Interbank clearing is a non-cash payment system between banks, where the clearinghouse acts as an intermediary.
2. Currency clearing - a settlement between countries with a mutual offset of payments for the delivered goods (services). The cost of goods and services is the same and is calculated using the clearing currency.
3. Simple clearing - the obligations of each party to the clearing are considered for each transaction in the aggregate of clearing obligations.
4. Multilateral clearing - settlements of each clearing entity are carried out on all transactions in the aggregate of clearing obligations.
5. Commodity clearing - offsetting between firms for goods, services or securities. The basis of settlement is the balance of payments. Any clearing is a licensed activity. Clearing companies are necessarily regulated by the Central Bank of the respective country. (European Central Bank, 2009)

The most common of all clearing types is interbank clearing.

3.3 Interbank clearing and settlement

Interbank clearing and settlement processes are a system of non-cash payments between banks by an offset of mutual monetary claims of legal entities. Clearing in the banking sector can be carried out both within the country and between countries (Cross-Border Interbank clearing). (Tompkins & Olivares, 2016)

Depending on the scope of application, interbank clearing may be:

- Local - between banks of any region or between banks of a certain banking group;
- Internal - between branches of one bank;
- National - within the whole country.

Based on the method of clearing can be identified clearing committed:

- through the establishment of the Central Bank and major commercial banks;
- through a special organization of interbank settlement (clearing) chamber;
- through the clearing department (settlement center) of the head bank but in settlements between its branches is used intrabank clearing.

Payments can be made:

- on a gross basis (each transaction is settled separately);
- on a net basis (participating banks allow claims and liabilities to accumulate over a period of time - usually one business day).

The clearinghouse performs the functions of accounting for mutual obligations of the clearing system participants, the final clearing settlement is carried out by the settlement agent. The process of offsetting the obligations of the parties-participants of the clearing system is called a clearing session, it is carried out by the clearinghouse several times during the day. (Tompkins & Olivares, 2016)

3.4 International payment systems

In any economic system, except for completely closed ones, there is a need to make payments across the national border. For domestic payments, there are an official payment system, settlement centers, etc. In contrast, international payment arrangements are traditionally based on bilateral correspondent dependence of banks in International monetary and financial relations. Recently, the interdependence of national payment systems has been growing related to the needs of international trade and finance, which is increasingly evident in the case of foreign participation in domestic payment systems and in domestic financial markets in general.

In fact, there is a global payment system. For each national payment system that has a connection with the global payment system, there is a need to work in accordance with the generally high standards of reliability. In November 1990, the list of standards was published by the Central banks of the group of ten. The list of standards appeared in response to the initiative of commercial banks to create clearinghouses for multilateral offsetting of contracts in foreign currency. One of these projects was implemented in London under the name “organization of clearinghouses for currency operations” (ECHO).

All current banking systems are divided into banking and payment systems. The difference between them lies in the fact that within the system of Bank messages only operational transfer and storage of settlement documents are carried out, and the settlement of payments is provided to the participating banks, while the functions of the settlement system are directly related to the fulfillment of mutual requirements and obligations of the members of the settlement system.

The first group includes such systems as SWIFT – the system of international financial telecommunications and Bankwire – a private electronic network of US banks. The second group consists of Fedwire - network of the US Federal reserve system; CHIPS - New York international payment system of payment chambers; London automatic system of payment chambers CHAPS. In Japan, there is the system of interbank transfers "Sentencia". In addition, the European Union has two regional super-systems of the EU member states - TARGET and Euro I, which

combine gross settlement systems operating in real time. They offer payment services throughout the European Union and provide payments in euros around the world. (Tompkins & Olivares, 2016)

3.5 The object of Interbank clearing and settlement

1. The most popular objects in the clearing market are the goods.

As a category, the product allows you to clearly determine its economic value, has a weak dependence on financial risks, however, is not without drawbacks due to its low mobility, narrow specialization and specific target orientation. This kind of drawbacks impose some specific requirements on the participants. For example, clearing and settlement in the goods market are often gross rather than net. In this case, it is much easier to meet the needs of the participants.

2. The second most popular objects in the clearing market are the derivatives.

Shares, bonds, all securities are frequent guests of Bank clearing, this is due to the high liquidity and mobility of this category of assets, however, there are some difficulties. The very process of introducing securities into the clearing market is costly. In addition, not all participants agree to introduce settlements in derivatives.

3. The third most popular are banking services.

The main advantages of the objects of this category are the lowest cost, versatility, absolute liquidity. However, the narrow target orientation does not allow banking services to displace other objects from the clearing market. (CIRASINO & NICOLÌ, 2010)

Clearing and settlement processes are almost the most important levers of influence on the market of funds and currencies. With their help, the amount of money between all participants in the process is minimized. The guarantee of a successful outcome of the case when using clearing and settlements ensures efficiency and mobility in the market. (Tompkins & Olivares, 2016)

3.6 Interbank payments

In order to understand what the advantages and disadvantages of certain methods of clearing and settlement may be, as well as the development, the procedure of interbank payments should be considered. This is an important aspect of understanding what is happening because clearing and settlement are part of the action. It follows that if a factor affects one part of the entire interbank transfer process, it can also influence the processing and settlement of these payments.

In most countries, when transferring money, for example on the client's initiative, banks use the digital method rather than transporting banknotes from Bank to Bank. When the client of one Bank sends money to the client of another Bank, they need to make a payment between the accounts in digital form. Two main solutions are used for this: using correspondent accounts of banks or using payment systems of the Central Bank. (Bank for International Settlements, 2017)

3.6.1 Correspondent and Central Bank

The first way will be to consider the use of correspondent accounts. The first bank opens an account with the second bank and simply transfers the required amount to its account in the second bank. Due to the fact that a great number of transactions can take place on a day, banks put the same amount in each other's accounts or exchange assets for the amount of the deposit. Nevertheless, it is not very profitable and risky to have money in every bank where your clients transfer money.

In this regard, attention should be paid to the next method of interbank transfers. This method involves the use of the Central Bank system. If all banks open accounts in one Bank and carry out operations through it, this system will greatly simplify the task of transferring money. This function is performed by the Central Bank. This process can be carried out using real-time gross settlement systems (RTGS) to process each payment during the payment period. Another way involves the use of deferred net settlements (DNS), where all payments for a certain period of time are made every hour or at the end of the day.

After interpreting how it works, the clearing and settlement processes should be explained. Under RTGS and DNS, these processes are conducted by the Central Bank. As for intra-bank transfers, the bank itself carries out clearing and settlements. The beneficiary's bank shall clear and settle the transaction with correspondent banks. (BANK FOR INTERNATIONAL SETTLEMENTS, 1997)

3.7 International payments

It is important to understand that accounts in the Central Bank are called the settlement, they significantly improve the process of transferring money. However, this system usually works in one country and currency, there are exceptions such as CHIPS or EURO 1. (Tompkins & Olivares, 2016)Those banks that use the Central Bank have an advantage over those that do not work with the Central Bank, as they have to open correspondent accounts in these banks.

After reviewing the bank transfer system within a country or a certain territory, united by the agreement and the single currency, it will be useful to consider international payments. Correspondent accounts are an important component, they can be used to use foreign currencies to banks that have an account in a foreign bank. In this case, the customer may send foreign currency to the customer of the Bank in another country using the same currency.

However, there are various difficulties, for example, it will be difficult for a small bank to open an account in a foreign bank, so it will have to use another Bank as an intermediary in its country Another way is to use RTGS to be able to transfer in different currencies, which can further increase the number of intermediaries. In addition, the cost of correspondents and the time to transfer money also increases. (BANK FOR INTERNATIONAL SETTLEMENTS, 1997)

3.8 Challenges of clearing and settlement process

Certain problems arise after a thorough study of clearing and settlements, as well as interbank transfers. A reliable and efficient payment system is necessary to

maintain the stability of banks, financial markets, and monetary policy. Since the payment system is a vital part of the financial system, it requires close attention in the process of clearing and settlement.

The main disadvantages that complicate the implementation of non-cash payments are:

1. Speed

For balanced work of interbank payments, it is necessary to carry out quickly all operations on their way.

On the one hand, transactions within a country or territory in one currency can be processed quickly thanks to the work of Central Banks, namely RTGS or DNS. However, not all banks can use it and they have to use correspondent accounts in banks with a current account. It turns out several clearing and settlement processes, and hence the time spent on them increases. On the other hand, transfers abroad take even more time, as they require even more intermediaries, a more thorough check in each of the banks and thus significantly slows down the transfer.

2. Costs

Spending plays an important role in the processing of a huge number of operations per day.

The next question is the amount of money spent on the transfer and its processing. There are difficulties due to fees for clearing and settlement in banks with correspondent accounts, as well as for registration with the Central Bank. As for cross-border payments, the fees for these processes are becoming even higher. A large number of intermediaries, the size and reliability of the Bank, the means necessary for a thorough analysis and foreign currency can significantly affect the issue of providing such service to all its customers. (Bank for International Settlements, 2017)

3. Access (borderless)

Banks can usually be of different sizes, be in different countries and have different reputations.

Due to certain events between different people, countries or forces, there can be many difficulties with the movement of bank funds both inside and outside the country. The payment processing process may be rejected or considered for a long time due to distrust of the new bank. The situation with international payments is much more complicated because the checks are very thorough and require a lot of time and money. Besides, when imposing sanctions on a country or its citizens, many banks simply will not be able to transfer money in foreign currency.

4. Security

One of the most important things in the procedure of sending money is security at all stages of its processing. (Bank for International Settlements, 2017)

Every bank can become a victim of cybercriminals. The Central authority through which transactions are conducted can also become a means of attack on all banks that use it as a money transfer. In addition, software developers should also constantly monitor the relevance of the protection provided by their software. Besides, each bank and its employees can be attacked, important data can be stolen, or money can be transferred to other accounts. Because of this, banks can lose money and important data, these attacks, and hacks can significantly worsen the work and reputation of banks in the technological era.

5. Transparency

Visibility of all the necessary information on banks, customers, money transfer processes between banks would greatly simplify the process of clearing and settlements.

Without trust, few in the banking sector can succeed. This applies to relations with banks inside and outside the country, regulators, and customers. In the current state of Bank transfers, it is difficult to gather all the necessary information to check whether everything is in order with the Bank, its customers, and money. Thus, the processing time increases, there is a possibility of failure of payment processing,

the risk of error, and after the difficulty of finding it. In addition, it has a strong impact on cross-border transfers, creating many problems for banks due to the lack of transparency in their operations and other important information. (Bank for International Settlements, 2017)

3.8.1 Finding

Thereby these problems indicate that nowadays the system of bank transfers and its processes needs to be improved. Although the process of money transfer works, and there is no critical need to change it, during the fast-growing technologies, it must be done. Speed, cost, transparency, accessibility, and protection are among the most important points for money transfer. Whereas the process of clearing and settlement, created to simplify and process transfers, cannot always provide the right level of service and it needs to be finalized. Thus, in theory, there are prerequisites to the fact that these processes require an upgrade. In this regard, it will also be useful to know what the expert in this field thinks about it. (Wadsworth, 2018)

4 RESEARCH

4.1 Method (Interview)

To confirm the hypothesis that the clearing and settlement system needs improvement, an Expert interview was conducted. The expert asked not to disclose his confidential data in connection with his employment. Nevertheless, it can be argued that the respondent is a qualified specialist in the field of clearing and settlements. In confirmation of this, it should be mentioned that the respondent received an economic education, worked in this field in high positions and attended various trainings, seminars, and lectures on professional development. The interview included the main issues related to the clearing and settlement process, expert opinion on the situation in the sphere of clearing and settlement, the experience of interaction and examples in Russia and abroad. Based on the above, it is clear that the interview meets the criteria necessary for a qualitative study, so after that, the information obtained during the interview can be considered. (Mason, 2002)

4.1.1 Domestic interbank payment

At the beginning of the interview, the respondent spoke about the situation in the field of clearing and settlements within the country, namely the transfer of money and their carrying out through banks-correspondents. As previously described in the research work, this method consists in the use of the corresponding account in the partner banks and the processing of payments directly through them. According to the expert, they mostly use the services of the Central Bank to process payments within the country, as it happens in other developed countries, but correspondent accounts are an integral part of Bank transfers. The system of gross payments in real time of the bank of Russia is called the system of Bank electronic urgent payments. It is based on an Automated Workplace of the Central Bank's Client. It allows to quickly and efficiently carry out settlement and clearing between banks, the whole process is performed several times a day and takes from one to two hours for the operation. (Group-IB, 2016)

It can be assumed that this system is very useful and excellent for sending and processing payments, but it is not. The first drawback indicated by the expert is the cost. The respondent pointed to the fact that banks need to pay for the services of the operator and the controller, give the money to the Treasury and to pay a certain amount of money when using the system of the Central Bank. This fact clearly shows that a considerable amount of money is spent on transaction processing and on various participants. The second more important issue is the security of clearing and settlement operations.

In November last year, according to the respondent, on them and some more banks cyber-attacks were made. The Automated Workplace of the Central Bank's Client through which payments fall into the Central Bank, and then to the counterparty during the processing process, was hacked on the side of this bank. Thus, the attackers replaced the payment details specified by the bank on their own and then withdrew the money abroad through the SWIFT system. More information can be found on the website of the security company "Group-IB" in the article "MoneyTaker: in pursuit of the invisible". It follows that this system is not so secure and can be hacked but there are also other difficulties in the clearing and settlement processes. (Group-IB, 2017)

4.1.2 International interbank payments

The situation with international payments should be considered separately. As mentioned earlier in the research, for the bank to make transfers in another currency, it is necessary to have accounts in these currencies. It follows that in the chain, which will be a transaction during the process of clearing and settlement, one of the banks will be located abroad. (BANK FOR INTERNATIONAL SETTLEMENTS, 1997)

The complication is that because of the sanctions, it is very difficult for the bank in which the expert works to open a correspondent account in a foreign bank. To verify the bank's reputation, it is necessary to fill out a 40-page questionnaire in English. The completed information should also include an explanation of how the

bank will verify that payments to the accounts of companies included in the sanction's lists are not included in the payment. In addition, the review of the contract takes about six months. (Korhonen, Simola, & Solanko, 2018)

As a solution to this problem, a respondent told that account can be opened in a Russian Bank, which already has an agreement with the foreign bank, and make payments through it. However, a payment made through a respondent bank can be simply rejected by a foreign Bank. This is because the third party, the bank that originally sent the transaction, is not verified by bank abroad. Thus, the system is not very effective, sending money abroad is very difficult, slow and expensive. All these cases show that the Russian system of processing payments, both domestically and internationally, has much to develop, and there is already one solution. (Korhonen, Simola, & Solanko, 2018)

The emergence of the Perspective payment system of the Central Bank of the Russian Federation will allow clearing and settlements every half an hour and immediately provide the bank with a receipt that the counterparty has received the payment. This system allows processing payments in near real time. Besides, it also enables to transfer payments abroad using the SWIFT system. (Perestenko, 2016) The respondent has high hopes for it, but it is not known whether it will work much more effectively. In addition, there is still the same issues of security, costs, a processing time for international payments, government influence, transparency, and political manipulation. All this shows that the clearing and settlement system both in Russia and abroad needs improvement, thus allowing to consider blockchain technology as a solution to certain problems in this area

5 THEORETICAL BACKGROUND

5.1 Blockchain

The blockchain is a distributed network that stores data on transactions (actions) that are recorded in a certain order and form a constant sequence of related blocks. Block - a kind of folder in which the encoded information about contracts and transactions within the system is embedded. This folder has its own attributes that cannot be spoofed and that contain information about the previous folder in the chain. This attribute has a special name - hash. (Tapscott & Tapscott, 2016)

Distributed systems are technologies of data exchange, which are characterized by such features:

- all network members own a full copy of all data that is recorded in the register (chain);
- copies of each member are identical; updates to all copies of the database occur automatically and simultaneously;
- any changes (additions) in the chain occur without the intervention of intermediaries, based on the protocol of consensus. (Antonopoulos, 2017)

5.2 Sectors

This technology can be considered from three different points of view:

- Technology

Technically, the blockchain is a database, which is a distributed register with the possibility of open verification.

- Business

From a business point of view, the blockchain can operate as an exchange network to process transactions, transfer value, assets between equal partners, without the help of intermediate agents.

- Law

From a legal point of view, the blockchain checks transactions, replacing (or rather, making unnecessary) the former regulatory authorities.

Split into three parts makes it possible to understand how extensive the use of blockchain is. (Mougayar, 2016)

5.3 Components

Crypto economy can be characterized as a combination of economics, cryptography and game theory, which has a system of incentives in combination and operates in a decentralized manner. The main problem of this system is to reduce the likelihood of fraud.

Before Bitcoin, there were many peer-to-peer decentralized currency systems that failed because they could not solve the biggest problem of reaching consensus. This problem is called "the problem of Byzantine generals". (Mougayar, 2016)

5.3.1 Game theory (the Byzantine generals)

Game theory is the study of mathematical models of conflict and cooperation between intelligent decision-makers. Bitcoin blockchain, invented by Satoshi Nakamoto, had to solve the well-known puzzle of game theory - "the problem of Byzantine generals". The solution is to guarantee victory by mitigating the consequences of any attempts by a small number of dishonest generals to lie about the coordination of their forces in the attack.

The solution is to verify the work done in processing the sent messages and limit the time required to verify the messages to ensure their accuracy. The consideration of the "resiliency of the Byzantine scheme " is imperative as it operates on the assumption that no one can be trusted, and yet the system provides confidence that the transaction has passed and safely reached the counterparty without being affected by potential attacks. Thereby, it is based on the trust in the network. This new method of achieving security at the end of a transaction has fundamental implications, as it calls into question the existence and role of currently trusted intermediaries, who are traditionally involved in transaction checks. (Popper, 2016)

5.3.2 Cryptography

Cryptography is the heart of the blockchain that keeps the system running. The architecture of the blockchain suggests that trust between the participants of the network is based on the principles of mathematics and economics, in other words, formalized. Cryptography also guarantees security, based on the transparency and verifiability of all operations, and not on the industry-traditional limitation of system visibility.

Cryptographic science is used in many areas to secure the blockchain, and it is based on three basic concepts: hashing, keys, and digital signatures.

Hash

A "hash" is a unique "fingerprint" that helps without the need for actual viewing to verify that a certain piece of information has not been changed.

Keys

Keys are used at least in a combination of two spheres: public and private. For an analogy, imagine a storage that needs two unique lock's codes to open it. In this case, the opening code is used by the sender to encrypt information that can be

decrypted only by the owner of the closing code. The private key should never be revealed.

Digital signature

A digital signature is a mathematical computation that is used to authenticate a (digital) message or document.

Cryptography is based on the public or private hegemony, which maintains the harmony of the blockchain: public visibility but the private inspection. It's a bit like the email: it can be posted, but it doesn't give any information about what's inside. The private key is needed to log into email, and since the email address belongs to only one person, no one will be able to assign it to themselves. (Mougayar, 2016)

5.3.3 Mining

Each data operation, whether it is an addition or an authorized change, is assigned a specific set of digits (hash) by the system, which other participants need to find by searching through certain formulas and functions. As a rule, in already existing systems, all participants compete for the first of finding the right solution. The participant, who finds the right combination first, announces it to others and everyone must agree, as further searches become meaningless. Thus, miners are people who provide the power of their computers to find this solution and, if successful, create a new unit of the system, receiving a reward for it. (Antonopoulos, 2017)

The other main verification method is the Proof-of-stake (PoS) algorithm. Its method eliminates large energy costs and provides owners of virtual coins the ability to determine the verification of transactions. In simple words, the more coins a user has in his wallet, the higher the probability that the system will choose him to check transactions and add a new block to the network. Unlike Proof-of-Work (PoW), PoS rewards network members with fees for transactions included in a

particular block. They are paid by users for the transfer of funds. (Tapscott & Tapscott, 2016)

5.4 Example

How the blockchain system works on the example of bitcoin

1. Peter sends John $ 10,000 to another country. The money is needed urgently, and the transfer through the bank will take a long time.
2. Friends decide to carry out a blockchain transaction, as it will take about 10 minutes, depending on the Commission and network load.
3. Peter creates a bitcoin wallet and deposits $ 10,000 worth of bitcoins into his account. John already has that wallet.
4. Peter sends John a bitcoin transaction worth $ 10,000 plus Commission.
5. Peter's transaction together with other miners' transactions are included into a block and put it in the blockchain. (Miners are users who support the Bitcoin blockchain.)
6. After adding to the blockchain transaction is considered confirmed, and John gets to his wallet the amount in bitcoins equal to 10 000 dollars.

5.5 History of blockchain

In November 2008, the Bitcoin project was registered on the developers ' website SourceForge.net. In January 2009, Nakamoto published the first release of the program “Bitcoin Core v.0.1”, which allowed the users to create (mine) blocks on their personal computers. In the same month with the help of blockchain technology, the first transaction in the history of bitcoin transfer took place. Satoshi Nakamoto sent 10 coins to Hal Finney's bitcoin address. This is recorded in the block № 170. (Nakamoto, 2008)

After that, the blockchain is often associated with cryptocurrencies, but the technology of blockchains can be extended to any interconnected information blocks. Bitcoin was the first application of blockchain technology, that is all. In practice, the blockchain can be used wherever: financial transactions, real estate transactions, insurance, logistics, traffic violations, registration of marriages, etc. (Antonopoulos, 2017)

One of the most important decentralized platforms for blockchain applications is Ethereum (Ethereum), which operates based on smart contracts. It was presented to the public in January 2014 by Vitalik Buterin and launched on July 15, 2015. Smart contracts are called protocols, which are mathematical algorithms that check the obligations between the participants of the Ethereum system. The user will not receive the transfer of the asset until he or she fulfils the conditions specified in the contract. Thus, it became possible to use smart contracts in a trade, periodic payments, insurance system, and other financial products. (Ethereum community, 2017)

Thanks to the creation of the blockchain, a new way to achieve social consensus were found, allowing to confirm the truth of all transactions without the participation of a third party. Blockchain came to this world to remind about respect for freedom of choice, and just to freedom. It became a defender of the freedom that large corporations and governments often infringe. (Popper, 2016)

5.6 Types of blockchain

Not always and not all elements of the technology are implemented in the same way. Depending on the vastness, openness, and requirements of the network, the blockchain can be divided into three types:

- Open - this option is implemented in the bitcoin network (Tapscott & Tapscott, 2016);
- Consortium - something similar can be seen in Ripple and its collaboration with banking consortia (Ripple, 2018);

- Private - blockchain created specifically for one organization (network members are employees of one company).

The difference between these types is primarily in availability, anonymity, and competition within the system. Thus, in an open blockchain, the entry of participants is not limited, and anyone can become a miner if there is enough computing power. In this case, this type is not subject to any authority. Simply put, it is the most decentralized blockchain.

In closed networks — service and private-network members are identified; data validation is performed by designated users. In addition, there may be a body that monitors the implementation of the rules and supports the configuration of the network. Many confuse the concept of distribution and decentralization. Distribution suggests that all network members have access to the data, can track transactions, and verify their authenticity and authenticity. In this case, the system can be decentralized (without a governing body) or centralized. (Tapscott & Tapscott, 2016)

On the one hand, the public version of the blockchain still has some flaws in terms of all kinds of risks. On the other hand, consortium blockchain has an appropriate governing body but it can also interfere with all other processes. The task is exactly how to create the most secure, user-friendly and useful blockchain with high speed and bandwidth. (Popper, 2016)

5.7 New business model

Conventionally, all innovations in this area can be attributed to one of four types. They are formed by the intersection of two axes: the degree of automation and the complexity of the functional model. Automation reflects the extent to which human participation is required: low — human participation is necessary, high — model works without people. The complexity indicates the number of functions of the model: low - one function, high - a variety of functions.

Smart contracts are the basic form of the company built on the blockchain. Human involvement is necessary for smart contracts and they have only one function. This contract is a special code that contains a set of instructions on the Blockchain. It requires the participation of people, usually for the multilateral signing of treaties.

An ordinary contract is an agreement between the parties to the transaction, recorded on paper. Negotiating the terms of the transaction, the settlement of disputes, if there are discrepancies, requires effort. Smart contracts removed all the preparations for the signing of the contract and complying with its terms. Doing business is simplified.

Open network enterprises - the creation of a network of smart contracts but with a low level of automation. Companies become part of the network. As a result, the costs of coordination are reduced, suppliers and partners appear, which previously seemed incredible.

An autonomous agent is a device or program that collects information and can make independent choices. It has a high level of automation but only one function. The ability to determine the way to achieve the goal of the agent is distinguished from the normal application. The agent reacts to changes in the environment.

Distributed automated enterprises are associations of the open network enterprises and autonomous agents. The system makes decisions and operates without human intervention-most daily routine operations can be programmed. Every process runs in accordance with the procedures of smart contracts. (Tapscott & Tapscott, 2016)

Naturally, people are still far from distributed automated enterprises but having already examples of open network enterprises, progress is rapidly moving forward and changing the current business model.

5.8 The use of blockchain

Even though the concept of blockchain was conceived as a monetary and financial instrument, thanks to the system of "smart contracts", the capabilities of the blockchain have grown and are now being implemented in many areas of human activity.

It is obvious that the blockchain technology is relevant not only for cryptocurrency transactions but for the entire FinTech sector. Anything related to transactions can be supported by the blockchain. (Wattenhofer, 2016)

The prospects of Blockchain in the financial sector have been recognized by the world's largest banks. R3 consortium was established in 2013. It consists of banks such as JP Morgan, Goldman Sachs, Santander, and others. The group is testing a decentralized registry in the banking sector. Individual banks are also investing in blockchain start-ups that have been appearing regularly for the last few years. (R3, 2018)

Banks ' interest in technology is linked to the potential threat posed by cryptocurrencies to them. Blockchain will help reduce transaction costs and make them safer. However, the implementation of a fully decentralized Protocol in the banking sector would undermine it from the inside. (Mougayar, 2016)

The practicality of the blockchain is undeniable in everything related to data storage and authentication. This decentralized data system has the potential to destroy corruption. Blockchain allows storing people's dates of birth, financial transactions, and fingerprints. It is possible to keep information about documents such as diplomas, passports, driver's licenses. In the long term, it can help in the fight against all sorts of fraud. (Antonopoulos, 2017)

5.8.1 Banking

Blockchain technology offers a cryptographically secure way to send digital assets without the need for trusted third-party organizations — in particular, banks. In

addition, tools such as smart contracts promise to automate many tedious processes in the banking industry, from compliance checks and claims processing to probate. (Tapscott & Tapscott, 2016)

Banks are involved in the commission of interim payments, provide credit and loans. Blockchain, as an impartial and "direct" (without intermediaries) technology, is able to change all aspects of the industry:

- Payments

By removing the “middle-man” who approves transactions between consumers, blockchain technology can accelerate payments at lower rates than banks.

- Clearing and settlement systems

The blockchain technology can reduce operating costs and bring people closer to real-time transactions between financial institutions. (Mougayar, 2016)

- Fundraising

The blockchain technology provides new companies with a possibility to attract capital via initial coin offerings.

- Securities

By" tokenizing " securities such as stocks, bonds, and alternative assets, the blockchain enhances the structure of capital markets.

- Loans and borrowings

By eliminating the need for credit intermediaries, the blockchain can make borrowing safer and provide lower interest rates. (Mougayar, 2016)

5.9 Clearing and settlement

With the development of microelectronics and communication, the introduction of automated interbank payment systems based on modern communication technologies began. The new systems require not only high data rates but also the security of transactions, as well as the ability to process large amounts of data quickly.

The blockchain is able to reduce costs directly on such operations as clearing, mutual settlements, and investigations. It makes sense because after switching to the distributed registry, there will be no need to reconcile data, confirm transactions and analyse possible errors.

Therefore, instead of relying on a network of custodial services and correspondent banks, transactions can be calculated directly on the blockchain. Thus, it will reduce the cost of maintaining a global network of correspondent banks. (Bank for International Settlements, 2017)

5.10 Advantages

Among the advantages of blockchain technology the following can be identified:

1. Access

Blockchain has no boundaries since it works through the Internet and the location of the participants in the transaction does not matter. This benefit allows any Bank to use this system anywhere, and all data can be quickly verified thanks to the transparency of transactions and their verification.

2. Transparency

When using this technology, all information about each transaction will be available for inspection. It is possible because each block has a timestamp, transaction number, and reference to the hash of the previous block. This feature allows viewing when the transfer was made, from whom and to whom and where the money came from. In addition, the need for continuous transaction verification is reduced.

3. Operational and security risks

Since this system is a distributed network, it consists of many computers (nodes) connected to each other, which reduces the risk of failures or cyber-attacks. This fact allows worrying less about security during transaction processing. The validity of the transaction is checked by many nodes, and if some of them fail, it will not affect the operation of the entire system. (Wadsworth, 2018)

4. Speed

Currently, payments in the blockchain are processed within 10 minutes. It is not affected by distance, a status of the bank or the location of the counterparty. Once a transaction is confirmed, all information about the transaction becomes immediately visible, which reduces its search. Besides, there is no need to use a variety of consumers, as this system works directly. In addition, there are already new solutions to increase the speed and number of transactions.

5. Cost

There is no need to pay different participants who normally process transactions. Moreover, the participants of the transaction do not have to spend a lot of money on foreign transfers. The only thing that is required to conduct interbank transactions through the blockchain is to pay a small commission. This is much nicer than the amount that would have to be paid for a normal interbank operation. (Wadsworth, 2018)

5.10.1 Threat

Blockchain also has several disadvantages:

1. Characteristics of the technology limit the use of the blockchain in the Interbank transfers: transactions cannot be undone and the lost funds cannot be recovered.

2. Scalability. The current volume of bitcoin transactions is 300 thousand per day but there are already various solutions used in practice.

3. Consistency. The legal status of the blockchain is not defined and agreed between national jurisdictions. The instrument must be approved by regulators from different countries in order for banks to use blockchain platforms.

4. Need a regulator. Payments can be made directly to each other but will need to confirm the identity and availability of assets, resolve disputes, monitor compliance.

5. Open data. Transactions in the system are open to all participants in the chain: banks should be ready to share most of their data.

6. Loss of Commission. Banks, regulators, clearinghouses and others earn huge money on global payments. It is unclear how much they will lose due to the new technology. Change the existing technology of interbank settlements in the blockchain system would entail considerable costs for the obvious non-obvious profit.

Switching to blockchain or any other alternative is a time - consuming task with unclear prospects. There must be a real need and benefit that covers all costs and difficulties for these changes to take effect. (Wadsworth, 2018)

5.10.2 Digital change

Despite the prospects, one can hardly expect a rapid transition from centralized to decentralized financial systems. The blockchain is hampered by technological immaturity, legal uncertainty, and unclear benefits.

Financial market participants are not ready to lose control over it. Current blockchain projects are attempts of centralized systems and large capital to repair the industry itself. They use blockchain to get ahead and fix technical flaws without changing the infrastructure. Blockchain can make the banking system more efficient, but in the medium term, it is unlikely to squeeze credit institutions and payment systems. (Popper, 2016)

5.11 Technology implementation

After getting acquainted with the blockchain technology and its capabilities in the field of interbank transfers, it is possible to move to examples of use by companies.

5.11.1 Ripple

Ripple is the cryptocurrency with exclusive source code. The growth of popularity of cryptocurrency is due to a special technology that significantly speeds up the speed of transactions and reduces the cost of the commission, as well as focus on the banking system. Ripple is a centralized network controlled by one legal entity of a large group of organizations. This is both a drawback of the project and its main advantage.

Ripple - interbank transfer technology. In simple words, Ripple is a technology of interbank transfers. A platform that helps banks transfer money from one country to another. In other words, if Bitcoin helps one person to transfer money to another person without intermediaries, Ripple allows banks to do so. (Ripple, 2018)

For a better understanding of how this system works, its workflow needs to be analysed. For example, a resident of France wants to transfer money to a resident of Germany. To do this, the first goes to the bank, sends, and the second receive, but inside the bank, there is, as it were, a subsystem. This allows to safely, quickly and with a minimum commission to make this transfer, while both residents do not even know that they have become members of the Ripple system. According to analysts, this is the fundamental reason for the prospects of Ripple.

In the future, the more banks switch to this technology, the more they will need Ripple, which means the rate of coins will grow. Besides, for example, in order to make transfers, Bitcoin-people or organizations should understand the system and create new services. At a time when the Ripple system does not need to think about it to end users, only banks. (Ripple, 2018)

So far, more than 100 banks have announced integration or experimentation with Ripple, and many companies have announced collaboration.

The advantages of Ripple cryptosystem are:

- The possibility of transactions between any currencies and assets;
- High transaction speed;
- Unlimited scalability;
- Ripple's cryptosystem is not a "disruptive technology", it is designed to improve existing payment technologies by accelerating exchange operations and facilitating trade in low liquid assets. (Ripple, 2018)

In Ripple, there is a protocol Interledger for the efficient and fast transaction via the payment network. Interledger allows transactions between different blockchains using a cryptographic guarantor. This protocol will greatly simplify international and interbank payments. Interledger provides unlimited scalability of the infrastructure money transfers and complete privacy of transaction data. (Ripple, 2018)

5.11.2 JP Morgans

A pilot project for the construction of the interbank exchange system was launched in 2017. The name of this project is the Interbank Information Network. Blockchain network of Quorum based on cryptocurrency Etherium created by private developers JP Morgan is used at its core. At present, when the Interbank Information Network partner network has 75 members, this information system allows cross-border payments in Africa, Asia, Europe, Latin America, and the Middle East. JP Morgan announced the launch of the project last year. The main goal of the project is to speed up interbank payments and provide the institutions participating in the project with the opportunity to exchange information transparently.

The traditional international payment system still required multi-stage control and processing of interbank transactions. Since transactions are made through banks or between banks, especially outside the United States and the European Union, they require a passing agreement with the receipt of responses from various stakeholders. Processing requests sent to other banking organizations takes time, which leads to various problems and delays. (JPMorgan, 2018)

The Interbank Information Network (IIN), built on the basis of the Quorum blockchain network, allows to safely place the necessary data in the blockchain and share them in solving current issues on coordination and confirmation of transactions. Instead of searching their information databases, partner companies could use data directly placed in the blockchain network and be confident in their reliability. This significantly speeds up the payment processing process.

Currently, within the framework of the built network, transactions are made daily for an amount approximately equal to $14,500. Nevertheless, this is only the beginning for the widespread introduction of the new system. In the future, IIN developers plan to support payments not only in US dollars. (JPMorgan, 2018)

5.12 IBM

The technological giant International Business Machines Corporation (IBM), which has gained trust as a leader in the development of products based on blockchain technology, is at the forefront in the field of combining payment systems and logistics solutions. IBM has been interested in this technology for five years, which indicates a leisurely and sustainable approach to the recognition of blockchain solutions at the enterprise level. The latest developments of the company are aimed primarily at the logistics sector but not limited to them. (Blessing-Hartley, 2018)

Implementation of blockchain-based applications has come to the fore for IBM since 2015. Information that IBM is developing its own payment system based on blockchain was eventually confirmed, although initially, this project was experimental. The company was interested in the possibilities of technology, for example, in the field of banking services. It is necessary to reduce the cost of support

and maintenance of the register. Blockchain provides some intriguing possibilities here. (IBM Corporation, 2017)

The IBM project uses smart contracts to register transactions between different parties in order to conduct many transactions around the world. Funds held in escrow accounts are transferred after the fulfilment of contractual obligations. This payment system eventually became an integral part of IBM's core blockchain platform, which was launched in April 2015. It provides the operation of blockchain networks in the IBM Cloud. (Blessing-Hartley, 2018)

The IBM blockchain platform is fully functional today and uses the Hyperledger Fabric technology from the Linux Foundation, in the creation of which IBM has contributed. (IBM Corporation, 2018)

In the last five years, IBM, focusing on the development of blockchain technologies, lays the foundation for expansion in this area. In this regard, IBM conducted beta testing of its Blockchain World Wide (BWW) payment system in September this year. The project aims to become a competitor to Ripple's global payment solutions using the Stellar blockchain platform for processing transactions between banks in real time. (IBM Corporation, 2018)

5.12.1 Hyperledger technology

The Hyperledger project began its existence at the end of 2015 within the framework of the Linux Foundation, which is engaged in ensuring the development of not only the famous operating system. In February-March 2016, 20 companies and organizations joined the project, including IBM, which transferred the source code to OpenBlockchain (later renamed Fabric), and in May Intel entered with the code of Sawtooth components. Today, the list of Hyperledger’s partner companies includes 100 organizations, such as Airbus, Daimler, Fujitsu, Huawei, Nokia, Samsung. Financial institutions and banks are represented in the person of J. P. Morgan, Well Fargo, American Express and others. (Hyperledger, 2018)

Projects in Hyperledger go through various stages of development: from the idea and its elaboration to active work and even stagnation. For a project to move from an idea to an incubation phase, it must have a fully operational code base and an active development community.

Permission types

The blockchain is a technology that can exist without cryptocurrencies and applications. It is logical that when cryptocurrencies showed the solvency of the technology, the idea arose to separate it from cryptocurrencies so that the blockchain could be used in isolated corporate environments. There was even a special terminology:

- Permissionless (with free access) is one that does not require special permission to interact with. The blockchain protects itself with consensus algorithms, which, in turn, are unthinkable without the concept of rewarding miners or nodes that support the network insecurity. A striking example of this blockchain is cryptocurrencies.

- Permissioned (by permission) is the blockchain, the infrastructure of which is controlled by its creators. The consensus based on the maintenance of security nodes. The miners here do not make sense, as usually similar blockchains are non-public. If the unit of account (the token) exists here, then only for technical reasons because it cannot be withdrawn to the outside world and therefore is not worth anything. These blockchains inherit permissionless type properties in terms of security, history immutability, and decentralization. They can also work with smart contracts. (Brakeville & Perepa, 2016)

Types

Hyperledger consists of eight components:

- Sawtooth: a project provided by Intel. This tool is constructed for the development, implementation, and maintenance of public digital ledgers.

- Fabric: developer tool the development of private permissioned-blockchains. The developer can choose from several available consensus algorithms, blockchain data formats, and user authentication methods. Smart contracts that are written in Go language are supported.

- Burrow: client-permissioned node of the blockchain, which is able to perform smart contracts almost the same as the Ethereum virtual machine. Contracts operate on different compatible blockchains from different subject areas.

- Iroha: a group of components and libraries for Fabric that simplifies the integration of blockchain with existing infrastructure. This tool is designed for mobile applications where data is stored and synchronized on the blockchain.

- Indy: a software development kit (SDK) developed at the Sovrin Foundation. This allows managing digital passports (Self-Sovereign Identity) and their integration with public blockchains.

- Composer: a rapid prototyping interface for Fabric that allows programming the logic and contrasts of your private blockchain.

- Explorer: this is a guide that allows users to view balances, transaction status, and other information.

- Cello: a tool to deploy blockchain-as-a-service on various computing clouds and virtual environments. (Hyperledger , 2018)

Hyperledger components are quite fragmented and are not always connected with each other, as they were transferred to the fund by different organizations at different times, however, the initiative is developing rapidly and perhaps someday the developers will bring the project under a single code base. (Hyperledger , 2018)

5.12.2 Hyperledger Fabric

Fabric is a blockchain framework that was originally proposed by IBM and DAH (Digital Asset Holdings). It is developed to provide the basis for blockchain-based solutions and is based on a modular architecture where various components can be connected if necessary, such as a consensus algorithm. Smart contracts in Fabric are called chaincode. Hyperledger network Fabric includes the "peers" that perform blockchain code register data access, support transactions and interface applications. (Cocco & Singh, 2018)

Fabric was built for projects that require Distributed Ledger technology (DLT). Supports chaincode in Go (Golang), Java and JavaScript (via Hyperledger Composer, or since version 1.1) and therefore potentially more flexible than the smart contract language.

In Hyperledger Fabric there are three core members of the blockchain:

1. Clients - users who make transactions.
2. Peers - the type that manages transactions. These include guarantor nodes that verify that the transaction requirements are met.
3. Orderers – members that form transaction blocks and add them to the blockchain. (Cocco & Singh, 2018)

In Hyperledger Fabric (HLF) there are no tokens, but there are smart contracts, which are called chaincodes for this network. Although HLF does not imply the use of tokens, it does implement the ability to exchange assets. This means that it allows people to retain information about physical property and liabilities. Therefore, Hyperledger Fabric has a high degree of control over verification and limited access to information about transactions. This has a positive effect on the scalability and privacy of this platform. (Cocco & Singh, 2018)

Use of Hyperledger Fabric technology has great potential in various fields of activity. For example, the consortium CLS group (Barclays, Bank of America, Bank of China (Hong Kong), Bank of Tokyo and others) are developing an alternative to

SWIFT-transfers. Sony has developed a system for storing data on education. (Hyperledger, 2018) IBM's prospects are staggering, perhaps they will be able to create the largest blockchain in the world.

5.12.3 IBM Blockchain

IBM continues to develop areas in the blockchain technology sector that will reshape business processes in the digital age and create a secure and reliable network. Its latest IBM blockchain product is the first cloud service to create private blockchains with access to companies. The new IBM service is hosted on the Bluemix cloud and will allow companies to create private blockchain networks in just a few hours.

Unlike centralized internal networks, which are currently used by most companies, IBM blockchain will allow creating decentralized, private, reliable networks. Its participants will be able to freely exchange information, knowing that only those who have the appropriate permissions can see the information posted. Besides, this information will remain unchanged after registration in the chain of blocks.

IBM blockchain also enables to create private communication channels for confidential operations of key network members. This is the first commercial application built on technology with Hyperledger open source, developed by the Linux Foundation with which IBM has collaborated for many years. This blockchain is capable of processing more than 1000 transactions per second, which is an ideal option for large companies with significant transaction flows. In addition, it has enhanced open source code to improve system security. (IBM Corporation, 2018)

5.12.4 IBM Blockchain Projects

There are some already implemented and planned to perform the initiatives of IBM.

- Cross-border payments

In October 2017, IBM, in collaboration with Stellar.org and KlickEx Group has announced the blockchain is the solution to implement the cross-border payments in the blockchain while reducing time and cost calculations. (IBM Corporation, 2018)

- Education

Sony Corporation and Sony Global Education together with IBM have developed a new platform for recording educational information on the blockchain. (Sony Group, 2017)

- Food safety

To solve the problem of contaminated food consumption and provide greater consumer confidence in the global food system, a group of food manufacturers and retailers such as Dole, Walmart and Nestlé began to use the IBM Blockchain platform. (IBM Corporation, 2018)

- Identification

In 2017, IBM and SecureKey Technologies introduced their own network for the exchange of digital identifiers and attributes. Consumers will use the network to instantly prove their identity, for example, when opening a bank account obtaining rights or any other documents. (IBM Corporation, 2017)

- Insurance

To improve the efficiency of a multinational insurance, AIG, IBM and Standard Chartered Bank have implemented a successful pilot project, which is a multinational insurance policy based on a smart contract, using the blockchain. (IBM Corporation, 2017)

- Luxuries

When an asset is valuable, it is more likely that criminals will be interested in it. IBM and Everledger work together to ensure the authenticity of diamonds and the transfer of information about each gemstone. (Kemp, 2018)

- Private equity trading

Northern Trust Corporation (NTRS) in collaboration with IBM launched the first commercial deployment of blockchain technology for the private equity market. The network is used to administer a private equity fund. (NORTHERN TRUST, 2017)

- Transportation

IBM and A.P. Møller - Maersk have combined their efforts to create a new digital solution on the blockchain, developed to record information on the supply chain, which has ensured the smooth global trade. (Churchill, 2018)

The above examples demonstrate IBM's active participation in various applications of blockchain technology. However, in addition to the present, the future vision of the process is also important. What matters is how businesses and end-users perceive and use this technology. Since the blockchain already has a strong influence in most business sectors, it is necessary to understand its advantages, since the gap between theory and practice has already begun to significantly reduce. Companies such as IBM will become conductors of new technologies in everyday life. (Antonopoulos, 2017)

5.12.5 Financial sector

As mentioned earlier, IBM uses blockchain technology in various fields, but financial is one of the most important. Several worthwhile projects have already been presented in which IBM has been able to use this technology to improve the performance of various processes. There are some of IBM's financial solutions:

- Rethinking global Finance

As part of its global offerings, IBM also provides businesses with access to financial services through the IBM Global Financing platform, which is designed primarily for IT hardware, software, and services. As IBM's attention to blockchain grew, it became clear that the technology could provide rapid tracking of large-scale financial processes, especially when it comes to dispute resolution. The project is able to reduce the time spent annually on dispute resolution. Dispute resolution

has become more efficient, requiring no average of 40 days, as is usually necessary. The proof-of-concept project allows processing a two-year transaction volume within ten days. (IBM Corporation, 2018)

- ClsNet

The settlement giant CLS is completing testing of its Bank payment application based on blockchain technology. The service will be launched this summer and at least seven banks are due to login in the first months. CLS together with IBM is working on the implementation of the payment network service tied to the blockchain. The system is developed to embed technology into banking systems in order to increase the level of standardization in the world currency markets, as well as reduce the cost of this process.

Today, there is no standardization in the global currency markets – banks have to complete the process manually, which often leads to disparate approaches, offsetting, and higher costs. CLS plans to offer two options for connecting to the CLSNet service, providing direct and intermediate communication through the SWIFT financial message provider. The CLS representative explained that customers will rely on SWIFT in the early stages, while direct hosting will be offered as "a service whose functionality continues to grow as customers adopt it and develop the blockchain." (CLSNet, 2018)

- We.trade

A group of European banks made a series of first cross-border financial trading transactions using the jointly developed blockchain platform We.trade. The platform We.trade, built on IBM's Blockchain Platform and Hyperledger Fabric technology, was installed by Deutsche Bank, HSBC, KBC, Natixis, Nordea, Rabobank, Santander, Société Générale and UniCredit in order to improve the efficiency of cross-border financial transactions. Testing of the platform began in May, and the commercial launch is scheduled for the summer. Development of We.trade can go very fast because of the platform's focus on trading in the environment of small and medium-sized businesses in Europe. (we.trade, 2018)

5.12.6 Partnership with Stellar

There is a Blockchain World Wire project that has been developed as a global financial network based on the Stellar Protocol, which makes it possible to make international payments in real time. (IBM Corporation, 2018)

Stellar is another technology designed to simplify the movement of financial resources both between ordinary people and between different financial organizations and companies. The developers strive to make the implementation of monetary operations simple and accessible, which allows banks to reduce their costs and increase profitability for the business. The year of creation of the new platform is 2014. It is based on the same source code as the well-known Ripple and was first perceived, and in fact, an offshoot of this network, although eventually gained full independence.

Stellar is a decentralized protocol, on the basis of which it is possible to organize financial activities, including the sending of funds across the planet. For example, a man sends a transfer to his partner in the US currency, and partner, if he wishes, can receive these funds in euros or in any other currency. However, the basic idea, as with Ripple, is to simplify transfers between cryptographic and Fiat money as much as possible. Stellar is a distributed currency exchange on a global scale. (Crushcrypto, 2018)

The work of this platform should be considered. In the network of Stellar, there is an internal currency, which is called the same as the entire network or abbreviated STR. The basic elements of the network are ledger, which is a kind of conditional, which is equally accessible to all members of the community. It is a kind of storage where all transactions and balances are reflected.

There is a requirement that each balance must constantly be at least 50 coins STR, the amount is insignificant, but the desired effect is achieved. This requirement was established to protect the network from overload by creating a huge number of accounts (malicious spam). There is a way to protect against operational (transactional) spam, which is expressed in many transactions, during which a small amount of money (0.00001 STR) is withdrawn from the balance. This

money is not charged in favor of the system and cease to exist. (Crushcrypto, 2018)

Stellar transfers to any account are made very quickly, literally instantly, and completely free of charge. A limited number of coins does not allow to devalue the currency. The network supports all possible currencies, and participants are not required to store their savings in STR or use them in exchange transactions. Stellar's distributed exchange model provides users with the ability to trade on their own. The network will take care of the conversion, turning in search of the best option to the numerous market makers competing for the opportunity to make a profit. (Crushcrypto, 2018)

This is suitable for the role of an intermediate currency in the case when the counterparties cannot decide on the common currency (a combination of gateways). The use of STR as a neutral option is very convenient and devoid of counterparty risks. For example, one side of the transaction prefers US dollars, and the second – the Euro. It is not always possible to find a market maker that satisfies both sides and works with this currency pair. In these cases, the intermediate currency is coming to the rescue, namely STR, to which each party changes its funds to make the transaction, and then takes the reverse exchange.

Entry of the usual money in the system and exit from it is carried out through banks, financial institutions, financial companies, which in this case act as gateways. (Crushcrypto, 2018)

6 RESEARCH

6.1 Method (Case study)

The case is based on the description of the "Blockchain World Wire" solution, which shows what IBM offers to improve the process of clearing and settlements in the banking sector. Thanks to the already built blockchain network "Stellar", the universal Blockchain World Wire system allows financial institutions to significantly increase the speed of processing and clearing when making cross-border payments. (IBM Corporation, 2018) IBM has also tested the use of the "Strongholg" coin attached to the US dollar and working on the basis of Stellar, so this token could also be used by users of the payment system as a bridge for processing transactions. (Lund, 2018)

Among the advantages of the new IBM platform is primarily called transparency of transactions, low cost of transactions, increased productivity, a simplified form of payment for transactions, a high degree of security. It is expected that this platform is designed primarily to support the processing of transactions made by Central banks in the digital currency. It is known that many financial regulators took part in the development of the Blockchain World Wire ecosystem. (IBM Corporation, 2018)

6.1.1 Process

A more precise process can be described in this way. In the World Wire framework, transactions of financial institutions can use digital assets of their choice, whether it is a digital currency of the Central Bank, cryptocurrency or stablecoin as a bridge to Fiat currencies. The digital asset facilitates trading and provides important settlement instructions to confirm the transaction.

Using the World Wire API connection, institutions can use their existing payment systems to easily convert Fiat currencies into the desired digital asset. The platform then simultaneously converts the digital asset into a second Fiat currency (for

the recipient), which is almost instantaneous completion of the transaction. All transactions are registered in the Stellar blockchain for security and purity purposes, and it also helps to comply with regulatory requirements because there is actually a permanent record of every transaction using IBM Blockchain World Wire. (IBM Corporation, 2018)

6.1.2 Competitive advantages

Competition in facilitating cross-border payments has intensified. Until recently, the main contenders for the title of the dominant international payment was SWIFT system and Ripple Labs and its products developed for the institutional banking sector. However, everything changed when in early September, IBM announced that it had finished beta testing its DLT system Blockchain World Wire (BWW) and was ready to release the final product. Thus, the Blockchain World Wire system can compete with the traditional Swift payment system, as well as the xRapid transaction settlement system from Ripple. (Ripple, 2018)

The benefits of the new solution are faster payment processing, simultaneous clearing and settlement, reduced time for dispute resolution and negotiation, and significantly reduced clearing costs. Blockchain World Wire also eliminates the presence of multiple parties in a single transaction and significantly reduces capital requirements for international transactions. In addition, Blockchain World Wire increases end-to-end transparency through the use of a single exchange fee between all currencies, and this potentially reduces the existing time and costs for connecting to new markets and revenue streams. (IBM Corporation, 2018)

The BWW algorithm can be technically embedded in other IBM products, which will facilitate and accelerate its promotion through an extensive network of business connections. Thus, the young system immediately rose to the top of the industry pyramid. (IBM Corporation, 2018) And the last stumbling block is the use of Stellar as an intermediary currency, which, although more volatile, but unlike XRP (Ripple Cryptocurrency) cannot even in principle be considered as a security, which removes issues with regulation. It remains to be seen if BWW’s dependence

on the stablecoin will provide a competitive advantage over Ripple's solutions. (Ripple, 2018) One thing is clear: IBM is serious and deliberately oppose their development of Xrapid from Ripple.

Naturally, there are many questions about how each aspect of the clearing and settlement process is improving from a technical point of view. In addition, it is interesting to learn more about the nuances of the Stellar blockchain network. However, this case study was only needed to evaluate and investigate the latest blockchain solution in the field where the clearing and settlement process is present, from IBM. This was done to make clear that this technology has a huge potential at least since such big players in the financial world as IBM and SWIFT are interested in it. Besides, this case has shown a precise picture of how it works and what it is trying to improve, those gaps that the conventional system cannot change because of its limitations.

7 CONCLUSION

The research topic was the use of IBM blockchain technology to improve clearing and settlement processes in the banking sector. To understand the answer to this question, the study was divided into several parts. They did not only reveal the idea of each topic separately but also contributed to the overall idea of the research work.

First, the use of clearing and settlement processes and their challenges was considered in the banking sector. After that, an interview was conducted in which the expert described the situation with clearing and settlements in Russia and confirmed with the examples of several shortcomings of the system described in the theoretical part of the thesis. Then the blockchain technology was presented and its use by IBM as a solution for clearing and settlement processes. Several successful projects, which already solve many problematic aspects of the current processes of clearing and settlement were reviewed. All this information was combined and presented in such a way that it would be easier to understand the research work.

The main objective of this research work was to research the applications of the blockchain technology in the bankingsector. For this purpose, an area that needs improvement was chosen. After that, a reliable case-company was found, which has already implemented blockchain technologies. Research methods were used to confirm the written information.

The research hypothesis of the thesis was “IBM technology can improve the process of clearing and settlement in the banking sector with the help of blockchain technologies”. The effectiveness of blockchain technology and its applications were outlined by the means of IBM technology and a case-study where a transaction was accepted with a clearing system (blockchain-based) in a real-time and the payment went through. At the time of the study, the available solutions were more suitable for international payments. Nevertheless, they have a huge potential for all types of interbank payments.

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