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APPLICATION OF CENTRAL BANK DIGITAL CURRENCIES IN CROSS-BORDER SETTLEMENTS

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Application of central bank digital currencies in cross-border settlements

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Abstract

This review article discusses the main aspects that require special attention when designing the cross-border use of digital currencies. These include interoperability models for central bank digital currency systems, communication, currency conversion and liquidity management processes, settlements, compliance verification and fraud prevention. In addition, the advantages and disadvantages, as well as risks associated with the introduction of digital currencies of central banks, the Kazakhstani experience of testing the Digital Tenge are described, examples of existing projects and international initiatives are demonstrated.

Keywords: digital currencies, cross-border settlements, interoperability, compliance, currency conversion, liquidity, access, financial intermediaries, settlements

JEL classification: E50, E58

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Introduction

Central bank digital currencies (hereinafter – CBDC) are a fundamentally new phenomenon that has the potential to transform the financial system and improve cross-border settlements. With the continuing trend of increasing international trade on the one hand and the increasing need to modernize transaction models on the other, the issue of implementing efficient, fast, secure and independent payment methods is becoming increasingly urgent. Traditional payment methods involve high costs, processing time, and dependence on third-party organizations, which has prompted many countries to start exploring the possibilities of implementing CBDC, which can significantly improve the efficiency of cross-country settlements.

Digital currencies and cross-border settlements

Digital currencies of central banks are a new digital form of money issued by a state issuer, which is the obligation of this issuer to be used primarily as a payment instrument.

It is believed that the first system with the properties of the CBDC was the Finnish smart card system Avant, developed in 1993. Similar ideas and prototypes appeared later in different countries, including Kazakhstan: in 2013, the Chairman of the National Bank of the Republic of Kazakhstan G. Marchenko proposed to develop a national electronic currency system.

The main problem of all such systems was the totality of technical complexity of implementation in the absence of fundamental innovations and advantages. The situation changed in the period 2013-2016: the development of distributed ledger technologies (hereinafter – DLT) in conjunction with the sharp growth in the popularity of the cryptocurrency market attracted the attention of many central banks and fintech organizations to the innovative properties of cryptocurrencies, namely the possibility of implementing automated and self-executing contracts, also known as “smart contracts”, the immutability of the registry, the token nature of monetary units, programmability at the token level, etc.

At the moment, many central banks attach great importance to the study of the CBDC: at least 100 jurisdictions are implementing various projects in this area. One of the most important features of most CBDC is the digital format, which allows for programmable use of money and automation of a whole range of different processes; for this reason, CBDC have great potential in building fundamentally new financial products, creating a reliable financial infrastructure of the future, as well as in simplifying and accelerating existing business processes through automation (including in the case of cross-border payments).

CBDC can be divided into two types: retail (for widespread use) and wholesale (only for settlements between financial institutions), while the intended use of a particular type of digital currency in each country may differ. For example, professors of European universities, based on Chinese experience, point out that enabling offshore clearing banks to issue digital yuan fully equivalent in terms of legal status and value characteristics, gives the possibility of using the *retail* digital yuan provided by the central bank of Hong Kong in mainland China, and vice versa.

Wholesale digital transactions are intended for commercial banks and other financial institutions making large transactions (Linden R. W.H. and Łasak P., 2023). The literature also notes differences in the areas of application of a particular type of digital currency in terms of improving the availability of financial services, introducing innovative products in various sectors of the economy, etc.

The question of finding the best way to implement cross-border payments is quite relevant, since international trade is an integral part of daily trade. To date, the cross-border settlement mechanism has undergone many changes and modifications, but problems such as the duration of transactions, the complexity of compliance verification processes, limited operating time, difficulty in converting currencies and imperfect transparency continue to exist.

Experts of the European Central Bank analyzed the best way to simplify cross-border settlements, including modernized correspondent banking, new cross-border fintech solutions, crypto-assets, global stablecoins, compatible instant payment systems with currency conversion and, finally, CBDC compatible systems with currency conversion (Bindseil U. and Pantelopoulos G., 2022). The subject of the analysis was primarily such factors as cheapness, instantaneity, versatility and reliability, that is, everything that can be improved in existing cross-border settlement systems.

In summary, the results of the study show that cryptographic methods are the least effective in solving this issue, while the mechanisms of interoperable instant payment systems and the same CBDC systems with currency conversion have the greatest potential[1]. This provision is primarily due to the possibility of technical unification, the relative simplicity of their architecture and the preservation of monetary sovereignty.

In case of application of the method of ***compatibility of internal instant payment systems*** *with the implemented currency conversion infrastructure*, there is a need to ensure effective interaction of authorities of different jurisdictions, which requires a certain level of readiness and ability to cooperate. At the same time, ensuring this interconnection has some potential in improving cross-border payments and addressing current shortcomings, as this system:

- build on existing and proven infrastructures;
- avoid closed systems and fragmentation;
- maintain the necessary level of competition;
- it retains monetary sovereignty.

However, along with compatible instant payments, a simpler form of ensuring the speed and cheapness of cross-border payments, ***CBDC compatible systems*** *with*

[1]*For reference*: speaking about the way to improve cross-border settlements in the form of new *fintech solutions*, it should be noted that faster cross-border payments presented by fintech companies contributed to increased competition and, as a result, reduced the cost of payment services. However, there are doubts about the long-term and potential scalability of such solutions due to a more disparate approach, for example, compared with correspondent banking. The use of *cryptocurrency* as a tool to simplify cross-border payments, as it turned out, does not contribute to cheaper services due to the decentralized system and making payments outside any jurisdiction, which creates additional risks of legal regulation. *Stablecoins* have great potential to simplify cross-border payments through a combination of traditional and advanced technologies. However, it is claimed that stable coins are most susceptible to threats such as loss of monetary sovereignty, currency substitution, and fragmentation.

currency conversion are distinguished. This is primarily due to the definition of the role of commercial banks as providers of currency exchange services, where payment transactions are carried out through an appropriate centralized system, which allows central banks to ensure **proper regulation, cheaper operations and the necessary level of liquidity**. However, it should be recognized that the continuity and regularity of payments through digital currencies requires that the same criteria be met in the domestic environment.

Thus, cross-border payments can be improved through the introduction of digital currencies, but this requires considerable effort to design in detail and, importantly, lay the necessary infrastructure at the initial stage.

Speaking about the CBDC from the point of view of a tool that helps to eliminate current shortcomings in settlements, it should be noted that they have the same advantages as the central bank (hereinafter – CB) cash – finality of settlements, liquidity and integrity (Ralphs, 2023). In addition, digital currencies have properties such as:

- Reducing credit and liquidity risks by increasing the availability of financial services, reducing transaction costs, and CB providing;
- The absence of impact on financial stability: in most cases, the use of CBDC provides for the preservation of a two-tier banking system and does not significantly change the process of creating credit and deposit funds, thereby not affecting financial stability.

For these reasons, the work on wholesale central banks is mainly driven by the desire to expand cross-border payments, as evidenced by the data of a survey of various CBs conducted by the Bank for International Settlements (hereinafter – the BIS) in 2023 (Di Iorio, A., Kosse, A. and Mattei, I., 2024).

Advantages and disadvantages of CBDC in cross-border settlements

CBDCs have a number of significant advantages over traditional forms of money in the context of cross-border settlements.

The main advantages include:

1. Reducing transaction costs:

CBDCs reduce the costs associated with international payments by eliminating intermediaries and streamlining settlement processes. This is particularly important in emerging economies, where high costs of international remittances can significantly constrain economic activity.

2. Acceleration of calculations:

Traditional cross-border payments can take anywhere from days to weeks depending on the banking systems and jurisdictions used. CBDC can provide quick settlements[1], which will significantly increase the speed of international operations.

3. Enhancing transparency and security:

The nature of digital currencies provides an opportunity to improve the monitoring and control of cross-border transactions, which in turn helps to reduce

[1]In the test mode, cross-border payments in international projects were made in 60 seconds.

the risks of fraud, money laundering and terrorist financing, as well as increases confidence in international payments.

Potential risks and possible threats include the following:

1. *Macrofinancial risks:*

Widespread use of CBDC outside the issuing country could lead to currency substitution, posing a threat to financial stability, especially in countries with less developed economies. It can also lead to instability in capital flows and the increased impact of external shocks on domestic markets. In order to reduce and control risks, it is planned to adapt the current currency legislation to establish limits in volumes that contribute to achieving a balanced capital flow and preventing currency substitution.

2. *Compliance:*

The implementation of the CBDC requires strict adherence to international standards in the field of preventing money laundering and terrorist financing. This poses additional challenges in the development and implementation of CBDC, especially in the context of global trade, where different legal regimes operate. For this reason, the development of new compliance standards and mechanisms at the international level is critical.

3. *Problems with liquidity management:*

The instant settlement mechanism used on platforms with tokenized assets implies the need to reserve a certain amount of liquidity in advance. Such market conditions, implying an increased need for liquidity, can lead to disadvantages and slow transaction completion. In this regard, it is necessary to solve the issue of providing liquidity on the basis of financial institutions or international organizations.

4. *Inconsistency of regulatory mechanisms:*

While this problem can be solved to one degree or another through the application of the interoperability model based on the multicurrency plafthorm of the Central Bank, the process of creating platforms based on such a model requires a large amount of time and resources. Additional difficulties are created both by different regulatory mechanisms regarding anti-money laundering and countering the financing of terrorism (hereinafter - AML/CFT) in different jurisdictions, and by the incompletely formulated legal status of the CBDC themselves in many countries.

5. *Lack of reliable and standardized mechanisms to ensure technical compatibility between new and old systems:*

The emergence of new systems, especially based on blockchain and other DLTs, in the absence of a developed mechanism for “backward compatibility” with existing systems will inevitably lead to fragmentation of liquidity and increase other risks. It is worth noting that there is no complete solution to this problem, but its complexity can be significantly reduced by either creating separate systems to ensure backward compatibility, or including backward compatibility as one of the main requirements for new payment systems.

Thus, the success of CBDC implementation depends on the ability of countries to create a reliable and interoperable infrastructure that minimizes possible threats and ensures effective international payments.

Models of organization of cross-border settlements on the basis of CBDC: technical and operational aspects

On the basis of current methods of cross-border and cross-currency compatibility, the BIS identifies three main models of interoperability of the CBDC (Auer R., Haene Ph. and Holden H., 2021):

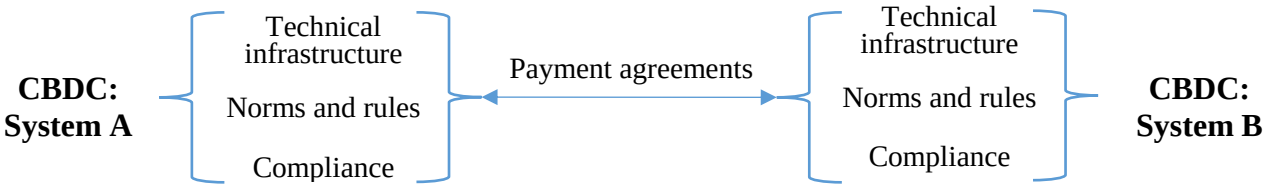
— Compatible systems;
— Interrelated systems;
— One system.

The similarity of models is characterized by the need to devote considerable effort to their development and standardization, as well as international harmonization. Speaking of differences, it is necessary to consider each model separately:

- ***Compatible CBDC systems*** involve the development of different CBDC systems, taking into account interoperability with each other, which will ensure the ease of cross-border settlements with respect to the processes of counterparty identification and transaction monitoring (see Figure 1). One of the key factors in this model is the standardization of message formats, cryptographic methods, and other parameters. An example of such a system is ISO standardization, which is already used in a number of projects. While the interoperable model does not directly link the different CBDC systems, it can improve cross-border payments by improving the efficiency of payment processing and harmonizing protocols, and by facilitating the participation of foreign payment system providers (hereinafter – PSPs) in different systems and jurisdictions. However, depending on the access model (see below for more details on access models), some limitations may remain, such as the need for individual PSPs to establish correspondent banking relationships.

Figure 1

Compatible CBDC systems



- ***The CBDC interrelated systems model*** provides for the interlinkages between the different CBDC systems through technical and contractual agreements (see Figure 2). Mutual agreements allow participants in the interrelated CBDC systems to transact with each other without having to become a direct participant in

each of them or enter into intermediary agreements. These relationships may include Payment versus Payment (hereinafter – PvP) settlement mechanisms that reduce settlement risk in cross-currency transactions.

The key issue of the interrelated model is the communication mechanism between the CBDC systems:

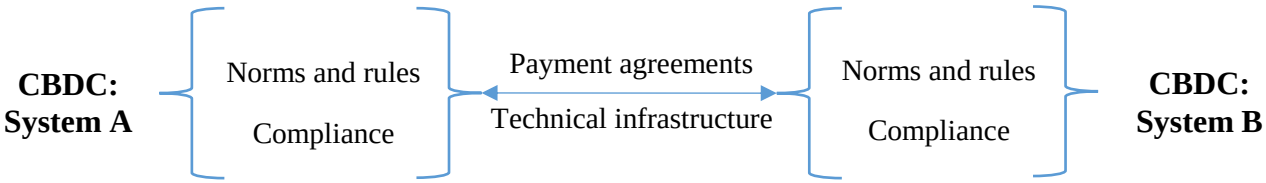
— **The single point of access mechanism** requires the creation of a single gateway for all participants – such a gateway can be a PSPs acting as a single correspondent bank with access to both CBDC systems. This model differs from the above model of interoperability in that the status of the gateway organization is fixed in agreements between participants at the regulatory level, and the organization itself acts as a gateway for all other participants. At the moment, there are no examples of a single point of access mechanism implemented for the CBDC, but similar methods are used in the framework of the euroSIC payment system, which provides access to financial institutions throughout the EU for *Switzerland outside the European Union* (hereinafter - the EU);

— Within the framework of **bilateral agreements** between two CB, participants of one system can directly make transactions with participants of the other system. In particular, the *Jasper-Ubin project (Canada, Singapore)* was built on the basis of bilateral agreements;

— **Concentrator agreements** (also known as the hub and spoke system) involve a common hub connecting two or more CBDC systems. The most striking example of the application of concentrator agreements of the model of interrelated systems of the CBDC is the project *Helvetia (Switzerland)*. It is important to note that the hub can be an independent payment system, which at the same time is not a prerequisite.

Figure 2

Interrelated CBDC systems

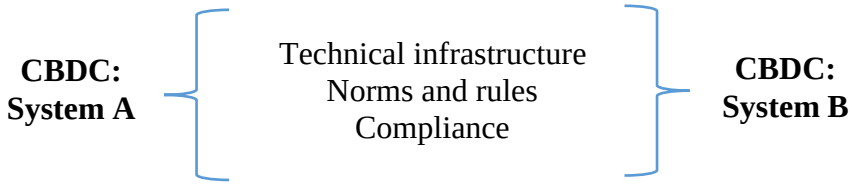


- **A single system of different CBDCs** (or a multi-currency CBDC platform) involves the creation of a single technical infrastructure that will serve several CBDCs (see Figure 3). This model may offer the same services as the interlinked model (e.g., PvP transactions and a single currency trading platform), but it may set common access/participation requirements for all participating jurisdictions. Combined with a single technical infrastructure and a high level of unification, the multi-CBDC model can provide additional advantages over the

interconnected model by better stimulating competition. The most famous examples of such projects are *mBridge (Thailand, China, Hong Kong, Saudi Arabia and the UAE) and Dunbar (Australia, Malaysia, Singapore, South Africa)*. Despite the significant advantages of a single multi-CBDC system, each CB needs to address such global issues as the readiness to transfer certain functions of system control and monitoring to the operator in accordance with jointly agreed management mechanisms, as well as other issues that require compromises between several CB.

Figure 3

Single CBDC system (multi-CBDC)



Thus, the final choice of the CBDC interoperability model depends on the Central Bank's willingness to cooperate, the level of standardization and the ability to integrate new solutions into existing systems, which determines the complexity and timing of their implementation at the global level.

At the same time, the circulation of digital currencies in cross-border transactions is accompanied by many transactions, each of which must be carried out according to agreed procedures. Thus, it is necessary to understand how and to what extent access is provided to various entities, how communication should occur between systems, what infrastructure should be in place for currency conversion and compliance verification processes, and determine the process of final transfer of ownership of financial assets.

On this basis, the following elements can be distinguished:

1) Access Policy and Communication;
2) Currency conversion and liquidity management;
3) Compliance and fight against fraud;
4) Finality of calculations.

Next, we suggest considering each of them.

Elements of CBDC implementation in cross-border settlements

1. Access and communication policies for end-users and financial intermediaries

In the development and implementation of CBDCs, considerable attention is paid to their regulation and integration into existing financial systems. However, in addition to these aspects, the issue of access to and communication of CBDC is equally important, involving not only the management of interactions between various financial intermediaries and service providers, but also the development of effective policies for end users, especially in the context of cross-border transactions. It is important to note that access policies involve trade-offs that each jurisdiction must consider.

Options for access of foreign financial market entities and non-residents to the CBDC may be full access (direct), implying that foreign or domestic organizations receive direct access to the CBDC system, or intermediary (indirect) access provided through domestic organizations. Direct access requires that foreign entities have supervisory mechanisms on the part of the Central Bank issuer, as exemplified by the real-time gross settlement system in Switzerland (Helvetia Phase II). This system allows foreign banks to participate in transactions through remote access while complying with supervisory standards, AML/CFT, as well as communication infrastructure requirements.

Direct ownership and use by foreign users of the CBDC can greatly simplify cross-border transactions, eliminating the need for currency conversion and allowing payments to be made in another jurisdiction. However, with such access, differences in internal and external regulatory requirements can keep the details of transactions from being checked for compliance. Also, despite the potential facilitation of cross-border payments by reducing the volume of foreign exchange conversions, the widespread use of CBDCs outside the issuing jurisdiction may entail macro-financial risks, such as the substitution of the national currency and the acceleration of transmission of economic shocks. Policymaking must therefore take into account not only the possible negative consequences for neighbouring countries, but also the risks of destabilization of their own economies caused, for example, by significant capital inflows (Reslow A., Soderberg G. and Tsuda N., 2024).

A foreign entity that does not have direct access to the Central Bank may gain indirect access through a *correspondent banking agreement*. However, this method of ownership of the Central Bank will be a requirement to a private organization, and not a direct obligation of the CB, which subsequently entails the emergence of credit risk.

In addition to ways to provide access to digital currencies, it is also necessary to pay attention to the establishment of restrictions on the possible amount of ownership of digital currency and the number of transactions it performs for both financial institutions and individuals. Such restrictions may be imposed on the basis of domestic and international standards. Among the possible options of the limits

are limits on the maximum storage of digital currency, limits on the amount of transactions and on the number of transactions in certain time periods. In terms of cross-border transactions, limiting the volume of CBDCs that individuals and entities can own can reduce risks to the international monetary and financial system, including those related to capital flow volatility, currency substitution and other macro-financial risks.

An alternative approach is to enter into bilateral agreements between central banks that will allow for flexible management of the access and use of CBDCs. For example, tourists may be subject to less stringent restrictions on the use of the CBDC while in the country, but more stringent after leaving the country.

In terms of communication, having a standardized framework of digital identifiers across jurisdictions will certainly facilitate more effective communication and messaging across borders and systems. Interaction between two systems of cross-border exchange of digital currencies can be carried out in several ways. For example, the implementation of application programming interfaces (hereinafter - APIs) can facilitate communication, and PPUs can independently create the necessary messaging infrastructure. It is important to note that a combination of the two approaches is not excluded. Also, it should be noted that the ability to scale is of particular importance here, since there is a need to provide many different communications and communication channels.

Experts point out that through the use of standardized data, messaging, and APIs, the scalability problem is reduced. There is a need to consider at an early stage whether communication should become an integral part of the basic infrastructure or whether it should be left to the discretion of the PSP.

Thus, when designing cross-border settlements using the CBDC, special attention should be paid to the issues of non-resident access to the CBDC, communication with financial intermediaries and currency exchange operators, as well as restrictions on ownership and transaction amounts.

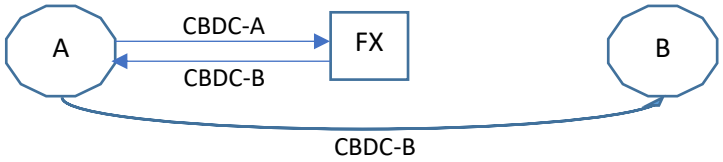
2. Currency Conversion and Liquidity Management

One of the key tasks in the implementation of the CBDC is to ensure the possibility of making cross-currency transactions that require the introduction of appropriate infrastructure. There are several models of currency conversion when using the CBDC, each of which has its own characteristics and risks. For example, experts associate the process of currency exchange with the policy of access of financial entities of CBDC.

The first model involves exchanging one central bank for another through an internal financial exchange provider (hereinafter – FX) (see Figure 4). In this case, the payer, who has access to foreign digital currencies and has the ability to keep them in his wallet, and the recipient do not interact with financial intermediaries, but directly send and receive the digital currency in the desired conversion, which ensures a high speed of settlements. However, in such a model, the process of currency exchange rate formation remains unclear, which presents a potential difficulty in designing the interoperability of CBDC systems.

Figure 4

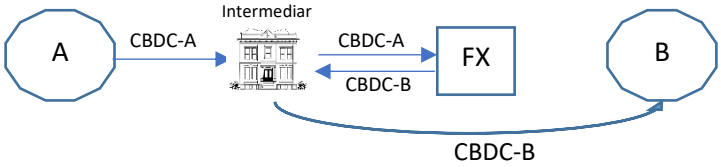
Exchange of digital currency through FX provider



The second model is based on the premise that the payer does not have the ability to hold and transact with a foreign digital currency, which involves the presence of a financial intermediary in the form of an entity with such access, converting currencies using an FX provider (see Figure 5). This model implies an increase in transaction costs, since intermediary services not only increase the duration of the transaction, but can also charge an additional fee for it.

Figure 5

Exchange of digital currency through intermediary organization and FX provider



The third model describes the mechanism of making a transaction only with the help of an intermediary with the ability to make transfers and exchange currencies (see Figure 6) (Reslow A., Soderberg G. and Tsuda N., 2024).

Figure 6

Exchange of digital currency through an intermediary organization

It is noteworthy that in the first model of digital currency exchange, resident A and resident B independently participate in one or another model of interoperability of CBDC systems, and in the other two models only an intermediary in the form of a financial institution takes part. It should be noted that despite the simpler scheme of interaction in the first model, today international projects are more focused on ensuring interaction in accordance with the second and third models.

To ensure the smooth operation of all three models, a liquid foreign exchange market is needed, which can be provided through centralized foreign exchange services or on shared platforms.

It should also be noted that any restrictions on the storage of digital currency imposed on intermediaries and foreign exchange providers should be based on the volume of demand for this currency, as well as provide for the possibility of instant replenishment of accounts.

Thus, one of the important features of the CBDC design in cross-border settlements is the provision of a currency conversion infrastructure with uninterrupted replenishment of a sufficient level of liquidity to ensure quick settlements.

3. Compliance and combating fraud

In addition to the aspects described above, which require special attention in the design of the implementation of CBDCs in the system of cross-border payments, the issue of compliance is also of critical importance. The fight against illegal transactions and fraud remains one of the most important factors directly affecting the credibility and sustainability of the cross-border payment system. Harmonization and harmonization between jurisdictions is needed to minimize delays, increase transparency in cross-border transactions, and reduce the costs associated with differences in regulation and control.

It is known that an important part in the fight against illicit financing is the national implementation of reliable AML/CFT regimes in accordance with international standards established by the Financial Action Task Force (FATF). It is therefore expected that each national system will design CBDC in accordance with these requirements. An important challenge for countries issuing digital currencies is to develop control mechanisms that can ensure security and compliance with regulatory requirements in the context of their global use. Also, special attention is paid to the anonymity of users of the CBDC, since the level of allowed confidentiality in cross-border transactions can differ significantly from domestic payments (Report to the G20, 2022).

One example of innovative solutions in this area is the Mandala project, which was launched by the BISIH Singapore Innovation Centre in cooperation with the central banks of Australia, Korea, Malaysia and Singapore. This pilot project aims to simplify compliance procedures and automate transaction control. The Mandala protocol encodes regulatory requirements, such as AML/CFT measures, into a common protocol, allowing banks to share transaction information and verify

compliance in real time. This will create additional transparency and improve the efficiency of cross-border payments, while ensuring compliance with all legal requirements.

The Mandala protocol uses transaction information provided by banks to automatically apply appropriate compliance measures. In addition, it generates evidence of compliance with regulatory requirements that may be associated with any settlement asset, including CBDCs, tokenized deposits, or other forms of payment. For example, this project allows you to verify the presence of certain entities in the sanctions lists (Project Mandala, 2024).

Nevertheless, in addition to measures taken at the international level, ensuring internal control and compliance with standards are currently priority areas, as this will facilitate the implementation of existing systems in international ones.

4. Finality of settlements

Today, the cross-border payment process is often divided into two parts: transaction execution and settlement, and they are executed independently of each other. The advantage of such separation is the possibility of multilateral clearing and netting. The disadvantage is that there are long delays between the conclusion of the transaction and the calculations. Instant calculation implies that the transaction and settlement are the same thing.

Speaking about instant cross-border settlements, it is important to understand that foreign exchange providers who make conversions have a special role here. As mentioned earlier, in order to make a payment smoothly and quickly, FX providers must have the most liquidity and the least amount of restrictions. The instantaneousness of calculations can be ensured only when all prescribed norms and requirements are complied with, and the system of compliance checks is automated.

It should be noted that instant payments imply an irrevocable and unconditional transfer of ownership of financial assets between the parties to a financial transaction. In other words, once the settlement is recognized as final, the transaction is considered complete and the parties involved can no longer cancel or modify it.

As you know, experiments with cross-border payments are more focused on the speed and use of smart contracts to facilitate PvP settlements.

Future cross-border agreements may therefore require programmability or alternative methods to comply with such protocols, and this becomes an important design feature to be considered. Thus, key constructive considerations requiring attention to transboundary aspects include:

- Instant calculation
- Availability 24/7
- Programming capability

Examples of existing projects and international initiatives

To date, there are several major international projects aimed at testing and implementing CBDCs in cross-border settlements. These projects represent an important step towards building a global central bank digital currency infrastructure and draw useful lessons for future developments. It is important to note that each project is unique in its approach to making cross-border payments using digital currencies.

mBridge

The project aims to explore the mBridge Ledger (mBL) platform, which supports peer-to-peer cross-border payments in multi-currency central bank and real-time currency transactions, which can be shared by multiple central and commercial banks. This DLT-based platform is designed to enable instant cross-border payments and settlements. In 2022, the BIS, together with the central banks of Hong Kong, the UAE and China, launched a pilot project that carried out transactions on existing transactions, as a result of which the project was able to reach the Minimum Viable Product (MVP) stage (Project mBridge Update, BIS Innovation Hub, 2023).

The mBL platform provides the ability of the blockchain to process transactions based on smart contract codes that can be executed on widely used blockchain platforms. In addition, the issuance, redemption and payments by CBDC are made using smart contracts written using the Solidity programming language, participating central banks have open access to the use of this code.

The mBridge project is based on interoperable CBDC systems, which in turn provide for the decentralized execution of many components in the transaction. Thus, each participant, having their own mBridge environment, has full control over their infrastructure and operations.

One of the main features of this project is the mechanism of protection of personal data of the subjects making the payment. By assigning pseudonymous addresses generated by a randomly generated pair of keys, sensitive data can only be accessed by counterparties of the transaction and central banks, which have the ability to identify the parties involved in the transaction and decrypt the data of that transaction.

Interconnection with the internal systems of project participants is carried out through APIs based on the ISO20022 standard. Commercial banks interact with counterparties by connecting the main banking system to the server part of mBridge, and for the Central Bank, the issuance and redemption operations of the Central Bank are supported by the integration of mBridge into internal payment systems.

Today, mBridge is working with private companies to find new solutions and use cases that will help develop the platform and demonstrate its full potential.

Icebreaker

The project, implemented by the BIS Nordic Innovation Center in cooperation with the Bank of Israel, the Bank of Norway and the Swedish State Bank, is aimed at testing the technical feasibility of international and inter-currency transactions.

One of the key aspects of the project is to break down each cross-border transaction into two separate domestic payments that are made within the respective national systems. Settlements are made using coordinated PvP agreements using temporary hash contracts, which practically eliminates the risk associated with the counterparty in currency transactions. Currency exchange service providers provide their quotes to Icebreaker Hub, which chooses the most favorable rate for the payer for each payment request. In addition, in the event of a lack of liquidity in a particular currency pair, the system automatically uses intermediate currencies to facilitate the exchange. Then, with the consent of the payer with the currency quote, a request is sent from the payer's wallet to the recipient's wallet to obtain a hash value (number or phrase), which will be used to unlock previously transferred blocked amounts. Next, a payment is initiated from the payer, as a result of which, through Icebreaker Hub, the blocked amount is transferred to the recipient's wallet, where the received funds are subject to unlocking using a hash value (Project Icebreaker, BIS Innovation Hub, 2023).

Although there are several steps to be performed at each stage and messages are sent back and forth, the entire process was completed within seconds during the project system testing. The Icebreaker model provided the minimum technical requirements for retail CBDC systems.

SWIFT: CBDC Sandbox

The first results of the experiments were obtained in 2021 and since then the project has undergone significant changes and reached wide development. The project attracted the participation of 38 central and commercial banks and market infrastructures from different countries, making it one of the largest global projects in this field. The results of the project to date cover not only PvP payments, but also complex Delivery versus Payment (DvP), which can be automated and organized using the CBDC Connector platform, which allows such transactions to be made continuously. It has also been demonstrated that SWIFT is capable of supporting various interoperability models, which greatly simplifies the process of connecting systems to the proposed infrastructure. In addition, the use of smart contracts and tokenization have reduced the risks of fraud and duplication of financing (Connecting digital islands, SWIFT, 2024).

Participants in the experiment noted a significant reduction in transaction costs due to process automation and a decrease in the number of intermediaries. SWIFT has also successfully demonstrated the possibility of integrating existing CBDC networks with tokenized asset platforms, which is critical for the further development of digital financial instruments.

The National Bank of the Republic of Kazakhstan (hereinafter - the NBRK) participated in this project to test the Digital Tenge (hereinafter - DT) in cross-border settlements, in connection with which a more detailed technical infrastructure will be described below (see the part of Experience of Kazakhstan).

In addition to the projects listed above, there are others that cover different aspects of the application of CBDCs in cross-border settlements (see Table 1).

Table 1

International projects of CBDC application in cross-border settlements

Name	Participants	Platform	Model	Features
Aber	Bank of the United Arab Emirates, the Central Bank of the Kingdom of Saudi Arabia	Hyperledger Fabric	Interconnected CBDCs systems (bilateral agreements)	The work carried out made it possible to identify a number of aspects for improvement (in particular, in the field of ensuring technical compatibility of platforms and ensuring security), as well as to test a number of hypotheses regarding the feasibility of DvP payments
Dunbar	Reserve Bank of Australia, Central Bank of Malaysia, Monetary Authority of Singapore, Reserve Bank of South Africa, BIS	R3 Corda и Quorum	Multi-currency CBDC platform	A multi-currency unified settlement platform will allow participants to pay each other in different currencies directly, without intermediaries such as correspondent banks, which in turn provides faster, cheaper and safer payments
Helvetia Phase II	Swiss National Bank, Goldman Sachs, BIS	SIX Digital Exchange, SIX Interbank Clearing	Interconnected CBDC systems (concentrator agreements)	Support for end-to-end transactions and real-time settlement. The compatibility of DLT systems with traditional banking systems has been demonstrated
Jasper-Ubin	Bank of Canada, Monetary Authority of Singapore	Quorum, Corda	Interconnected CBDCs systems (bilateral agreements)	The possibility of cross-border payments of wholesale CBDC using DLL has been implemented, as well as interoperability between different systems (Quorum, Corda) has been achieved

Source: compiled by authors based on publications [13-16]

Thus, the results of international projects show the potential for implementing CBDCs in cross-border settlements, offering solutions to improve the speed, security and transparency of transactions. However, each of these solutions requires

adaptation to the unique technical and regulatory conditions of different countries, which underlines the need for further coordination and development of global or regional standards for the full integration of the CBDC into the global financial system.

Experience of Kazakhstan

The history of the «Digital Tenge» project dates back to 2021, when the NBRK conducted the first study on the potential implementation of the CBDC in Kazakhstan. In particular, in 2021, the architecture of the CG platform was developed, a number of issues of the economic design of the project were clarified, and the basic scenarios of the DT life cycle were tested, such as emission, distribution, labeling, translation and purchase in an emulated environment. In 2022, the project was further developed: a decision-making model on the implementation of the DT was prepared, an economic study of the effects of the potential implementation of the CBDC in Kazakhstan using macroeconomic modeling was conducted, and the use of conventional and labeled DTs in a limited loop with real users and trade and service enterprises was tested for the first time. 2023 was an important milestone in the development of the project: the national digital currency was launched into pilot operation, the DT platform was integrated with the information systems of pilot participating banks and international payment systems Visa and MasterCard, and a number of innovative scenarios were implemented (the implementation of stablecoins with reference to the DT, as well as scenarios from market participants). In addition, the “Digital Vouchers” scenario was implemented and tested, which allowed to automate the hot meal service in schools and improve the payment process with the participation of the state. In 2024, pilot projects are being implemented on the use of marked CBDCs in public procurement and tax administration mechanisms on the DT platform, as well as further research of offline payments.

The direction of cross-border payments using the DT is actively developing. In 2023, the NBRK received the status of an observer member in the mBridge project from the BIS, currently work is underway to obtain full membership in this project and the subsequent participation of the Republic of Kazakhstan in cross-border payments in the national digital currency. In addition, in 2023, a pilot project was carried out jointly with SWIFT and the Monetary Authority of Hong Kong: transactions in national digital currencies of the Republic of Kazakhstan and Hong Kong were carried out in test mode using the DT platform and the SWIFT CBDC Connector system. As part of testing and testing of the mechanism, at least 60 transactions were carried out with an average processing time of 15 minutes each.

The technical implementation of this testing was carried out through specialized platforms provided by SWIFT, thanks to which it became possible to connect entities to transfer financial messages. Thus, through the opening of digital accounts in emulated banks of the Republic of Kazakhstan and Hong Kong, the sending of digital currencies occurred by debiting funds from the account and sending a financial message through the router and translator of financial messages

necessary for the transfer of value and exchange of information. As described above, the method of using a correspondent bank as an organization with the ability to store CBDCs and generate messages in ISO 20022 format was used in the testing. It should also be noted that the conversion of currencies was carried out outside the platform, so the exchange rate was available at the initiation of the payment. Further development of the platform provided for the implementation of the compliance mechanism through two-way automated verification at the initiation stage of payment, in connection with which it was possible to identify the uniqueness of the payment, its correctness and compliance with AML / CFT rules.

As part of the 2024 work, negotiations are also underway with central banks of other jurisdictions to carry out direct bilateral transactions in national digital currencies as part of pilot projects.

Conclusion

CBDCs have significant potential to transform cross-border settlements by offering solutions aimed at reducing transaction costs and accelerating payments. However, the introduction of CBDCs poses a number of challenges, such as compatibility with existing financial systems and regulatory risks.

The purpose of using CBDCs for cross-border payments is to create an efficient, fast and secure international settlement system that can replace traditional methods with higher costs and longer processing times. CBs play an important role in facilitating these transactions, ensuring both the stability and reliability of payment systems, and implementing standards for interstate interaction.

Access to a national CBDC is important for all participants in the system. Clear rules and access criteria should be developed for non-residents to determine their ability to use a national digital currency. It is also important to establish conditions for financial intermediaries and currency exchange service providers, which will create a flexible and transparent system to support cross-border payments.

The issue of providing the infrastructure for currency conversion is an integral part of the design of CBDC in cross-border payments. The definition of a mechanism for the provision of foreign exchange and the interaction of end users with the providers of these services will help to achieve the goal of instant cross-border payments. The role of central banks in facilitating foreign exchange transactions and enhancing liquidity is critical to the system's success, especially in the context of international trade.

Compliance and AML/CFT standards also require special attention. There is a need to develop mechanisms for automated verification of transactions for compliance, which will improve the effectiveness of compliance procedures.

Speaking about the experience of Kazakhstan in testing the DT in cross-border settlements, it should be noted that the possibility of technical implementation of these operations was confirmed, and aspects requiring further development were identified.

List of references

1. Bindseil U., Pantelopoulos G. (2022) *Towards the holy grail of cross-border payments*, *Working Paper Series, European Central Bank.* Available at: https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2693~8d4e580438.en.pdf
2. Nili, C. and Waliczek, S. (2024) *Modernizing financial markets with wholesale central bank digital currency*, *World Economic Forum official website*. Available at: https://www3.weforum.org/docs/WEF_Modernizing_Financial_Markets_with_Wholesale_Central_Bank_Digital_Currency_2024.pdf
3. Linden R. W.H. and Łasak P. (2023) *The Digitalization of Cross-Border Payment Systems and the Introduction of the CBDC, Financial Interdependence, Digitalization and Technological Rivalries.* Available at: https://pocketbook.de/de_en/downloadable/download/sample/sample_id/8140203/
4. Ralphs A. (2023) *Simplifying cross-border payments through CBDC technology*, *OMFIF*. Available at: https://www.omfif.org/2023/12/simplifying-cross-border-payments-through-cbdc-technology/
5. Di Iorio A., Kosse A. and Mattei I. (2024) *Embracing diversity, advancing together – results of the 2023 BIS survey on central bank digital currencies and crypto, Bank of International Settlement official website*. Available at: https://www.bis.org/publ/bppdf/bispap147.pdf
6. Auer R., Haene Ph. and Holden H. (2021). *Multi-CBDC arrangements and the future of cross-border payments, Monetary and Economic Department, BIS Papers*. Available at: https://www.bis.org/publ/bppdf/bispap115.pdf
7. Reslow A., Soderberg G. and Tsuda N. (2024) *Cross-Border Payments with Retail Central Bank Digital Currencies, International Monetary Fund, Fintech Notes.* Available at: Cross-Border Payments with Retail Central Bank Digital Currencies (imf.org)
8. Report to the G20. (2022*) Options for access to and interoperability of CBDCs for cross-border payments, BIS Innovation Hub, CPMF*. Available at: https://www.bis.org/publ/othp52.pdf
9. Project Mandala. (2024) *Project Mandala: shaping the future of cross-border payments compliance, BIS*. Available at: https://www.bis.org/about/bisih/topics/cbdc/mandala.htm.
10. Project mBridge Update. (2023) *Experimenting with a multi-CBDC platform for cross-border payments, BIS Innovation Hub.* Available at: https://www.bis.org/innovation_hub/projects/mbridge_brochure_2311.pdf
11. Project Icebreaker. (2023) *Breaking new paths in cross-border retail CBDC payments, BIS Innovation Hub.* Available at: https://www.bis.org/publ/othp61.pdf

12. Swift CBDC sandbox project – Phase 2. (2024) *Connecting digital islands, SWIFT Result Report.* Available at: swift_cbdc_sandbox_project_results_report_phase2_final_220324.pdf
13. Project Aber. *Saudi Central Bank and Central Bank of the U.A.E. Joint Digital Currency and Distributed Ledger Project Central Bank of U.A.E., Saudi Central Bank.* Available at: https://www.sama.gov.sa/en-US/News/Documents/Project_Aber_report-EN.pdf
14. Project Dunbar. (2022) *International settlements using multi-CBDCs BIS Innovation Hub.* Available at: https://www.bis.org/publ/othp47.pdf
15. Project Helvetia Phase II. (2022) *Settling tokenised assets in wholesale CBDC, BIS Innovation Hub.* Available at: https://www.bis.org/publ/othp45.pdf
16. Jasper–Ubin Design Paper. (2019) *Enabling Cross-Border High Value Transfer Using Distributed Ledger Technologies, Bank of Canada, MAS.* Available at: https://www.mas.gov.sg/-/media/Jasper-Ubin-Design-Paper.pdf