

Digital money: options for the financial industry

Financial institutions and financial market infrastructures have to keep responding to new technological developments, new regulations and changing customer requirements. In recent years, innovations in transaction and settlement technology and new forms of money have been the main subject of discussion in this area. The following article explores the options available to the financial industry when it comes to using digital transaction technologies for payment settlement. The financial industry is anticipating significant efficiency gains from the interplay of distributed ledger technology (DLT) and the digital representation of assets it enables (referred to as tokenisation), as well as digital money. In particular, the use of a common database by all participants and the automated settlement of processes by means of smart contracts make DLT of interest with regard to its potential applications in the financial industry and in the real economy alike. These uses include, in particular, the automated transfer of assets (such as securities) against payment and the secure settlement of cross-currency payments. However, in order to benefit from the full potential offered by DLT, it must be possible to integrate cash leg settlement into the relevant processes.

With this in mind, central bank digital currency (CBDC), tokenised deposits and stablecoins are being considered as the primary options when it comes to financial market and large-value transactions. However, it is questionable whether stablecoins will meet with broad acceptance for transactions in the financial sector, partly because of their governance structures and the quality of the collateral used to back them. Some banks are working on tokenised deposits, which take today's commercial bank money a technological step further on the basis of DLT. However, a host of legal and practical issues concerning such deposits are still unresolved. For this reason, many central banks around the world have turned their attention to wholesale CBDC, which is digital central bank money used by a restricted user group within the financial sector to settle DLT-based transactions. Central bank money also logically lends itself to the settlement of large-value (wholesale) transactions, as it avoids the risk of default entailed by the use of commercial bank money. Moreover, it is the task of the central banks to promote the smooth operation of payment systems. Used in this context, wholesale CBDC would be a way of tokenising the cash leg of a transaction, facilitating direct use in DLT networks. However, this could have negative implications for the implementation of monetary policy or banks' liquidity management, for example. Alternatively, interoperability solutions would afford the opportunity to combine the advantages of DLT networks with settlement processes in existing payment systems. The benefits of digital money could be reaped with little risk and without an unreasonable amount of effort via interfaces with the settlement systems already available or by utilising trigger solutions.

In any case, close coordination and cooperation among market players, banks and central banks is indispensable for further developments in this area in order to prevent fragmentation and stand-alone solutions being developed in the future digital money ecosystem.

New settlement technologies in the financial sector

New technologies like DLT spark debate about provision of digital money in the financial sector

The current discussions about digital money are mainly focused on CBDC being offered as a complement to cash. Also referred to as retail CBDC, this central bank money, which can be used by the general public in retail payments at the point of sale or online, for instance, is currently being explored by the Eurosystem as part of its digital euro project. At the same time, there is an increasing interest in new settlement technologies, especially DLT. In the past, the Bundesbank has, on multiple occasions, reported on the possible design of a CBDC and its implications for payments and securities settlement.¹ In the meantime, various central banks and credit institutions have continued their deliberations on how, for example, tokenised assets² can be settled in cash. In addition, the regulatory environment has evolved – it has become possible to issue electronic securities in Germany, for example, and regulation of the crypto sector is being introduced in the European Union.

Central banks promote development of efficient and market-oriented settlement infrastructures

This article focuses on the use of digital money in the financial sector, particularly in the area of large-value payments (wholesale transactions). The financial industry is anticipating significant efficiency gains from the interplay of DLT, tokenised assets and digital money. Furthermore, it is the task of the central banks to promote the smooth operation of payment systems. However, owing to substantial scale and network effects, financial market infrastructures demonstrate a high degree of persistence, even when superior solutions have become available. Innovations may thus be delayed or prevented as high initial investment outlays, coupled with the fact that advantages can often be only vaguely quantified, impede switchover. It is therefore also the task of central banks to promote the further development of the infrastructures that they are usually responsible for operating or supervising. Moreover, unclear or unsuitable legal or regulatory frameworks may hinder the necessary innovations.³

DLT use cases in the financial sector

DLT can be described as a settlement technology for transactions of digital assets. A distributed ledger is used to collect and store transaction data, allowing for the transfer of digital or digitally represented assets.⁴ The innovative nature of the technology is essentially reflected by two characteristics. First, common decentralised databases reduce reconciliation problems between participants that would otherwise have to be solved using complicated reconciliation chains, sometimes with several intermediaries or systems being involved. Second, the use of smart contracts⁵ enables the automated monitoring of contractually agreed terms and execution of such contracts. This could potentially simplify complex business cases. Traditionally, the settlement of a transaction comprises a sequence of steps, which also include, first, verifying mutual claims and liabilities (clearing), and, second, carrying out the actual transaction (settlement), particularly where multiple banks are involved. Such transactions require an appropriate settlement infrastructure, within which trusted intermediaries minimise the risks along the process chain and allow the transaction to be settled. By contrast, within a DLT network, clearing and settlement can take place on the same platform, in fully automated form, directly and without delay – without intermediaries, in other words. Smart contracts ensure that the transaction is only settled with final effect if – and only if – all contractual con-

Automation and ease of reconciliation drive DLT's potential for financial industry use cases

¹ For details on retail CBDC, see Deutsche Bundesbank (2021a). Finer aspects of the argumentation pertaining to the role of DLT in this article are discussed in Deutsche Bundesbank (2017). For details on tokenisation, see Deutsche Bundesbank (2019). For information on decentralised finance, see Deutsche Bundesbank (2021b).

² Tokens are digital units of value which can be transferred across a DLT environment and can perform various functions in a network, such as digitally representing a physical asset.

³ See Droll and Minto (2022).

⁴ See Deutsche Bundesbank (2017).

⁵ Smart contracts are programmed algorithms that automate the performance of contractual rights by verifying and then autonomously executing actions in the DLT.

ditions are met. This principle of atomicity⁶ guarantees security and efficiency in the settlement process and minimises risks simply by virtue of the technology.

Potential for use, especially in the area of financial market infrastructures

From a conceptual perspective, this feature makes DLT attractive with regard to implementation in many areas of the financial sector. DLT is generally suited to use cases in which assets are exchanged against each other and where counterparty risk exists between the contractual parties. It has particularly great potential for use in the area of financial market infrastructures, which include payment systems, securities settlement systems, trade repositories and securities depositories, as the basic principles of delivery-versus-payment and payment-versus-payment can be specified and carried out on the basis of DLT.⁷ Delivery-versus-payment means that asset transfer occurs if – and only if – the transfer of the corresponding payment has been completed. In a DLT-based infrastructure, settlement processes could virtually be carried out in real time (T+0), as it would be possible to transfer and settle tokenised assets in real time. In addition, the upstream and downstream settlement processes would effectively be integrated into the transaction process. Overall, this would then reduce counterparty risks and operational complexity as well as facilitating liquidity management. In principle, the legal nature of the underlying assets is immaterial. This means that even non-financial assets such as real estate can be tokenised. In Germany, legislators have already laid the legal foundations for permitting the issuance of DLT-based securities in the form of the Act on Electronic Securities (*Gesetz über elektronische Wertpapiere*). The regulatory framework paves the way for post-trade and management processes throughout the life cycle of DLT-based securities.

DLT could lead to improvements in cross-border payments

In the case of cross-border and cross-currency payments, the payment-against-payment principle can be used to ensure that the final transfer of a payment amount denominated in a certain currency takes place if – and only if – a

simultaneous payment is made in the other currency. Applying this principle shortens intermediation chains, lowers costs and speeds up transaction processes. It is precisely these kinds of payments that show particular room for improvement in terms of efficiency and security: owing to outdated systems, limited opening hours and long transaction chains, international transactions are relatively slow, expensive and opaque.⁸ In addition to the complexities involved in managing liquidity in foreign currencies, the lack of harmonisation and standardisation across different jurisdictions has so far proved a stumbling block for initiatives aimed at simplifying operations. Improving cross-border and cross-currency payments is a complex issue that requires comprehensive solutions. DLT could be part of one such solution.

One example of a purely private project conducted by a payment service provider is Visa's B2B Connect, which is testing a DLT-based payment system for cross-border interbank payments.⁹ The platform is intended to connect banks worldwide, thus preventing the formation of long correspondent banking chains. In principle, such platforms could be used not only to transmit payment messages, but also to directly integrate digital forms of money. Another example is Ripple. A DLT-based network that connects payment service providers with each other forms the basis of this infrastructure. Alongside recourse to bilateral credit relationships, transactions in the Ripple network can also be processed using the network-internal Ripple crypto token (XRP). Nevertheless, the use of XRP as a transaction medium entails exchange rate and counterparty risks. There is also uncertainty about the legal nature

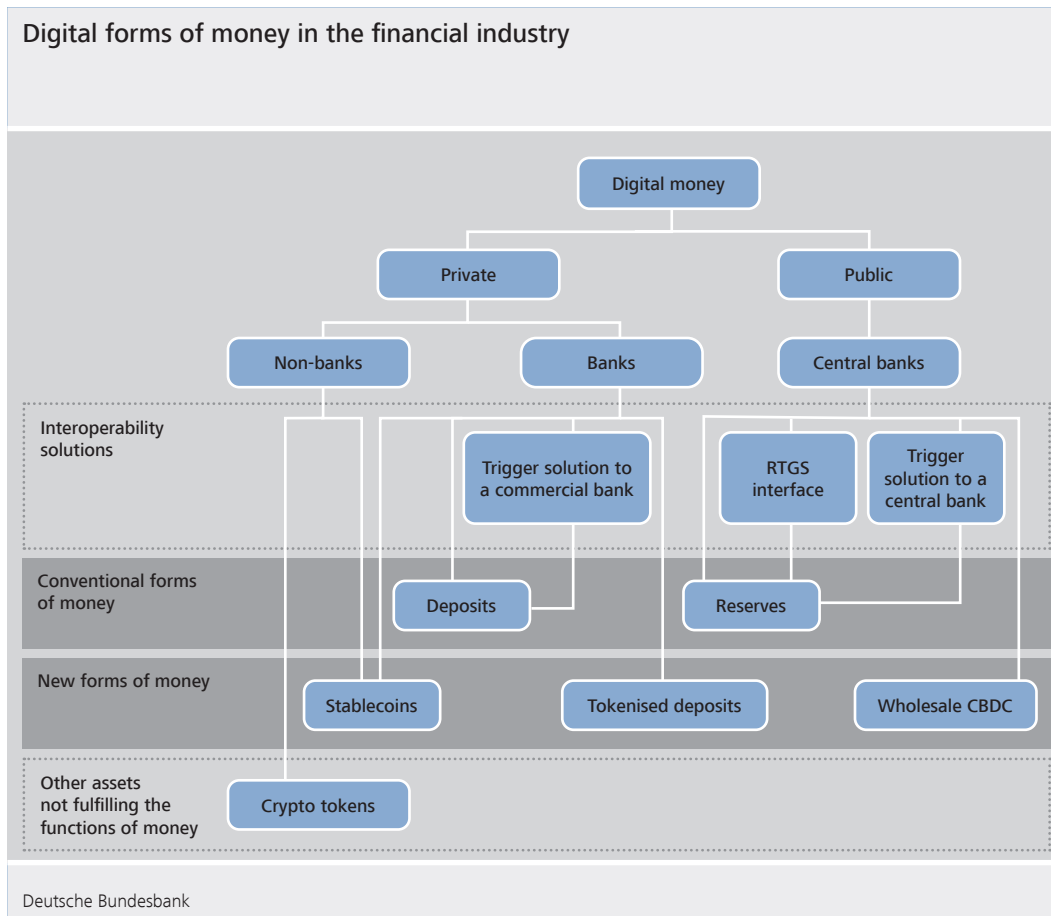
Market participants are testing both DLT-based forms of money and DLT infrastructures

⁶ Atomicity is a principle in database systems which ensures that data-changing transactions, which mainly consist of a sequence of database operations, are either executed completely or are not executed at all.

⁷ The work of the trade repositories, which also fall under the umbrella of financial market infrastructures, could be facilitated by the use of a single unrefuted database, too.

⁸ See Deutsche Bundesbank (2022).

⁹ See Visa (2019, 2023).



of XRP.¹⁰ In addition to specific use cases, individual market participants are experimenting with setting up holistic DLT-based platforms that map out entire value chains. The viability of holistic platforms such as these depends on the private sector risk of the provider and requires high initial investment. Up to now, such platforms based purely on DLT have not been able to achieve a decisive breakthrough or demonstrate a definite advantage. This holds particularly true in terms of efficiency gains, cost savings and operational resilience.¹¹

Overall, the adoption of DLT in the financial sector is coloured by the “chicken and egg” dilemma, which is unlikely to be resolved without cooperation and exchange. Current activities are chiefly focused solely on conceptual aspects, presumably because DLT technology can only be used once an efficient and market-ready solution for cash leg settlement is available. At the same time, credit institutions and central banks are likely to wait for real use

cases in the financial industry to emerge before developing appropriate payment and infrastructure solutions. In any case, an increasing prevalence of DLT applications with potentially high trading and transaction volumes requires appropriate cash leg settlement. The chart above categorises the various forms of digital money that could possibly be used for this purpose in the financial industry.

Private sector settlement solutions

The current monetary and payments system is a two-tier arrangement in which central banks and commercial banks are responsible for pro-

¹⁰ The US Securities and Exchange Commission (SEC), for example, has accused Ripple Labs of selling XRP in an unregistered securities offering. See US Securities and Exchange Commission (2020). This is currently the subject of an ongoing legal dispute.

¹¹ See Accenture (2022).

The Regulated Liability Network

In essence, the Regulated Liability Network (RLN) is an interoperable network of commercial bank and central bank liabilities. The aim of the infrastructure is to improve national and international payments by using distributed ledger technology. The concept originates in the article entitled “The Regulated Internet of Value”, published by Citigroup in 2021.¹ Representatives from various industries came together in 2022 to publish a white paper fleshing out the idea of the RLN.²

In the RLN, the liabilities of central banks as well as regulated institutions, such as commercial banks and e-money institutions, are tokenised and stored in a common decentralised database. Using a harmonised technical platform aims to improve the efficiency of payments without jeopardising the two-tier banking system. With the RLN, central banks would be able to benefit from technological progress, but on the basis of a market-oriented approach.

The initiators of the RLN want to shift the focus of the debate on central bank digital currency (CBDC) to give commercial bank money and e-money a more prominent role. While discussions so far have often made a distinction between private and public forms of money, proponents of the RLN want to concentrate on distinguishing between regulated and unregulated forms of money. The main reasons for this change in tack are threefold: to avoid fragmentation in the monetary system resulting from the parallel development and use of CBDC, stablecoins and tokenised deposits; to preserve the two-tier banking system; and to distinguish unregulated forms of money, such as certain crypto tokens, from the regulated monetary system. At the same time, however, CBDC should not marginal-

ise the role of regulated commercial bank money.

The idea behind a RLN, i.e. an interplay of various tokenised forms of money on a common platform, has already been taken up on several occasions. The Bank for International Settlements (BIS) describes the idea of a common, programmable platform on which tokenised forms of money circulate as holding “great promise”. Instead of RLN, the BIS uses the term “unified ledger”^{3,4} and stresses the importance of governance of a common platform, in which the central bank would have to play an important role. In a position paper, the German Banking Industry Committee advocates broadening the approach to the project to consider an ecosystem comprising retail CBDC, wholesale CBDC, trigger solutions and tokenised forms of commercial bank money.⁵

In November 2022, the Federal Reserve Bank of New York announced that it would conduct a 12-week research study on the feasibility of the RLN. One aim of this proof of concept, in cooperation with a number of major US banks as well as Mastercard and SWIFT, was to develop and test a RLN prototype. The project described the RLN as a “theoretical financial market infrastructure [that] provides a multi-asset, always-on, programmable infrastructure containing digital representations of central bank, commercial bank, and regulated non-bank issuer liabilities, denominated in US dollars”.⁶ A final report on the feasibility study is still outstanding.

¹ See Citigroup (2021).

² See The Regulated Liability Network (2022).

³ See Carstens (2023) and Bank for International Settlements (2023).

⁴ The XC platform proposed by the IMF is also based on similar considerations. See Adrian et al. (2022).

⁵ See German Banking Industry Committee (2021).

⁶ See Federal Reserve Bank of New York (2022).

Private sector solutions enable cash leg settlement of DLT-based transactions

viding central bank money and commercial bank money, respectively. This allocation of tasks helps to safeguard innovative drive in the private sector, amongst other things. This is reflected in, for example, the emergence of new private forms of money such as tokenised deposits and stablecoins, which generally enable cash leg settlement of DLT-based transactions. In principle, crypto tokens that are not deemed to be stablecoins could also be used for this purpose. However, owing to considerable fluctuations in value in the past, they do not satisfactorily perform the functions of money. Users also face uncertainties with regard to security and regulation. In this respect, it is rather unlikely that crypto tokens will be used for large-value payments.

Tokenised deposits leave many questions unanswered

Tokenised deposits¹² are an option that ties in closely with the existing delineation of roles in the current payments environment. Solutions developed by individual banks or groups of banks that could deliver efficiency gains in a specific set of applications are one possible innovation here. These could, for example, take the form of internal settlement systems or applications for certain customer segments. Tokenised deposits are often perceived by the banking industry as taking today's commercial bank money a technological step further on the basis of DLT. However, there are still many legal and practical issues to be addressed. Depending on the specific design of the tokens and the way in which they are transferred, they could be treated as 1) deposits, 2) e-money tokens within the meaning of the EU's Markets in Crypto-Assets Regulation (MiCA), or 3) tradable securities or another type of financial instrument as defined in Article 4(1) and Section C of Annex I to Directive 2014/65/EU (Markets in Financial Instruments Directive (MiFIDII)). Here, too, as is the case with traditional payment transactions, interbank clearing and settlement between the banks involved in the transaction is still necessary – using tokenised central bank money, for instance, as in the concept embodied by the Regulated Liability Network (see the box on p. 21). It is still un-

certain whether tokenised deposits would be covered by deposit insurance in the event that the issuing bank were to fail. It would also be necessary to ensure that the relevant anti-money laundering rules were implemented and that terrorist financing could be prevented.

Alternatively, DLT-based money can be issued in the form of stablecoins. Stablecoins can differ widely in terms of governance and the issuer's business model, as well as with regard to technical characteristics.¹³ Unlike tokenised deposits, stablecoins do not necessarily have to be issued by banks and still represent a claim on the issuer when they are transferred from one user to another (bearer instrument) – at least under MiCA.¹⁴ The respective holder's right to redemption is generally accompanied by the proviso that the stablecoin can, at least in principle, be purchased by anyone, regardless of whether they already have an existing business relationship with the issuer. For this purpose, stablecoins are usually backed by collateral.¹⁵ This is intended to keep the value of the token stable against its reference value – a single currency, for example.¹⁶ Funds received

Stablecoins also beset by uncertainties although they are comprehensively regulated, at least within the EU

¹² In previous publications, the alternative term "tokenised commercial bank money" was used. The EU's Markets in Crypto-Assets Regulation (MiCA) explicitly excludes "deposits" within the meaning of Directive 2014/49/EU from its definition of crypto-assets. In the absence of a universally-applied term, then, "tokenised deposits" is a more appropriate descriptor. MiCA is – by international standards – a relatively comprehensive regulation governing crypto-assets, including stablecoins. The regulation contains, for example, requirements relating to the issuance of crypto-assets. It governs the authorisation requirement necessary for issuers, regulates the supervision of issuers and contains provisions on capital adequacy and proper business organisation, amongst other things.

¹³ In the EU, MiCA restricts the issuance of stablecoins referencing a single currency (e-money tokens) to banks and e-money institutions. Barely any comparable regulations exist outside of the EU to date.

¹⁴ See Bank for International Settlements (2023).

¹⁵ Owing to the wide range of design options, it may be the case that the issuer limits the use of stablecoins to a certain group.

¹⁶ MiCA divides stablecoins into two categories according to the type of reference asset to which they refer. The first, e-money tokens, refers to crypto-assets that maintain a stable value by referring to the value of an official currency. Meanwhile, asset-referenced tokens are, according to MiCA, crypto-assets that are not e-money tokens and that maintain a stable value by referencing another value or right or a combination thereof, including one or more official currencies.

by customers in exchange for stablecoins are to be invested in safe and liquid assets and kept separate from other investments.¹⁷

Banks can issue e-money tokens – in other words, stablecoins, the value of which is pegged to a single government-issued currency – even without a reserve set up for this specific purpose. However, it is questionable whether an individual issuer’s token would be widely accepted and used. Alternatively, banks could come together to form a consortium and set up a special-purpose vehicle (SPV) that issues a token on their behalf (provided that this vehicle fulfils the relevant regulatory requirements). However, this would pose challenges with regard to how the SPV is governed, for example.¹⁸ At the same time, the quality of collateral would play an important role, especially for use in large-value payments. Collateralising the issued tokens with central bank money could completely eliminate counterparty risk.¹⁹ However, this scenario presupposes that the central bank is willing to set up appropriate trust accounts for this purpose – an option that the Eurosystem currently does not permit.²⁰ Under the DLT pilot regime (Regulation (EU) 2022/858), commercial bank money in tokenised form and stablecoins may be used in DLT settlement systems, where settlement in central bank money is not practical and available.

most developed countries.²² Commercial bank money plays a dominant role in this context. This is a claim on a commercial bank, but is closely linked to central bank money. Commercial bank money is denominated at par with central bank money. A depositor can withdraw deposits in commercial bank money from a bank and receive central bank money in the form of cash in return.

Central bank money, which is primarily held by credit institutions (reserves), is used to settle large-value payments. Banks and other financial market players that hold an account with the central bank can settle critically important large-value interbank payments or capital market transactions in central bank money. In 2022, the Eurosystem’s large-value payment system, TARGET2, processed around 400,000 payments each business day with a total value of €2.2 trillion, resulting in an average transaction value of €5.5 million.²³ By comparison, the average transaction value of a payment settled via a retail payment system in the euro area is around €822.²⁴ The use of central bank money reduces risks in the financial system, promotes financial stability, facilitates monetary policy and ensures trust between market participants. As well as being entailed by central banks’ statutory mandate, the general requirement for settlement in central bank money is defined in particular in the Principles for Financial Market Infrastructures (PFMI).²⁵ These principles were drawn up by the Basel Committee on Payment

Settlement of large-value payments in central bank money stabilises financial system

Settlement in central bank money

Central bank money is the value basis for all relevant forms of money

Central bank money is the safest and most liquid form of money. Its importance is key in the monetary system in general and in payments in particular.²¹ In countries that pursue a stability-oriented monetary policy, central bank money constitutes the sole and ultimate value basis for all relevant forms of money. Central bank money in the form of cash is used primarily as a means of payment and store of value in daily life. However, the importance of cashless payments in the retail segment is growing in

¹⁷ Examples of collateralised stablecoins issued by banks are Société Générale’s EUR CoinVertible (EURCV) and National Australia Bank’s AUDN, although they were both issued before MiCA came into force. See Société Générale (2023) and National Australia Bank (2023).

¹⁸ See Swiss Bankers Association (2023).

¹⁹ See Deutsche Bundesbank (2021a).

²⁰ See European Central Bank (2022a).

²¹ See Diehl and Drott (2023).

²² See Glowka et al. (2023).

²³ See European Central Bank (2023a).

²⁴ See European Central Bank (2022b).

²⁵ Principle 9 of the PFMI requires all systemically important financial market infrastructures (FMI) to conduct settlements in central bank money where practical and available. See Committee on Payment and Settlement Systems and International Organization of Securities Commissions (2012).

and Settlement Systems (CPSS) and the International Organization of Securities Commissions (IOSCO). The goal of these principles is to improve the stability and resilience of financial market infrastructures.

Central banks keep settlement infrastructures fit for purpose

New technological developments – such as the digitalisation of money we are currently witnessing – and the associated changes in user demands, mean that settlement in central bank money needs to be reviewed on a permanent basis to check that it is fit for purpose. Central banks are responsible for ensuring that central bank money is able to retain its stabilising function and that it is not replaced to a significant degree by private forms of money for large-value payments. If new technologies such as DLT become market-ready and achieve market penetration, it must be ensured that central bank money can also be used for these new types of settlement. Central banks are caught in a conflict between innovation and stability. The legal mandate necessitates a particularly high degree of care with regard to the stability and functioning of the financial system as a whole. Innovations or functional advancements in the settlement infrastructure should therefore certainly not be at the expense of the stability, security and universality of central bank money. At the same time, they may be necessary to prevent the significance of central bank money from being eroded – a risk posed by settlement structures no longer being in line with market requirements.

“Vision 2020” projects strengthening Eurosystem’s market infrastructure

The commitment to secure, stable and efficient settlement infrastructures for central bank money is reflected in ongoing modernisation measures. For instance, the Eurosystem has launched a number of projects under the “Vision 2020” initiative to improve the Eurosystem’s market infrastructure and further deepen integration of the European financial market. Alongside TARGET Instant Payment Settlement (TIPS) for the settlement of real-time retail payments and the shared Eurosystem Collateral Management System (ECMS) platform, one particular example is the TARGET2/T2S consoli-

ation project, which was implemented when TARGET and the new T2 large-value payment settlement service went live on 20 March 2023. This has modernised the Eurosystem’s range of services offered in the area of large-value payments and securities settlement and has expanded it to include a central liquidity management system. In addition, greater use of common components leverages synergies and improves the automation of processes.

Expanding the existing payment functionality

DLT and the real-time gross settlement (RTGS) systems provided by central banks that are usually used for large-value payments at the moment are not readily compatible. Today’s RTGS systems are based on a sequential transfer mechanism. Payment messages are submitted electronically by the participating banks and then processed individually. Autonomous execution of messages is limited to recurring payment instructions such as standing orders or liquidity transfers. This means that there is no straightforward way for payment messages that are automatically generated by DLT or smart contracts to be processed by RTGS systems. To integrate DLT-based transactions into the existing settlement infrastructure, central banks must make technical adaptations to those systems. The aim here is, on the one hand, to synchronise the existing RTGS functionality with DLT-based settlement and, on the other, to maintain the tried-and-tested functioning, security and efficiency of the RTGS system.

One such synchronisation option is using trigger solutions, which form a technical bridge for the monetary settlement between an external DLT network and an existing RTGS system. Information from the DLT network can be translated into RTGS-compatible payment messages and sent to the payment system via a corresponding link. The respective payment is then automatically initiated (triggered) and executed. Confirmation of the successful settle-

Synchronisation of RTGS systems with DLT networks, ...

... be it with the help of trigger solutions ...

ment of the payment is automatically sent to the DLT network, where the original transaction is then settled with finality through the delivery of securities, for instance. This mechanism requires an infrastructure that can operate between the DLT set-up and the RTGS system, making them compatible.²⁶ At the same time, the intermediary infrastructure performs the function of a trustee, steering the transaction process and ensuring the simultaneous settlement (atomicity) of the flow of goods and money in the two systems using the delivery-versus-payment principle. Technically speaking, the trustee function could be fully automated through the use of smart contract functionalities. But trigger solutions not only provide interoperability between RTGS systems and DLT networks – a technology-agnostic design can also be used to connect different DLT protocols and networks in order to enable settlement across multiple DLT networks. In practice, trigger or bridge solutions have already been successfully tested by the Bank of England in Project Meridian, the Banca d'Italia and the Bundesbank.²⁷

*... or RTGS
interfaces, ...*

Besides establishing a trigger solution, existing interfaces could be used to connect DLT systems to the RTGS system. In this kind of model, the DLT system acts as an ancillary system to the RTGS system, which settles the cash leg of the payments transmitted by the ancillary system. The central bank just provides an adapted communication interface for this purpose. Some central banks, such as the Swiss National Bank and the central banks of the Eurosystem, provide ancillary systems with access to their RTGS system via a corresponding interface, through which payment messages can be exchanged. As part of its RTGS Renewal Programme, the Bank of England has conducted various proof-of-concept studies on how DLT-based settlement models could be connected to the system, for example by using a simple application programming interface (API). RTGS interfaces function in a similar way to trigger solutions, but allow only a lesser degree of complexity, as the smart contract functional-

ities are only found within one single DLT system connected as an ancillary system and the settlement options are therefore limited to this system. Trigger solutions, meanwhile, provide a multilateral interface which, from a technical point of view, enables the settlement of complex transactions across several connected systems.

The advantage of trigger solutions and RTGS interfaces is that they can unlock the opportunities afforded by DLT-based settlement solutions without the need to compromise on security, stability and risk profile. Central bank money settlement would continue to take place in the established systems, and access to central bank money would remain restricted to professional market participants. Minor technical adjustments would allow existing payment systems to be expanded to include programmable payments without involving a huge amount of technical effort. The only natural limitation would be in the (current) functional scope of the payment systems, in terms of operating hours, for example. No new form of money would be needed, though; a suitable access point to the RTGS system would be the only requirement. At the same time, there would be no need to make adjustments to regulatory requirements, account management or users' liquidity management. If access to central bank money remained unchanged, possible implications for the implementation of monetary policy and financial stability would likely be easy to control and manage overall.

In addition to providing a technical bridge solution, the settlement of DLT-based transactions could also be realised by providing wholesale CBDC. The term wholesale CBDC is employed with various meanings, but in widely used definitions it refers to the settlement of DLT-based transactions in tokenised central bank money.²⁸ A wholesale CBDC token would be classified as

*... promotes
innovation in
settlement of
central bank
money without
jeopardising
security and
stability*

*Wholesale CBDC
would be a way
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tating direct
use in DLT
networks, ...*

²⁶ See Diehl and Drott (2023).

²⁷ See BIS Innovation Hub and Bank of England (2023), Banca d'Italia (2022) and Deutsche Bundesbank (2021a).

²⁸ See Bank for International Settlements (2018) and Diehl and Drott (2023).

The Eurosystem's exploratory work on wholesale CBDC

In accordance with its legal mandate, the Eurosystem enables the settlement of large-value payments (wholesale transactions) in central bank money using efficient and reliable settlement and payment systems. For this reason, the Eurosystem is continuously modernising its existing TARGET Services in order to improve settlement infrastructures.

At the same time, it is closely monitoring recent market developments relating to the use of innovative technologies in the field of market infrastructures and securities settlement, in particular initiatives to implement distributed ledger technology (DLT) in this area. Against this backdrop, the Eurosystem will work with financial market players to test various technical solutions allowing the cash leg of financial market transactions on DLT platforms to be settled in central bank money. This exploratory work aims, first, to combine and develop the existing work of individual national central banks within the Eurosystem. This includes, in particular, the experiments on tokenised central bank money that the Banque de France has been conducting since 2020 as well as experiments by the Banca d'Italia and the Bundesbank on bridge and trigger solutions. Second, the Eurosystem is looking into how various solutions could be used to allow interaction between TARGET Services and DLT networks and what interrelationships this would entail. It is also analysing potential implications, for example with regard to governance aspects, settlement efficiency and banks' liquidity management. The work is to cover both transactions in test environments and transactions settled in "real" central bank money in live operations.

The aim of the exploratory phase is to gain insights into how support of DLT-based forms of settlement from a payment perspective might work, and the opportunities and risks it presents. Ultimately, the Eurosystem aims to ensure that large-value payments in the Eurosystem will continue to be settled in secure central bank money going forward to ensure the stability, integration and efficiency of the European financial system and payments system.¹ The Eurosystem has, with TARGET2-Securities, already made a significant contribution to integrating settlement infrastructures in the individual European countries; the objective is to prevent this progress from being put at risk again by a refragmentation as a result of innovative developments. The exploration phase therefore does not anticipate a potential Eurosystem policy stance, for instance in favour of introducing wholesale CBDC. At the same time, the exploratory work is distinct from the digital euro project, which deals with the potential issuance of a digital form of central bank money to the general public for retail payments, for example in the retail sector. The Eurosystem's analysis of the possible advantages and disadvantages of using DLT to settle large-value payments is supported by a newly established market contact group, which aims to promote dialogue and the exchange of information between industry and the Eurosystem.

¹ See European Central Bank (2023b).

a new form of central bank money. This could be provided by the central bank on its own DLT network or on one operated by a third party to allow market participants to settle DLT-based transactions automatically by using smart contracts. In the case of an independently operated DLT system, there would be two main implementation options: (1) integrating tokenised assets into the central bank's DLT network or (2) operating a pure money and central bank-based DLT network that interacts with market-operated DLT networks via a corresponding mechanism. The option of using wholesale CBDC to transfer tokenised assets in return for tokenised money on DLT infrastructures using the principle of atomicity corresponds with the original idea of DLT. Alongside settlement being available around the clock without interruption (24/7), the consistent use of DLT could result in efficiency gains in settlement.

... but is associated with potentially greater implications

Many central banks around the world are looking into options for applying and implementing wholesale CBDC. The analysis of potential implications and risks, in particular, requires a prudent approach. From a central bank perspective, it is essential to ensure that appropriate governance rules are in place to guarantee continued control over central bank money. For issuance of tokenised central bank money on DLT networks operated by third parties, which is also theoretically possible, the central bank would have to be provided with ultimate control rights concerning the governance and operation of the private DLT infrastructure in order to be able to fulfil the responsibility it has over central bank money. The use of public DLT networks by central banks is likely to be ruled out for this reason alone, just like the use of networks in which the finality of payment settlement cannot be guaranteed. Even if weighing up the arguments made outsourcing central bank money to networks operated by third parties seem possible, reputational risks would, in any case, remain for the central bank if problems occurred. Furthermore, a token that represents central bank money can only be transferred to a single DLT platform and first requires

liquidity to be provided from the balance on the central bank account (pre-funding). Tying up part of a balance at the central bank in wholesale CBDC tokens in this way could make liquidity management more difficult for credit institutions and requires further analysis given the implications for the implementation of monetary policy.

■ Challenges and outlook

DLT and tokenised settlement are relatively new market segments and it is virtually impossible to tell how they will develop going forward. A large proportion of financial industry players are focusing on DLT as a settlement technology and expect an increase in the number of potential uses. However, many initiatives have not yet progressed further than the prototype stage. Given the lack of market-readiness and dearth of experience, there is still a need for fundamental analyses relating to software architecture, robustness and security. At the same time, the legal framework for a future market structure would have to continue to be adjusted accordingly. Important factors for the general acceptance of the technology will probably be that actual problems in the market can be solved and that the technology offers specific added value in terms of cost savings, efficiency gains or simpler processes for businesses. DLT is therefore not likely to be the only method of choice – especially as centralised infrastructures prove to be superior for many applications.

New technologies should solve specific problems and not be an end in themselves

If DLT applications are accepted and proliferate in the market, a growing number of solutions are likely to be developed to settle the cash leg of the respective use cases. Greater demand from the financial industry is likely to accelerate the development and use of digital money. New requirements call for new features that money should fulfil and, as a result, allow new forms of digital money to emerge. Generally speaking, when it comes to payment transactions, all actors have an interest in settling them

Coexistence of several forms of digital money expected in future

Global trends around wholesale CBDC

Work on central bank digital currency (CBDC) is stepping up around the world. In its 2022 survey on CBDC, the Bank for International Settlements (BIS) identified more than 80 central banks engaged in CBDC-related endeavours. Most of these central banks have moved on from observation and have now entered phases of analysis and experimentation. According to the survey, three-quarters of the respondent central banks are conducting analyses of retail CBDC as well as looking into wholesale CBDC. So far, however, more progress has been made on retail CBDC. Interestingly, efforts regarding both retail and wholesale CBDC are more pronounced amongst emerging market and developing economies than advanced economies.¹

Through its network of Innovation Hub Centres, the BIS is playing a particular role in coordinating various projects involving wholesale CBDC, focusing predominantly on the cross-border settlement of payments and securities transactions.² The mBridge³ and Dunbar⁴ projects are two practical examples of conceptual studies on joint multi-currency distributed ledger technology (DLT) platforms. DLT-based settlement of cross-border and cross-currency transactions aims to reduce transaction costs, settlement times and operational complexity. To this end, corresponding national or regional platforms could also be linked together.

Singapore, which traditionally sees itself as the financial and technological centre of the ASEAN countries (Association of South-east Asian Nations), has been undertaking concerted and systematic efforts towards utilising DLT for a number of years now. Through its experimental work encompassed by the Ubin project, the Monetary Authority of Singapore (MAS) has been investigating how Singapore's economy and competitiveness could be strengthened by

the creation of a settlement system for a tokenised Singapore dollar. In addition, the MAS is testing the possibility of using wholesale CBDC to enhance cross-border payments. Its work in this area includes, for example, experimental projects in collaboration with the Bank of Canada (Jasper-Ubin) and the Federal Reserve Bank of New York (Cedar x Ubin+).⁵

In October 2022, the Reserve Bank of India launched a pilot project aimed at improving secondary market transactions in government securities. The project involves testing the issuance, maturity and trade of digital government bonds as well as the cash-leg settlement of these bonds using wholesale CBDC. Future pilot projects are set to address cross-border payments.⁶

In Europe, the Swiss National Bank (SNB) has been especially active in feasibility studies, conducting its Project Helvetia to examine near-live systems for settling tokenised assets in central bank money on DLT networks.⁷ As part of its "Swiss payments vision", the SNB is investigating three different approaches to settling token transactions: synchronisation of the settlement of tokenised securities with the SIC payment system (RTGS link), issuance of a Swiss franc wholesale CBDC directly on a DLT network, and approval of a privately issued token backed by central bank money that would be protected even if the issuer were to default.⁸

¹ See Kosse and Mattei (2023).

² For an overview of the BIS Innovation Hub's projects, see <https://www.bis.org/about/bisih/projects.htm?m=3102>

³ See Bank for International Settlements (2021).

⁴ See Bank for International Settlements (2022).

⁵ See Monetary Authority of Singapore (2017, 2023) and Accenture (2019).

⁶ See Reserve Bank of India (2022).

⁷ See Bank for International Settlements, SIX Group and Swiss National Bank (2022).

⁸ See Maechler and Moser (2023).

in safe, stable and regulated forms of money. Against this backdrop, it is essential that market players, credit institutions and central banks coordinate and collaborate with one another. Moreover, interoperability is likely to be crucial for any potential ecosystem of digital money to prevent stand-alone solutions being developed and guard against fragmentation in the payments space. With efforts being made in Europe towards greater consolidation of financial markets in the context of the European capital markets union, this is also an important aspect for the EU in particular. In principle, various solutions regarding the application of DLT in the financial sector are conceivable and could co-exist in parallel owing to the diversity of the use cases.

Nevertheless, these solutions are more likely to be used in retail payments. Tokenised deposits and stablecoins could in principle also be used for larger value payments if they prove technically suitable. To ensure interoperability, however, innovative infrastructures are required for settlement in central bank money, potentially also in the form of wholesale CBDC. Central bank money would thus continue to serve as a monetary anchor in order to ensure the fungibility of various digital forms of money. In any case, central bank money remains the number one choice for large-value payments. However, digital central bank money does not necessarily need to be provided directly on the DLT network for this purpose. Technical bridge solutions can facilitate interaction between digital networks and existing infrastructures. At the same time, trigger solutions represent a low-effort way to assess the actual need for DLT-based forms of settlement in the short term and – if necessary – to work on a long-term solution in parallel.

Digital central bank money can serve as an anchor in a future digital ecosystem

The fact that central banks are examining the possibilities of settling cash legs using DLT-based transactions in the financial industry by no means rules out the use of retail CBDC or other forms of private or digital money, such as e-money, tokenised deposits and stablecoins.

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