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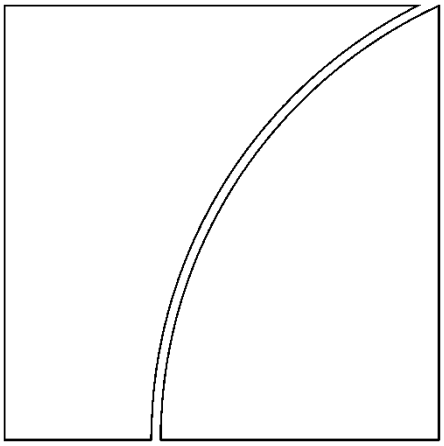
Consultative Group on Innovation and the Digital Economy



Leveraging tokenisation for payments and financial transactions

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Foreword

Tokenisation has the potential to reshape the financial system. It can have significant implications for payments and financial markets, offering increased efficiency, transparency and accessibility. In this regard, central banks play a key role in accommodating new technologies and ensuring market equilibrium, while also preserving the singleness of money. The advantages of tokenisation can be exploited in the context of unified ledgers, integrating central bank money, commercial bank money and other assets, to streamline operations and enhance overall efficiency.

The Consultative Group on Innovation and the Digital Economy (CGIDE) was launched in February 2020 to meet the demand for greater cooperation in technological innovation and the digital economy by BIS member central banks in the Americas. It reports to the Consultative Council for the Americas (CCA), which brings together the Governors of the central banks of Argentina, Brazil, Canada, Chile, Colombia, Mexico, Peru and the United States (Board of Governors of the Federal Reserve System and Federal Reserve Bank of New York). This group provides a forum where senior central bank officials can cooperate in pursuit of the following objectives:

a. analysing and developing public technological infrastructures geared towards tackling common shortcomings in all participating jurisdictions;

b. promoting an environment suitable to open banking, potentially through the development of key application programming interfaces (APIs); and

c. analysing these public technological infrastructures in terms of market structure and regulatory implications

This report was prepared by a technical task force of central bank experts, **chaired by Fabio Araujo (Central Bank of Brazil)**, which was launched in March 2024. It does not represent an expression of the policy position of central bank experts in the Americas region regarding tokenisation. Its main purpose is to open the discussion about asset tokenisation and its role in integrated financial ecosystems and to report on the experiments being conducted in the region. It also aims to serve as a reference for central banks, providing insights into the benefits and challenges of tokenisation and its potential for the financial system. The report seeks feedback from central banks and the public. Comments are welcome and should be addressed to americas@bis.org.

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Executive summary

As tokenisation in the financial system advances, there is value in discussing potential use cases and real-world initiatives by central banks and the private sector, as well as future challenges and policy implications. Tokenisation is the process of generating and recording a digital representation of traditional assets on a programmable platform. This may offer a unique opportunity to reshape the financial system, potentially providing greater efficiency, transparency and accessibility. Some purported benefits of tokenisation rely on the integration of different forms of money and assets into shared ledgers so as to streamline operations and improve overall efficiency. However, the development of such an infrastructure is still nascent.

In March 2024, the CCA Consultative Group on Innovation and the Digital Economy (CGIDE) launched a technical task force with the purpose of exploring the potential of tokenised assets for safe and efficient transactions settled in central bank money. The aim of this report is to provide insights into ongoing tokenisation projects and their potential to improve the financial system.

The report discusses the potential use cases of tokenisation as well as ongoing applications in central banks. Tokenising different forms of money, trading (possibly small fractions of) securities and posting collateral for a loan are just a few possibilities that could emerge. In the use cases examined, all parties involved in a transaction may benefit from tokenisation. For end users, transactions could be instantaneous, programmable and less costly. Users may also manage their digital assets directly, with transparency and immutability. For banks and loan agents, tokenisation allows them to offer innovative financial products that could increase demand for their services. With a modern and user-friendly financial ecosystem, customer convenience and satisfaction may improve. Operational efficiency could also increase if tokenisation streamlines processes and reduces transaction costs through atomic settlement and smart contracts. Participants may also benefit from improved risk management through secure collateral handling and greater confidence in the system's enforcement capabilities, as well as better regulatory compliance.

Real-world examples of how central banks are exploring tokenised solutions include the work of the Central Bank of Brazil (BCB) and the Central Bank of Colombia (BanRep). The BCB has launched Drex, a project for a digital Brazilian real, which, in a first stage, supports the coexistence of wholesale tokenised central bank money, deposits, e-money and treasuries. Other assets and use cases are to be incorporated in later stages. Meanwhile, BanRep has explored possible use cases for a wholesale central bank digital currency (CBDC) in a tokenised financial market based on distributed ledger technology (DLT). From the private sector, tokenisation initiatives cover the Regulated Liability Network (RLN), the HSBC Orion asset tokenisation platform, the Goldman Sachs Digital Asset Platform (GS DAP) and those run by Brazilian companies.

In addition to use cases and progress to date, the report also explores future challenges of tokenisation. For instance, questions remain around the issuance of tokenised central bank money (reserves) and interoperability across existing and tokenised systems.

As the CGIDE moves forward, several key questions arise for further exploration. For instance, how can tokenised systems be interoperable with each other and with other financial and payment systems? What will comprise the set of safe settlement assets in a tokenised financial system? These remain an important area for further work by central banks to help advance understanding of tokenisation in payment and financial systems and to prepare for the challenges and opportunities that may arise.

This report does not represent a policy position of CGIDE members and observers on the design or implementation of tokenisation in payments and the financial sector. Instead, it is offered as a public good to advance the work on these issues and to share insights from a group of experts in the Americas.

Introduction

In recent years, financial and payment systems have undergone a great transformation. First, the need for cash in the form of banknotes and coins is declining in many countries, including some emerging market and developing economies (EMDEs). Second, the digitalisation of payments and the replacement of physical point of access by digital means are a key trend. Many people rely on digital means such as banking applications, rather than going to bank branches or automated teller machines (ATMs). Despite these changes, in many jurisdictions, the financial system still faces three shortcomings, as stated in Carstens and Nilekani (2024). First, it is too slow as individuals and businesses often have to wait several days before their funds are finally deposited in their accounts. Second, it is too costly as individuals and businesses face high fees (eg for cross-border payments) and firms usually pay high interest rates for short-term loans. Third, the range of financial products and services is limited, and their design features do not match the needs of unbanked and underbanked people.

Tokenisation - involves generating and recording a digital representation of financial or real assets on a programmable platform – could offer an opportunity to overcome these challenges and shortcomings. It can offer increased efficiency, transparency and accessibility, and may be seen as the next step following dematerialisation and digitalisation (Aldasoro et al (2023)). Tokens are not merely digital entries in a database. Rather, they integrate the records of the underlying asset with the rules and logic governing the transfer process for that asset. Tokenisation can offer significant advantages, particularly in areas where frictions in payments and financial systems persist (BIS (2023)). It may foster new types of contracts, streamline processes and facilitate atomic settlements, benefiting various financial use cases. However, these potential benefits would be also accompanied with risks. For an overview of both the opportunities and risks, see BIS-CPMI (2024).

The vision of a tokenised financial system highlights key questions for central banks. They need to consider the trade-offs and the balance between different types of settlement assets in tokenised arrangements and decide how or in what form to provide central bank money as a settlement asset for these arrangements. One option may be for central banks to issue tokenised central bank reserves. Indeed, a growing number of central banks are considering issuing a wholesale CBDC in the medium term (Di Iorio et al (2024)). Some early projects with wholesale CBDCs were conducted by the BIS Innovation Hub with, among others, the Swiss National Bank, the Monetary Authority of Singapore and the Bank of France. In Latin America, the Central Bank of Brazil (BCB) is exploring a digital real (Drex) for wholesale transactions, paired with tokenised deposits for retail transactions. From the private sector, the Regulated Liability Network (RLN) is exploring the feasibility of a financial market infrastructure (FMI) operating in a shared ledger, accommodating various types of regulated money (including central bank money, commercial bank money and electronic money) on the same chain.

Tokenisation and its implications for payment systems and financial markets have been a key area of focus for the Consultative Group on Innovation and the Digital Economy (CGIDE). During 2023–4, the group organised a series of webinars with representatives from central banks, academia and the private sector in which participants discussed the potential, challenges and practical use cases of tokenisation. For example, central banks are exploring tokenisation and DLT to enhance interoperability and cross-border payments. Some private initiatives are developing tokenised multi-asset infrastructures, including features such as 24/7 availability, transaction tracking and programmability. Furthermore, some fintechs and startups are leveraging asset tokenisation to offer financial services – from credit to investment options – more efficiently. At the CGIDE meeting in Mexico City on 29 February and 1 March 2024, the group established a new task force on asset tokenisation with the purpose of exploring the potential of tokenised assets for safe and efficient transactions settled in central bank money.

This report is part of the activities of this task force. It does not represent a policy position of CGIDE members and observers on the design or implementation of tokenisation in payments and the

financial sector. Instead, it is offered as a public good to advance the work on these issues and to share insights from a group of experts in the Americas region, by providing lessons from ongoing tokenisation projects and their potential impact on the financial system.

This report has three sections. Section 1 describes the role of integrated financial ecosystems. Section 2 summarises the preconditions and other considerations relevant to the potential adoption of tokenisation. Section 3 discusses use cases of tokenisation and experiences in the region and around the world. Finally, there is a brief conclusion.

1 Role of integrated financial ecosystems

An integrated financial ecosystem may facilitate diverse financial transactions and support the emergence of innovative financial services. In such a system, different tokenised assets could co-exist on common programmable platforms, enabling end users to transact directly through applications.

Unified ledgers provide a "common venue" (ie a shared programmable platform) where digital forms of tokenised money and other financial assets co-exist.[1] They enable two necessary functions. Firstly, they bundle all the elements needed to complete financial transactions – financial assets, ownership records, rules governing their use and other relevant information – in a single venue. This indicates a capacity to combine different components on one platform (composability). Secondly, money and other financial assets act on the ledgers as executable objects. This suggests that transactions can be conducted electronically via pre-programmed smart contracts (programmability). It may reduce the need for manual interventions and reconciliations that arise from the traditional separation of messaging, clearing and settlement, thereby reducing delays and uncertainty. Tokenised deposits could act as commercial bank money used by individuals and businesses. A tokenised version of central bank money could be used for settlement between financial institutions or other economic agents (Carstens and Nilekani (2024)).

The development of such an infrastructure is still nascent, but there are initiatives from both public and private sector exploring unified ledgers and tokenisation. In Brazil, the BCB has launched Drex, a project for a digital Brazilian real. The Drex ecosystem includes Drex itself (central bank money), the Drex platform, its participants and its rulebook and regulation. The platform is supported by ledgers where wholesale tokenised central bank money, deposits, e-money and treasuries would coexist. Similar projects include those led by the Bank of Korea and the Monetary Authority of Singapore. The Central Bank of Colombia (BanRep) has been exploring possible use cases for a wholesale CBDC in a tokenised financial market based on DLT and blockchain. From the private sector, the Regulated Liability Network (RLN) is a collaborative initiative among US and international financial institutions to explore how shared ledger technology may be applied to all regulated monies on a common platform. In addition, the BIS Innovation Hub (BISIH) is exploring the potential of tokenisation in the financial system through Project Agorá, which involves seven central banks and more than 40 private sector financial firms.[2]

[1] The concept of unified ledgers does not mean "one ledger to rule them all" – a single ledger that encompasses all financial assets and transactions in an economy. Depending on the needs of each jurisdiction, multiple interconnected ledgers could coexist. A potential way to connect separated ledger could be through application programming interfaces (APIs). See BIS (2023).

[2] For more details, see BIS, "Private sector partners join Project Agorá", 16 September 2024 (last accessed on 18/02/2025).

2 Preconditions and other considerations

This section discusses the preconditions necessary for the successful implementation and adoption of tokenisation in the financial system.

2.1. Preconditions

If tokenisation is to be adopted at scale, financial consumers must be physically able to utilise it. Users need to have access to the digital ecosystem, usually done by means of a smartphone and adequate internet connection (preferably broadband). The degree and quality of internet access vary greatly in the Americas: in the United States, the percentage of citizens that had internet access in 2021 was over 90%, while in several Latin American countries this percentage was only around 50%.[3] Similarly, widespread smartphone ownership cannot be taken for granted, given the diverse socioeconomic situations of the jurisdictions in the region.

Users should also be digitally and financially literate in order to minimise uncertainty around new technologies and distribution channels. Conditional on a variety of factors, central banks may consider ramping up efforts to increase education about the benefits of digital finance. For instance, Brazil's Pix is an example of a communication strategy that was effective in stimulating use. The BCB succeeded in explaining Pix's characteristics and functionalities to all sectors of society, using several means of communication.

Beyond end-user basic connectivity and financial literacy, financial service providers must be sufficiently digitalised. Systems and ledgers should be, at a minimum, up to date, but preferably state of the art. Implementing tokenisation directly out of an outdated technological environment would demand large investments and entail acute risks, especially operational ones.

Neither the public nor the private sector will invest resources in this tokenisation process if they do not anticipate sufficiently high returns. It is expected that entities implementing tokenisation conduct a thorough cost-benefit analysis. The calculation for each sector differs: while most public authorities expect benefits to society, such as improvements in financial inclusion or stability, the private sector requires a higher return on investment (profits).

Although some tokenisation initiatives have demonstrated promising use cases and quick uptake in specific niches, risks and uncertainty remain. For example, legal risk, which is the unexpected or uncertain application of a law, hovers over tokenisation markets and their related sectors, such as the decentralised finance (DeFi) sector. Actors on both the supply and demand sides require a conducive normative environment, with solid legal grounding and supervision from a trusted institution, before embarking on a tokenised financial product. Additionally, international cooperation will be key to mitigate regulatory arbitrage over tokens, particularly in case of default or insolvency.

2.2. Other considerations

A fragmented market with poor interoperability may limit the potential benefits of tokenisation. Fragmentation could prevent tokenisation from reducing frictions, developing innovative use cases and mitigating risks. Different ledgers – both centralised and decentralised, by various providers could vie for market power, with little to no economic incentives to interoperate. Lack of interoperability could prevent network effects and economies of scale and scope. Fragmentation could also bring new or exacerbate

[3] Extracted from datareportal.com/.

existing risks, such as liquidity silos. It could lead to a multiplication of bilateral connections between platforms, and technological lock-in driven by market gatekeepers.

There are a variety of ways in which interoperability across systems can be achieved (eg through standardised messaging formats and legal agreements between systems and participants). For multiple ledgers, a unified interledger protocol could ensure integration and allow users to open their account in any ledger and facilitate transactions within the system (Carstens and Nilekani (2024)). Such a protocol should ensure the integrity and consistency of transactions across different ledgers, providing finality through strong technical guarantees that once a transaction, eg an asset transfer, is completed, it is secure and irreversible. Standardisation and data harmonisation offer further potential to prevent future interoperability difficulties. Furthermore, depending on a variety of factors, several authorities – including competition authorities and central banks – may need to cooperate to achieve interoperability.

Central banks would keep their main roles in a tokenised financial ecosystem. Financial system safety and efficiency are core component of their mission. These goals are pursued by supervising market participants, which maintains its centrality in an integrated tokenised financial ecosystem. It will continue to be important for central banks to adequately monitor the actions of market agents, assess their impact on the ecosystem and, if deemed necessary, induce changes. In some cases, this may require the self-evaluation of oversight capabilities under current regulation including possible cooperation with other authorities.

In general, central banks prefer to remain technology-neutral and focus their attention on activities rather than a particular technology. While financial systems currently rely on technologies such as centralised ledgers and application programming interfaces (APIs), emerging innovations (eg DLT, unified ledgers) are advocated as a possible future foundation for fully integrated financial ecosystems. Regardless of whether this goal is achieved using established or novel technologies, regulators are focusing on the risks associated with the functions performed by market participants and FMIs operators rather than the specific methods and tools they use to carry out these functions.

The design and governance of platforms that enable tokenised transactions may also be a challenge for owners and participants. Should they be owned by the private or public sector? Should they be built upon existing infrastructure or is it necessary to develop a new one? Like other financial infrastructures, these platforms could be operated by the private sector or the central bank. For instance, some central banks have implemented retail fast payment systems (FPS), eg Pix in Brazil, SINPE Móvil in Costa Rica or SPEI in Mexico.

Moreover, taking the stability of these environments into account, it is important to note that central bank money plays a key role in payment systems and FMIs (CPSS (2003)). It provides the safest and most liquid settlement asset available and is based on a clear institutional framework geared towards public policy objectives. In the context of tokenisation, central banks may choose to consider under what circumstances and in what manner they should provide central bank money as a settlement asset. In contrast, stablecoins, which are neither central bank nor commercial bank money, have exhibited wide differences in design, especially related to the degree and quality of asset backing. They represent a less safe alternative on the basis of which to build a tokenised ecosystem.

Liquidity risk, which is the danger of a counterparty not having sufficient funds to meet obligations in a stipulated time (despite potentially having sufficient funds in the future) is also of concern. Tokenisation platforms should support the use of a settlement asset with little to no liquidity risk (CPSS-IOSCO (2012)). Even so, this type of risk may still arise for various reasons, such as the high liquidity costs of pre-funding atomic trades, correlated movement of funds in smart contract-programmed trades or mismatch when converting tokenised assets to non-tokenised assets (or vice versa). Central banks should have operational, regulatory and supervisory measures to mitigate this risk.

The adoption of tokenised financial services will depend crucially on consumer trust. Regulators may thus pay close attention to custody risk, which stems from the loss of custodied assets originating from fraud, cyber security fragilities, insolvency, poor governance or even bad recordkeeping. In the case of tokenised assets, such risk encompasses underlying assets as well. A tokenised ecosystem will depend on solid controls over those aspects in order to assure consumers of product safety as regards the safekeeping of their assets.

Faced with these risks, many jurisdictions are progressing on the regulation of such platforms. Nonetheless, most are still in the early stages of that discussion, analysing how to classify and regulate digital tokens. There are doubts about whether they should be considered securities, commodities, property or something else. Additionally, not all regulators agree on the chosen classification, dampening prospects of global interoperability. In addition, asset tokenisation should comply with local anti-money laundering (AML) regulations and know-your-customer (KYC) requirements, among others.

Finally, since tokenisation and the implementation of unified ledgers are still in their early stages, regulators may consider a set of guiding principles. Among these, one could list the following: (i) a user-centric focus (ie the needs of users are prioritised in the most flexible way and at the lowest cost possible); (ii) interoperability (between multiple ledgers and with other parts of the financial system, including securities settlement and payment systems), (iii) scalability (ie the scope and range of assets to be tokenised, as well as the participants in the infrastructure, are likely to expand over time); (iv) security and privacy (vis-à-vis both users and participants); and (v) viability (ie the cost of the infrastructure is covered by participant fees).

3 Use cases

This section explores how tokenisation can benefit households, businesses, and other financial service users. We present basic theoretical use cases, a summary of potential benefits, and highlight some use cases already being tested or in live production in the region.

3.1. Theoretical use cases

Let's consider Alice's journey in a (theoretical) integrated tokenised financial system. In this system, all the purported benefits of tokenisation are realised. From converting her traditional bank balance into digital tokens to purchasing government bonds, trading them for stocks and finally using those stocks as collateral for a loan, Alice experiences a financial ecosystem that is user-centric, efficient and secure. To make this possible, it is necessary to integrate different ledgers that showcase the seamless integration of tokenisation in various financial activities. Alice's journey is then done through interconnected unified ledgers (IUL). Such infrastructures not only benefit Alice but also enhance the operational efficiency and service offerings of banks and loan agents (or any other institution). The IUL exemplify how tokenisation could improve financial markets, making them more accessible, transparent, and efficient for all participants.

Alice's comprehensive experience is detailed through the following four use cases, each highlighting a different aspect of her interaction with the IUL. We discuss tokenising different forms of money, purchasing government bonds, trading government bonds for stocks and using stocks as collateral for a loan (Table 1). In her journey, Alice can seamlessly transfer her traditional bank balance into a digital form (eg deposit tokens) within the IUL. With these tokens, Alice uses her wallet to purchase (small fractions of) government bonds through a series of liquidity pools and a smart contract. The smart contract ensures atomic settlement, converting her tokenised deposit into central bank reserve tokens and then into bond tokens. In addition, Alice can seamlessly trade her federal bonds for tokenised shares (stock) of the fictitious

company ACME. Finally, Alice can use her tokenised ACME shares as collateral to request a loan through the IUL. The steps of each use case are detailed in Annex B.

Summary of some potential use cases of interconnected unified ledgers (IUL) Table 1

Use case	Concept	Participants	User benefits
Tokenising money	Transfers money from Bank X into the IUL, converting it into deposit tokens	User Bank X Access agent IUL	Direct control over her assets, instantaneous transfers, lower transaction costs, and enhanced transparency
Purchasing bonds	Uses deposit tokens to buy government bonds through liquidity pools and a smart contract	User Access agent IUL	Seamless process with real-time updates and confirmations, ensuring an atomic settlement
Trading government bonds for stocks	Trades government bonds for stock tokens using liquidity pools and a smart contract	User Access agent IUL	Smooth and secure transaction process, with user app providing real-time updates and detailed transaction history
Using shares as collateral for a loan	Uses stock tokens as collateral to secure a loan; the smart contract locks the stocks and the loan is disbursed	User Access agent IUL Lender agents	Clear overview of user assets, loan details, and real-time updates, ensuring transparency and security

Sources: Central bank websites, Carstens and Nilekani (2024).

There are several agents involved in these use cases and play crucial roles. Alice, who is the end user; the bank, which enables the conversion into deposit and reserve tokens in the user wallet; the IUL, which enable the execution of smart contracts and atomic settlement and the integration of the different parties; and the access agent, which provides a secure and user-friendly interface for managing Alice's digital assets. In the last use case, lender agents also participate as they submit their loan offers (including terms like interest rate, due date, and collateral haircut) to Alice through the IUL and the latter selects the best offer for Alice.

The benefits of tokenisation could be significant for all parties involved. For Alice, she is able to make instantaneous, programmable and less costly transactions and she can manage her digital assets directly, with transparency and immutability. She also benefits from easy access to diverse financial products and services through her app and is able to purchase (small) fractions of assets. For banks and loan agents, tokenisation allows them to offer innovative and competitive financial products that would increase demand for their services. Operational efficiency could also increase as tokenisation streamlines processes and reduces transaction costs through its effect on the roles of intermediaries along the transaction chain. Banks and loan agents also benefit from improved risk management through secure collateral handling and confidence in the system's enforcement capabilities, as well as from better regulatory compliance. They then have incentives to participate and develop innovative products given attractive risk-adjusted returns from loans.

Overall, tokenisation, as described in this theoretical scenario, could bring tangible benefits and positive externalities to deposit and bond markets. It increases the efficiency of settlement processes and enables financial ownership, facilitating the creation of and access to new financial products. In addition, it lowers barriers to entry and increases competition.

3.2. Real-world use cases

Next, we review real-world cases. Initiatives run by central banks – such as those of the BCB or the BanRep – and by private sector may help to shed some light on what is possible in practice. In addition, the BISIH is exploring the potential of tokenisation in the financial system through Project Agorá. The project involves seven central banks from around the world. It is a public-private collaboration enabling cross-border payments using the correspondent banking model on a programmable tokenised platform combining tokenised central bank money and deposits in line with a two-tier financial system.[4]

3.2.1 Initiatives run by the Central Bank of Brazil (BCB)

From the perspective of the BCB, the approach to real-world applications involves integrating and regulating new technologies to benefit society, rather than banning them. This approach prioritises use cases that can, for instance, enhance overall liquidity and reduce the cost of capital. These benefits can be achieved by ensuring integrity and legal certainty in a DeFi-like environment, integrating tools and protocols into a CBDC-based platform.[5] While technology alone will not solve the challenges brought by market adaptation, proper regulation and governance – aligned with other central bank initiatives – can unlock the high potential of these new technologies.

Under this premise, the BCB's first initiative was the digital real edition of the LIFT Challenge.[6] A total of nine CBDC use cases were selected for the digital real edition, with five directly linked to asset tokenisation. One group proposed a DeFi-based solution for financing small and medium-sized farmers. This project has developed the tokenisation of a rural producer certificate (Cédula de Produtor Rural (CPR)), a credit instrument backed by the producer's crop. An on-chain marketplace with an auction facility was also created. This enables the negotiation of these instruments both domestically and abroad, from issuance to final settlement. The infrastructure would give small farmers access to new markets, facilitating the process of price discovery and injecting new liquidity into this market segment.

Another project tackled some hurdles to rural credit access. Earmarked credit for rural activity faces two major challenges: banks' limited reach to small farmers and the complex compliance requirements that prevent small farmers from safely benefiting from banks' services. The project created a marketplace for banks to connect with farmers. A smart contract managed the provision of credits, simplifying compliance with domestic regulations.

Another use case focused on the tokenisation of property rights for vehicles and real estate, implementing delivery versus payment (DvP) protocols suitable for each asset class. In this project, payment for the asset (eg house or car) and the transfer of property rights to the buyer occur mutually conditional on each other, eliminating counterparty risks and reducing transaction costs. In parallel, another project developed a similar protocol focusing on primary market issuance of corporate bonds.

Meanwhile, a treasury operation between a Brazilian commercial bank and its Colombian counterpart promoted the exchange of Brazilian and Colombian CBDCs. Although this is a limited case, the same sort of payment-versus-payment (PvP) protocol could be used for the bilateral exchange of different currencies. An improvement on that could follow the line proposed in BISIH Project Mariana, in

[4] For more details, see BIS (2024).

[5] Key technological features in the DeFi ecosystem include: (i) standardisation and interoperability, ensuring developments benefit the entire community; and (ii) reusability of protocols and composability of financial services, reducing the burden of creating new financial products and allowing for focus on specific business models.

[6] The LIFT Challenge is a special edition of the LIFT Lab with a specific objective. The Challenge – focused on a mature audience of banks, payment institutions and fintechs – brings together market participants interested in developing a minimally viable product (MVP) that meets pre-defined objectives and proposes innovative solutions for problems faced by the financial sector.

which automated market makers (AMM) based on liquidity pools could facilitate wholesale foreign exchange transactions using tokenised central bank money. This approach can build up more liquidity and further facilitate price discovery for currencies participating in the ecosystem.[7]

To enable these possibilities, the BCB drew inspiration from a model presented by Schär (2021). This model divides the DeFi ecosystem into layers dedicated to settlement, assets, protocols, applications and aggregation. The BCB understands that central bank developments should focus on the first two layers, while sharing the activities in the protocol layer with market participants. This approach highlights the platform nature of this infrastructure. In this sense, the BCB's CBDC initiative, Drex, can be characterised as a platform where the market could create and offer new services.

In other terms, Drex can be seen as a new digital public infrastructure (DPI), or a new FMI, provided by the central bank, based on its CBDC and made available for all participants in Brazilian financial markets. On top of that DPI, the final two layers would be left to market development. In the application layer, user-oriented services and products would be developed by authorised entities such as banks, payment service providers (PSPs) and fintechs. Finally, in the aggregation layer, much like an open finance environment, firms would aggregate applications to create and distribute tailored financial services.

This architecture has been implemented in partnership with the market through the Drex pilot. The first phase focused on ensuring the privacy of users' transactions while maintaining the decentralisation and composability features inherent in the Hyperledger Besu technology. To achieve this, privacy solutions based on zero-knowledge-proof (ZKP) technologies – specifically Anonymous Zether, Starlight and Rayls – were tested. The results of these tests should be published soon.

3.2.2 Initiatives run by the Central Bank of Colombia (BanRep)

BanRep is advancing an experimentation agenda to explore the use of a wholesale CBDC (wCBDC) in a tokenised financial market based on DLT. The projects aim to identify potential efficiencies in transaction processing and clearing services within the high-value payment system. They also aim to evaluate scalability, risks, costs and challenges through both internal and collaborative – potentially with other central banks – initiatives. BanRep also expects to evaluate how a wCBDC could enhance the secure development of tokenised financial instruments to improve the accessibility and efficiency of the financial system.

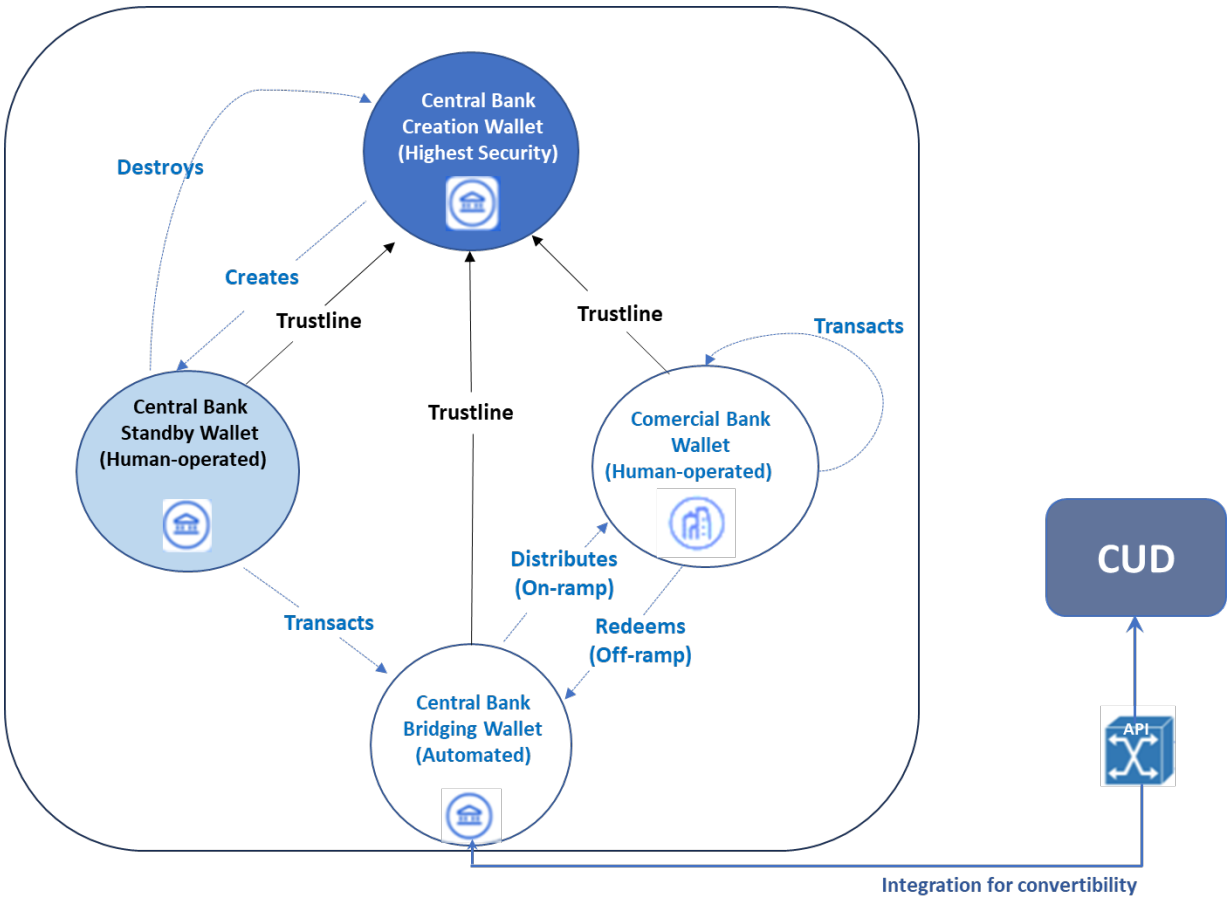
As part of this agenda, BanRep, in collaboration with the Ministry of Information Technology and Communications (MINTIC), Ripple and Peersyst, is conducting an experiment to issue wCBDC and tokenised securities based on DLT.[8] This involves building a scalable blockchain prototype in a test environment with simulated participants. The experiment evaluates efficiencies in DvP for primary issuance and in the clearing and settlement of transactions in the secondary market, as well as direct CBDC transfers between the wallets of financial entities on the blockchain.

The issuance of the wCBDC involves converting fiat balances from financial entities' deposit accounts in the Colombian wholesale payment system (CUD) into CBDC in their wallets on the blockchain (Graph 1). BanRep creates CBDC in the general ledger, assigning it to an internally owned "stand-by wallet". These funds can be subsequently transferred to a "bridging wallet" based on conversion demands from the participating financial institutions.

[7] For more details, see BIS, "Project Mariana: BIS and central banks of France, Singapore and Switzerland successfully test cross-border wholesale CBDCs", 28 September 2023 (last accessed on 04/03/2025).

[8] BanRep also participates in a proof of concept (PoC) with the commercial bank Davivienda and the Inter-American Development Bank involving the issuance of a tokenised private bond and the automation of the transaction chain in the primary and secondary markets. BanRep also participated in a multi-CBDC project with the BCB (LIFT Challenge). The results of this project are available at: revista.liftlab.com.br/revistas/2/artigos/104.

CBDC on the blockchain and integration with CUD[1] Graph 1



[1] Functions handled by BanRep: (1) creation and storage in the "standby wallet"; (2) transfer to the "bridging wallet"; (3) fulfilment of entities' requests to obtain CBDC (from CUD to the blockchain); (4) fulfilment of entities' requests to redeem CBDC (from blockchain to CUD); and (5) reconciliation of total outstanding CBDC. Functions handled by participating institutions: (1) custody of wallet keys; and (2) reconciliation of total outstanding CBDC.

Source: Authors' elaboration.

When a participant generates a conversion order (on-ramp), BanRep debits the requested amount from the institution's CUD account and credits it to the respective wallet ("commercial bank wallet"). This instruction is sent from the blockchain using the API offered by the deposit account system (CUD). After this, the participant can initiate transactions in CBDC (eg transfers, purchases, sales). The financial institution can also redeem part or all of its CBDC balance for central bank money in CUD when deemed necessary (off-ramp).

When a financial institution creates a wallet on the blockchain, Ripple's technology establishes a trust line with the central bank's "creation wallet". This process, verified by network consensus, is reported to all nodes, enabling CBDC transfers to the new wallet. The tokenised version of Colombian government securities must include specific attributes such as the bond name, ISIN code, interest rate, coupon frequency, first coupon date and maturity date, all of which remain immutable and verifiable on the blockchain (through its unique decentralised storage link).

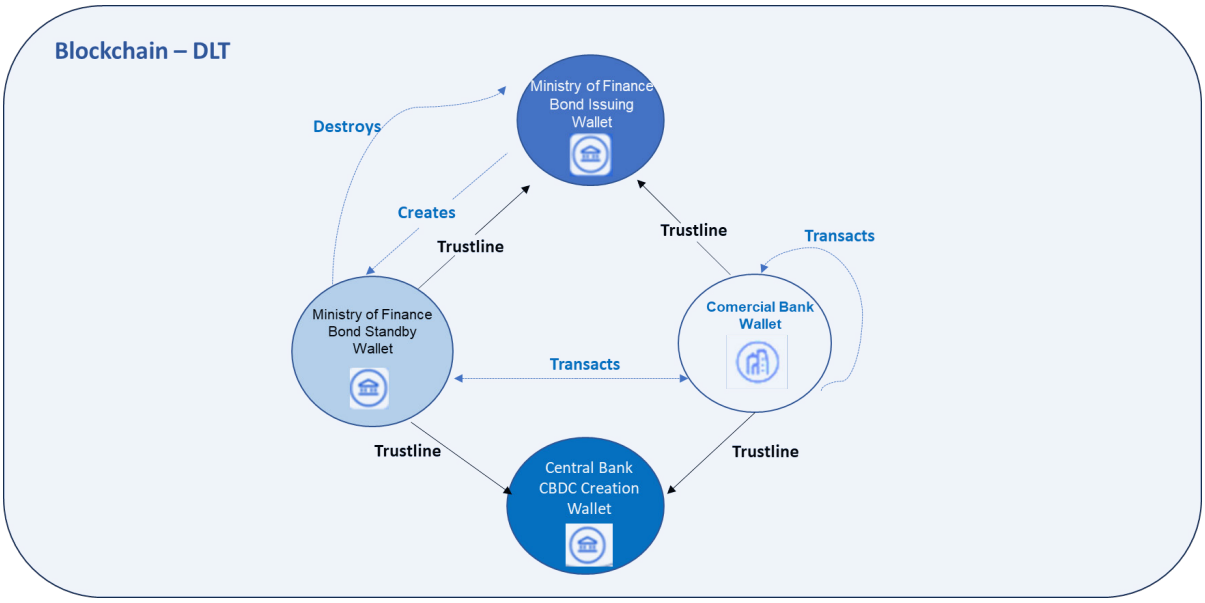
The Ministry of Finance and Public Credit (issuer of simulated securities) determines the nominal value of each bond, which will be available for primary market distribution. For each bond, the platform automatically creates a new "issuer wallet" and a new stand-by wallet to hold the bonds until the primary

market distribution. The Ministry of Finance and Public Credit uses its CBDC wallet to move funds in and out to support processes such as primary market distribution or coupon and principal payments (Graph 2). Clearing and settlement in both primary and secondary markets are handled through atomic swaps, in which the CBDC moves from the buyer's wallet to the seller's wallet and tokenised securities move from the seller's wallet to the buyer's wallet via smart contracts.

The BanRep's prototype has shown promising results. These include processing up to 9,700 transactions per second, resilience during node outages, reduced intermediaries because tokenised assets are on the blockchain, and the ability to scale the network with new smart contracts.

The next steps in wCBDC experimentation include inviting local financial institutions to participate in a new proof of concept (PoC) with customisable use cases, collaborating with other central banks on cross-border payments, exploring blockchain interoperability with other providers, advancing regulatory definitions to establish legal foundations and analysing information privacy management. BanRep will continue its experimentation agenda to evaluate the future potential of tokenisation and wCBDC.

Life cycle of a tokenised security — Graph 2



Source: Authors' elaboration.

3.3. Discussions within the CGIDE

During 2023, the CGIDE organised a series of webinars on asset tokenisation in which central banks and private sector representatives that have been operating or analysing token-based business models participated. Real-world examples from the private sector discussed within the CGIDE include the Regulated Liability Network (RLN), the HSBC Orion asset tokenisation platform, the Goldman Sachs Digital Asset Platform (GS DAP) and tokenisation initiatives run by three Brazilian companies.

The RLN initiative explores the feasibility of a FMI operating in a shared ledger, accommodating various types of regulated money (including central bank money, commercial bank money and electronic money) on the same chain. This would make it possible to bring different forms of money to the tokenised world, in which value is represented on the network (Box A).

Box A

The Regulated Liability Network

The Regulated Liability Network (RLN) is a collaborative initiative among financial sector representatives to explore how shared ledger technology could be applied to all regulated monies (central bank money, commercial bank money and electronic money) on a common platform.

The purpose of the RLN is to create a new shared ledger substrate for the sovereign currency system that is "always on, multi-asset and programmable." The network would deliver on-chain final settlement between the participating institutions in sovereign currencies and be compliant with all existing rules and regulations.

The RLN could bring several benefits. For example, the RLN may offer potential for a new global settlement infrastructure based on regulated issuers and instruments that could support both domestic and cross-border use cases. By including central bank money from multiple jurisdictions, it has the potential to create a global real-time gross settlement capability. It could also increase competition and reduce barriers to entry by providing a common platform for regulated financial and non-financial entities that could serve as the foundation for value-added services, while maintaining the two-tier system. In addition, the RLN could defuse the disintermediation effect of "narrow" CBDC proposals and could avoid the fragmentation caused by the development of individual "bank coins".

The New York Fed's New York Innovation Center (NYIC), in collaboration with members of the US financial services sector, participated in a PoC that experimented with the RLN concept. The working group led three workstreams on technical feasibility, business applicability and legal viability.

On technical feasibility, the PoC showed potential to deliver a payment system that can process and settle 24/7 in near real time, support interoperability, ensure privacy, facilitate programmability through smart contracts and deliver capital efficiency. The PoC demonstrated that the RLN concept is technology-agnostic, ie not reliant on a specific technology (RLN (2023a)).

Regarding business applicability, the PoC demonstrated that the basic operations of the RLN concept could effectively provide domestic and cross-border credit transfers. In addition, global payments in USD could be significantly improved through a system like the RLN with 24/7 availability and increased operational efficiency. The creation of a global instant dollar payment system would augment USD as an international settlement currency and facilitate global trade and financial settlements (RLN (2023c)).

On the legal side, a payment system based on the RLN concept could likely be created within existing rules and regulations. The use of shared ledger technology, including tokens, to record and update the ownership of central bank and commercial bank deposits should not alter the legal treatment of such deposits. Within the RLN infrastructure, tokenised central bank reserves would be considered equivalent to normal central bank reserves, and finality of settlement could also be achieved (RLN (2023b)).

Another private initiative is the HSBC Orion asset tokenisation platform. This platform is built on DLT and enables the tokenisation of both digital bonds and currency used for settlement. The choice to start with digital bonds was due to their favourable liquidity profile, potential for faster settlement and opportunity for fractionalisation. The services offered by HSBC also include custody and trading in both primary and secondary markets. Some of the advantages of this tokenisation platform include atomic settlement, precise settlement with traceability and DvP.

The HSBC Orion platform has a simple approach, namely facilitating bond transactions in a highly controlled environment. Yet when following the asset tokenisation trend based on a clear and consistent regulatory framework, it is natural to anticipate the rise of a more complete set of financial instruments in the future, with financial institutions helping to simplify the investment process.

In the CGIDE webinars, Goldman Sachs presented the GS DAP. The platform is built on a smart contract-enabling programming language called the Digital Asset Modelling Language (DAML) and the Canton ledger interoperability protocol. This language allows the platform to capture the complexity of rights, obligations and cash flows throughout the lifecycle of assets, including aspects regarding

data-sharing. It also makes digital representations of assets and transaction workflow accessible and fully automatable across distributed and interconnected systems of participants, creating a virtual ledger.

Additionally, representatives from three companies in Brazil, namely Credix, AmFi and Itaú Digital Assets, shared their experiences. They emphasised the importance of a well structured tokenisation process, which would be particular to each targeted business. In particular, business rules should be pre-developed, using smart contracts to integrate into a technology commonly used by most fintechs. For this, standardisation is crucial not only for blockchain but for various processes in the ecosystem.

Credix's business model leverages tokenisation and debt securitisation to enhance trade receivable transactions and credit provision. Credix was founded as a tokenised capital market ecosystem designed for debt financing and credit. Through the platform, asset originators can tokenise and securitise their assets, subsequently financing them through decentralised credit markets. This process increases asset liquidity, reduces costs and improves access to credit and investment opportunities. The underlying blockchain infrastructure facilitates custody, registry and settlement functions. For Credix, the advantages of using blockchain stem from on-chain data and related integration. They further recognise the importance of the regulatory momentum in Brazil, Colombia and Chile to the evolution of the fintech's ecosystem and the use of new technologies in traditional markets.

AmFi runs a platform for debt issuance based on blockchain technologies and smart contracts. They argue that the use of these technologies simplifies credit offerings and delivers a product with added value; reduced costs and greater transparency, safety and accessibility. As tokenisation replaces several intermediaries with smart contracts, it enhances transparency and traceability. They noted that asset tokenisation allows AmFi to distribute transactions automatically and to avoid conflicts of interest in transactions with multiple investors. Finally, they argued that these technologies are helping to leverage benefits for small and medium-sized enterprises (SMEs) with little or no access to traditional credit facilities.[9]

AmFi's technology has been used by UP Vendas, a company that offers affordable credit lines to resellers and micro-entrepreneurs. The platform allows UP Vendas to create, structure, distribute and operate financial products that were previously inaccessible to small businesses. Significant efficiency gains arise from the automation of several operational tasks and the reduction in the number of intermediaries. In a traditional operation, multiple agents like custodians, trustee agents, liquidators, brokers and distributors are involved. In a tokenised business model, these roles are executed by smart contracts, which also facilitate the negotiation of credits in secondary markets.

Both Credix's and AmFi's business models rely on using tokenised receivables as collateral to access credit lines. On their platforms, where interoperability and composability opportunities are still limited, they manage to provide credit based on "I owe you" (IOU) certificates issued by firms with higher credit scores. These can be used to finance short-term funding needs with more favourable interest rates. The cost reduction brought about by the tokenisation process makes this system scalable enough to reach SMEs that otherwise would need to rely on more expensive credit lines, if there were any available at all.

A tokenised financial ecosystem could favour SMEs' access to credit. First, if they obtain access to affordable information-generating systems (eg by creating and sharing accounting statements directly in a DLT system), the information gap can be narrowed, thus generating incentives for traditional financial institutions to extend more credit products to them. In particular, banks rely mostly on hard information (like delinquency records) to provide credit, and this is exactly what is currently missing on the borrower side. Additionally, SMEs could improve their collateral offering by tokenising real assets or trade receivables, also improving their standing in the credit market.

[9] SMEs are defined here as independent firms usually comprising less than 300 employees.

Interoperability in such tokenised platforms has the potential to further unlock credit markets. Suppose a large and well known company issues an IOU token as part of a project. This token can be easily divided and passed along several layers in the supply chain facilitating access to credit and reducing its cost. This may improve access to funding in two ways. First, the process of exchanging part of the original token is straightforward, compared with the current alternative, in which the IOU recipient would set up its own IOU certificate to help finance its suppliers, a process that tends to be highly costly. Moreover, costs would pile up quickly as the strategy trickles down supply chains, making it a non-viable alternative. Second, even without considering the above effect, passing along the original IOU would be more efficient once it carries the creditworthiness of the original issuer thus reducing the cost and making it feasible to reach SMEs.

Finally, Itaú Digital Assets discussed the use of tokenisation to expand access to investment products. Tokenised assets enable investors of any scale to participate in financial investments that are traditionally restricted to high-income or institutional clients within Itaú's portfolio. The presentation emphasised the importance of avoiding grey areas in regulation related to tokenised securities, so as to fully leverage this technology and close the access gap in capital markets. It further argued that a combination of a wCBDC and tokenised assets could improve efficiency and reduce costs throughout the supply chain in capital markets. Finally, the presentation suggested the need to reorganise the entire ecosystem to enhance interoperability and facilitate the coexistence of CBDCs, tokenised assets and stablecoins.

Conclusion

Tokenisation is a potential next step in the evolution of the financial system, following dematerialisation and digitalisation. It brings a unique opportunity to reshape payment and financial systems, offering the prospect of increased efficiency, transparency and accessibility through the application of smart contracts, programmability and atomic settlement.

The basic stages of tokenisation primarily focus on distributing assets to new agents by creating a pure digital representation of the original asset, while all business procedures are carried out through traditional methods. The natural progression is to integrate these business procedures into the tokenised space as much as possible. Achieving this level of automation could open, for instance, new funding markets for underserved or unserved groups.

In addition to the potential gains of these basic stages, there may be further opportunities to achieve greater efficiency and reduce costs. By interoperating such business models in a composable way, as observed in DeFi ecosystems, market participants could create new business models and increase market contestability, thereby breaking down informational and operational silos.

Potential use cases and real-world initiatives by central banks and the private sector help to uncover and understand future opportunities and challenges. Real-world initiatives can also contribute to understanding of the policy implications of alternative strategies for dealing with these challenges. The benefits of tokenisation may be exploited by integrating central bank money, commercial bank money and other financial and non-financial assets on the same ledger, to streamline operations and improve overall efficiency. However, the development of such an infrastructure is still in its early stages and there is plenty of experimentation ahead.

As the CGIDE moves forward, several key questions arise for further exploration. For instance, how can unified ledgers be interoperable with each other and with other FMIs? What should be the safe settlement asset in a tokenised financial system? These remain an important area for further work by central banks to help advance the understanding of tokenisation in payment and financial systems and to prepare for the challenges and opportunities that may arise.

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Glossary

Atomic settlement: Instant exchange of assets, such that the transfer of each occurs only upon transfer of the other.

Composability: The capacity to combine different transactions or operations on a programmable platform.

Central bank digital currency (CBDC): A form of digital money, denominated in the national unit of account, which is a direct liability of the central bank. CBDCs can be either retail (general purpose, for use by households and businesses) or wholesale (for use by financial institutions) (BIS (2021)).

Finality: The moment at which funds or assets transferred from one account to another officially become the legal property of the receiving party.

Interoperability: The capacity of diverse digital systems, platforms and applications to seamlessly exchange information, ensuring compatibility across varying technological frameworks.

Ledgers: Recordkeeping systems that guarantee finality and immutability by ensuring that once transactions are recorded, they cannot be altered, deleted or reversed.

Programmability: A feature of platforms and other technologies whereby actions can be programmed or automated.

Smart contracts: Self-executing applications of programmable platforms that can trigger an action if some pre-specified conditions are met.

Tokenisation: The process of recording claims on real or financial assets that exist on a traditional ledger onto a programmable platform.

Tokenised asset: A digital representation of a claim on an asset in a programmable platform.

Tokenised central bank money: A form of digital money, denominated in the national unit of account, which is a direct liability of the central bank.

Tokenised deposit: A digital representation of a bank deposit in a programmable platform. A tokenised deposit represents a claim on a commercial bank, just like a regular deposit.

Unified ledger: A digital platform that brings together multiple financial assets as executable objects on a common programmable platform.

Annex A – Members of the task force of the Consultative Group on Innovation and the Digital Economy

Members

Central Bank of Brazil	Renato Gomes (Chair of CGIDE)
	Fabio Araujo (Chair of task force)
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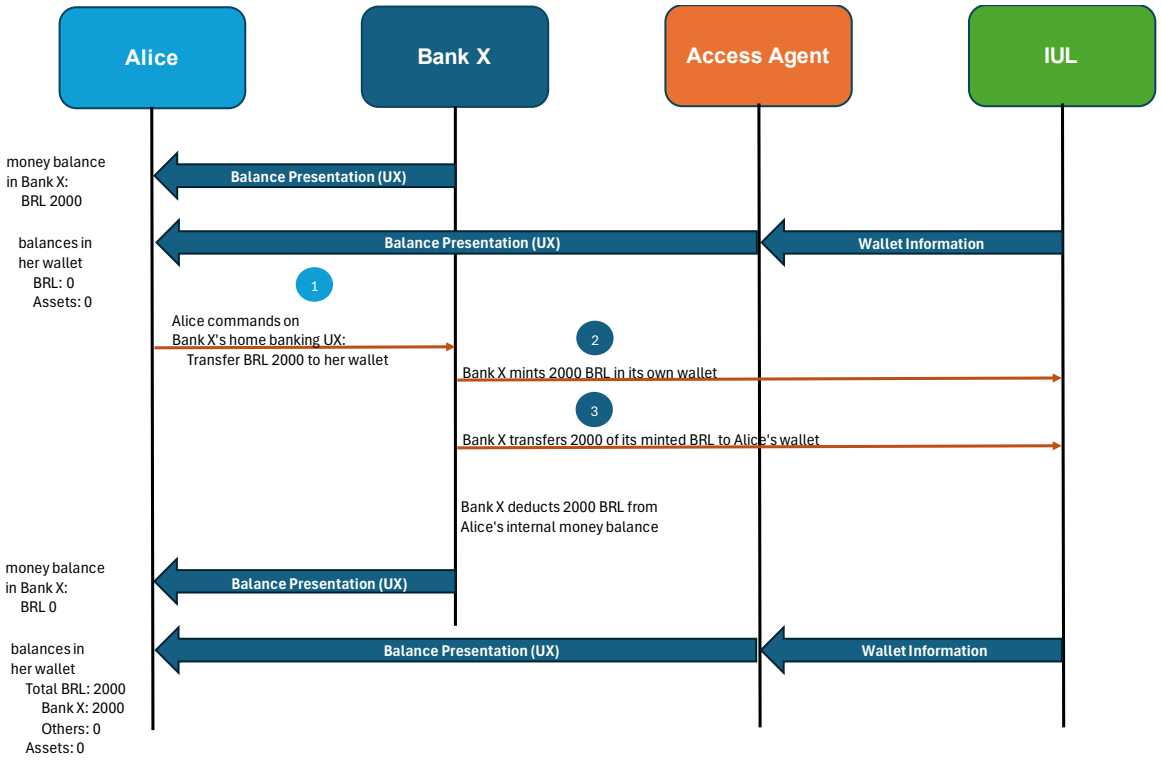
	Jaime Cortina
	Christian Upper
	Jon Frost (oversight)
	Tara Rice
	Peter Wierts
	José Aurazo (secretariat)

Annex B – Potential use cases through interconnected unified ledgers

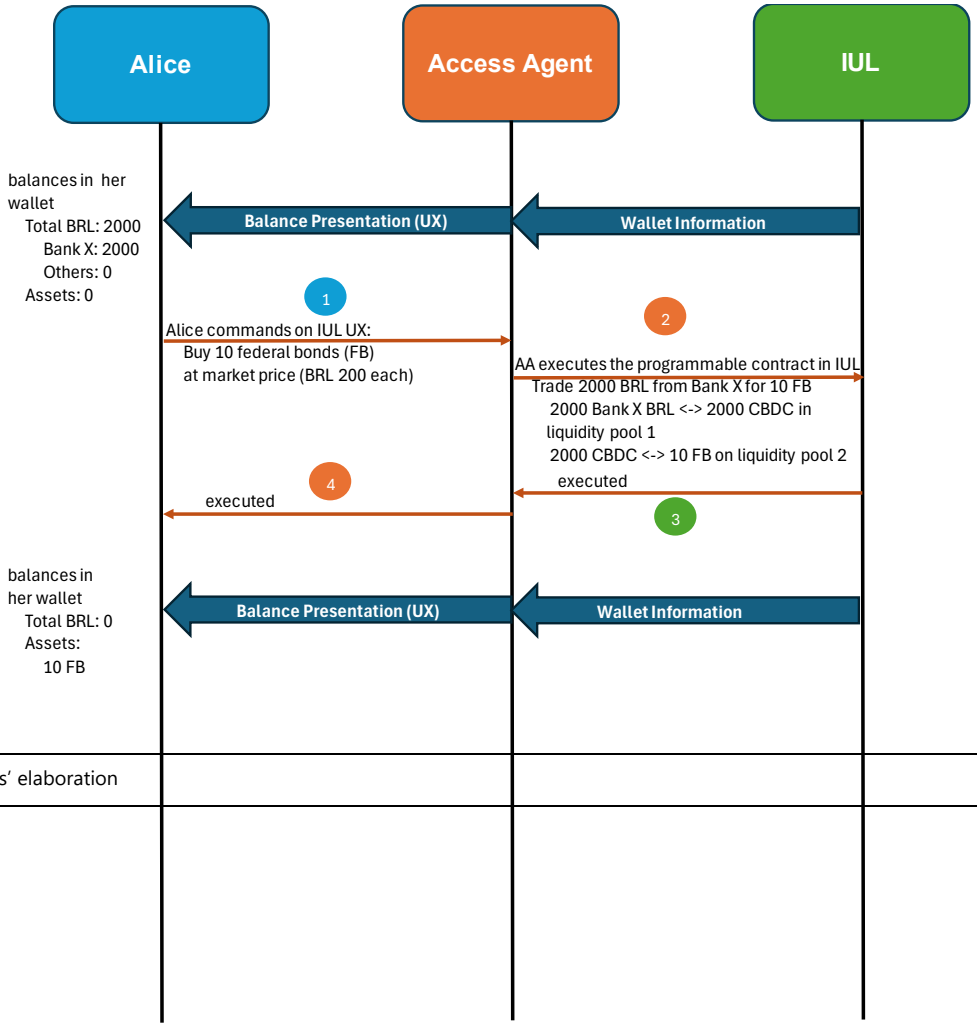
Tokenisation of money

Graph B1



Source: Authors' elaboration.

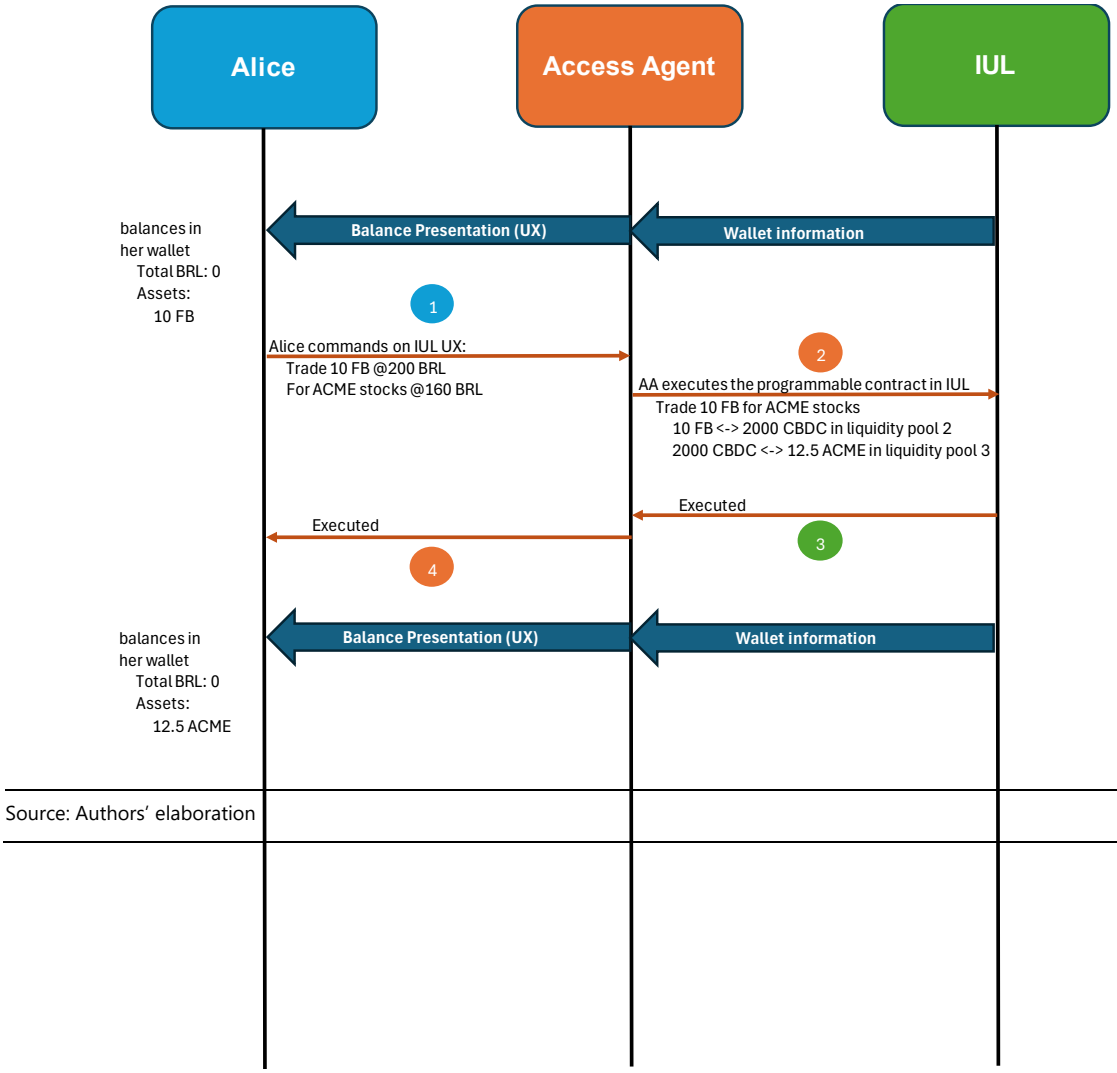
Purchase of government bonds through liquidity pools Graph B2



Source: Authors' elaboration

Trade using liquidity pools

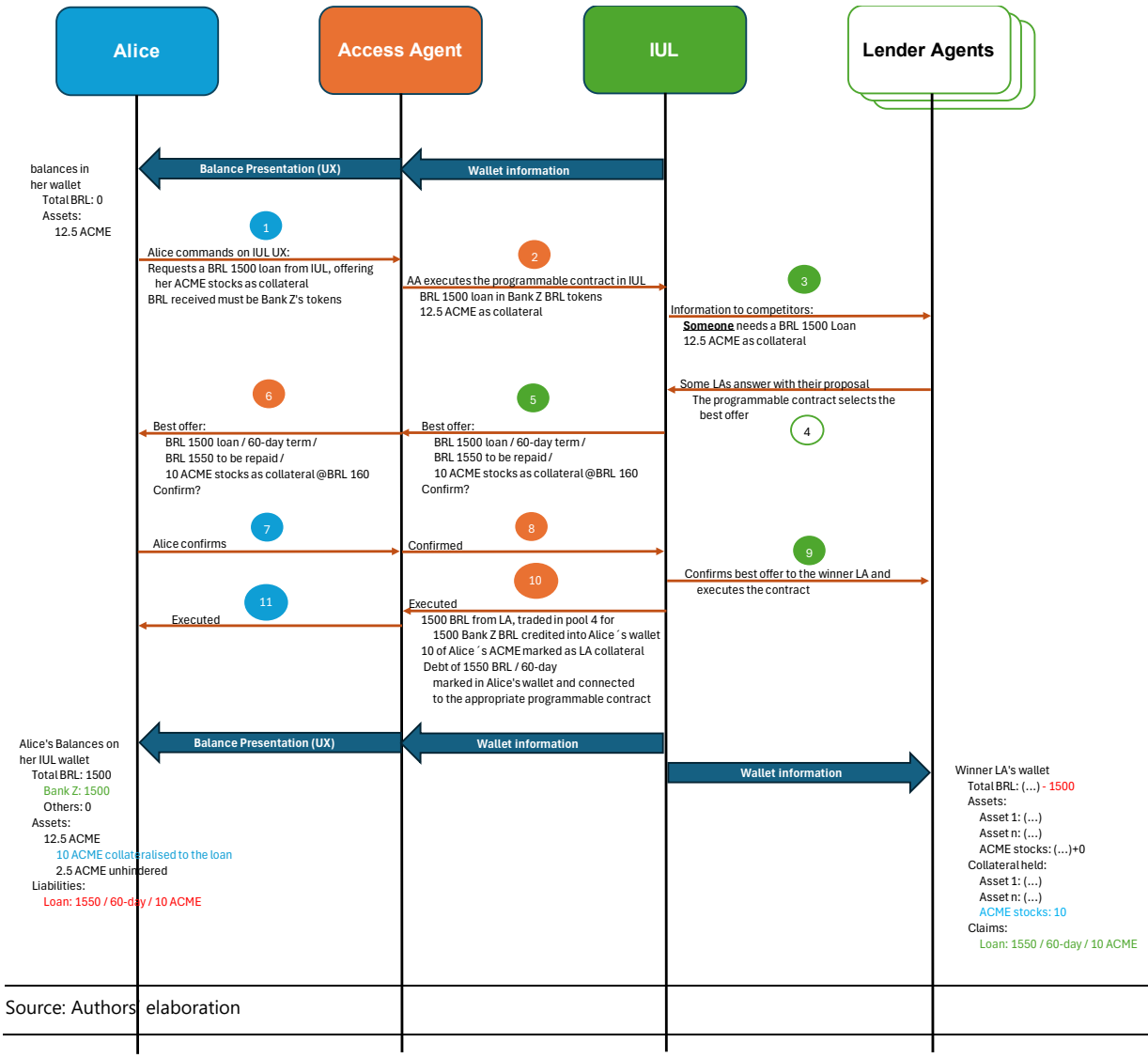
Graph B3



Source: Authors' elaboration

Loans using tokenised stocks as collateral

Graph B4



Source: Authors' elaboration