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Die Deutsche Kreditwirtschaft

REPORT | DIGITALISATION | PAYMENTS

# Commercial Bank Money Token

*Proof of Concept Report*

*New Forms of Money in an Era of Evolving Industrial Needs*

**17 July 2024**

## Addressing German industry needs in tokenised commercial bank money

The commercial bank money token, CBMT, represents a pioneering step towards a more digitalised financial system, achieved by placing commercial bank money onto distributed ledger technology, DLT. CBMT facilitates the seamless execution of money flows and business processes within the same systems, harnessing the flexibility and efficiency of DLT while retaining the trust and reliability associated with traditional banking.

A project group consisting of banks and industrial firms explored how DLT could be used to enable the convergence of new business processes within Industry 4.0 with efficient and safe financial settlement.

Although further examination is required, the results of the initial tests were positive. This is a step forward, showing clearly that the technology and respective use cases can also work in a real-life business environment. Additionally, results might also be used by the Eurosystem in its deliberations on issuing the digital euro in the form of a token.

The Federation of German Industries and the German Banking Industry Committee are monitoring the digitalisation of the financial system closely. We strongly support the group of banks and industrial firms in their efforts to create a technical solution which works for both sides. The CMBT has the potential to contribute significantly to a multi-solution-environment, together with other instruments such as a tokenised central bank currency.

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## Foreword

In response to industry demand, the concept of the commercial bank money token (CBMT) has been developed and information on the concept published by the German Banking Industry Committee (GBIC). In 2020, a working group was established to investigate the potential offered by tokenised commercial bank money. Their findings were publicly shared in July 2021, followed by a working paper in September 2022 encompassing the design principles and payment flows, and an updated version including multi-currency capabilities was released in April 2023. Since then, the concept has been developed even further. [1] [2] [3]

In September 2022, the Federation of German Industries (BDI) published a position paper asserting the need for a digital euro to be on-chain, and preferably issued by both the Eurosystem and the financial sector. The CBMT characteristics of this proof of concept (PoC) report align with BDI positions.

In Autum 2023, a group of bank representatives (Commerzbank, Deutsche Bank, DZ Bank, Helaba and Hypovereinsbank/Unicredit) and industrial firms (Airplus, BASF, Evonik, Mercedes Benz and Siemens) –referred to as the project group in this report – decided to conduct a PoC lasting approximately seven months. BDI and GBIC monitored the testing.

The following report provides a detailed overview of the PoC, its key findings and potential next steps.

[1] See German Banking Industry Committee “Europe needs new money – an ecosystem of CBDC, tokenised commercial bank money and trigger solutions”, 2021
[2] See Federation of German Industries “The Digital Euro“, 2022
[3] See German Banking Industry Committee “Working paper on commercial bank money token”, 2023

## Executive summary

In an era of rapid technological advances and evolving industrial needs, traditional forms of money and payment systems have reached their limit. The CBMT concept has been derived from industry demand for a new form of money that facilitates emerging technologies such as DLT and enables industry 4.0 operations. With this secure and digital form of money, companies can transfer funds directly from wallet to wallet, without intermediaries such as banks. Conditional payments can be coded based on predetermined rules outlined in smart contracts, empowering businesses to automate processes, enhance efficiencies, improve transparency, bolster security and unlock potential cost savings.

The CBMT has been designed to coexist with existing financial infrastructures, i.e. existing commercial bank money, while enabling the use of DLT. It is account based, mirroring existing deposits. Key design principles include interoperability, secure programmability, robust governance and regulatory compliance, ensuring that CBMT remains as closely within the current regulatory framework as possible while operating on different DLT platforms. It also relies on traditional interbank settlement, which allows the CBMT to operate in the absence of a wholesale Central Bank Digital Currency (wCBDC) or Unified Ledger on DLTs. A Technical Service Provider (TSP) provides shared services for participants, its roles and responsibilities are elaborated and will be further refined.

The PoC demonstrates the technical feasibility of the CBMT and assesses its potential to serve as a transformative force within the financial ecosystem. Functional use cases, including basic money transfers and advanced corporate payments, were investigated in three different environments. Certain aspects, such as compliance considerations, were marked out-of-scope.

Results confirm that the CBMT is viable and offers considerable potential. It provides a trusted means of payment, enabling the realisation of a variety of use cases across corporate functions. Results also showed that the CBMT is a versatile settlement instrument. It works across a variety of DLT platforms, has the potential to scale and should present no barrier to integration into existing systems via APIs. Further, tests led to the conclusion that engagement with regulators and supervisory authorities must continue. The ECB provided positive initial feedback in regards to the nature of the CBMT as a deposit in a different technical form. While highlighting the promising features of the CBMT, the PoC also identified areas requiring further exploration, such as privacy, bank and corporate integration, and further alignment with regulators and supervisory authorities. The next phase will focus on expanding the network of participants, refining the CBMT framework with special attention to the TSP and its governance, and pursuing formal approval from the supervisory authorities to conduct real money tests.

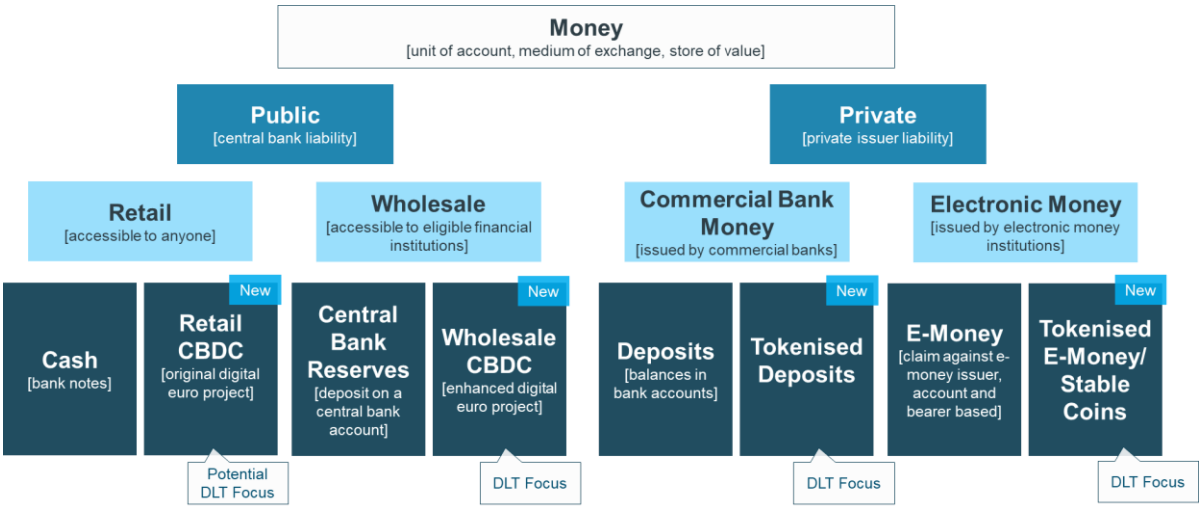
The PoC has demonstrated that the CBMT has the potential to deliver meaningful benefits to industrial firms. It represents an important milestone in enabling on-chain payments using existing deposits, delivering new efficiencies, and paving the way for innovative new products. Continued collaboration among banks, corporates, regulators and further stakeholders will be crucial to realise the full potential of the CBMT and for banks to retain their role as trusted partners.

## Background and motivation

### Overview of today's digital money landscape

Today's regulated money landscape can be divided into different sub-forms. Money can be issued by a public or private institution as a liability. Public institutions comprise central banks, whereas private institutions comprise commercial banks and electronic money (e-money) institutions. Crypto currencies will not be considered since they do not fulfil most of the features of fiat money: unit of account, means of payment and store of value.

**Figure 1: Digital Money Landscape**




Source: Deutsche Bank, CBDCs in Europe: retail and wholesale projects to follow, 2023

There are different forms of central bank money that can be used for payments in the retail and wholesale (i.e. interbank) markets. In the retail markets, physical cash is a central bank liability that is used as a medium of exchange. In the past, physical cash was the only form of central bank money which could be held by retail clients. Retail central bank digital currencies (rCBDC) represent the new form being issued as a central bank liability that can be transferred digitally. Currently, the European Central Bank (ECB) is working on a rCBDC. Although there are as yet no plans for a tokenised version, some members of the Eurosystem seem increasingly open to exploring DLT for this purpose.

Central banks also issue money for interbank transactions. These account balances, called central bank reserves, represent deposits held in real-time gross settlement (RTGS) systems (in the euro area Target 2, T2). This type of money is only available to eligible institutions. In July 2023, the ECB enhanced its digital euro project and initiated, together with Deutsche Bundesbank, Banque de France, and Banca d'Italia, another work stream focusing on the use of DLT for managing wholesale settlements by connecting existing payment systems (T2 or TIPS) or new DLT-based payment systems (DL3S) to market DLTs for the settlement of tokenised securities (Delivery-versus-Payment, DvP) or payments (Payment-versus-Payment). Such wholesale initiatives have been explored by many central

banks around the globe for years now, yet most projects are still in a pilot or development phase. This form of money can only be used for payments amongst banks. Corporates do not have access to this form of money.

Commercial bank money and electronic money issued by e-money licensed institutions are forms of electronic money and represent private entity liabilities. These types of money can be held by retail or corporate clients as deposits in bank accounts or balances in digital e-money wallets or on prefunded cards. Tokenised deposits at banks or tokenised e-money (the regulated form of stablecoin in the European Union) are new forms of digital money issued by private institutions using DLT.

Stablecoins (blockchain-based e-money) are currently the focus of regulators and supervisors worldwide. Many countries have started to work on comprehensive regulatory frameworks for this new form of money. In Europe, centralised, fiat-backed stablecoins, such as EURe from Monerium, are private digital forms of money that will be regulated by the Markets in Crypto-Assets Regulation (MiCAR) as of 30 June 2024. MiCAR builds on national e-money directives and provides a European rulebook for all crypto services and issuers of stablecoins. Internationally, geographical regulatory differences may emerge, although it can be observed that many jurisdictions are following the MiCAR as a blueprint or aligning their national regulation with global regulatory recommendations, such as the Financial Stability Board (FSB). In addition to centralised stablecoins backed by fiat currency, there are also decentralised stablecoins issued by distributed autonomous organizations (DAOs) with unconventional assets such as cryptocurrencies backing the fiat-currency denominated tokens. These decentralised and algorithmic stablecoins, which refer to complex algorithms and not assets, are usually not considered in regulatory developments.

To date, adoption of stablecoins in Europe is still low for transactions in the real economy or regulated financial markets. They are still predominantly used for more efficient crypto trading on centralised exchanges or transactions in decentralised finance (DeFi). Interestingly, in countries facing high inflation and unstable currency regimes, stablecoins denominated in US-Dollars are increasingly adopted as a medium of exchange between people (P2P) and in market transactions (C2B), as well as for cross-border P2P or salary payments. While many expect regulated stablecoins to become a competitive new form of money, especially for cross border payments, there is not yet a meaningful adoption for corporate use cases today. This is due to regulatory and accounting ambiguities as well as a lack of exceptional added value compared to the current means of payment.

**Commercial bank money and tokenised deposits**

Commercial bank money equals roughly 85 percent of the money supply in Europe today. Banks are actively experimenting with DLT/blockchain-based infrastructures to provide new ways of managing deposits and payments for their clients. Deposits held in these accounts can be moved on the bank's DLT-based account management system without changing the nature of the deposit. Therefore, no additional regulation is required to issue tokenised deposits. However, a solution for settlements between different banks issuing tokenised deposits is required in order to scale these experiments.

Today, financial institutions settle in central bank money via RTGS systems whenever a client from one bank sends money to a client from another bank. The tokenised deposit networks would need to be connected to these payment systems or to a blockchain-based payment system moving central bank money on a blockchain (wholesale CBDC token).

Trigger solutions from Bundesbank or Banca d'Italia, or the wholesale CBDC token of Banque de France, could be used to enable settlement between different tokenised deposit solutions from multiple

banks. Bilateral nostro accounts could be maintained by the different participants to clear the transactions and reduce the number of settlement transactions to a net balance. On a comprehensive scale, however, maintaining a large network of bilateral nostro accounts would neither be efficient nor cost effective. Hence, settlement in central bank money between the banks is still required to settle tokenised deposits, claims and liabilities represented as balances in the bilateral nostro accounts.

To overcome these hurdles, some banks have started to investigate the issuance of bearer-like tokens that even non-clients can hold after being KYC-ed by a third party: such “deposit tokens” could allow settlement – using the liabilities of an issuing bank as a settlement asset – without the need to settle in central bank money. Clients would then be able to hold multiple tokens from multiple banks, even if they are not an onboarded client of the issuing bank. This would be similar to stablecoins as settlement, and ultimately also takes place in private issuer liability as a book-to-book transfer. What remains unanswered is the question as to whether the issuer of such a bearer deposit token would need to keep ownership records of the tokens in its internal systems. It is likely that an issuing bank will need to know who is holding their liabilities and only identified, onboarded and KYC-ed individuals or entities will be able to hold these assets. This brings it back to the area of blockchain-based accounts and therefore tokenised deposits.

Another market development is a synchronised or shared ledger approach. Tokenised deposits would be issued on a ledger that is used by multiple banks and corporates, either as a shared private blockchain or possibly as a public blockchain. Current initiatives include synchronised bank-centric ledgers or shared ledgers, or ledgers of corporate clients on which the tokenised deposits from multiple banks are issued. The CBMT described in this paper falls into this bucket as it tests the issuance of tokenised deposits of multiple banks on a shared ledger. However, the question of how to settle the tokenised deposits of each bank remains open.

To overcome the issue of settlement of tokenised deposits, to avoid having to rely on rCBDC for all innovative (B2B)-transactions and to preserve the two-tiered architecture of modern monetary systems, the Bank for International Settlements (BIS) foresees the use of DLT infrastructures for issuance of private and public money on a unified programmable ledger. Banks would issue tokenised deposits which are automatically settled in tokenised central bank money. Such shared, bank-permissioned infrastructure would be similar to the concept of the Regulated Liability Network (RLN) that has already been tested in two PoCs in the UK and the USA. The most advanced projects in this regard are the DREX-project from the Brazilian central bank and the CBDC-project from the South Korean Central Bank. While the work on this concept is still in its pilot stage, it could be the network on which CBDCs, stablecoins and tokenised deposits can be issued in the future, allowing for innovative use cases while preserving the public-private partnership for the issuance of money.

**The need for a CBMT**

The ongoing digital transformation of industry, often referred to as Industry 4.0, encompasses the adoption of technologies such as DLT, offering substantial opportunities for both process automation and the creation of innovative business models. As industries start to adopt DLTs to develop new ecosystems, the limitations of current forms of money become increasingly apparent. The automation of business operations in DLT ecosystems requires completely synchronised and self-governing payment flows and thus German Industry demands a safe form of DLT-based money (money “on-chain”).

To highlight an example: a potential use case for CBMT is the payment of robot and machine services in industry. Robots could be paid automatically for the work they perform for other companies or

customers with the help of tokens. Autonomous vehicles could use tokens not only as payment for self-driving vehicles, but also as payment for their passengers or other services, such as parking spaces, tolls, petrol stations or charging stations. This would increase the flexibility and efficiency of business processes, increase convenience for users, and simultaneously reduce costs and resource consumption in the industry. For corporate treasury and financial institutions, the multi-issuer token concept enables rule-based money management, allowing for risk management of default risks and improvements in management of working capital.

Current private and public forms of money are not available on-chain. Stablecoins are on-chain but do not adequately fulfil industry needs for value stability or regulatory simplicity, and would introduce new frictions, potentially imposing systemic risks. Therefore, an unmet demand for a new technical form of money exists that can be closely integrated into industry DLTs and services as a secure and cost-effective form of money.

In its current project, the ECB is working on a version of an rCBDC. Unfortunately, no industrial use cases have been considered yet. Having said that, a discussion on whether to include such use cases and issue the digital euro as a token seems to be evolving. In the meantime, and as another important player in the diverse digital money landscape of the future, on-chain commercial bank money could also address the needs of the industrial sector. Commercial bank money has the right characteristics to be a secure form of on-chain money. It is also crucial for facilitating economic activities, providing the means for transactions, investments and savings.

**Figure 2: Advantages of the CBMT**


Source: Project Group

### The CBMT and other projects

There are two similar concepts. The unified ledger, as detailed in the 2023 Annual Economic Report of the BIS, and the Regulated Liabilities Network (RLN) first put forth in a report in June 2021 by Tony McLaughlin of Citi bank.[4] [5]

The BIS describes a unified ledger as a type of financial infrastructure that could enhance the global financial system, combining tokenised commercial bank and central bank money as well as assets on a programmable platform. The main difference between the CBMT concept in this paper and the unified ledger is that the latter has one or more CBDCs issued on it. The CBMT can operate with or without a wholesale CBDC, relying on traditional interbank settlement systems if no token-based wholesale CBDC common to the two settling banks is available.

The RLN approach seems different at first glance but is based on the same underlying idea of tokenised deposits and the technological upgrade of money. The CBMT integrates well with the concept of the RLN, opening up options to settle between banks using the RLN. The main difference is that RLN has been predominantly tested as a financial infrastructure, focusing on increasing efficiency in payments and settlement of financial assets. The CBMT concept focuses more on facilitating payment settlement in manufacturing, working capital or non-financial processes on DLT networks. [6] [7]

## PoC objectives

The group of banking and industry representatives defined the following PoC objectives.

- To demonstrate multi-bank tokenised deposits on three diverse technical platforms to show feasibility and to better understand the potential of CBMT.
- To explore a series of use cases including minting, transfer and redemption across bank tokens and the use of smart contracts to demonstrate programmability of payments using CBMT, prioritising real world industry use cases.
- To explore multi-currency use cases and gather information on cross border payments.
- To gain insights into different technologies in order to understand their limitations and challenges and to help inform the group on technological options.
- To elaborate on the possible operating model for a CBMT platform operator or TSP.
- To elaborate on integration needs between a CBMT and existing payment systems and corporate payments infrastructure.
- To deepen understanding on legal positioning and to inform the regulators and supervisory authorities on the potential benefits and positioning of the CBMT.

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[4] See Bank of International Settlement “Annual Economic Report”, 2023
[5] See Bank of International Settlement “III. Blueprint for the future monetary system: improving the old, enabling the new”, 2023
[6] See Regulated Liability Network
[7] See Regulated Liability Network “Digital Sovereign Currency”, 2022

- To confirm that there is strong demand and need for a CBMT and justification for further investigations and development.

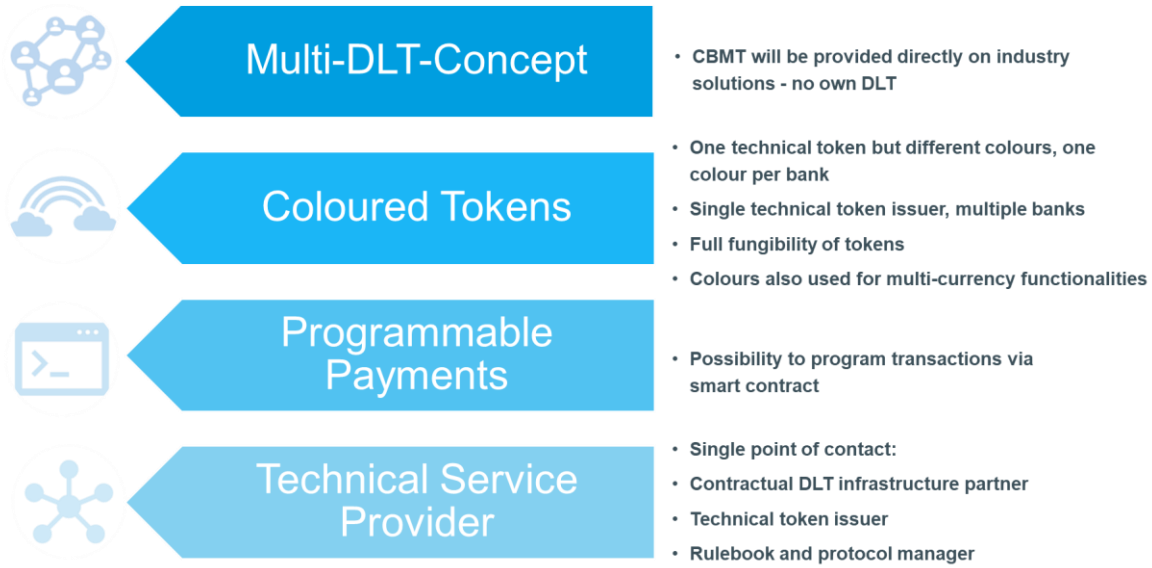
Additionally, the group also defined the following activities as being out-of-scope. This definition pertains solely to the PoC and does not reflect any limitations of the CBMT framework. The exclusions will be revisited and tested in another phase at a later stage.

- System access restrictions, such as authentication methods.
- Authorisation of transactions.
- Compliance with data protection standards and regulations concerning Anti-Money Laundering (AML) and Know Your Customer (KYC).
- Analysis of current privacy/zero-knowledge proof protocols and adaption of the CBMT to a chosen approach.
- Business validations such as balance checks and whitelist validations.
- Actual integration of the CBMT into banks or corporates existing infrastructure.
- Detailed remittance information.
- Transfer or tokenisation of real deposits.
- More simplified regulatory reporting obligations and processes (for instance foreign trade reporting).
- Interoperability and distribution of the CBMT on current industry DLT.

## Design principles and operational considerations

The CBMT design is guided by a set of high-level design principles which can be considered to be minimum requirements. These requirements form the core of what the CBMT will look like and how it will operate. Outside of these design principles, the CBMT design aims to deviate as little as possible from existing commercial bank money. For example, CBMT collateralisation will comply with banking regulation requirements, ensuring parity with deposits based on traditional accounts. The CBMT is interest bearing and is intended to be compatible with traditional deposits, ensuring a level of trust and security comparable to traditional bank money.

**Figure 3: The CBMT Design**




Source: Project Group

### Multi-DLT concept

The CBMT concept includes a diverse set of functionalities that aim to encapsulate and address industry demands. Among these features, interoperability takes a prominent role and has the following four dimensions:

- Ability to interoperate with traditional deposit accounts to facilitate convertibility.
- Capacity for seamless interaction between the CBMT issued by different banks, ensuring fungibility.
- Ability for the CBMT to be used similarly on different DLT networks.
- Capability for integration between the CBMT systems and payment initiation frameworks, such as smart contracts.

Furthermore, there should be as few limits as possible placed on today's basic process environments, including both banking and corporate environments. This approach ensures a smooth integration of the CBMT concept, along with any necessary regulatory or supervisory adjustments. The existing mechanisms for reporting, interbank settlement and KYC can be implemented for the CBMT.

### Coloured tokens

“Tokens that have property rights attached are said to be ‘coloured’ tokens, to distinguish them from other, apparently identical, tokens that are used solely as money to make electronic payments.” [8]

The decisive property right for the CBMT lies with the issuer. A colour is assigned to the CBMT for each issuer. Firstly, this makes it clear, at all times, which issuer is liable. Secondly, all CBMTs are technically identical. They can therefore be implemented as a single smart contract on any DLT network.

### Programmable payments

The CBMT is not designed as programmable money, in order to preserve universality and fungibility. It does allow for conditional payments, such as smart contracts. These can be used for transactional purposes without compromising the universal application of the token.

Redemption of the CBMT is assured for transactions between trusted addresses, identified by issuing or accepting banks; transfers to untrusted addresses are subject to AML and KYC regulations.

Each implementation of the CBMT must restrict the transfer of the CBMT to addresses on a whitelist. This is necessary to ensure that all transfers of the CBMT are subject to the rules for commercial bank money. Smart contracts for CBMT will either enforce compliance checks against a whitelist or facilitate limited, non-whitelisted transfers while maintaining a transfer history which resets upon engaging with the compliance-enforcing smart contract. This approach ensures that the CBMT transactions adhere to regulatory and contractual guidelines.

Confidentiality shall be maintained according to banking secrecy and AML/CFT standards, aligning with existing audit and supervisory practices. Given AML constraints, complete customer anonymity is unfeasible, though limited anonymous transactions may be explored, especially if not covered by future CBDC implementations.

### Technical service provider

The CBMT framework incorporates a component known as the TSP. The TSP can be seen as the entirety of the infrastructure that supports the CBMT at a technological and operational level. The TSP is tasked with handling all functions and services that fall outside the capabilities of traditional banks or industry companies. The TSP is characterized by four dimensions: compliance manager, scheme manager, contract manager, and implementation manager. The compliance manager monitors regulatory compliance and acts as single point of contact for supervisors and legislators regarding the CBMT. The scheme manager dimension concerns the definition and evolution of the token standard. The contractual relationships between DLT providers, banks and customers lie with the contract manager.

The implementation manager is responsible for the implementation of smart contracts on a given DLT, but also provides an API for services shared across DLTs.

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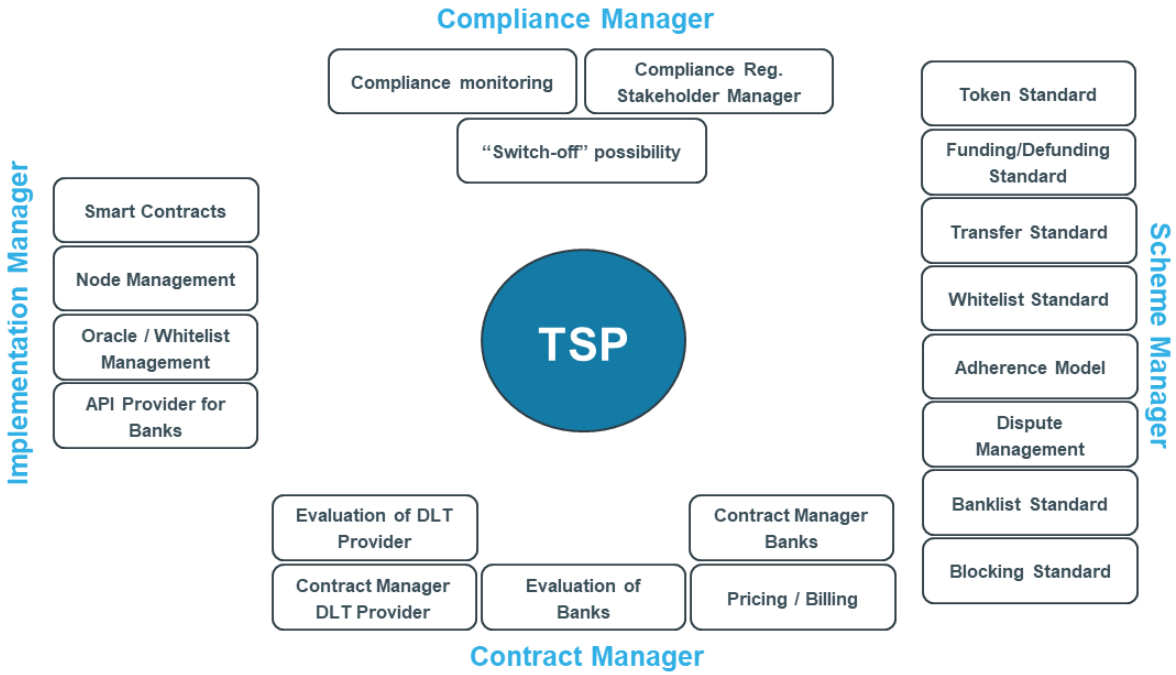
[8] See European Central Bank, Occasional Paper Series “Distributed ledger technologies in securities post-trading”, April 2016, Page 16

**Figure 4: Dimensions of the TSP**




Source: Project Group

### Other design considerations

There are further high-level design considerations to highlight. The following is a non-exhaustive list which represents some important elements that the CBMT would aim to include.

- Corporate customers should be able to participate regardless of whether they run their own node or participate in a DLT network via APIs.
- The CBMT is designed to be a year-round, 24/7 system. The transaction finalisation on the DLT is instantaneous, targeting transaction speeds that meet or exceed those of current electronic payments.
- The system is designed to allow for the denomination of the CBMT in any amount, ranging from fractions of a cent to substantial sums. This allows for high precision payments with more than two decimal digits.
- The bank-specific components of the CBMT framework ensure compliance, security, and interoperability in line with current banking regulations and practices.

### Considerations for integrating the CBMT into bank infrastructure

The PoC did not conduct any specific bank integration tests. However, the test cases explored did help to further inform participants regarding what to consider in respect to future integration.

The DLT platform that orchestrates and settles the CBMT transactions including minting, transfer and redeeming tokens across industry platforms must be tightly coupled with participant bank's core banking systems. Ultimately the CBMT is an extension of the commercial bank money infrastructure and as a design principle needs to be closely aligned with the existing payments infrastructure already used by banks today. This technical coupling requires secure communication with essential bank systems responsible for deposit account management, transaction monitoring and adherence to supervisory standards.

Some functional and technical touch points for bank integration are outlined below.

- Banks need to consider the deposit account setup for tracking movements from existing account systems to the blockchain account system and back to the existing account system. Options include dedicated individual token accounts/wallets parallel to existing accounts or alternatively omnibus accounts that aggregate cash movements for the CBMT participants, while internal mechanisms track holdings in the DLT account systems. The latter would be akin to the mechanism used by the ECB ASI6 technical account operation, as an example.

- As part of the process to check the availability of funds, the CBMT platform will need to be able to inform users if sufficient credit is available to make upcoming payments. In addition, a function to enable earmarking of funds pending ex-ante check would need to be implemented to avoid double spending.

- Settlement can happen whenever tokens are sent from clients of one bank to clients of another, either on a gross or net basis. Net settlement can be supported by new on-chain clearing systems on a bilateral or even multilateral basis. However, net settlement might increase implementation complexity in the banks' backend systems depending on the way the CBMTs are recorded in the traditional payment systems. Depending on the payment type and size, participants could choose the priority and banks could therefore opt to settle net or gross. Settlement could be done via RTGS connections, but also via any other future wholesale payment mechanism such as wholesale CBDC or other ancillary wholesale payments system.

- Traditional interest rate calculation can apply if end of day token balances are converted into traditional balances. However, in a 24/7 all-year-round scenario, a more sophisticated mechanism could be employed to credit interest on token balances based on intraday holding periods.

- Signalling of payment transaction and messaging from the CBMT DLT to AML/CFT, sanctions and fraud monitoring and reporting systems are critical. The ex-ante reporting mechanisms for sanctions checks need to be given special consideration due to the potential dislocation between ex-ante checks and smart contract execution. Responsibility could be delegated to the TSP, or a sanctions service called by the transfer smart contract prior to transaction execution could be made available.

- A key guiding principle is to integrate with existing bank processes as much as possible to avoid bifurcation of processes. Reporting items include customer reports, tax reporting and

transaction archiving. It is envisaged that banks would leverage or build adapters or APIs in order to facilitate these processes.

- On and off boarding of new corporates will need to be monitored via the TSP. Onboarding will require KYC procedures to be ratified by the TSP and by relevant banks. Exit procedures need to be considered if a corporate or bank is blocked or chooses to leave the network.

- APIs need to be leveraged in order for bank systems to communicate with the TSP for a variety of critical services including corporate payments transaction management, compliance monitoring, identity and access management. Banks will need to build or leverage existing APIs to facilitate such data exchanges. In addition, IT system onboarding processes, application support operating manuals, outsourcing relevance analysis, IT Risk assessment, network management and IT governance need to be considered.

- Infrastructure considerations include web portal deployment, node hosting, wallet infrastructure, integration into secrets management and, likely, building messaging adapters and adhoc interfaces to securely communicate with bank systems for which APIs may not be readily available.

- In addition to instructing the movement of tokens, a typical payment needs to provide payment related information. It is anticipated that the CBMT would likely leverage the ISO20022 messaging format combined with JSON messages for simpler data sets.

In summary, the integration of the CBMT into bank infrastructure is complex. Future phases should closely examine these integration specifics, potentially incorporating real-money tests to help refine requirements.

## Regulatory and legal considerations

Regulatory and legal considerations surrounding the CBMT are critically important, as the goal is to closely align with the existing framework of commercial bank money. The CBMT, with its complex nature and multifaceted implications, requires careful examination of legal qualifications, compliance measures and interactions with smart contracts.

Operating within account-based systems, the CBMT utilises distributed ledgers for peer-to-peer transactions. While efforts are made to ensure regulatory and supervisory compliance and control over the CBMTs, the shared responsibility between banks and industry DLTs introduces new complexities. The whitelisting system ensures that the CBMT is only transferred to pre-verified addresses, which will enhance traceability and strengthen compliance with existing regulations.

## Test approach and use cases

To verify the aims of the PoC, the CBMT was implemented in three different sandbox environments and tested against use cases defined by the working group. A first set of test cases were chosen to demonstrate the fundamental functionalities and prove that the CBMT is usable as a settlement instrument. These were termed as pure money use cases covering simple transfers. The second set of test cases looked at the CBMT from a perspective of implementing functionalities that are impossible or hard to conduct with current forms of deposits and transfer mechanisms. All tests were performed in

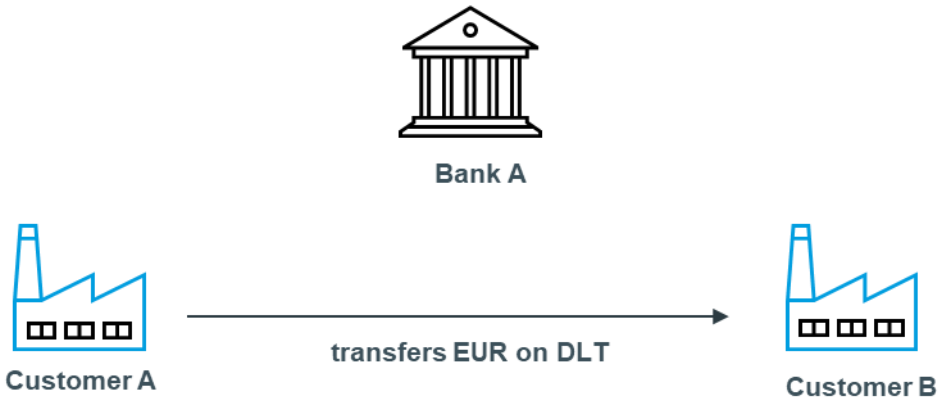
sandboxes not connected to internal systems of corporates or banks. The tests were performed by manually operating the systems through their interfaces and inspecting the output and the on-chain records.

**Pure money use cases**

Initial tests delved into establishing accounts that mirror the balance the clients hold in their off-chain accounts, converting some of this balance into Euro CBMT tokens (on-chain accounts), and facilitating transactions between accounts held with the same bank. In this case, no interbank settlement is needed, as only one bank is involved.

The second pure money use case covered the transfer of the Euro CBMT tokens between clients of different banks. The issuance of the CBMT representing bank-specific liabilities on the same network used coloured tokens which represent the liabilities of the individual issuing banks. The fungibility of the bank liability is guaranteed through the orchestration of token conversion at the customer level and subsequent net or gross settlement between banks. The interbank settlement happens on RTGS systems. In future, CBDC or other wholesale settlement mechanisms could also be used. On a unified ledger, both versions, that is money transfer between customers and the interbank settlement, could be carried out as atomic transfers on the same or synchronised ledgers.

**Figure 5: Pure Money Use Case – Money Transfer Between Customers of the Same Bank**




Source: Project Group

**Figure 6: Pure Money Use Case – Money Transfer Between Customers of Different Banks**


Source: Project Group

### Advanced corporate use cases

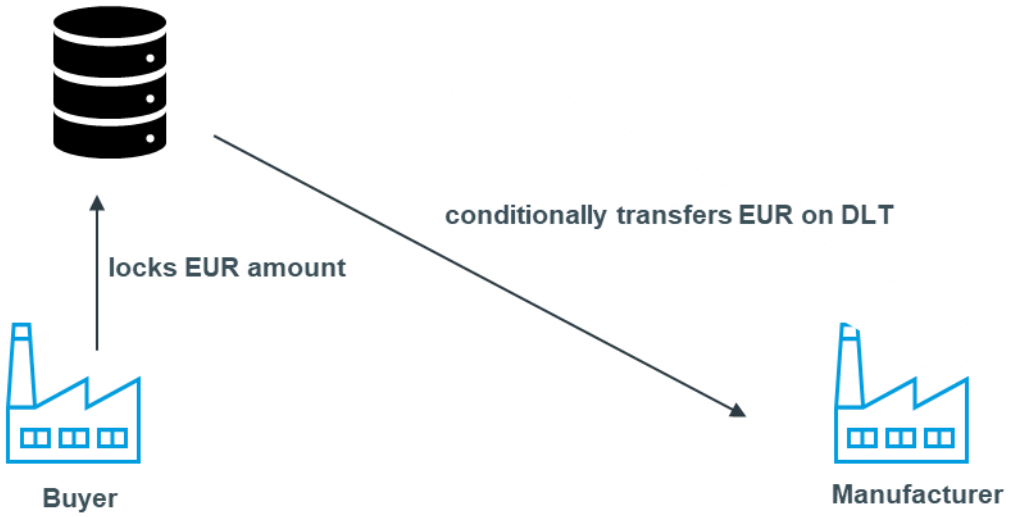
More advanced corporate use cases were examined, including working capital optimisation, streaming money use cases and DvP use cases. The focus was on use cases that go beyond traditional money transfers and that integrate with client's business processes. In all cases, the interbank settlement was assumed to use traditional settlement methods.

The working capital optimisation use case aimed at programming payments for the shipment and delivery of goods and included a variety of conditional payment solutions. The CBMT were sent to a smart contract that governed the whole process, or they were locked in the wallet of the sender, leading to no cash outflow. Upon acceptance of the process, upon receival of the goods and, for example, upon reaching a certain date, automated transfers to the receiving party were made from the smart contract or sender's wallet.

The streaming money use case can be described as an automated payment whenever goods are produced, or services are utilised (pay per production / pay per use). The payer transfers the whole sum as predefined in the set-up of the order to a smart contract, which then transfers the money to the receiving party once a defined amounts of goods has been produced (simulated production). Certain inputs, such as the amount of time the production is to run, the capacity of production per minute and the price of the produced goods could be specified, which resulted in corresponding and automated payments from the streaming money smart contract to the producer of the goods. In an alternative setup, repeated high-precision payments are made for sub-cent amounts without a setup fee and locked amount in the smart contract.

The DvP use case showcased that a non-fungible token smart contract could interact directly with the tokenised deposit smart contract and could showcase immediate delivery vs. payment of on-chain assets.

**Figure 7: Advanced Corporate Use Case – Working Capital Optimisation**




Source: Project Group

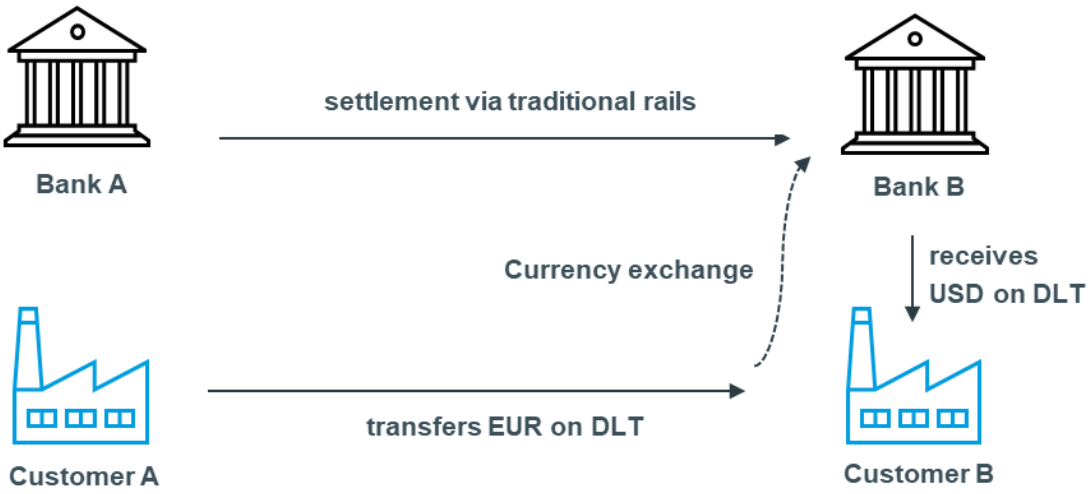
**Figure 8: Advanced Corporate Use Case – High Precision Payments**


Source: Project Group

### Multi-currency use cases

The PoC also tested and demonstrated multi-currency payments, namely US dollar to euro transactions, showcasing its potential for cross border payments. In one PoC, a USD settlement bank was introduced that provided USD nostro accounts to EUR banks, who in turn provided USD accounts to their corporate clients. In another PoC, traditional FX-settlement was assumed, but having USD and EUR as CBDC available on a common infrastructure streamlined the settlement.

**Figure 9: Multi-Currency Use Case**




Source: Project Group

## PoC Testing Environments

The PoC was conducted in three separate sandbox environments developed by three different vendors. Within these sandbox environments, the participants engaged in the execution of described use cases. All environments use a consensus mechanism with low energy consumption compared to Proof of Work.

The different PoC sandboxes diverged in terms of their technical features. Key differentiators included the use case coverage, user experience, underlying accounting methods and underlying DLT/blockchain used.

The pure money test cases were performed in all environments. The advanced corporate use cases were carried out in the environments where they were available, under the assumption that they could likely be built from the basic building blocks of the CBMT on the other platforms as well.

While a realistic production setup would be accessed mainly through automated APIs, each PoC also had an interface for inspecting and operating the system manually.

**TABLE 1: OVERVIEW OF SERVICE PROVIDERS AND THEIR CHARACTERISTICS, SOURCE: PROJECT GROUP**

| **Vendor** | EPN - European Public Network | NEXI | R3 |
|---|---|---|---|
| **Technology** | Ethereum Virtual Machine | SIA Chain – HL Besu | Corda |
| **Network** | public permissioned | private permissioned | private permissioned |
| **Consensus** | proof of authority | proof of authority | notary model |
| **Money repre-sentation** | account based<br>ERC-1155 | account based<br>ERC-1400 | UTXO[9]<br>proprietary |
| **Test Cases** | Pure Money<br>Streaming<br>Multi-Currency<br>(WCO) | Pure Money<br>WCO<br>DvP<br>Streaming<br>Multi-Currency | Pure Money<br>DvP |

**EPN PoC**

The EPN PoC was implemented by DZ BANK together with the European Public Network e.V., an association that operates a public permissioned Ethereum network. DZ BANK fills several roles, both participating as a bank and acting as a TSP for the CBMT on the EPN network. It also collaborates with Helix ID to provide a third-party wallet application and operates a node within this network.

The network infrastructure was operated by the European Public Network e.V. DZ BANK also operated a node within that network. All participants could access the network through direct connection to the EPN. The machine setup for the CBMT consisted of the Ethereum network run by EPN and an additional machine for operating the separate, simulated bank backends.

[9] While the representation of the CBMT in Corda was UTXO, the implementation enforced in the Digital Currency Sandbox meant that clients could only hold the CBMT of an issuer whom they had a contractual relationship with.

For the PoC, DZ BANK acted as a TSP, developing and publishing a set of smart contracts implementing the CBMT on the EPN. In this role, DZ BANK also registered and whitelisted other corporates and banks from the group.

Access to the network for users was enabled through a third-party wallet application by Blockchain Helix AG. This application can store the cryptographic keys used to access a CBMT. It also enables the display and transfer of a CBMT between participants from a chosen issuer and in a chosen currency. Both the functionality of the ERC-1155 contract and the administrative processes were also available through a Javascript SDK and a command line application. A summary of all transactions was available through a web interface to all transactions on EPN. DZ BANK used Javascript SDK, available to all participants, to set up the banks and the client account relationships.

An implementation compatible with the ERC-1155 standard was selected for the implementation of the CBMT. ERC-1155 allows for representation of different currencies and issuers within the same smart contract. ERC-20 was rejected, as it did not allow for good representation of different currencies and issuers. The additional administrative functionality specific to a CBMT was deployed as a second smart contract. The deposits of each participant were represented internally as accounts. As an example, a smart contract implementing a three-party escrow scheme for locking a CBMT was deployed for a custom business process. Such smart contracts can be deployed on EPN by any system user and used by consenting parties.

Tested functionalities included pure money use cases as well as currency conversion and high precision payments.

Bilateral clearing of token balances between banks was implemented through a smart contract in a two-step manner. In the first step, one bank requests the clearing of on-chain balances with a second bank. In the second step, the other bank accepts that clearing and the smart contract then swaps tokens in the given amount. The remaining balance is displayed to the banks for settlement in the traditional system.

**NEXI PoC**

The NEXI PoC was implemented by NEXI, a PayTech that operates acquiring and merchant payment services globally across a broad range of different payment channels and methods, providing support for the digital economy and the entire payment ecosystem. It also designed a technical infrastructure to support the functionalities and requirements of the CBMT. NEXI served not only as the designated TSP, orchestrating the deployment of smart contracts, but also formed the backbone of the entire ecosystem, managing the IT operations.

The network infrastructure for the PoC is Hyperledger Besu on a private network, operated by NEXI. The machine setup for the CBMT consisted of several nodes for the banks and their clients run by NEXI. A realistic production configuration allows banks to connect through APIs to the network. Clients can connect to the network through APIs provided by their banks.

NEXI also acted as the TSP for the PoC, developing and publishing the set of smart contracts implementing CBMT on the SIA Chain. In this role, NEXI also registered banks from the group.

Access to the system was exclusively through web interfaces provided by NEXI. A smartphone and PoS application is also available, but was not used for the PoC. The banks used this interface to register their clients. Each bank had a user interface that provided an overview of all the accounts it

provides to both corporates and banks, and the transactions that took place using these accounts. Each corporate had a user interface for each bank it holds accounts with, where balances, transaction history and the user interfaces for the different use cases described above were provided.

A custom implementation compatible with the ERC-1400 standard was selected. The ERC-1400 interface was enhanced with additional functions such as a user whitelist, anti-counterfeiting, verification of issuers, functional validations, clearing and settlement with Fiat Money, multi-currency support, possibility to reserve tokens for specific uses, whitelist, interest tier and limits, operations functionalities and event management.

Tested functionalities included pure money use cases as well as multi-currency, working capital, streaming money and DvP.

The smart contract can initiate bilateral clearing operations. Tokens representing liabilities from different banks are atomically swapped between each pair of banks. Any credit or debit position in the on-chain clearing system is notified to the bank operator for net settlement in the traditional system.

### R3 PoC

The R3 PoC was implemented by R3, a provider of solutions in digital assets, digital currency and interoperability, underpinned by its DLT and tokenisation platform, Corda. R3's primary focus is enabling regulated financial institutions with solutions to build, connect and progress digital markets.

The network infrastructure for the PoC is based on Corda nodes, operated by R3 in a sandbox environment. In the tests, R3 acted as the technical service provider. The central notary node required by the network was also run by R3. While the distributed architecture based on Corda allows each bank or corporate to connect to the CBMT network via Corda, all nodes were managed by R3 to reduce the deployment complexity.

The smart contracts that govern the CBMT were written and deployed by R3, acting as the TSP. They were developed based on its existing digital currency sandbox. Access to the system and whitelisting of network participants was managed by R3.

Access to the system was through a web interface provided by R3. A production configuration allows additional connectors on top of the browser interface. Banks and corporates can opt to connect directly via the Corda protocol and develop their own automated workflows and multi-party interactions based on smart contracts.

As a basis for the PoC, R3 used its existing digital currency sandbox, which models CBMT using a UTXO standard. This implementation, together with Corda's privacy model, shares transaction data on a need-to-know basis only. Each issuer of a CBMT defines a partition of the network to which the token can be moved. The multi-issuer capability is implemented by burning the CBMT of one issuer and minting the CBMT of the other issuer whenever a cross-issuer transaction occurs. Settlement between the banks was simulated on an automated gross basis.

The functionalities of the pure money use case were tested.

Interbank settlement happens on traditional rails. The settlement information is available on a dashboard. Both issuing banks are involved in orchestrating the settlement for the amount due between them.

## Key findings

### Viability and potential

A CBMT is viable and offers considerable potential. The CBMT concept has proven to be effective in the test environments, which underlines the suitability of the tested technologies for both basic and advanced transactional use cases. The tests have shown that basic use cases, such as standard transactions between two different accounts, can be realised with CBMT as with existing infrastructure.

In addition, CBMT could significantly expand the possibilities for rule-based/conditional transaction use cases. For example, the CBMT enables the implementation of complex business logic in transaction processes. It is expected that these future improvements will have a significant impact on payment possibilities and thus open up new innovative application scenarios. In the long term, companies should be empowered to manage their own transaction processes independently, thereby strengthening their operational autonomy. This exciting breakthrough is facilitated in the wider corporate landscape by bringing an established form of money, commercial bank money, on-chain.

### Versatility and settlement

The CBMT is a versatile settlement instrument. The three PoC approaches were diverse, but the CBMT was represented in all three approaches in a satisfying manner.

Both private and public permissioned networks were found to be useful, depending on the use cases. Using a public permissioned network makes sense when issuing securities on the primary market. Sensitive financial transactions should only be visible to the involved parties. The working capital optimisation cases fit well with private permissioned networks, but a secondary market for future payments is harder to realize.

The operating environments and vendor setups were also quite different. NEXI integrated the CBMT into their SiaChain environment as a turnkey package. DZ BANK, on the other hand, created and deployed a set of CBMT smart contracts on an existing Ethereum network and leveraged open standards to integrate with third party applications. A single vendor makes setting up and understanding the system much easier, while having an open system strengthens the autonomy of the corporates in choosing vendors and providers that fit their preference.

TABLE 2: OVERVIEW OF VENDOR SPECIFICS, SOURCE: PROJECT GROUP

| | | | |
|---|---|---|---|
| **Vendor** | EPN - European Public Network | NEXI | R3 |
| **Technology** | EVM, public permissioned | HL Besu, private permissioned | Corda, private permissioned |
| **Portal** | no portal, but SDK for integration available | portal per bank | unified portal |
| **Vendor** | open | single vendor | single vendor |
| **Privacy** | transactions are visible to all participants in the network | transactions are hidden, visible to network operator and banks providing the accounts | transactions are hidden, visible to banks providing the accounts |
| **Node access** | full | limited | full |
| **Developer knowledge** | Ethereum / EVM | Ethereum / EVM | Corda |
| **Network trust model** | multiple operators | single operator | single operator / notary node |

### Communication with regulators and supervisory authorities

During the PoCs, the project group communicated with regulators and supervisors. The initial feedback on the CBMT was positive, no showstopper was identified. Legal opinions commissioned by project group members support the thesis that the CBMT is a deposit in a different technical form, recorded on a DLT. More communication will be important when moving forward to ensure that banks, legislators, supervisory institutions and CBMT users have a common understanding of the CBMT.

### TSP Operating Model

In all three PoCs, the role of the TSP was assumed by a single entity. The focus was on the implementation manager dimension. Onboarding project group members was found to be most efficient if there was a single point of contact. In a realistic production setting, the TSP would not be a single legal entity, as some tasks can be provided by multiple parties. The implementation of the CBMT on different DLT networks would potentially be carried out by different vendors or software teams. Testing of the CBMT implementations for compliance with the schema would also be more involved.

Some services common across the PoCs were also identified. Common APIs for network participant information and regulatory reporting will need to be defined by the implementation manager. A pre-packaged software setup would ease the onboarding of new customers, but it is unclear whether this should be provided by the TSP or a third party.

As the discussion progresses and the project group members gain experience with the CBMT, the technical and operational tasks of the TSP will need to be refined further. A resilient governance structure for the legal entities making up the TSP will need to be found to ensure the stability and evolution of the CBMT concept and implementation.

## Open questions

No showstoppers for the future integration of the CBMT into banks and industry's legacy systems were identified during testing. However, the timeline for the system's go-live depends on several factors: regulatory and supervisory requirements play a crucial role in determining the readiness for deployment. The integration with corporate client's ERP and treasury management systems and integration with core banking systems must be carefully considered and then implemented. Business processes will need to be extended in order to integrate the CBMT.

The setup and governance of the TSP was not finalised. The project group identified four major dimensions which require further refinement. Some TSP tasks may be better provided by governmental entities. Other tasks may be provided by one or more competing companies.

## Next steps

The next phase of development will focus on the increasing the number of CBMT network participants. The inclusion of a greater number of banks, a more diverse spectrum of industry participants and innovative technology providers would be beneficial. This growth is not merely quantitative; it aims to enhance the framework's resilience, enrich the system's functionality and deliver a more comprehensive service offering to a broader user base.

As the landscape for tokenised deposits evolves, it will be important to further explore integrating a CBMT with other networks like RLN, and to explore how a CBMT could be integrated into a unified ledger concept and project. Both banks and their clients want options when selecting a network for their business and financial processes. CBMT as a concept should work with either approach.

An additional next step is a pilot test of a functional integration of the CBMT within the existing systems used by banks and industrial firms. Concrete corporate use cases should connect business processes on the corporate side, potentially including physical machines. On the bank side, clarification on the

prerequisites for integration, reporting and more is in scope for a real money test of the CBMT. To achieve this goal, the plan is to actively engage with regulators and supervisory authorities in order to gain formal approval. The ultimate objective is to cultivate an environment that supports the further development of the CBMT framework, while simultaneously upholding stringent regulatory standards, ensuring that the CBMT remains both cutting-edge and trustworthy.

The setup and governance of the TSP needs to be refined along the four major dimensions. Some tasks may best be fulfilled by a central governing body, while others seem better placed with government entities. Other tasks may be provided by one or more competing companies.

## Imprint

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