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Bundesverband deutscher Banken e. V.
Bundesverband Öffentlicher Banken Deutschlands e. V.
Deutscher Sparkassen- und Giroverband e. V.
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Die Deutsche
Kreditwirtschaft

Europe needs new money – an ecosystem of CBDC, tokenised commercial bank money and trigger solutions

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The **German Banking Industry Committee** is the joint committee operated by the central associations of the German banking industry. These associations are the Bundesverband der Deutschen Volksbanken und Raiffeisenbanken (BVR), for the cooperative banks, the Bundesverband deutscher Banken (BdB), for the private commercial banks, the Bundesverband Öffentlicher Banken Deutschlands (VÖB), for the public-sector banks, the Deutscher Sparkassen- und Giroverband (DSGV), for the savings banks finance group, and the Verband deutscher Pfandbriefbanken (vdp), for the Pfandbrief banks. Collectively, they represent more than 1,700 banks.

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Table of Contents

1 Management summary

- Digitisation and digital life now affect all areas of living and the economy. This means we need new digital forms of money – in other words a digital euro. The German Banking Industry Committee (GBIC) would like to make a proactive proposal for moving forward with the **development of an ecosystem for innovative forms of money**. In our view, the global trend towards central bank digital currency (CBDC) is unmistakable and represents both an opportunity and a challenge. In addition to CBDC, more advanced payment solutions developed by the banking industry will also play a major role in future. **Tokenised commercial bank money should be issued and existing payment systems should be geared to DLT-based business processes** in order to create payment solutions to complement CBDC.
- We are convinced that a digital euro is key to **strengthening Europe's digital and monetary sovereignty** and **ensuring the continent's medium and long-term competitiveness**. Its introduction will require the further development of today's forms of money and the creation of ecosystems that can satisfy the demands of a digital economy.
- The main drivers of the future payments ecosystem are, first, the digital transformation of industry (**Industry 4.0**), which is currently seeing an extensive automation of processes using distributed ledger technology (DLT) and smart contracts. Second, a **decline in the use of cash** brought about by changing consumer behaviour. And, third, the emergence of new players and competitors, especially **global tech companies**, coupled with **increasingly strong competition from China** in the international monetary and technology arenas, which all poses a threat to Europe's digital and monetary sovereignty.
- We see **retail CBDC**, a currently much-discussed form of digital euro, primarily as a **complement to the cash** used today by households and distributed by banks in their tried and tested capacity as intermediaries. Retail CBDC will be successful if citizens, in particular, accept it as an attractive addition to existing forms of money and payment methods. Banks can help to increase the attractiveness of retail CBDC by **enabling its use in programmable applications** for citizens. Central banks and the banking industry should collaborate on implementing this new monetary form.
- To avoid possible negative consequences for businesses and consumers, retail CBDC should be designed with care. Unrestricted introduction of retail CBDC could result in **disintermediation of banks**. This, in turn, could lead to a **decline in lending capacities, increase the cost of financing for businesses** and thus **profoundly impede economic growth for the foreseeable future**. To enhance the acceptance of the digital euro and the financial inclusion of the population, citizens in the euro area should be able to hold a wallet containing a limited amount of CBDC at a bank of their choice.
- A holistic CBDC project of the ECB should also explore the **possible introduction of wholesale CBDC** in order to fully exploit the advantages of DLT in the capital markets. In addition to the use of this new technology for securities settlement, the corresponding payments in central bank money should also be executed with the help of DLT. A much faster solution than introducing wholesale CBDC might be to adjust the existing TARGET2 architecture to meet the requirements of DLT-based capital market transactions with the help of private-sector settlement systems that access liquidity deposited there. The Eurosystem should support private-sector initiatives along these lines with a view to improving the time to market. The idea of **integrating a trigger chain into TARGET2** should also be considered.

- Tokenised commercial bank money is another **potential addition to the ecosystem**. The main task of tokenised bank money will be to provide swift and effective support for the ongoing digitisation of Industry 4.0 business processes and also to underpin the rapidly growing importance of digital assets and the digitisation of foreign trade transactions. Tokenised bank money could be used as a **further development of today's bank money for DLT systems** and would enable a **flexible supply of liquidity to the economy** as well as bank money creation. GBIC proposes **three possible governance models** to meet the challenges associated with technical and economic interoperability of tokenised bank money.
- Absolute prerequisites for the implementation and widespread use of tokenised bank money by businesses are a pan-European standard and suitable regulatory framework. **Support from the ECB and policymakers** is essential, as is **dialogue with the industry**. Any ECB digital euro project should provide for a discussion forum to foster a standard for tokenised bank money developed by the banking industry.
- When it comes to existing payment solutions, institutions and service providers are already working successfully on offers geared to the needs of the DLT-based business processes of their corporate customers. A key feature of these so-called **trigger solutions** is the **close technical integration of DLT with the processing of payment transactions**. The associated complexity and the potential for value-added offerings (to cover delivery versus payment, or DvP, needs, for example) make it necessary for the parties involved to cooperate closely with one another. There is also potential for further technological standardisation to achieve (additional) efficiency gains for both institutions and their customers.
- A general challenge in the context of programmable payments is the automation of payment initiation and the relevant frameworks governing civil and payments law. In the long term, we see a need for European legislative initiatives to promote machine-controlled legal transactions with due consideration of their payment law aspects.

2 Status quo: Today's monetary system

The publication in early summer 2019 of the White Paper on Facebook's currency "Libra"– which has since been renamed "Diem" – and the emergence of the first Central Bank Digital Currencies (CBDCs) in Sweden, China and the Bahamas have triggered an intensive debate about the future development of payment transactions and today's monetary system. Four developments in particular pose new challenges for our current system and make a case for digital money supply: (1) the digital transformation of industry and the associated growing demand for automated processes, (2) the emergence of alternative private payment methods, provided, for instance, by globally operating Big Tech companies, (3) the nationwide decline in the use of cash, and (4) the need for solutions that permit a full settlement of capital market transactions through Distributed Ledger Technology (DLT).

(1) Digitalisation is advancing at a fast pace and in nearly all economic domains. In the manufacturing sector, it is evident from the increasing automation of business processes, which has led to significant efficiency gains. In this context, a key role is played by Distributed Ledger Technology, which is advantageous in three respects: First, due to distributed data storage, there is no single point of failure, which makes sensitive business data more resistant to potential attacks or attempts of data manipulation. Secondly, distributed data storage and a consensus mechanism previously defined by network participants permit the validation of transactions and the development of digital consortiums. Where a cross-company or even cross-sectoral association used to be inconceivable because of prohibitive distrust costs, trust is now created by transparency. Thirdly, "smart contracts" (automated contracts) will make it possible to automatically execute a transaction based on previously defined terms and conditions, and will therefore permit unimagined forms of automation, transparency and digitalisation of current analogue processes.

(2) The emergence of private global currencies – issued, for instance, by globally operating Big Techs – might pose a serious threat for the geometry and stability of the two-tier banking system made up of central banks on the one hand, and commercial and savings banks on the other. In summer 2019, the Libra Association (renamed Diem Association in 2020) – a consortium of companies largely initiated by Facebook – announced for the first time that it wanted to issue a global currency in the form of a stablecoin. In view of the fact that the members of the consortium include global players such as Facebook, Spotify and Uber, and considering that Facebook alone with its subsidiaries WhatsApp and Instagram reaches nearly 2.8 billion customers[1], Diem could achieve wide coverage after its launch. The digital and monetary sovereignty of the current banking system may be jeopardised by such stablecoins, which will directly compete with payment solutions provided by banks in the form of tokenised money and central bank money in the form of cash. The central banks have been warned internationally and, not least due to this announcement, they are examining the introduction of digital central bank money for the general public, which would provide a complement to cash. However, commercial and savings banks are likewise called upon to promote the development of tokenised money.

[1] https://de.statista.com/statistik/daten/studie/37545/umfrage/anzahl-der-aktiven-nutzer-von-facebook/

(3) It has been observed for years that consumer behaviour is changing in many countries: Digital and mobile payment methods are gaining ground[2], while payments made with notes and coins are declining. Even in cash-loving Germany, the use of cash has decreased significantly during the Covid-19 pandemic: by 19 percentage points[3] in the first half of 2020 compared with the same period in 2019. A preference for digital and mobile payments among consumers, as well as the acceptance by merchants of such payments, are on the rise even in Germany. However, the primary beneficiaries of this trend are non-European providers of credit card schemes, peer-to-peer pay apps and in-app payments. It is particularly against this background that commercial and savings banks in Germany and Europe will need to take up the challenge of digital innovations with particular determination.

(4) Digitalisation and the increasing relevance of DLT will also have implications for capital markets. As early as June 2016, the European Securities and Markets Authority (ESMA) published a discussion paper analysing the benefits and challenges associated with the use of DLT in securities markets. Efforts are currently being made in Europe and in Germany to support the shift toward settling capital market transactions on the basis of DLT.

[2] https://bankenverband.de/newsroom/meinungsumfragen/bargeld-karte-kontaktlos/
[3] https://www.faz.net/aktuell/finanzen/meine-finanzen/geld-ausgeben/bezahlen-die-bargeldnutzung-sinkt-wegen-corona-deutlich-17009394.html

3 Challenge: Tomorrow's world

3.1 How will we live tomorrow? Smart Cities, Industry 4.0, IoT and M2M Economy

New digital technologies will play a key role in our lives in future. Below, we will describe some of the most important trends, some of which are interdependent and have the potential to transform payment transactions on a lasting basis.

Industry 4.0

A key driver of the digital revolution – specifically in Germany – is what is known as Industry 4.0, i.e. the end-to-end digital interconnection and automation of industrial processes. Industry 4.0 is characterised by the fact that – unlike in the past – processes will not only be adjusted and accelerated, but entire business models will be radically changed. The digitalisation of entire production chains will be facilitated by networked machines and machine systems and by introducing new process control methods (e.g. digital twin). In the past few years, networking in the context of Industry 4.0 has been particularly accelerated by the opportunities provided by blockchain technology. The benefits resulting from networking and the data it generates are obvious: Companies which manufacture industrial plant, for instance, will obtain more information on how this plant is used and can therefore develop more flexible and needs-based product offerings. The data obtained will also make it easier to identify and leverage potential service improvements; this can lead to additional cross-selling opportunities.[4] What is important from a bank's perspective is that the new digital opportunities will also have an impact on payment processes. Fast, convenient and personalised payment options such as pay-per-use models will enable companies to flexibilise and optimise payment flows and to focus more on the core elements of their business (e.g. marketing and selling their own services/products).

Machine-to-Machine Economy & Internet of Things

The "Machine-to-Machine" or M2M economy stands for machines communicating with each other without any additional active involvement of human beings. It will play an important role in the context of Industry 4.0 in the cities of the future and will be based on the autonomous networking capabilities of the "Internet of Things" (IoT). Such networking of physical objects will permit the continuous end-to-end automation of business and payment processes seemlessy; in the M2M economy, for instance, it is conceivable that the car of the future will pay with complete autonomy for energy sources such as petrol, hydrogen or electricity received at service stations. According to estimates by the news portal M2M Communications, the number of "IoT-capable devices" will increase globally to more than 75 billion objects by the year 2025.[5] This enormous number of networked terminal devices will create new marketplaces, industries and business models, as various "as-a-service" models demonstrate. This, in turn, will require new customised solutions for billing and payment processes.[6]

DLT will play a key role in this context because it will provide a more efficient means for technological networking than current technologies. At the same time, some basic requirements have to be met so that networked terminal devices can easily communicate with each other, such as the expansion of the 5G network and nationwide access to fibre-optic Internet connections. Finally, cyber security will be a key

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[4] https://www.bitkom.org/Presse/Presseinformation/Digitalisierung-schafft-neue-Geschaeftsmodelle-in-der-Industrie
[5] https://www.m2m-kommunikation.de/news/internet-of-things-bis-2025-wird-es-75-milliarden-iot-devices-geben.html
[6] https://blog.wiwo.de/look-at-it/2020/08/26/internet-of-things-kuenstliche-intelligenz-die-vier-phasen-der-machine-economy/

success factor because this greater networking of objects can only work in the long term and reliably if these are made resilient to hacker attacks. Particularly in the context of automated payment processes, trouble-free and tamper-proof networking of objects will be indispensable.[7] This is no less important for the payment processes involved.

Smart Cities

The global trend towards urbanisation[8] raises many questions about how to organise coexistence in ever growing and ever more complex cities. One vision that is described over and over again in this context is that of the "smart city". This vision involves a holistic development concept aimed at making cities more efficient and more progressive. To this end, the above-mentioned trends will combine with each other in a wide range of scenarios. The corresponding efforts are often focused on networking energy and mobility infrastructure and on a broad expansion of data-based processes, including the associated payment processes. Digital administration and identity verification processes (authentication) are also relevant here; these processes, such as Self Sovereign Identity (SSI), are based on DLT.[9]

Opportunities and challenges for payment transactions

Payment transactions of the future will need to support the developments described above, in particular by leveraging potential efficiency gains facilitated by the programmability of payment processes, by integrating autonomous payment methods and nano payments (of amounts smaller than 1 euro cent) and by facilitating direct, non-revocable payments without any interface to an intermediary. Many of the potential innovations in underlying transactions cannot yet be implemented in today's payment infrastructure or else only to an inadequate degree. This is where innovative digital forms of money or a digital euro – for instance in the form of tokenised commercial bank money – might provide a solution. The form, timing and scope will depend on each individual case and use case, bearing in mind cost/benefit considerations. The following chapters will examine this question from various perspectives.

3.2 Use cases for digital money

Based on four target markets, we will assess the need for a digital euro in the form of tokenised commercial bank money or CBDC or as an application of programmable payments by means of a trigger solution. Preliminary remark: If only today's conventional payment transactions were to be used, there would be disruptions in the process between the underlying transaction on DLT and the payment transactions.

	Capital markets related		B2B			B2C		P2P
	Electronic securities	FX	Digital assets (without electronic securities)	Trade finance	M2M	IoT	PoS	P2P
DLT-based underlying transaction (asset leg)	✓	✓	✓	✓	✓	✓		
DLT-based payment (payment leg)	✓	✓	✓	✓	✓	✓	✓	✓

Figure 1

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7 https://www2.deloitte.com/de/de/pages/technology/articles/internet-of-things.html
8 https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS
9 https://home.kpmg/de/de/home/branchen/oeffentlicher-sektor/smart-city.html

Electronic securities & FX

The legal framework for electronic securities has been created in the recent past; as a result, it will be possible to settle securities on the basis of DLT as of the beginning of 2022. In future, the electronic security (the "asset leg") will be coupled with DLT-based settlement of payments (the "cash leg"). The benefit of DLT-based settlement is that it permits genuine Delivery-vs.-Payment (DvP) and Payment-vs.-Payment (PvP) processes, reducing execution times from days to minutes, minimising counterparty risks and hence drastically cutting costs. In addition, the use of DLT is conceivable in the forex market.

Digital assets

In the field of B2B, it is conceivable to issue and trade in digital (including crypto) assets and to consider tokenised securitisation of conventional assets (e.g. real estate, rights). Since autumn last year, the market capitalisation of crypto assets, in particular, has increased rapidly.[10] Above all for illiquid assets such as real estate, tokenisation provides enormous opportunities because these assets could then be traded on a liquid market and in fragments of their current total value, which would make them accessible for a wider range of investors. However, the tokenisation of rights, images, licences, etc. likewise holds enormous potential. DvPs, for instance, could reduce process times from several days to just a few minutes.

Trade finance

In the field of trade finance, automation can help to tap significant potential, in particular for step-by-step transactions. DL (distributed ledger) technologies could help to reduce the counterparty risk.

Machine-to-Machine Payments

Pilot projects have shown how machines can communicate with each other autonomously and make payments independently. DLT will mainly help to create trust between various parts of the value chain that are not yet networked today. In addition, it yields efficiency gains in networked value chains and cost savings, for instance, by reducing administrative costs.

Internet of Things

More than anything else, the expansion of the Internet into the physical world – in other words: the networking of more and more terminal devices (Internet of Things, IoT) – calls for the integration of payment functionalities. Intelligent, smart and sensory systems could be interlinked via DLT.

Point-of-Sale

New forms of money can also be used at the Point-of-Sale (PoS), e.g. in retail outlets, the catering sector or also online. While today's card payments that are settled via commercial and savings banks cover the demand for digital payment opportunities with tokenised commercial bank money, there is currently no option for consumers to make anonymous payments in the digital sector, as they can with cash in the analogue world.

P2P (Peer-to-Peer)

The decline in the use of cash, as outlined above, leads to a greater demand for digital solutions in respect of transactions between private retail customers (peer-to-peer). Functionalities such as "offline capability", "anonymity" and direct transfer without intermediaries could be important for consumers if they want a substitute for cash.

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[10] https://www.statista.com/statistics/730876/cryptocurrency-maket-value/

3.3 Characteristics of payments with digital money

The following paragraphs describe those properties of digital money which facilitate and characterise the use cases cited above. Not all the properties must necessarily be fully developed for each use case.

Automated payments

The increasing tokenisation of the economy will lead to more intensive process automation and integration, which, in turn, requires automation of the payment process.[11]

Option of anonymous payments

Transactions and payment processes must generally respect two principles: On the one hand, they must comply with existing constitutional protections for individual personal rights and with data protection regulations. On the other hand, it is vital to ensure that the degree of anonymity will not undermine rules designed to prevent money laundering and the financing of terrorism.

Some use cases call for a certain degree of anonymity.[12] Today, anonymous payments are made by final consumers mainly in the form of cash. Recent trends, such as making mobile payments by means of everyday objects able to perform that function (e.g. smart phones and watches), contribute towards reducing the role of cash. Nevertheless, anonymous payments remain relevant for consumers, and new payment systems should therefore make them possible. This can be ensured by an appropriate design of digital money.

Pay-per-Use Payments

In the "Pay-per-Use" model, manufacturers make machinery and equipment available to customers who only pay for their actual use. The use is monitored by recording a wide range of machine data and transmitting these to the manufacturer. Applications can include the billing of customer-specific consumables or services, even the disposal of the machine. Manufacturers can also draw on appropriate financing solutions offered by financial service providers for this purpose. In the context of "Industry 4.0", such financing solutions are fully digitalised, often based on DLT. In this context, financial service providers offer the option to keep wallets or virtual accounts for machinery or equipment, so that the payment processes can be integrated into processes controlled by smart contracts.

"On-Demand Concepts" constitute another variant of "Pay-per-Use". In this case, consumers are able to access services by making (advance) payments. It is possible, for instance, to enable functions in a vehicle "on demand", with payment triggered automatically.

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[11] Note to readers: In December 2020, the "Programmable Money" Working Group published its outcome document. The Working Group had conducted a discourse among experts on the topic of "Programmable Money" at the initiative of the Federal Ministry of Finance and Deutsche Bundesbank. Some passages from this document will be quoted below because of its topicality, similarity of content and overlap of experts.

[12] **Transaction partners:** Transparency is required in respect of personal data that are relevant for a contract and that are needed to execute a payment transaction. **Payment infrastructure:** There should be limited anonymity vis-à-vis the operator of the payment infrastructure. The limitation must be justified by the operator's obligations and by operational considerations. This partial anonymity is elementary for reasons of competition law, in particular if the operator is a private-sector company. Nevertheless, access to partially anonymised information is necessary to perform the duty to report transactions of relevance to money laundering. Any other disclosure of such data should be prohibited under penalty of law. **Governmental institutions:** As a rule, anonymity must be ensured vis-à-vis governmental institutions. Exceptions may be defined if there is a legitimate governmental interest, in particular oversight of payment transactions, measures to counter money laundering or the financing of terrorism, and law enforcement. **Uninvolved third parties:** Full anonymity should be ensured at all times vis-à-vis uninvolved third parties.

"Pay-per-Use" business models permit the development of new closed ecosystems, into which payment processes need to be integrated. These processes are often based on the M2M payments outlined above.

Payments for specific purposes

Payments for specific purposes are used to permit a transfer of funds exclusively for (legally or contractually) defined purposes. Well-known examples include real estate loans, interest payments and principal repayments, donations and financial investments. Aside from the payment process, financial service providers have often established complex business processes to check and ensure the purpose of the payments.

By basing programmable payments on smart contracts, these checks can be performed during the payment process itself, so that there is no need for elaborate validation procedures.

Key requirements to be met when payments are linked to specific purposes are:

- the digitalisation of the purposes (e.g. real estate, loans, securities, projects),
- the unique, forgery-proof identification of the recipient and purpose, and
- the firm allocation of the sum transferred to the purpose intended.

Nano payments including payment streams

Pay-per-Use models in particular sometimes expect incremental or continuous payment streams. Examples include petrol service stations, telecommunications and mobility services. Nano payments cannot be made with today's payment processes.

Nano payments or payment streams mean that the claims and counterclaims of service providers and customers are always in balance. As a result, there is no need to distinguish between receivables and payables, which can be time-consuming.

Apart from the challenges posed by "Pay-per-Use" models in terms of payment processes, as described above, there are some other aspects to consider:

- The amounts to be paid per unit of use are usually in the range of a few cents or even less; when use of the service ends, the amount is rounded to up to the nearest full cent.
- The settlement of the payment processes used must therefore be particularly cost-effective.
- A continuous exchange must be ensured between the participating machines and/or between the service use and the money transfer to be made autonomously within set limits.

3.4 Payment transactions and DLT

A range of instruments are available to implement payment transactions today. Aside from straightforward credit transfers, a variety of transactions are supported which, overall, facilitate smooth payment processes even if unexpected events occur. Major procedural and legal background aspects are not transparent for users, including the two-tier banking system, regulatory requirements and disruption management.

In contrast to that, the transfer of value on a DLT is fully transparent and – technologically – totally different. Depending on the design of the tokens used, effects of the two-tier banking system or explicit steps in the process designed to meet regulatory requirements may be visible and identifiable. The value transfer is direct, final and indivisible (atomic payment). The entire process is much simpler, in particular due to the disruption of all intermediaries. Tokenisation should be considered in all shapes and forms.

Tokenising money is one of many potential resources based on DLT. As tokens constituting money work on exactly the same basis as all other tokens, this money will lose its special status once tokenisation in general advances.

At the end of the day, at least in the eyes of payment transaction experts, payments as we know them today are only transacted to a very limited extent on DLT: it remains a transfer of value between two addresses.

A token for "payments"

A token (issued by banks) lends itself to DLT-based "payments" whenever it transports the basic properties of today's commercial bank money into DLT environments. These basic properties include, for instance, a guarantee of exchange into central bank money (1:1), fungibility or universal usability, and interoperability throughout the currency zone. Furthermore, such a token should be "technology-agnostic" to a certain extent, so that it can be implemented on all DL technologies that are in common use today.

Some of the current DL technologies implement tokens by means of smart contracts which have defined interfaces. This makes it possible to endow the tokens with their own inherent logic. In order not to jeopardise the requirements described above, this option should not be pursued. Instead, payment programmability should be achieved by means of smart contracts which trigger the transfer of the token between two addresses. An ability to modify the token as such, meanwhile, is not desirable.

Additional requirements to be met by the design of the token are defined in the sections below.

4 Ecosystem of CBDC, tokenised commercial bank money and trigger solution

To meet the challenges outlined above, it is important, on the one hand, to maintain the existing principles and the added value of the current payment transaction system already in place; on the other hand, however, digital solutions provide an opportunity to shape the payment world of tomorrow (see chapter 3.1). Efforts will focus on further developing today's forms of money and their integration into the payment system. Introducing only one of the future forms of money while discriminating against all the others would not be appropriate. Each of the future forms of money outlined below has its own rationale. For this reason, each of these forms of money must be considered on an equal footing and as part of a coherent whole for the purposes of a target operating model.

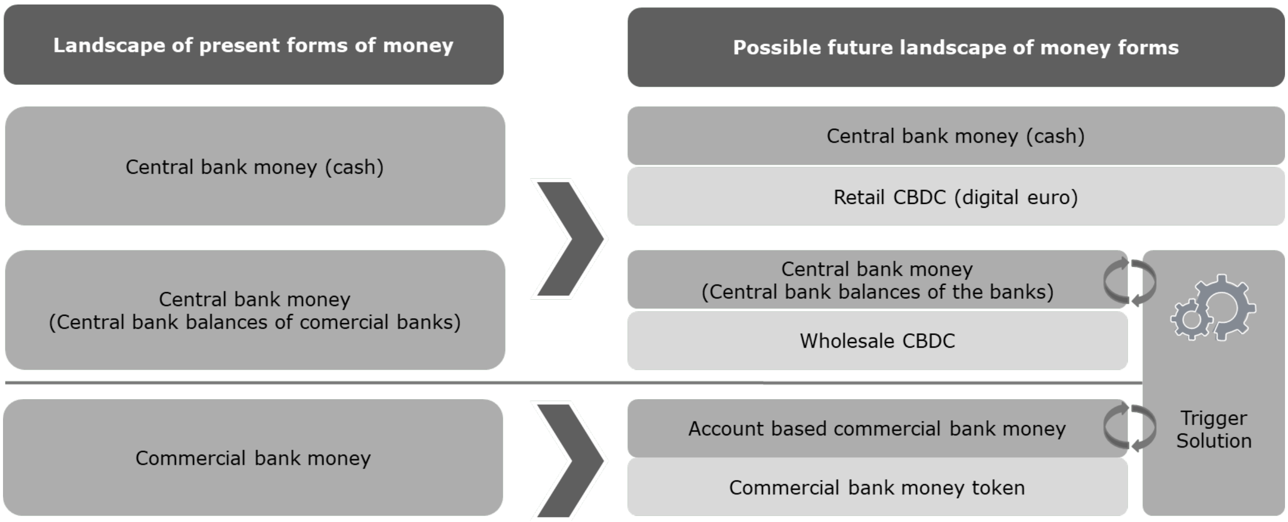

Figure 2

Like today's forms of money and payment processes, the horizon for digital solutions mainly encompasses four types of money:

a. **Wholesale Central Bank Digital Currency** (wCBDC): a new, digital form of central bank money for interbank transactions.
b. **Retail Central Bank Digital Currency** (rCBDC): a new, digital form of central bank money, similar to today's cash, in particular for private individuals.
c. **Tokenised commercial bank money**: digital version of the scriptural money currently managed by commercial and savings banks.
d. **Trigger solution**: a technological bridge between an underlying transaction based on a new, digital technology (e.g. blockchain) and the existing payment transaction systems, able to "trigger" payments in an automated and/or programmed fashion.

CBDC

CBDC is a digital form of today's central bank money which can generally be divided into two sub-categories:

- First, what is known as "retail CBDC" (rCBDC). This could grant non-banks their first digital access to central bank money. In everyday life, this legal tender is currently available to them only physically in the form of cash.[13] As outlined chapter 3.2 above, suitable use cases include in particular PoS, IoT and P2P for B2C.

- Secondly, wholesale CBDC (wCBDC). This is digital central bank money which would be used solely in payment transactions among commercial banks and savings banks, other financial institutions and central banks. It would be suitable in particular for large volumes and is designed for capital-market-related services (e.g. securities and foreign currency transactions). wCBDC is suitable for use cases in the capital market environment, in particular FX and electronic securities.

The decision on the introduction of CBDC will be taken by the ECB; beforehand, however, it will require a very thorough analysis and a detailed discourse, *inter alia* with the banking sector. The pros and cons of digital central bank money will largely depend on the details of the design. The potential forms and design options for rCBDC will be discussed in greater detail in the chapter on CBDC. The use of wCBDC is explained in more detail in the "Capital Market" chapter.

Tokenised commercial bank money

Both rCBDC and wCBDC – the digital form of today's central bank money – would be complemented by a tokenised DLT-based form of commercial and savings bank money, which could primarily provide a potential solution for a wide range of business-to-business (B2B) applications, in particular with a view to Industry 4.0 and DLT-based underlying transactions. The DLT benefits outlined above would have a supporting effect. These benefits would help significantly to leverage efficiency gains and permit an implementation of customer business logic. Since commercial and savings banks can directly make tokenised commercial bank money available to business enterprises on a wide variety of DLTs, the companies' underlying transactions would remain independent. Use cases for digital assets, M2M or trade finance are particularly suitable in this context.

Models based on a variant of tokenised commercial bank money might similarly prevail in the capital market sector (e-securities & FX) or for large-value payments. This will depend on the support of central banks. Until the introduction of a wholesale CBDC by the ECB, tokenised commercial bank money might also support interbank settlements in the capital market or large-value payments.

Tokenised commercial bank money might enable commercial and savings banks to continue to create money, which is important for financial stability, and hence to maintain flexible lending and supply of liquidity. A decline in total assets – which is a risk if CBDC is used abundantly – could be avoided by clearly limiting the volume and the functions of rCBDC. The proven two-tier financial system – made up of the central bank and commercial banks – would remain intact. Potential credit risks for depositors could be countered by suitable governance models. Various forms and design options of tokenised commercial bank money are described in the Chapter "Tokenised Commercial Bank Money".

[13] One exception is the "Bundesbank-certified cheque", a "securitised" instrument and cash-like form of central bank money which is only rarely used in everyday life; see Section 23 BBkG.

Trigger solution

The trigger solution builds a bridge between the novel technology (e.g. DLT) on which an underlying transaction is based and conventional payment transaction systems in central bank and scriptural money. Because one property of trigger solutions is to make use of existing infrastructure, they can be implemented within a short period of time and can easily be scaled. Today, commercial and central banks have already launched various initiatives that explore implementation options or are already performing test runs. One disadvantage is that, due to the required discontinuity in media, a transaction coordinator is needed to set the payment trigger by transmitting information in the conventional manner. Improvements could be achieved if smart contracts were included as payment triggers in regulatory provisions.

The benefits and drawbacks compared with tokenised commercial bank money are complex. First the other drawbacks: Unlike most DLT-based approaches, a trigger solution can only result in a DvP-like construct because the payment-versus-delivery nature of the transactions cannot be fully ensured, so that intermediaries have to be used for this purpose. This process can therefore not be equated with what is known as an "atomic swap" because it is still fraught with interface risks for capital-market-related transactions (including the settlement of securities). Long-term drawbacks may be the high availability required and the effort needed to keep the technical interfaces up to date, as well as the fact that a relatively old technology is used as a basis. Another downside is the fact that nano payments are not possible or that micro payments are not cost-efficient. In addition, conventional payment transaction systems must ensure that a large number of participating commercial and savings banks are capable of instant transfers and provide consistent availability (24/7). However, this has largely already become reality due to the increasingly widespread use of instant payments.

On the contrary, an upside is the fact that it would not be necessary to invest in token-based payment systems that would have to operate in parallel, and the operational implementation would probably be less complex for all the parties involved. Depending on the use case, trigger solutions can be seen as a transitional solution or even as a longer-term solution. The integration of standardised APIs, combined with clear proof of identity between the participating systems, is the target operating model, but also a challenge.

Potential solutions along the timeline

It is currently not yet possible – due to the investment cost and risks cited above, but also because of the exceptionally great opportunities provided by the various use cases – to assess how long it would take to implement the potential solutions. The chart below illustrates various conceivable scenarios for the implementation of the different digital forms of money and payment.

Today, there are already productive DLT-based applications (e.g. in the fields of trade finance, e-securities etc.). New developments and advances are being pursued with great vigour, in particular by commercial and savings banks. As outlined in Chapter 3, this trend will probably not abate, but rather intensify. Based on target groups and use cases (line 1), Figure 3 describes the type of underlying transaction on the DLT (line 2) and the associated potential provision of different forms of money (line 3). A small circle stands for a less pronounced and less widespread type of underlying transaction, while a big circle indicates a more pronounced and more widespread type of transaction. If an underlying transaction can already be implemented on a DLT, it can generally be assumed that implementing trigger solutions would not take long in this case. Development and implementation in profitable business models will probably help primarily to facilitate additional B2B solutions. Finally, the next step would be adding B2B and B2C use cases to reflect progress in, among other things, the field of digital central bank money and tokenised commercial and savings bank money.

		Capital markets related		B2B			B2C		P2P
1		Electronic securities*	FX*	Digital assets (without electronic securities)	Trade finance	M2M	IoT	PoS	P2P
2 **DLT-based underlying transaction** (asset leg)		✔	✔	✔	✔	✔	✔		
3 **DLT-based payment**** (payment leg)		✔	✔	✔	✔	✔	✔	✔***	✔***
Potential start									
2 **Marketability DLT (DLT-based underlying transaction)**	2021-2022	✓	✓	✓	✓	✓	✓		
	2023-2026	✓	✓	✓	✓	✓	✓		
	>2026	✔	✔	✔	✔	✔	✔		
3 **Solution**	2021-2022	Trigger/ Fully backed Stablecoin	Conventional payments	Trigger	Trigger	Trigger	Trigger		
	2023-2026	Trigger/ Fully backed Stablecoin	Fully backed Stable-coin	Trigger/ Commercial bank money token	Trigger/ Commercial bank money token	Trigger/ Commercial bank money token	Trigger/ Commercial bank money token		
	>2026	Wholesale-CBDC/ Fully backed Stablecoin	Wholesale-CBDC/ Fully backed Stablecoin	Trigger/ Commercial bank money token	Trigger/ Commercial bank money token	Trigger/ Commercial bank money token	Trigger/ Commercial bank money token/ Retail-CBDC	Retail-CBDC	Retail-CBDC

(existing payment systems will remain)

Piloting DLT-based business transactions (✓) to significant market shares on DTL (✔)

* FX with DLT-based underlying transaction
** Possibility of/aim toward DLT-based payment
*** depending on ECB's decision regarding a digital euro

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Figure 3

In view of the diverse forms of the various models and the associated opportunities and risks, it is important to bear in mind that digital solutions do not have to be in keen competition with each other. Instead, the objective is a parallel development of specific use cases in line with the maturity of suitable solutions, making use of different forms of digital money in the process. A key issue will probably be that the provision of new forms of money must be closely linked to cooperation with the central bank and the regulator.

5 Retail-CBDC

5.1 Abstract

- In this paper, the German Banking Industry Committee (GIBC) attempts to specify, for the first time, the conditions under which, from today's perspective, a digital form of central bank money might be successfully introduced for eurozone citizens[14] (digital euro, retail CBDC),[15] for the European Central Bank (ECB)[16] and, not least, for financial institutions.
- GIBC supports the idea of a digital euro. In our opinion, the overall economic advantages of introducing one could be significant and strengthen the international competitiveness of the eurozone.
- A digital euro will only be successful if citizens see it as an attractive addition to the forms of money and payment methods already available to them.
- The proven intermediation function of banks should be used to introduce the digital euro. This way, any negative consequences for economic growth and employment can be prevented.
- Caution must be exercised in choosing the design of the digital euro, so as not to inflict any damage on the real economy. If a digital euro is introduced without conditions, banks expect there to be a significant burden placed on their refinancing and liquidity base. This might lead to an increase in financing costs for the real economy, e.g. for longer-term loans. Financial institutions in Germany and Europe play a key role in financing the economy.
- GBIC sees many advantages in a digital euro being issued and settled via a decentralised infrastructure, with the active involvement of regulated and supervised banks as intermediaries, trustees or settlement agents.
- Demand for a digital euro might therefore not only increasingly replace cash in our everyday lives, but also weaken the deposit side of banks' balance sheets thereby making, for example, maturity transformation more difficult.
- In order to integrate the digital euro into the proven two-tier banking system, the focus should be on its use as a method of payment. Bearing in mind the principle of subsidiarity, the ECB should also avoid replacing existing innovative payment solutions in the financial sector with its own offers.
- Financial institutions are perfectly placed to make the euro suitable for new digital payment processes that go beyond merely supplementing cash as digital legal tender, e.g. with the help of blockchain technology. They are already working on programmable payment procedures by incorporating DLT protocols into existing payments (trigger solutions) and digital bank money (bank money token).
- The usability of programmed payments is a feature that might considerably increase the attractiveness of the digital euro for citizens and give banks the opportunity to provide associated services. However,

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[14] In this text, "digital euro" stands for retail Central Bank Digital Currency which can be used by non-banks, in contrast to wholesale CBDC which is used in payments between banks and central banks and not dealt with here.
[15] The terms citizen, household and consumer are used synonymously in relation to retail CBDC in this text.
[16] For the sake of simplicity, the abbreviation ECB is used as synonymously with the European System of Central Banks (ESCB).

GBIC has reservations about the direct programmability of the units of a digital central bank currency. As this would mean it would no longer be a widely accepted and universal method of payment.

- As with cash, the digital euro should be aimed at households using it for everyday payments, in particular for retail payments and those to government institutions. It is essential to clarify the terms of its availability for intraday use and those for businesses to transfer the excess digital euro back into bank deposits as quickly as possible.
- In order to strengthen acceptance of the digital euro and financial inclusion of the population, each citizen (resident) in the European Monetary Union (EMU) could be granted through EU or national law the entitlement to a wallet containing a (precise) quantity of CBDC held at a bank of their choice. This would implement the upper limit in a way that is operationally effective and can be controlled. GBIC believes that introducing a clearly defined, low upper limit to appropriately restrict the supply of digital euros in circulation is the only practical solution that can be implemented with reasonable effort.
- GBIC has deliberately chosen not to name any specific amount for the proposed upper limit in this paper. This is because we are convinced that the amount the upper limit is set at will have major political, economic and communications ramifications and will potentially be crucial for the success of a digital euro. Careful analysis is needed to determine the level at which it should be set. We would be willing to engage in an in-depth dialogue on this and other related issues.

5.2 Motivation and background

In October 2020, the European Central Bank (ECB) published a report on the digital euro and subsequently initiated a public consultation, the results of which were announced in mid-April 2021. GBIC also took part in this consultation. This paper is an initial attempt by members of GBIC to set out in more detail the framework conditions – as seen from today's perspective – under which the introduction of a digital euro for end consumers (retail Central Bank Digital Currency, CBDC) might be a success for citizens in the eurozone, the ECB and financial institutions. Firstly, the paper analyses what effects CDBC might have on the banking sector. It then considers the main functions and required features of a digital euro as well as looking at a preferred technical framework needed for the infrastructure of a retail CBDC and describes a functional model to achieve it. All the statements in this paper are based on current framework conditions with low interest rates. Should interest rates rise sharply then this would considerably amplify the urgency of the arguments, particularly those for effectively restricting the digital euro.

All members of GBIC agree with the basic assumption that the digital transformation will not only fundamentally change the way we live and do business, but also the way we pay for goods and services. GBIC is, therefore, of the opinion that central banks across the globe must consider the ways in which central bank money can or should undergo a digital transformation. GBIC shares the view of the central banks that retail CBDCs could help them fulfill their statutory tasks, also in a digitised world. In particular, this includes maintaining public confidence in the currency, ensuring price levels and the financial system remain stable, and providing secure and robust payment systems and infrastructures. However, an in-depth analysis reveals that a project to provide all the citizens of a currency area with central bank money in digital form – similar to cash – represents a major challenge for central banks and financial institutions for a variety of reasons.

The ECB has not yet made a final decision as to whether a project to produce a digital euro really will go ahead. Nevertheless, the members of GBIC support the basic idea of a digital euro. In our opinion, the overall economic disadvantages of not introducing one could well be considerable. It is perfectly reasonable to expect that, in the coming years, the eurozone will see an intensifying of international competition in the field of money and finance – driven by global technology companies on one hand (e.g. from stablecoins), and foreign central banks on the other (e.g. from their national CBDCs). It is therefore vital that the euro – as the currency and legal tender of the eurozone – retains its key role as a unit of account, a means of payment and a store of value. Anything else would not only damage the reputation of the ECB, but also be a threat to the eurozone's currency and economic policy sovereignty. Effective monetary policy aimed at ensuring price stability in its own currency area would no longer be possible if wage pricing in the real economy or, e.g. lending, were no longer based on the euro. We would then risk seeing a system of parallel forms of money with diverging values and exchange rates.

The success of a digital euro would depend largely on whether citizens in the eurozone saw it as an attractive addition to the forms of money and payment methods currently available to them. As well as the more familiar basic requirements of cash as a general means of exchange – that it is universally accepted, that it can be used easily, quickly, securely and anonymously – digitisation would also mean that it could be used for frictionless online payments with no media discontinuity or delay.

A digital euro that offers citizens no or not enough added value over alternative payment solutions is unlikely to compete successfully with the latter despite all the overall economic and sovereign necessities. Many citizens in the eurozone have set out their ideas in the ECB's consultation. What respondents wanted most from a digital euro was privacy (43%), security (18%), usability across the eurozone (11%), the absence of additional costs (9%) and offline use (8%).[17] The latter would be significant if the digital euro, like cash, is to perform the task of acting like a safety net in times of crisis. The design of the digital euro must be based on these preferences.

The success of the digital euro will depend very much on the financial institutions of the eurozone. Members of GBIC have emphasised that the intermediary function of banks in the monetary and financial system must not be weakened by the introduction of a new digital form of central bank money. Otherwise, this will have negative consequences for economic growth and employment. They are further of the opinion that including financial institutions in the process of circulating the digital euro would tangibly improve its chances of success because their existing core competencies could be used as a foundation from which to build on.

Against this background, it is vital we first identify what features a digital euro must have if it is to complement physical cash at the digital level, and what functions it should perform in a two-tier banking system. The following two sections deal primarily with these "design questions" and their implications for the commercial banking system.

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[17] https://www.ecb.europa.eu/pub/pdf/other/Eurosystem_report_on_the_public_consultation_on_a_digital_euro~539fa8cd8d.en.pdf

5.3 The technological infrastructure for a digital euro

In its report from October 2020, the ECB outlined various scenarios for the technical design of a digital euro. Their descriptions were relatively abstract. However, the choice and later implementation of one of the scenarios for a digital euro will be crucial in influencing its overall economic impact and the functionality of the banking sector. We, therefore, recommend that a decision is made as to which infrastructure is the most suitable before deliberating further.

In the opinion of GBIC, there are convincing arguments in favour of also applying long-established and proven forms of cash allocation to the digital euro. Accordingly, direct access to the Eurosystem and thus also to future retail CBDCs would remain the preserve of financial institutions. They would swap their own central bank credit for digital euros – which would remain a liability to the ECB – and issue these to their customers in exchange for cash or bank credit (deposits). Issues of trust and, where appropriate, anonymity surrounding subsequent transactions between citizens, companies and possibly government payment recipients of a digital euro would have to be regulated with appropriately chosen technological and legal solutions.

GIBC is aware that acceptance of the digital euro, and therefore its success, will depend very much on ensuring payment transactions are confidential and, where appropriate, anonymous. It is not yet fully known to what degree a digital euro could guarantee the anonymity of a payment transaction. There may well be hidden barriers in terms of technological feasibility or in the regulatory requirements that will need to be met. In particular, anti-money laundering and combating the financing of terrorism (AML/CTF) regulations in their current form might stand in the way of widespread anonymity. Appreciable discrepancies between citizens' preferences and the technical regulatory possibilities cannot therefore be ruled out. There are also fundamental technical issues that still need clarifying, such as how and whether a digital euro can also be used "offline". At this point in time, it is not yet possible to provide more detailed answers to these questions.

The advantage to citizens of involving banks in the process would be that they could have their digital euros transferred directly to existing bank accounts. Furthermore, the banking system's existing core competencies, such as customer proximity, existing access channels (branches, online solutions), setting up accounts/wallets, know-your-customer (KYC) processes and anti-money laundering and combating financing terrorism, could continue to be used without the Eurosystem having to set up new infrastructures and processes. At the same time, banks would be able to provide new and innovative banking services based on the new digital euro.

When these considerations are compared with the ECB's proposals for an infrastructure for a digital euro, the idea of having a decentralised and indirect "hybrid bearer digital euro and account-based infrastructure" seems to be the most promising.

With a decentralised infrastructure of this kind, citizens would hold digital euros as a claim against the ECB in a wallet (like a depot) at their financial institution, which would act as a settlement agent. The banks would remain in contact with their customers and would be involved in the processing of payments made with a digital euro. They could offer a range of financial services based on the digital euro, thereby maintaining the financial link between citizens, businesses and the central bank. The two-tier banking system would remain largely the same.

However, it is important to add that there is not currently enough information available about the technological feasibility of this proposal to assess whether the requirements of a digital euro outlined below could be implemented in full. There is, therefore, some uncertainty as to what extent elements of the ECB's other infrastructure proposals might have to be taken into account.

In its report, the ECB has stated that the digital euro should be free of charge for citizens. Nevertheless, payments with a digital euro will require huge investment by the banks, businesses and the public sector, both in the preparatory phase and later in everyday operation, as well as generating ongoing operating costs. To cover the costs, the banks will need a pricing model for the digital euro and related products and services, and this would apply whether it is the ECB or citizens that end up paying for the costs of the digital euro. Insofar as the banks are acting in the interests of the state and on behalf of the central bank, this issue of apportioning costs fairly should be discussed in good time with all the parties involved.

5.4 Thoughtfully introducing a digital euro

Integrating the digital euro into the two-tier banking system would mean…

Digital central bank money for non-banks – the digital euro – would be an innovative form of money that would unify certain characteristics that were previously separate. A digital euro of this kind would combine the advantages to citizens of cash as currently the only legal means of payment and of bank money as currently the only way of making cashless payments. It therefore has the potential to change the geometry of the European banking system. As a result, integrating it into the two-tier banking system will not be possible without changes being made to the existing monetary order, if the advantages of a functional separation of central and commercial bank money, which are indispensable for a market economy, are to be maintained.

As a new form of money, the digital euro would open up additional, attractive opportunities for citizens to use it either for making payments or as a store of value in the form of monetary assets. Citizens can currently only choose between cash and bank deposits. But soon there will be the digital euro, which is superior to both of them. It will reduce the costs to citizens of holding central bank money to almost zero and is therefore a more attractive alternative to cash. Not only that, but with a digitally transferrable form of central bank money, if citizens decide they no longer have confidence in the bank where their accounts are held or in its deposit protection scheme, they can transfer "in a single swipe" some of their financial assets to a risk-free form of digital euro. Demand for a digital euro might therefore not only replace cash in our everyday lives, but also destabilise the banks' deposit base and make maturity transformation more difficult. In addition to causing a gradual, structural disintermediation of the banking system, there would be a very real risk that a crisis of confidence which calls into question the entire banking system could result in the large-scale transfer of funds from banks to the central bank in a very short space of time, almost at the click of a mouse (digital bank run). Introducing a digital euro without conditions could therefore severely impair financial stability.

...limiting its direct impact on the banking system.

GBIC has been carefully considering the issues surrounding structural disintermediation. In its assessment, financial institutions would face the following challenges in the event of a substantial loss of customer deposits:

- The large-scale loss of deposits from a number of customers would have a negative liquidity effect on banks in today's low-interest environment.
- Demand for a digital euro may increase the banks' need for central bank funds. The ECB would have to accommodate this need.
- Within the financial networks, outflows of customer deposits at the primary level are also likely to have significant repercussions for the central institutions, whose function is liquidity equalisation.
- Given today's regulatory requirements, the loss of customer deposits would have a fundamentally negative impact on the liquidity coverage ratio (LCR) and net stable funding ratio (NSFR). Heavy-lending financial institutions with long-term loans are likely to be particularly badly affected. Small-scale customer deposits are especially valuable for meeting liquidity ratios due to their stability. This stability could be put at risk from the specific characteristics of the digital euro. As a result, it would make the banks' maturity transformations more difficult, their offers of long-term loans would become more expensive and their interest income would decrease.
- Ultimately, shifting payments to a digital euro would inevitably have a negative impact on earnings from commissions.

When introducing a digital euro, it is important to avoid such long-term changes to the financing structures of the banking system and the economy, e.g. with banks reaching maximum regulatory ratios more quickly. After all, in Germany and in Europe, financial institutions play a key role in financing businesses, citizens and, not least, the public sector. Consequently, the concrete design of the digital euro must be chosen with caution in order to avoid damaging the real economy.

......designing it to complement innovations to payments developed by banks.

Making the euro suitable for new digital payment processes, e.g. with the help of blockchain technology, should remain a task for the financial institutions. They are already working on programmable payment processes (trigger solutions) and digital bank money (bank money token) that is specifically designed for use by businesses.

Banks are not only willing but also in a position to offer their corporate customers innovative solutions, since today's monetary and payment system offers cannot fully exploit the potential of distributed ledger technologies (DLT) in the corporate sector. These could be used to further digitise processes in the economy, for example, for use in smart contracts (automated payment triggers in the process) or nanopayments (payments worth fractions of a cent).

One alternative to tokenised money in these process chains is to link DLT structures in the economy with today's payments (trigger solution) which would also allow smart contract automation for a variety of purposes. GBIC has been in intensive discussions with the corporate sector for some time now to develop needs-based and innovative solutions in this area.

Although demand from businesses is currently limited, we expect it to increase dramatically in the coming years. GBIC has recognised the necessity to develop and offer solutions in this area. Working groups and projects have been set up both within commercial banks and at the national and European level. The objective of these projects is to strengthen European payments and keep them autonomous and competitive with the big tech companies, currencies from foreign central banks or means of payment provided by non-banks and/or non-government actors.

In general, the Eurosystem should avoid holding back projects in the financial sector – also in view of the subsidiarity principle – with superior offers of its own, thereby stifling innovation in this area of the banking sector.

Rather, GBIC hopes the Eurosystem will proactively support the coordination process among commercial banks in the eurozone. In particular, it is a matter here of establishing joint European and possibly even global standards for trigger solutions and commercial bank money tokens, as well as international payment solutions using (wholesale) CDBC.

…carefully reviewing and questioning its programmability.

In principle, the opportunities from this kind of programmability also lend themselves to the digital euro. It would even be possible to programme the digital monetary unit itself. This means that digital money could be programmed with a series of inherent logics based on its characteristics, which would link the use of digital central bank money to specific and predefined conditions. The digital euro might also be used in programmable payments systems. This would include automatically handling potentially very complex digital business processes. Here, too, payment would depend on certain pre-programmed conditions being met. Both versions are being discussed in connection with retail CBDC.[18]

GBIC has reservations about the direct programmability of the units of a digital central bank currency, especially if the digital euro were to lose its characteristic as a general, universally valid and frictionless means of payment.In contrast, the programming of payments is likely to quickly become important for cashless payments. Banks are developing the instruments required to do this with trigger solutions and bank money tokens. Programmability will require innovative energy. Thanks to their proximity to customers, banks are well placed to develop programmable payment applications. This also applies to end-user applications which used the digital euro. Not only would this make the digital euro very attractive for citizens, it would also give banks the opportunity to offer new products and service.

…limiting the digital euro to its function as a means of payment.

To successfully integrate the digital euro into the two-tier banking system, it is vital that the digital euro is not allowed to replace cashless payments and bank deposits. Both can only succeed if digital central bank

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[18] See the Bundesbank's monthly report from April 2021, p.66: https://www.bundesbank.de/en/publications/reports/monthly-reports/monthly-report-april-2021-864102

money is not asked to go beyond its function as an everyday means of payment and become a store of value, i.e. "stored" as an investment. As a result, the digital euro must be limited as effectively as possible to its function as an everyday means of payment for citizens.

This is no trivial task. Up to now, there have been good reasons why neither central bank nor commercial bank money can only be used for particular purposes – and there are some fundamental considerations as to why this should be the case in a free state under the rule of law. Both forms of money can basically be used as transaction cash, precautionary cash or as cash assets. The motives for non-banks to hold money are therefore not easily distinguishable in today's money order.[19]

In order to prevent the digital euro being used as a store of value on a large scale, the amount of digital central bank money in circulation at non-banks should be effectively limited, in our opinion. It is nevertheless important to ensure that any restrictions placed on it that do not apply to cash and commercial bank money are kept to a minimum, so that the attractiveness of this new form of money is not compromised in any way. After all, the aim of the digital euro should still be to counter the decreasing use of central bank money for everyday payments and to give citizens access to an equally convenient and secure, but more contemporary form of central bank money for the digital age.

...modelling the monetary cycle on the cash cycle.

The first important step in controlling the amount of digital euro in circulation would be to model the circulation of the digital euro in the economy – i.e. how this new form of money is created, circulated and destroyed – on today's cash cycle, as follows:

- Citizens would obtain digital euros either by depositing cash or – and this is likely to be the rule – by debiting a bank account. This would allow the amount of digital euro in circulation to grow.
- It would require banks to have sufficient central bank money at their disposal.
- While citizens hold digital euros or exchange them amongst themselves, they would remain part of the supply of digital euro in circulation at non-banks, this would not change.
- If, however, citizens make purchases, whether at physical shops or online, then what happens is similar to what already occurs with cash today. Latest by the end of each day, though possibly also several times a day, the digital euros in "business wallets" are automatically credited to the company's current account.
- As soon as the digital euros that are circulating in the economy and being accumulated by businesses and, in some cases, also in households are transferred back to bank accounts, i.e. are credited to a current account at a bank, the cycle is complete. The amount of digital euro in circulation at non-banks begins decreasing again.

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[19] "Money is not earmarked" – see also the Bundesbank's monthly report July 2020, p. 47-60:
https://www.bundesbank.de/en/publications/reports/monthly-reports/monthly-report-july-2020-837652
Cash hoarding by German households – how much cash do they store and why? (representative survey conducted from January to April 2018), on the methodical difficulties of obtaining true information about the motivations of individuals holding cash.

This would result in a controllable and limited amount of digital euro in circulation, comparable with today's cash cycle. In view of the primary goal of providing citizens in the eurozone with a digital counterpart to cash for all everyday purchases, suitable precautions need to be taken to ensure the digital euro cannot be used by other groups of users, particularly businesses, as a store of value and/or for intraday payments.

…limiting the amount of digital euro given to each citizen.

However, these measures alone may not be sufficient to effectively restrict the amount of digital euro in circulation at non-banks. These restrictions must therefore be kept to an absolute minimum and remain proportionate to their intended purpose. Several instruments to achieve this are currently under discussion:

- Tiered remuneration system (staggered interest model)

  In its review from October 2020, the ECB proposes a system with staggered interest (tiered system).[20] In this system, the amount of digital euro that can be held is unlimited. However, all amounts from a yet to be determined threshold pay interest at unattractive rates, i.e. far lower than usual market rates. It is assumed that the digital euro will not bear a positive rate of interest in its function as a means of payment, this basically means a negative interest rate for all amounts above the "allowance".

  This model is likely to be a suitable method of preventing the structural disintermediation of banks in periods when confidence is stable. But if there is a run on the banks, it will likely fail because, as experience shows, a bank run cannot be prevented simply through controls on interest rates.

  The same applies to potential cross-border capital flight within the eurozone. In the event of even a minor crisis of confidence in an individual member state, its citizens could – on a large scale, with little effort and within a very short period – use the ECB or the national central banks of the eurozone as safe havens by converting their bank deposits into digital euros. This new form of "flight to safety", which has never existed before, could make balances of payments between member states considerably more volatile. The investing public are unlikely to be put off by low or negative interest rates on the digital euro.

  Added to which, it would be very detrimental to citizens' confidence in the stability of the currency and the monetary policies of the central bank if, for the first time ever, legal tender in the eurozone were to be given a "built-in interest rate disadvantage" thus deliberately ascribing it a loss in value ("stamp scrip").

- Expiry date

  An alternative solution could be to limit the holding period for reserves of digital euros. This would mean digital euros issued by the ECB via a bank to a customer of that bank could only be used for payments for a limited period of time – a week or a month, for example. After which time, the digital euro would automatically be credited back to a bank account.

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[20] See U. Bindseil, Tiered CBDC and the financial system, ECB Working Paper no. 2351, January 2020: https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2351~c8c18bbd60.en.pdf

While these variants would be appropriate to at least weaken the problem of disintermediation, they still would not solve the problem of bank runs. There is considerable doubt as to whether this model would work in practice. It would mean that citizens would always have a "mix" of digital euros in their wallets issued on different dates, and therefore also with different expiry dates, which they would constantly have to keep a close eye on. By crediting these amounts back to a bank account automatically, it would mean sums would simply "vanish overnight". In conclusion, there is concern that money with an expiry date – similar to that of food, for example – would not be accepted as proper legal tender.

- Fixed upper limit

  One solution to the problem associated with the digital euro of structural disintermediation and to the problem of a digital bank run could be a fixed upper limit on the amount of digital euro any one citizen can hold. An upper limit of this kind would presumably be easy to implement on a technical level. For example, if an incoming payment in digital euros exceeds the upper limit in a citizen's wallet, the "excess amount" would automatically be transferred into bank deposits.

  To achieve this, each holder of a wallet for digital euros would have to have an "overflow account" at a bank of their choosing, ideally the same one that acts as the settlement agent for their wallet.[21]

Considering all the pros and cons of the instruments discussed here to effectively and appropriately limit the supply of digital euro in circulation, GBIC believes that a fixed upper limit per citizen is the only feasible solution. All the other alternatives under discussion have considerably greater disadvantages.

In order to ensure the upper limit described above serves its purpose, it should be incorporated into the European legal framework in a way that makes it as "change-proof" as possible. This would be the only way to prevent the upper limit becoming the subject of political discussions and/or decisions. (It could, however, be linked to nominal benchmarks, such as BPI or disposable income per capita, over longer intervals.)

5.5 How high should the absolute upper limit be for each citizen?

It only remains for us to overcome the challenge of deciding what amount the upper limit should be set at. The figure may not be so high that it does not solve the problems of disintermediation and of bank runs. Yet, it may also not be so low that it fails to give citizens sufficient "freedom" to make payments in digital euros.

In an effort to empirically determine an upper limit for the digital euro, it has been suggested that the figure could be linked to the supply of cash circulating in the eurozone as a reference value. In 2020, this figure was around 4,000 euros per capita of the entire population of the eurozone. However, this figure is unsuitable as a reference value because there is also high demand for euros as an investment, especially among wealthy individuals, and from outside the eurozone. Other indicators should be used to estimate or restrict digital central bank money per head of population for everyday payments. Key figures include:

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[21] ibid, p. 3: "*Where holding limits are imposed, respondents agree that the best way to allow incoming payments above that limit is by automatically transferring the excess digital euro to an account held with a private institution.*"

- In 2019, disposable income per capital in Germany was almost 2,000 euros per month and in the eurozone this figure was almost 1,800 euros on average.
- In 2017, the average German purse or wallet contained nearly 110 euros.
- They also stashed an average of 1,364 euros in their homes for emergencies.
- Representatives of the ECB have been discussing a sum of 3,000 euros.[22]

GBIC is deliberately not naming any specific amount for the upper limit. This is because we are convinced that the amount the upper limit is set at will have major political, economic and communications ramifications and will potentially be crucial for the success of a digital euro. Careful analysis is needed to determine the level at which it is set. We would welcome an in-depth, professional dialogue with, among others, representative of the ECB on this issue.

If the maximum amount of digital euros that individual citizens can use is set somewhere within the range mentioned above, and if the rules outlined above for the return flow of the CBDC within the bank money cycle are adhered to, then this would represent an effective barrier against the disintermediation of banks. At the same time, the digital euro could also fulfil a number of important functions as well as acting as an attractive addition to cash in the everyday lives of citizens. This would also benefit businesses.

5.6 Outlook and recommendations

In general, the introduction of a digital euro for non-banks with a decentralised infrastructure would be a complicated undertaking, with the need to strike a balance between it being used widely by citizens and preserving banking functions in the economy. The results of discussions between members of GBIC are summarised as follows:

- By guaranteeing citizens permanent access to central bank money, the digital euro should complement the function of cash, thus securing the basic supply of central bank money in digital form to the population.
- The digital euro should be non-interest bearing, like cash.
- The digital euro should not be programmable as a monetary unit, but it should certainly be capable of being used in programmable payment processes.
- GBIC would prefer the digital euro to be brought into circulation via decentralised infrastructure, in which the banks maintain contact with the customers, manage their customers' wallet and implement the transactions. This would also include, for example, processes already in place today aimed at anti-money laundering and combating terrorist financing, and in particular those for verifying identities.
- In order to counter a structural disintermediation of the banking industry and a digital bank run, we recommend introducing a fixed upper limit for the amount of digital euros a user can hold at a time.

[22] See U. Bindseil, Tiered CBDC and the financial system, ECB Working Paper no. 2351, January 2020: https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2351~c8c18bbd60.en.pdf

The precise amount should be determined as part of the political process using empirical data on the use of cash.

- It should be possible for the digital euro to be used for payments between households as well as for everyday purchases and public services.
- Businesses would convert the digital euros they receive from transactions into bank deposits within a short period of time, latest by the end of each day.
- Assuming these conditions are in place, we do not expect there to be any long-term negative effects of disintermediation on the commercial banking system and therefore also no considerable disadvantages to the economy as a whole.
- However, these conclusions only apply under the current environment of low interest rates with high excess liquidity in the banking sector.

6 Tokenised Commercial Bank Money

6.1 Abstract

- In the present paper, the German Banking Industry Committee (GBIC) has for the first time summarised its conceptual analyses in respect of tokenised commercial bank money. The analyses were conducted as part of the "Digital Euro" project. The institutions and associations involved have formulated strategic guidelines and functionalities for tokenised commercial bank money, described potential governance models, drawn up technological blueprints and identified initial implications for the financial reporting of commercial and savings banks.
- The concept is based on the digitalisation of business processes in industry (Industry 4.0), the growing importance of digital assets, and the digitalisation of foreign trade transactions, which call for the further development of payment transactions.
- The German Banking Industry Committee (GBIC) assumes that the use of Distributed Ledger Technology (DLT) as described above will become increasingly important, with the underlying transaction being based on DLT. This requires a new form of money – tokenised commercial bank money – which will enable efficient, fully digital handling of payment transactions.
- Tokenised commercial bank money is embedded in an ecosystem of Central Bank Digital Currency (CBDC), which is primarily designed for use by citizens as a digital form of cash, and the Trigger solution, which dovetails DLT-based business processes used by corporate customers with conventional payment transactions.
- Tokenised commercial bank money uses the fundamental properties of the latter as a model. Tokenised commercial bank money is directly fungible with tokenised money issued by other participating commercial and savings banks. It can also be directly converted into today's commercial bank money and into cash or a future CBDC.
- Since it is issued on the customer's DLT, tokenised commercial bank money ensures that the programmable payments are technologically interoperable, without creating frictions due to changes in media.
- Tokenised commercial bank money is complemented by a set of pioneering functionalities that cannot be covered by conventional commercial bank money. Due to the use of DLT, it is possible anytime to settle tokenised commercial bank money transactions in near-time and in extremely small amounts. Nano payments in the sub-cent range, for instance, are also possible. Tokenised commercial bank money is above all attractive for innovative business models because it permits programmable payments to be made smoothly. For this purpose, tokenised commercial bank money operates on programmable infrastructure, which is indispensable for future use cases such as automated payments in the context of the Internet-of-Things or Machine-to-Machine Payments. A further advantage of DLT-based tokenised commercial bank money transactions is that payments are always immediately final from the customers' perspective.
- Due to its design, tokenised commercial bank money can reduce transaction costs and risks, thereby increasing process efficiency, and since it is a payment vehicle that generates no friction losses, it strengthens Europe's universal appeal as a place to do business.

- Tokenised commercial bank money therefore generates essential added value for the digitalisation of the European economy and promotes Europe's competitiveness and its monetary and digital sovereignty. Its introduction is contingent on the development of a European standard and the creation of a regulatory environment that can only be achieved with the involvement of the ECB, national central banks, policymakers and industry.

6.2 Tokenised commercial bank money and its strategic principles

Today's commercial bank money serves as a model for the development of tokenised commercial bank money because it ensures convertibility with central bank money and fungibility among issuing commercial and savings banks. Tokenised commercial bank money is also committed to the precept of guaranteeing convertibility and fungibility. To this end, it will be essential to involve both the ECB and national central banks, so as to ensure that the value of tokenised commercial bank money will be linked one-to-one to the nominal value of the euro. Aside from cooperation with the ECB and national central banks, it would also be desirable to include tokenised commercial bank money in the EU Commission's DLT pilot regime. Embedding tokenised commercial bank money in this regime might help to identify regulatory adjustments required without nipping innovation in the bud.

In the context of cooperation with the ECB, one factor to consider is that tokenised commercial bank money will not be the only new digital means of payment in the next few years. If the ECB Governing Council decides to launch a project designed to introduce a digital euro and, at a later point in time, also to introduce the euro CBDC, tokenised commercial bank money and CBDC must at all costs be prevented from cannibalising one another. While the ECB as the guardian of monetary sovereignty must ensure public access to central bank money, commercial and savings banks will be able – due to their close contacts with industry – to facilitate innovative programmable payment transactions on a wide range of DLTs used by industry. Only a symbiosis, i.e. a clear separation of functions and target groups, will allow CBDC and tokenised commercial bank money to unfold their full impact. To this end, a close exchange with the ECB will be indispensable.

New programmable payment transactions, such as Machine-to-Machine Payments or fully automated payments within the framework of the Internet of Things, will open up new ways to monetise banking services and will also create opportunities for credit institutions to retain and enhance their specific customer interfaces. However, such banking services will only be accepted by industry if the implementation of tokenised commercial bank money is preceded by a plausible cost/benefit analysis demonstrating its added value for businesses and society.

One strength of the current two-tier banking system is the flexible supply of liquidity by commercial and savings banks to business enterprises and consumers. This added value should continue to be guaranteed. In other words, even after the introduction of tokenised commercial bank money, our customers will be able to use bank deposits, and commercial and savings banks, in turn, can continue to create credit, and hence, commercial bank money.

Tokenised commercial bank money can only be launched Europe-wide, which is why the initiative of the German Banking Industry Committee must be seen as an initial impetus. The process of designing tokenised commercial bank money should ultimately lead to the creation of a standard that is suitable for Europe. Only if we introduce tokenised commercial bank money that is standardised across Europe can we succeed in maintaining Europe's competitiveness by making available a secure monetary and payment system to meet new requirements.

6.3 Functionalities of tokenised commercial bank money

Tokenised commercial bank money must have various functionalities and meet customers' consolidated requirements and needs. From a customer's perspective, the long-term benefits of tokenised commercial bank money must provide sufficient potential to be widely accepted and to justify the initial expenditure.

A key aspect is its **interoperability**, which involves four dimensions: (1) interoperability with existing forms of money, in particular with commercial bank money (convertibility); (2) interoperability between tokenised money issued by different commercial and savings banks (fungibility); (3) interoperability between tokenised commercial bank money issued on different DL technologies; and (4) interoperability between tokenised commercial bank money and payment trigger systems (e.g. smart contracts).

To exclude counterparty risks and ensure the token's universal applicability, all four forms of interoperability must be guaranteed. Consequently, future tokenised commercial bank money needs to be fungible between commercial banks and savings banks and – bearing in mind existing limits – it must be convertible to today's commercial bank and central bank money (cash, in the medium term also CBDC). Technologically, interoperability can be achieved by issuing the token on the customer chain. To ensure **fungibility and convertibility**, it is essential – as it is for today's commercial bank money – that tokenised commercial bank money is collateralised at least in line with Basel IV requirements. In addition, 24/7 availability of tokenised commercial bank money must be ensured.

Such tokenised commercial bank money can be made available for both corporate customers (in B2B, B2C) and retail customers along with retail CBDC (B2C, C2C); in addition, it could also be used for governmental bodies (B2G, C2G). In corporate banking, the visionary strength of tokenised commercial bank money lies primarily in the fact that it can also be used for fully automatic machine-to-machine payments in future. On the other hand, programmability of the token (in the form of "inherent properties") and hence possibly limiting it to a specific purpose is not planned, nor is it desirable because its **universal applicability** – a key property of money – might then no longer be guaranteed. In addition, there would be a risk of exchange rates emerging between various types of tokenised commercial bank money, which would jeopardise fungibility. These risks can be ruled out by prohibiting such programmability. However, this would not affect the intention to define the properties of commercial bank money inherently in the token, e.g. denominated one-to-one in euros.

However, due to the programmability of the underlying infrastructure, specific functionalities can be assigned to tokenised commercial bank money (e.g. by means of smart contracts). In this way, only the payment will be programmed, while the monetary unit in the form of tokenised commercial bank money can continue to be used in a sovereign and universal manner. Hence, ensuring technological interoperability will be essential to provide services that are tailored to customer needs. This applies both with regard to DLT in industry and in respect of today's payment transactions infrastructure. Interoperability can either be based on APIs or be facilitated by direct issue on the blockchains of corporate customers. As a key prerequisite, industry's underlying business transactions must remain unaffected and abstract. Since fungible tokenised commercial bank money ultimately operates on a DLT, immediate transaction finality should always be ensured from the customer's perspective.

Tokenised commercial bank money should be **arbitrarily divisible**, with amounts ranging from **sub-cents** to high amounts. **Confidentiality vis-à-vis third parties** will be ensured in line with current and future regulatory requirements (e.g. within the framework of banking secrecy and AML/CTF compliance), similar to today's audits. Today, the CTF audit must be performed in several steps by means of manual processes, which slow down the transaction time. At the same time, some use cases require (maximum) transaction speeds in seconds for tokenised commercial bank money. Although full compliance with CTF requirements is essential, it will be technologically challenging to achieve both objectives (see Chapter 5.3).

A significant feature of the functionalities must continue to be that tokenised commercial bank money can be settled against various foreign currency coins, including future coins, and **cross-border**. First of all, however, it will be necessary to create the regulatory requirements for cross-border settlement. Tokenised commercial bank money should also be capable of cross-currencies settlement.

This fundamental functional design of tokenised commercial bank money is also closely linked to the underlying governance model to ensure fungibility. Some properties of tokenised commercial bank money therefore also depend on the choice of model and will be described in the next chapter.

Above and beyond overriding functionalities, tokenised commercial bank money can also provide additional functionalities derived from the use cases. This includes a potential **temporary offline capability without limiting the amount** (or a permanent offline capability with a limited amount) and the use case of anonymous payments. Customer anonymity in the context of tokenised commercial bank money can be largely ruled out in view of currently applicable AML requirements. However, one potential approach to solving this problem would be imposing a maximum amount per customer. Making anonymous payments possible via tokenised commercial bank money would mainly make sense and be desirable if a CBDC issued by the ECB did not cover this function.

6.4 Interoperability and governance model

The purpose of the governance model is to ensure the interoperability of tokenised commercial bank money. As already described in Chapter 6.3, there are four different forms of interoperability:

1. Interoperability with existing forms of money – convertibility
2. Interoperability of tokenised commercial bank money issued by different institutions – fungibility
3. Interoperability between tokenised commercial bank money and the payment trigger system
4. Interoperability between tokenised commercial bank money issued on different DLTs

6.4.1 Interoperability with existing forms of money – convertibility

Interoperability with existing forms of money, which can also be referred to as convertibility, ensures that the nominal amount of tokenised commercial bank money can be converted anytime into commercial bank money. Tokenised commercial bank money is exchanged for a traditional customer deposit, and hence, commercial bank money. Since tokenised commercial bank money is kept on wallets outside bank accounts, the (technical) challenge is that the issuer of tokenised commercial bank money must always be known because the exchange into commercial bank money always takes place at the issuer. It might be that, for legal reasons, this will only be possible at the customer's "own" commercial or savings bank. For this reason, it might be necessary to link each wallet to a commercial or savings bank, and if a customer receives tokens from other banks, these tokens may have to be converted into tokens specific to the commercial or savings bank concerned (or new tokens may have to be issued).

6.4.2 Interoperability between different institutions – fungibility

The second form of interoperability – also referred to as fungibility – is the interoperability between tokenised commercial bank money issued by different institutions. To this end, tokenised commercial bank money must be exchangeable anytime with any other tokenised commercial bank money, regardless of the issuing institution and without this leading to an exchange rate. Commercial bank money (and hence, tokenised commercial bank money) is a liability of the issuing commercial or savings bank. Tokenised commercial bank money therefore also bears the credit risk of the issuing institution. For this reason, tokenised commercial bank money issued by different institutions is not automatically considered to be identical and exchangeable, especially since there are very different banks in the euro area. However, the fungibility of tokenised commercial bank money is an important prerequisite to its trouble-free use as a means of payment and store of value. To ensure fungibility, there are currently three potential solutions: (1) Fully collateralised stablecoin, (2) SPV with its own balance sheet and (3) commercial bank tokens.

(1) Fully collateralised stablecoin

In the fully collateralised stablecoin model, tokenised commercial bank money (CBMT) is the liability of a commercial or savings bank, but it is fully covered by central bank reserves (alternative: partial coverage by reserves and remainder covered by deposit guarantee scheme). Full coverage by central bank reserves eliminates the counterparty risk and ensures that all tokens are considered to be equivalent, regardless of the issuing institution. In the implementation of the token, the nominal amount must be kept as collateral in an ECB trust account in the form of central bank reserves. The reserves will only be released once the token has been destroyed; this will ensure full coverage at any time.

The advantage of such a solution is the token's intrinsic fungibility, the token carryover and the settlement coincide, which makes genuine DvP possible. This form of coverage permits a decentralised issue of tokenised commercial bank money. As a result, commercial and savings banks could, in competition, quickly implement tokenised commercial bank money on various DLTs. However, commercial and savings banks could conceivably agree to sharing a common technical service provider that will define common token standards and be in charge of issuing tokens. In the current economic situation of surplus liquidity, a fully

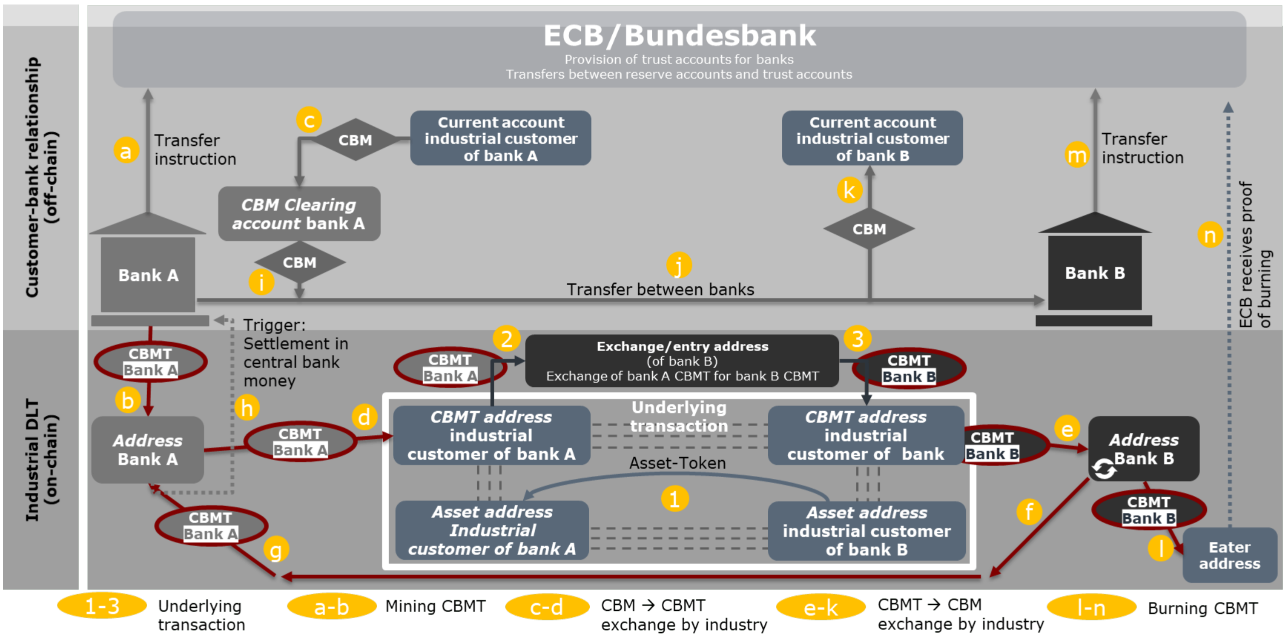

Figure 4 (for a detailed description see Appendix, chapter 9.1)

collateralised stablecoin is attractive from a treasury perspective. If part of the cover is provided by a deposit guarantee scheme, flexibly adjusting the share of central bank reserves is an option to deal with surplus liquidity, depending on the funding situation.

On the other hand, the advantages have to be weighed against a few disadvantages. Due to full collateralisation, the ability of commercial and savings banks to create credit will be limited. The fact that today's commercial bank money is only partially covered by reserves gives rise to significant funding requirements in central bank money for the banks if the coverage of the tokens provided by currently available excess reserves is not sufficient. Furthermore, this model depends on the ECB's willingness for close cooperation because the ECB needs to approve the trust accounts to be set up.

(2) Special Purpose Vehicle (SPV) with balance sheet

In the model of the SPV with balance sheet, tokenised commercial bank money is produced and issued by a central authority, a special purpose vehicle (SPV). This prevents a multi-issuer setting and guarantees the fungibility of tokenised commercial bank money. Tokenised commercial bank money is a liability of the SPV and is issued to commercial and savings banks in return for the provision of securities. The good functioning and attractiveness of this model crucially depend on what securities need to be provided.

To stay as close to today's model of commercial bank money as possible and to retain full flexibility in terms of money creation, there would be a need for collateralisation by credit claims of bank customers. However, this model seems to give rise to some problems and complexities: Against the background of the E-Money Directive, it can be expected that only very safe securities (e.g. government bonds or central bank reserves) can be provided as collateral, or else over-collateralisation will be necessary. As in the case of the fully collateralised stablecoin, money could be created to a limited extent only. At the same time, the use of credit claims as collateral might lead to the lemons problem described by George Akerlof, the

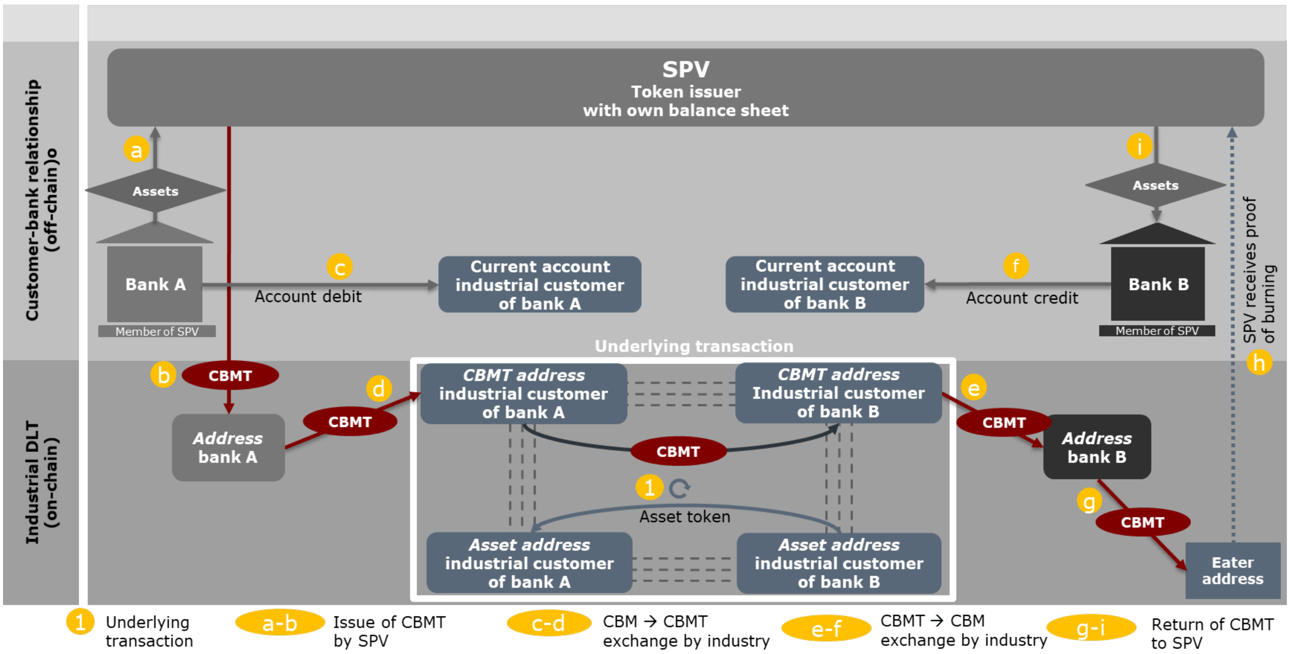

Figure 5 (for a detailed description see Appendix, chapter 9.2)

Nobel Prize winner in economics, because there is an incentive for each institution to transfer its worst claims to the SPV. Moreover, the SPV is a complex structure under company law.

As described in greater detail in the Appendix, there are fundamental balance-sheet differences between tokenised commercial bank money in the SPV model and in the other two models. From the perspective of commercial and savings banks, tokenised commercial bank money is an asset which – similar to a security – is resold by banks to final users and which, from then on, must no longer be kept on their own balance sheet. Intensive use of tokenised commercial bank money would also lead to a decline in the banks' balance sheet assets in favour of the SPV's balance sheet. At the same time, this characteristic is also the strength of an SPV's tokenised commercial bank money because it is a cross-bank token that is not exposed to any specific bank risks and always settles the transaction when the token is transferred. However, a drawback for banks would be that they would merely be suppliers of accounts for the custody of the SPV's tokenised commercial bank money if they want to make the necessary wallets available to their customers, and the role of banks in payment transactions would radically change.

(3) The commercial bank token

In the commercial bank token model, tokenised commercial bank money is a liability of the bank. Unlike the fully collateralised stablecoin, the commercial bank token is not collateralised with central bank money in an ECB trust account. The benefit of such a solution is that it is very close to today's commercial bank money and hence it maintains money creation by commercial and savings banks. The drawback is that tokenised commercial bank money always includes the issuer's counterparty risk, which therefore might lead to the development of exchange rates between tokenised commercial bank money from different issuers. To avoid this and to create fungibility, commercial and savings banks must grant each other credit lines and settle payments with central bank money. In the case of commercial bank tokens, the definition of token standards and the issue of the tokens could also be assumed by an external technical service provider.

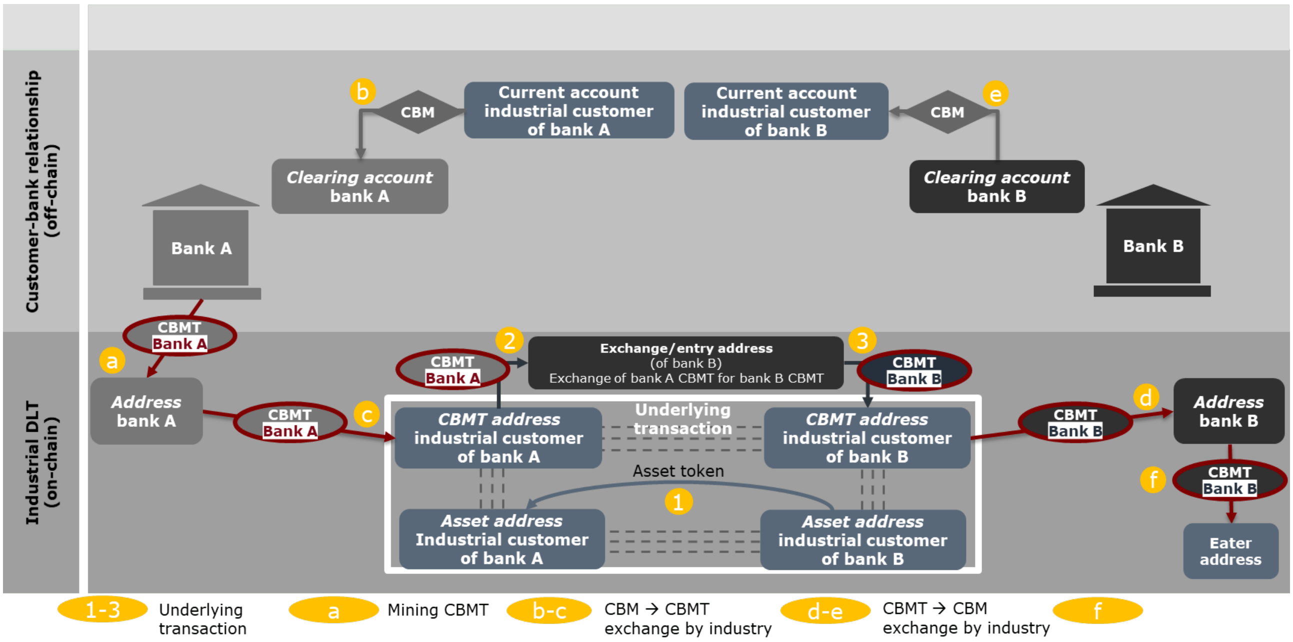

Figure 6 (for a detailed description see Appendix, chapter 9.3)

The difference between commercial bank tokens and the model of the fully collateralised stablecoin and the SPV with balance sheet is that the transaction is not directly settled upon the transfer of the token. Since the token is transferred in real time, the payment recipient or its bank must assume the payment sender's credit risk until the final settlement in central bank money. The most legally sound, most customer-friendly – and hence preferred – variant is that the credit risk is assumed by the payment recipient's bank. If a customer of bank A sends tokenised commercial bank money of bank A to a customer of bank

B, then bank B will credit tokenised commercial bank money of bank B to its customer and assume the default risk of bank A until the final settlement. Commercial and savings banks can either always settle immediately (e.g. via TIPS) or else grant each other credit lines and settle either when certain thresholds are exceeded or at the end of the day. In the medium term, the efficiency of this process could be further increased by using a wholesale CBDC.

The benefit of this governance model is that has very similar characteristics to current commercial bank money, and hence, the changes for commercial and savings banks would be limited, in particular with regard to their ability to create credit. The drawback is that it is not possible to transfer tokenised commercial bank money directly between sender and recipient; instead, transactions have to be addressed to the recipient bank, which will then generate tokenised commercial bank money of its own and credit it to the recipient. Furthermore, this governance model does not permit the use of a pure “on-chain” token but uses the settlement based on the existing payment system, which requires highly performant interfaces between the industry DLT and the existing payment transactions, and in future the interbank DLT of a wholesale CBDC.

6.4.3 Interoperability between tokenised commercial bank money and DLT-transaction

Since tokenised commercial bank money is to be mainly used for programmable payments (i.e. in combination with smart contracts), it must be ensured that tokens used in smart contracts will be interoperable. In this context, two solutions are conceivable. For one,

(1) The payment trigger system must be written directly on the DLT of the tokenised commercial bank money; and for the other

(2) The tokenised commercial bank money is made available on the various DLTs of the payment trigger systems.

In case (1), commercial and savings banks provide a platform on which tokenised commercial bank money is issued and on which smart contracts can also be placed. In such a model, clearing and settlement would also be facilitated for commercial and savings banks because only one token would be issued on a DLT. On the other hand, the final users would be obliged to place their smart contracts on the platform and could not use their preferred DLT without a bridge between the DLTs. In addition, there would be a single point of failure because all participating banks and customers would depend on a common platform.

In case (2), tokenised commercial bank money is issued on various DLTs. Final users could therefore use tokenised commercial bank money as a means of payment on their preferred DLT. At the same time, clearing and settlement would become more complex and require numerous interfaces because it would have to be possible across various DLTs to consolidate, settle and apply various token standards on the DLTs concerned.

Since industries are currently introducing DLTs of their own, some of which are different, it is already apparent that either customers will have to create a connection between their DLTs and the bank’s DLT (1) or else commercial and savings banks will have to make the required token available as service providers. To increase the attractiveness of tokenised commercial bank money for final users, there is a clear preference for the variant described under (2).

6.4.4 Interoperability between different DLTs

It must be possible to make payments between individuals who either accept only tokens of a specific DLT or who use a wallet which can only accept certain tokens. It must be possible to use tokenised commercial bank money of DLT 1 as a means of payment for a payment recipient who only accepts tokenised commercial bank money on DLT 2. Commercial and savings banks can provide the solution to this problem by exercising their function as intermediaries. For this purpose, commercial and savings banks will produce and destroy their tokenised commercial bank money on various DLTs: To transfer tokenised commercial bank money from DLT 1 to DLT 2, the bank will destroy the token on DLT 1 and generate it on DLT 2. However, commercial and savings banks would need to provide a connection to a blockchain infrastructure portfolio, which might increase investment costs.

6.5 Technological framework for use of tokenised commercial bank money

Various aspects of the target operating model for tokenised commercial bank money were described in the subchapters above. These play a key role in the choice of technology and practical implementation.

Aside from functional requirements and the embedding of tokenised commercial bank money in the ecosystem, the choice of the governance model, in particular, will have far-reaching implications, as explained in Chapter 6.4.

Since tokenised commercial bank money is to be made available on various DLTs, it must be technology-agnostic to a certain extent. For this reason, it is not possible to provide a description in terms of the practical implementation. On the other hand, the processes needed can be described with a granularity which permits a relatively direct implementation on the DLTs available today.

Technical onboarding of individual market participants

To achieve and maintain high market penetration, it must be possible for individual market participants to join the process at any time (i.e. during ongoing operations).

For issuers of tokenised commercial bank money, this will be possible due to the chosen governance model and the “mining and minting” process. For users of tokenised commercial bank money, this will be facilitated by external support processes of issuers, wallet providers, etc. and the process of “exchanging commercial bank money for tokenised commercial bank money”.

Offboarding of individual market participants

Like onboarding, individual market participants must be allowed to exit the market without suffering a direct economic loss. For issuers of tokenised commercial bank money, this process will be defined by applicable regulatory requirements and technically supported by the “burning” process. For users of tokenised commercial bank money, this will be facilitated by external support processes of issuers, wallet providers, etc. and the process of “exchanging tokenised commercial bank money for commercial bank money”. For more details, see Appendix under 9 “Technology blueprint and financial reporting of tokenised commercial bank money”.

Economic default of an issuer

In the event of a default by an issuer, the value of the tokens issued by the latter will be jeopardised. Market participants will be subject to same prudential safeguards that apply to today’s commercial bank money.

Termination of the market

Various scenarios are conceivable to terminate the market, i.e. to fully remove the support for a DLT by tokenised commercial bank money. This includes, for instance, the switch to a new DLT or changes in regulatory requirements that prohibit the operation of a currently supported DLT. In principle, this process can be implemented by applying the process of "offboarding individual market participants" to all the market participants.

However, it must be assumed that issuers and/or the SPV will provide support processes tailored to this specific case, in particular if the market is not only terminated but if there is to be a transition to a new market.

6.6 Regulation

It has not been possible to date to carry out a final comprehensive analysis of the regulatory requirements for the introduction of tokenised commercial bank money. Regulatory requirements differ depending on whether tokenised commercial bank money is classified as a deposit, eMoney or stablecoin in accordance with MiCA. In addition, there are various regulatory obstacles for the target operating model. Further analyses will need to be carried out to determine whether a separate classification for tokenised commercial bank money would be helpful.

To outline one of the most serious regulatory challenges, let us assume that tokenised commercial bank money is classified as a deposit. Consequently, the PSD2 would apply to payment transactions. However, in connection with tokenised commercial bank money, this is currently not helpful for various reasons: First of all, the PSD2 makes it impossible to handle smart contracts efficiently in connection with digital money (whether CBDC or digital commercial bank money). An amendment of the PSD2 would therefore be necessary because blockchain-based payment transactions are currently excluded from the scope of application of the PSD2. As stipulated in the account information services (AIS), the PSD2 needs to address, on the one hand, safe access to account information; on the other hand, access by third parties with the customer's consent is covered by the PSD2 or has become a legal obligation. Since the customer personally operates the blockchain in the architecture of digital commercial bank money or has access and full transparency in other architecture models at least via blockchain node, it is not useful to apply the PSD2 to account information services, and it is a major obstacle for the introduction of DLT-based systems. Transparency and access to transactions are provided directly, based on the DLT infrastructure. Moreover, there are plans in the current architecture of digital commercial bank money to place the wallets (= accounts within the meaning of the PSD2) on the blockchain of industry and hence of the customer, so that an interface for the customer will not only be obsolete, but will not have to be provided for financial service providers (APSPs in accordance with the PSD2).

The PSD2 also constitutes an obstacle with a view to payment initiation services (PIS), the second sphere of the PSD2, because financial institutions are simply unable to meet the PSD's technological requirements in terms of authorisation and authentication on a DLT. However, the PSD's objective is inherently already achieved by the technology. If the underlying transaction is concluded on the DLT (smart contract), all the conditions are already defined at an earlier point in time (long before the payment) and "digitally" signed by all the contracting parties concerned. This may involve both payment by means of triggers for today's payment transactions and payment with tokenised commercial bank money. If the PSD2 was applied in its current form, multi-factor authentication would have to be shifted to the underlying transaction. Other use cases such as Pay-per-Use and Machine-to-Machine Payments, in which industry has considerable interest, are thwarted by a two-factor authentication. In addition, the DLT/blockchain infrastructure is fully under the control of industry. Hence, it is simply impossible for banks to fulfil their obligation under the PSD2.

6.7 Outlook and recommendations

Whether it is necessary in the long term to introduce tokenised commercial bank money will need to be examined in particular against the background of the requirements of Industry 4.0 and in the context of the entire ecosystem. Tokenised commercial bank money can secure the industry’s innovation leadership in various fields and leverage significant potential efficiency gains. At the same time, extensive investments will be required to achieve this benefit. This will require an in-depth cost/benefit analysis at an advanced stage. It is clear that the introduction of tokenised commercial bank money cannot be a national project but will require a European approach. Aside from the necessary regulatory framework, it will be indispensable to formulate a European standard that will ensure the interoperability of tokenised commercial bank money. It should not be left to the financial institutions alone or to the industrial enterprises concerned to create such a standard. Only a European campaign that is fully supported by the ECB, national central banks, the EU Commission as well as the Parliament and the Council can ensure the establishment of a standard. The following steps will be required to this end:

- Determining the Europe-wide need for tokenised commercial bank money
- Conducting an analysis and taking a decision in respect of the governance model
- Identifying actual standardisation requirements
- Identifying or establishing a standardisation body with the support of all the financial institutions involved as well as policymakers, regulators and the Central Bank.

7 Trigger solutions: payment solutions for DLT-based systems

7.1 Abstract

- DLT-based business processes and smart contracts will revolutionise broad sections of industry and business. Trigger solutions for corporate customers enable banks to link conventional payments to industrial and commercial business processes. Here, we can support our customers during this period of disruptive change.
- This chapter looks more closely at the customer requirements that need to be taken into account and the limits of conventional payment systems in this regard. It can help market participants develop individual solutions.
- The main feature of trigger solutions is their ability to closely interlink DLT with banks' payment processes on a technical level. This serves to achieve a high degree of automation for payment orders, to create fast transparency on the status of a payment and to integrate any value-added offerings (e.g. in the context of delivery vs payment).
- The heterogeneity of individual customer needs makes it necessary for there to be close coordination between the parties involved. Ultimately, this represents a valuable opportunity for banks to better meet the needs of their customers by gaining an even deeper understanding of their business models and processes. In terms of customers and financial institutions making efficiency gains, these can be achieved through greater standardisation, particular in the area of API-based customer-bank interfaces.
- When it comes to programmable payments, a general challenge lies in reconciling the automation of payment triggers with the relevant framework governing civil and payments law. This applies to all payment methods that are to be triggered automatically via a DLT infrastructure.
- To promote innovations of this kind, there is a need for action on two fronts. It would make sense to develop joint standards for master agreements, for instance, in order to create legal certainty and enable synergies for institutions and customers. Furthermore, legislative initiatives aimed at promoting machine-controlled transactions should also take into account aspects of payments law so that such related elements of the "Industry 4.0" can also be made future-proof.

7.2 Motivation and current situation

In terms of functionality, speed and efficiency, today's payment solutions have evolved in line with the requirements and needs of corporate and retail customers. As the process of digitisation advances, business relationships in the B2B sector are being transformed. They are increasingly moving from fragmented, manual processes and contractual relationships stifled by media discontinuity towards integrated systems that extend beyond the boundaries of an individual company. As the number of underlying transactions based on DLT increases, so too does the potential for further optimising the entire automation process.

These increases give us cause to consider how payments can be further developed to ensure there is continuity in the processing and system environments. However, this is where current payment solutions reach their limits in many cases due to media discontinuities. New offers, such as trigger solutions, tokenised bank money or a modern, digital means of payment issued by the central bank itself, like a retail or wholesale CBDC, could hold the answer. Although it will take some time to develop solutions using tokenised bank money or CBDC, the majority of use cases can already be modelled using a trigger solution. It therefore makes sense to use and, where necessary, expand established payment solutions to support new customer requirements.

The following sections examine more closely the use of existing payment solutions against the background of businesses' changing requirements resulting from the increased use of automated systems. This includes, among other things, smart contracts based on DLT. The term "trigger solution" has established itself here to describe how a payment is triggered by an automatic event in the DLT space. From the customers' point of view, a trigger solution can be used to settle a debt

- between non-banks (retail, corporate customers or other legal persons)
- in account-based bank money,
- using established mass or individual payment instruments,
- controlled by an automated system in the customer space (such as a smart contract based on DLT).

The term "trigger" in the narrower sense means the automatic initiation of payment orders via DLT (see also chapter 7.3 below).

This paper has two fundamental purposes. Firstly, the analysis serves as a guide for interested institutions[23] to plan for corresponding trigger solutions and to categorise existing offers from dedicated service providers. Secondly, the heterogeneity of the institutions' respective customer requirements and business policy preferences do not allow for a one-size-fits-all trigger solution. Rather, it is a matter of establishing guiding principles that show institutions how to find solutions and where the boundaries lie. Despite all the heterogeneity, there are also commonalities that could potentially lead to additional activities. These might include aspects of technical standardisation and legal issues that need looking at in greater depth.

The third section (chapter 7.3) gives a brief summary of the components and actors to be considered in the area of payments. It focuses primarily on models using credit transfer schemes (push payments). The fourth section (7.4) forms the main focus of the paper. By grouping the opportunities and limitations of trigger solutions into six fundamental aspects, we describe the technological and legal elements involved and bring them all together to form an initial idea for a modern customer-bank interface. The fifth and sixth sections take these findings and convert them into models that can be implemented on the basis of request-to-pay or direct debits (pull payments). Lastly, the paper outlines possible further activities.

7.3 Basic model

Trigger solutions are embedded in a classic four-corner model that includes the payer and the payee (here: corporate customer) and their respective banks or payment service providers. The following describes this using the credit transfer system (push payments). For a brief explanation of models that follow the pull idea, see chapters 7.5 and 7.6.

[23] Hereinafter, the term "institution" is used to cover banks of all categories and, where applicable, further payment service providers.

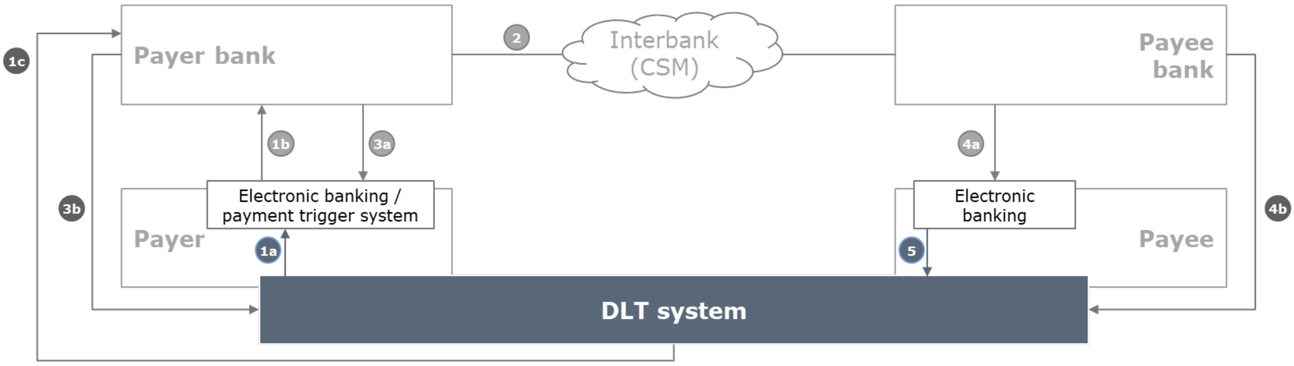

Figure 7 – Basic model

Figure 7 describes the components and (possible) process steps that need to be included. Areas where there is no direct interaction with the institution are marked in blue. Grey arrows describe the process steps of "classic" payments, which may be subject to specific requirements due to the special characteristics associated with trigger solutions. Red arrows describe the process steps that are not generally available within established solutions and only become relevant with the introduction of trigger mechanisms. It is assumed that all process steps are to be implemented digitally.[24]

- **DLT system: automated system, e.g. in the customer space (payer/payee), that verifiably documents** the circumstances of an underlying transaction and uses smart contracts to take on certain control tasks. Then a trigger automatically supports or fully effects the submission or authorisation of payment orders.[25]

- Process step **1a**: The DLT system sends a trigger to an electronic banking system in the payer space. This generates a payment submission or authorisation that can be sent to the payer bank (process step **1b**).

- Process step **1c** (alternative to 1a/1b): The DLT system sends a trigger directly to the payer's institution (without involving the payer space directly).

- Note: The availability and design of steps 1a, 1b and 1c in individual cases depend on whether direct interaction between the DLT and the payer bank is intended. There might be technical reasons for this (keeping system discontinuity to a minimum) or it might be a prerequisite for a secure system status (finality once agreed conditions are met with no ability for the customer to intervene). Another point to consider is whether the trigger is only intended to submit a payment or whether it will authorise it as well. In any case, in order to proceed to process step 2, the payer institution must be in possession of an authorised and complete payment order.

- Process step **2**: The payer institution executes a payment order in accordance with the rules of procedure applicable to that specific payment.

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[24] See chapter 7.4.3 und 7.4.7 for more information on the special role of high-performance interface standards.
[25] See chapter 7.4.3 for more on differentiating between submitting and authorising.

- Process step **3a**: The payer institution sends information about the status of the payment to the payer.
- Process step **3b**: The payer institution sends information about the status of the payment to the DLT system (without involving the payer directly).
- Process step **4a**: The payee institution sends information about the status of the payment (receipt of payment) to the payee. The electronic banking system in the customer space can transfer this information to the DLT system (process step **5**).
- Process step **4b**: The payee institution sends information about the status of the payment (receipt of payment) to the DLT system (without involving the payee directly).
- Note: The availability and design of steps **4a** and **4b** in individual cases depend on whether direct interaction between the DLT and the payee institution is intended.
- Note on 3, 4 and 5: the latency periods of the payment transaction for the DLT from these process steps will depend on the selected payment status (e.g. submitted, authorised, implemented, credited) and selected credit transfer scheme (see also chapter 7.4.2).

The process steps outlined here merely represent an initial, but by no means complete, approximation of possible combinations. However, they should still provide a sufficient basis for planning individual trigger solutions. Depending on the degree of automation desired, dedicated processes may be needed to deal with errors and exceptional cases. These have not been considered here.

Both customers and institutions should analyse and design each individual process step in terms of technological possibilities and the requirements of the underlying transaction. Chapter 7.4 highlights suitable categories, possibilities and also limitations.

7.4 Requirements for models for credit transfer schemes

7.4.1 Need for cooperation

As discussed above, trigger solutions are characterised by significantly greater integration compared to conventional payment solutions of the underlying transaction (e.g. in the context of a DLT system on the customer side) and the payment transaction processes.

In some very specific use cases, this integration *may* be so deep that the participating institutions are involved in both the underlying transaction and the operation of the DLT system. An example would be DLT-based solutions in the area of trade finance or documentary payments, where the involvement of, and value creation by, the institution goes far beyond mere processing of the payment transaction. In the majority of use cases, however (such as pay per use), the integration will be at a technical and organisational level only. But due to the high level of automation needed – both within the customer space and in the interaction with the payment processes – this integration will be subject to more complex and possibly additional requirements which could only be met by existing payment solutions to a limited extent, if at all.

"Seamless" integration therefore requires institutions and their customers to collaborate on planning the implementation of individual trigger solutions. Trigger solutions will only be able to realise their full potential if there is sufficient understanding of the customer's precise needs, of the technical processes on the DLT system and of the underlying transaction. And last but not least, institutions and customers need to understand and manage the risks, legal framework conditions and liability issues associated with a high degree of automation and possible value-added offers. This means there is a need for cooperation between the institution and customer and, depending on the use case and customer needs, also between the institutions involved.

The processing of payment transactions between banks is basically regulated by the existing legal framework and by rules of procedure such as those drawn up by the European Payments Council. Aspects and value-added offers that are not covered by these rules and regulations, such as service level agreements, dedicated interfaces with a DLT system or interbank DvP[26] offers, will need to be discussed and contractually agreed as well.

The "cooperation" outlined here should be seen as an opportunity. Close interaction with the customer side will be required – both by individual institutions and by the entire financial services industry. Based on these discussions, standards could then be developed (e.g. for a technical customer-bank interface or more detailed e2e process models). These could help to resolve the tension between the heterogeneity of customer requirements and the need for scaling that exists in payment schemes.

The following subsections look at cooperation in the context of five aspects, namely:

- transparency, speed and finality
- degree of automation
- geographical scope
- payment transaction data
- delivery versus payment

We will then show how standards for the most important data streams in a payment triggered by DLT can be defined with the help of suitable API interfaces to existing payment systems and innovative digital authentication authorities.

7.4.2 Transparency, speed and finality

DLT promises a fast transfer of digital, possibly tokenised assets as well as transparency and verifiability concerning the finality or current status of a transaction in the distributed ledger of transactions. Parallel processing of a payment via the conventional payment system thus represents system or media discontinuity. This could be problematic because the "success" of the payment is not immediately apparent to the DLT system but may be a major prerequisite for concluding a smart contract within the DLT system.

Trigger solutions need to mitigate this particular problem of system discontinuity by not only initiating the payment but also providing an information loop with respect to its success. This requires, first, efficient technical interfaces between the institution and customer or DLT system (see chapters 7.4.3 and 7.4.7) and, second, a component that compares the runtimes of the payment process with those of the processes on the DLT system. These will vary widely as a result of the requirements of the underlying transactions,

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[26] DvP: delivery versus payment

the technical design of DLT systems and the consensus mechanisms used, and will need to be examined in greater depth. Depending on the use case involved, it may be that the time needed to process a payment does not meet the expectations associated with the underlying transaction or the processes in the DLT system. With the exception of SEPA instant payments, where the amount is available to the payee within a few seconds, execution times are usually one bank working day (for a regular SEPA transfer) or possibly up to several bank working days (especially for international payments). Payment finality in terms of when the amount is credited to the payee's account may therefore be quite "slow" to achieve.

A possible solution for overcoming the temporal mismatch may lie in the processing model used. Swiftly transmitted information to the DLT system about the payment status, for example, could offer significant added value in terms of transparency and security even if the payment has not yet been credited to the payee's account. This raises the question of whether only the payer's payment service provider (payer bank) or whether both payment service providers should be involved in the process of reporting the payment status. A solution which considers it sufficient to have data from the payer bank only would mean that, initially, information could merely be provided about the authorisation or execution of a payment. Information about the execution of the payment can at least say something about its finality (e.g. that the payment is irrevocable). At this point, however, there is still a residual uncertainty with respect to whether and exactly when the amount will be credited to the payee's account (delays might be caused by technical problems, public holidays, verification processes along the payment chain, etc.). The involvement of both banks in the process, on the other hand, means the payer bank would confirm that the payer's account had been debited while the payee bank would confirm the receipt of the amount on the payee's account – thus offering information on the actual finality of the payment.

The aspects of a trigger solution outlined here could be developed further to mitigate delivery versus payment problems on the customer side and thus offer additional added value (see also chapter 7.4.6: Delivery versus payment). When it comes to requirements concerning transparency, speed and finality and assigning the associated roles, further fleshing out and standardisation depending on the type of the underlying transaction may prove helpful.

7.4.3 Degree of automation

DLT-based systems used for business processes in the customer space, for example, are characterised by a high degree of automation. Owing to the need for close integration and to process-related dependencies, there are similar expectations of trigger solutions for payment transactions. These relate to almost all the process steps outlined in chapter 7.3 at the interface between customers or DLT systems and institutions. These steps can be broken down into two basic categories:

- From customer or DLT system to institution: process steps affecting the submission or authorisation of payments.
- From institution to customer or DLT system: process steps that provide information about the status of the payment and, in turn, possibly trigger processes in the DLT system. These may, in particular, include process steps triggered if an error occurs (e.g. inability to execute the payment).

Once the necessary process steps have been identified in an individual trigger solution, the question arises as to what degree of automation is possible and required. The associated challenges and parameters can be divided into technological and process-related aspects, on the one hand, and legal aspects, on the other.

(i) Technological and process-related aspects of automation

The technological and process-related aspects of automation concern whether the customer-bank interfaces in question are technically capable of carrying out automated processes. This concerns, first, their suitability for transporting the data elements required (see chapter 7.4.5). But it is also important to consider their ability to be integrated into both conventional electronic banking systems and (possibly diverse) DLT architectures (mostly on the customer side).

In the German-speaking countries and in France, EBICS[27] is a communication standard widely used for corporate clients – especially for processing payments. It is open to question, however, whether this standard can satisfy all the demands of trigger solutions. True, the architecture is designed to transmit not only orders but also information flows, though the latter only on the initiative of the customer (pull rather than push). At present, not all of the process steps outlined in chapter 7.3 can be performed with the help of EBICS in the customer-bank relationship. Consideration could be given to developing the standard further.

It is also conceivable that institutions will develop proprietary interfaces for trigger solutions. Bearing in mind the aim of achieving infrastructure synergies for institutions and their customers, however, it would be advisable to develop an industry standard along the lines of EBICS to meet the special demands of trigger solutions. Consideration could be given to the API-based interfaces created to satisfy the requirements of PSD2. A significant number of institutions in Europe use the Berlin Group standard[28] for this purpose. The Berlin Group has already begun to develop the interface standard to cover other use cases besides meeting regulatory requirements. Future standardisation of the corporate client-bank relationship should take account of the additional needs resulting from trigger solutions (see initial technical design options in chapter 7.4.7).

(ii) Legal aspects of automation

An essential function of trigger solutions is to automate the initiation of a payment by a DLT-enabled event. If "total" automation were to be achieved, payments could theoretically be made without the involvement of a person at all. But this would be in conflict with the relevant legal framework and raise related liability and risk issues.

When an electronic credit transfer is initiated, two processes take place. First, the payer instructs their institution to make a payment and authorises it. Second, the institution authenticates the customer's identity: it makes sure that the party giving the instruction is actually the party authorised to do so. Due performance of both processes is a prerequisite for the payment being executed in a manner that provides legal certainty for the institution and its customer.

The authorisation of the payment is a civil law declaration of intent by the customer. The declaration of intent may be issued by natural or legal persons, although a declaration of intent by a legal person (such as a corporate client) is issued by its legal or statutory representative – that is to say by a natural person too. A machine (or in this case a rule lodged in a DLT system) has by its very nature no legal personality. An event triggered by a machine can only make a legally binding commitment on behalf of a legal entity if the contracting party can assume beyond all doubt and rely on the fact that it reflects the "real" will of the

[27] Electronic Banking Internet Communication Standard
[28] https://www.berlin-group.org/psd2-access-to-bank-accounts

legal person. This can pose a problem for the institution if the DLT system is operated in the customer space and the institution itself has no insight into the rules lodged there or into how they are technically and contractually linked with the underlying transactions of the corporate client involved.

The obligation under civil and supervisory law for institutions to authenticate the payer is defined by EU legislation on payment services (Second Payment Services Directive[29] and its delegated acts, plus national implementing legislation). Here, too, it is assumed that the payment service user whose identity is to be verified is a natural person and that authentication will be based on the use of two of the three elements “knowledge”, “possession” and “inherence” (e.g. a biometric feature). Scant consideration has been given to date to the option of introducing different procedures for corporate customers.[30] This can probably be explained by the considerable obstacles and uncertainties associated with such procedures. The relevant article sets no specific criteria to be met, yet at the same time procedures would need to be approved by national competent authorities.

It can thus be concluded that the existing legal framework is not compatible with the vision of fully automated payment transactions managed by machines (or DLT systems), or at least imposes tight limits on such a vision. Two conclusions for the banking industry can be drawn:

1. Long-term outlook

The idea of extending the civil law regime to take account of automated and autonomously operating machines is being discussed at European and national level.[31] The banking industry should become more involved in these discussions and broaden them to cover issues specific to banking, which are not limited to payment systems.

2. Short-term options

The design of current trigger solutions must take into account the tension described earlier. A key question is how deeply the institution will be integrated technically, contractually and in terms of processes into the underlying business of corporate customers operating DLT systems.

From a legal and risk perspective, very close integration could justify a very high degree of automation of the payment order. But given the level of associated complexity involved, it is doubtful whether this approach lends itself to a “mass-produced product” like payments. It will probably only be a viable option if the institution is itself involved in the value creation of the underlying transaction (take integrated trade finance solutions, for instance).

At the other end of the spectrum are trigger solutions that allow for greater standardisation and cover only payments processing and related processes. In terms of their contractual design, these should therefore be closely aligned to the legal framework governing payments and the room for manoeuvre offered there. A discussion of possible designs and relevant legal issues can only be briefly touched upon in this context: the basic idea is to abstract the “declaration of intent” (payment authorisation) from the “trigger” (submission of the payment order). It is true that the authorisation of payments is carried out by the payer,

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[29] Directive (EU) 2015/2366 on payment services in the internal market (PSD2)
[30] Article 17 of Commission Delegated Regulation (EU) 2018/389 supplementing Directive (EU) 2015/2366 of the European Parliament and of the Council with regard to regulatory technical standards for strong customer authentication and common and secure open standards of communication
[31] See, for example, 2017 report by the European Parliament to the European Commission on civil law rules in the area of robotics.

represented by a natural person. But this can occur at a time independent of when the payments are submitted by a DLT system. This may occur either ex post or ex ante:

- Authorisation prior to submission
  The payer first gives their institution authorisation for a maximum amount X to be paid within a defined period Y to a specific payee on the basis of a set of future payment submissions Z. The DLT system then submits payments within Y relating to Z (trigger), which the institution executes automatically.[32]

- Submission prior to authorisation
  Here, the DLT system first submits payment orders to the payer's institution. The payer subsequently authorises the submitted payments and the institution executes them.

The two models differ in terms of their banking complexity and legal classification. The prior authorisation model is more complex from a banking perspective but can enable a greater degree of automation.

7.4.4 Geographical scope

The choice of payment scheme to be used is a key question when designing individual trigger solutions. The scope relates both to the geographical location of the institutions involved and to the currencies to be covered.

The existing SEPA payment schemes are likely to prove the first choice for a variety of trigger solutions due to their high penetration among institutions and customers and their swift and efficient processing of payments. But they naturally have their limits. Geographically, for example, they are limited to the SEPA area and to payments in euros. It is true that the European Payments Council and individual operators of SEPA-related infrastructure are exploring ways of extending the geographical scope. But such initiatives are at an early stage of development.

Depending on the institutions involved, currencies concerned and the destination of the payments, the time needed for international payments differs widely, as does the associated cost. Close coordination of all parties involved is thus especially important to enable smooth interaction between DLT-based customer processes and payment transactions. To an even greater extent than with SEPA payments, the question arises as to whether, in some cases, it may make sense to aggregate or net individual claims in the interests of efficiency (especially to avoid small or micro payments). There will therefore be a need to find a "sweet spot" between the fastest possible settlement of individual claims (finality) and the economic viability of the trigger solution. Notwithstanding this, it is likely that a number of current political[33] and industry-driven[34] initiatives will also result in international payments being processed more efficiently.

7.4.5 Payment transaction data

Payment transaction messages, both between customer and institution and in an interbank context, contain a large amount of data. Some of these (account identification of the payee, payment amount, currency,

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[32] There is a need to examine in this case whether section 675x of the German Civil Code (BGB) is relevant or can at least serve as a guideline.
[33] See, for example, the Financial Stability Board's initiative "Enhancing Cross-border Payments".
[34] See, for example, SWIFT gpi (global payments initiative).

etc.) are needed to enable the payment to be executed correctly, while others (reason for payment, categorising codes, etc.) help easier assignment (or “reconciliation”) on the customer side.

In the context of a trigger solution, payment transaction data can take on two special functions. The first relates to the assignability of a payment on the customer side or by the DLT system. The high degree of automation relies on reference data being error-free, complete and in the expected form (or expected data element) when they are transported along the payment chain. The second function relates to the possibly diverse processes associated with a trigger solution that institutions may offer their customers. As outlined in chapters 7.3 and 7.4, various services may be offered over and above pure payment processing (such as pre-authorisation, payment status information, DvP mechanisms). To “activate” these for a specific transaction, it may be necessary to integrate corresponding instructions into the “trigger message” addressed to institutions.

The institutions and customers involved must cooperated closely on determining the precise processes and data. Limiting conditions will be set by the payment schemes used and their data formats. The ISO 20022 messages utilised for SEPA payments allow for an extensive set of structured and unstructured data elements. In 2022, SWIFT will start to migrate from the significantly more restrictive MT to the ISO messaging format. Once the process has been completed, the use of ISO 20022 will also be possible for international and individual payments.

Further standardisation of data element assignment would make sense if the process model outlined in chapter 7.3 and illustrated with technical requirements in this chapter 7.4 were further fleshed out and standardised on the basis of certain categories of use case. This could also help to resolve the tension between heterogeneous DLT architectures and customer requirements, on the one hand, and the need of customers and banks for synergies, on the other. It is also important to consider the bank instructions required for trigger solutions (see chapters 7.4.3 and 7.4.7).

7.4.6 Delivery versus payment

DLT-based processes offer a way of solving DvP problems with the help of pre-agreed rules and watertight verification concerning all the activities in a process chain. The system discontinuity for payment processing, which has already been discussed at various points, can also pose a problem here: a smart contract or similar event enabling the establishment of a legal position should only be fulfilled when there is certainty regarding the payment – and vice versa.

Institutions can develop value-added services for such cases that supplement their trigger solution with a delivery-versus-payment component, thus solving the above problem from the customer’s perspective. A possible design could be structured on the basis of the following two dimensions and degrees of complexity:

1. **Who provides the service? Who is the contractual partner? (a to c: ascending order of complexity)**
    a) Only payer institution or payee institution: trilateral relationship between payer and payee and the institution involved.
    b) Multilateral (payer institution and payee institution): adds an interbank relationship to the provision of the service and the contractual level.
    c) Third-party service provider: DvP processes are orchestrated by, and are the responsibility of, a third party.

2. What does the service consist of? (a to c: ascending order of complexity)

a) Mere offer of ongoing information on the payment status.
b) Technological integration of DLT and payment reservation and execution.
c) Commercial integration of DLT/underlying transaction and payment execution: supplementary offer of guarantee-like components.

The combination of the options in the two dimensions and the subsequent individual design will result in different degrees of (technical and legal) complexity. In parallel, the DvP problem will be mitigated to varying degrees from the customer's perspective.

A simple model consisting of a combination of 1a and 2b illustrates this. After the payer has authorised the payment, the payer institution can dispose of the amount in question. A confirmation is sent by the payer institution to the DLT system. The DLT system then sends a confirmation to the payer institution and the payer that the smart contract will be executed. Upon receipt of this confirmation, the payer institution releases the payment amount and executes the payment in the interbank space. This highly simplified illustration shows that added value can be generated with the help of relatively simple banking tools. The remaining risks (e.g. risk of payer institution's default, uncertainty regarding the success of the payment in the interbank space) could be reduced by using models of greater complexity.

7.4.7 API standardisation for the customer-bank interface

Previous sections, especially chapter 7.4.3, have emphasised the importance of efficient customer-bank interfaces to the success of trigger solutions. Common banking industry standards for interfaces will help to enable synergies for customers and institutions. In terms of flexibility, performance and scope on the institutions' side, it would make sense to build on the successful work of the Berlin Group on API standardisation. The standard should be expanded to cover direct communication between institutions and corporate customers, with special consideration of the requirements of trigger solutions. Some key points and proposed solutions are described below.

The API standard should be able to cover all the process steps outlined in chapter 7.3. This includes, first, the various conceivable forms of payment order submitted by a corporate customer. It is important in this context to take account of the distinction between payment submission and authorisation. It is also important to be able to transport instructions to the bank that go beyond a simple payment submission. In addition, standards that are as universally applicable as possible must be created for the various processes sending confirmation to the customer or DLT system; these must be able to transmit information on the payment status and possible further value-added services (e.g. DvP mechanisms).

Traditional customer-bank interfaces in payment systems are based on the ISO 20022 data models in widespread use in the interbank space. But as the introduction of interfaces for accessing payment initiation and account information services under PSD2 has shown, this XML-based architecture can only cope to a limited extent with more advanced processes and technical API processes. As a result, increasing use is now being made of JSON-based data models. This development should also be taken into account in the standardisation of a direct customer-bank interface, though individual customer preferences could possibly lead to standards permitting the use of both data models. It is also conceivable that hybrid solutions will emerge, in which the original payment transaction data can be transmitted in a conventional ISO 20022 format, with provision for additional information to be transmitted in the more efficient JSON format (especially if this information is to be transported not to a conventional electronic banking system but direct to a DLT system).

A particular challenge is how to enable efficient authentication processes via an API, as these have to manage the tension described in chapter 7.4.3 between a high degree of automation and the need to comply with the legal framework. On top of that, corporate customers may expect multibank-capable authentication procedures along the lines of those already used in conventional systems (such as EBICS). A prerequisite for standardisation to this end is doubtless that the possible solutions briefly outlined in the above chapter are fleshed out in more detail with special consideration of legal aspects. In addition, forward-looking plans for identity management technology using machines and automated systems should be investigated (especially in a DLT context). The self-sovereign identity (SSI) approach could prove helpful: SSI gives natural and legal persons control over their digital identities in compliance with the in legal requirements of the eIDAS Regulation.

7.5 Models using SEPA Request-to-Pay function

The previous chapter 7.4 discussed possible requirements and approaches for trigger solutions in the context of credit transfer schemes. The basic assumption here was that corporate customers would operate DLT systems in their space which, among other things, would assume the function of "triggering" a payment. A comparable assumption can also be made for many B2C use cases in areas such as the Internet of Things: the connected house, business models for the sharing economy or other pay-per-use offers (including mobility) are some initial examples.

Most of the payments needed in the B2C sector are today carried out using card products or direct debit schemes (both pull payment models). The use of credit transfer schemes (push models), by contrast, is possible only to a limited extent as things stand. No widely used, standardised interface is available for linking payment initiation with the DLT system or adjacent application (e.g. mobile app) associated with the underlying transaction. It is nevertheless possible that payment initiation service providers will develop corresponding solutions using the possibilities offered by PSD2.

In addition, the SEPA Request-to-Pay (SRTP) scheme[35] recently launched by the European Payments Council could in future take on an interesting role for trigger solutions. The SRTP scheme offers payees a way to digitally request the initiation of a credit transfer by the payer. If account-servicing institutions offer this service, the payer will be able to receive the request direct via online banking or a mobile banking app. The customer can then accept automatically and without fear of errors the reference data provided by the payee and transfer the requested amount conveniently and seamlessly. When it comes to the degree of automation and to finality, such a solution would be comparable to the option outlined in chapter 7.4.3, under which the authorisation of the payment takes place following the trigger (payment submission in the broader sense). It should be borne in mind in this case that the process will be temporarily paused because the payer must first accept the request to pay.

As things stand today, it is impossible to predict when and exactly how institutions in Europe will translate the SRTP scheme into concrete offerings for customers. What is clear, however, is that it represents an interesting opportunity to use the existing efficiency and scope of the SEPA payment system in trigger solutions, especially when interacting with consumers.

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[35] https://www.europeanpaymentscouncil.eu/what-we-do/other-schemes/sepa-request-pay-scheme

7.6 Models using direct debit schemes

Within the SEPA, direct debit schemes can also be considered as a means of implementing trigger solutions. When it comes to their scope and penetration in the banking industry, the direct debit is comparable with the credit transfer schemes discussed above. Measured in terms of the requirements for trigger solutions outlined in chapter 7.4, however, they differ with respect to the interaction of automation, speed and finality.

In the interbank space, a SEPA direct debit must be presented to the payer's bank no later than one bank working day before it is due. Though this rules out smart contracts that rely on very rapid payment finality, it should be sufficient for the majority of use cases. What is more, direct debit supports a high level of automation, especially on the payer's side, since there is no need to authorise the institution to make individual payments if a valid mandate is available. The SEPA B2B Direct Debit Scheme even lends positive support to the requirement for rapid finality. Rejection of the direct debit remains possible due to a lack of funds or for other reasons, such as a technical problem. But the possibility of the payer failing to honour the direct debit can be ruled out since, under this scheme, payers have to give their institution prior authorisation to always honour direct debits submitted by a specific payee. There is no unconditional ability to reject a direct debit, as under the "classic" SEPA Core Direct Debit Scheme.

The direct debit thus follows a process and is based on principles that are fundamentally different from those of a credit transfer (pull instead of push). It will only be able to effectively support trigger solutions if the underlying transaction and the processes in the DLT system can be aligned with these special features. Should this be feasible, however, it will also be possible to exploit the associated advantages (including the high degree of automation on the payer's side).

7.7 Outlook and recommendations

Trigger solutions are already being developed and offered by some institutions and specialist service providers. These offerings will expand as demand increases and we see further differentiation of use cases on the customer side. The heterogeneity of customer needs makes it essential for all parties involved to coordinate closely with one another. In this document, we have also been able to identify potential for possible further activities by associations and standard-setters:

- Customer-bank interfaces: Steps should be taken, preferably by the Berlin Group, to establish a standard for the technical customer-bank relationship based on state-of-the-art API architectures. In parallel, the potential for further developing the EBICS standard should be explored.
- Process design: Standardisation of customer-bank interfaces cannot be considered in isolation and without taking into account requirements relating to the overall process. The process model outlined in chapter 7.3 and illustrated together with its functional requirements in chapter 7.4 could therefore be fleshed out in greater detail and standardised. Criteria for standardisation might lie in the supported use cases on the customer side or the role model of the institutions involved. This could help to resolve the tension between heterogeneous DLT architectures and customer requirements, on the one hand, and the need for synergies on the part of customers and institutions, on the other.
- Legal framework: A particular legal challenge lies in the complex relationship between the objective of automating the customer's payment order and the related civil and payment law framework. Here,

too, it may make sense to develop common standards and practices – the solutions outlined in chapter 7.4.3 could serve as a basis. Thinking further ahead, legislative initiatives to promote machine-controlled legal transactions should also consider payment law aspects to ensure that innovation can flourish in an environment with a high degree of legal certainty.

- Further development of payment schemes: This document is based on the assumption that payment schemes (such as SEPA instant credit transfers) can be used in their existing form. But all payment and related schemes (such as SEPA Request-to-Pay) are continually being refined and adapted to changing customer expectations. In doing so, greater consideration should be given to the role of automated processes, smart contracts and distributed system structures on the customer side.

8 DLT-based capital market business

8.1 Abstract

- Current initiatives are considering the disruptive demands being placed on monetary and payment systems from digitisation, particularly from the perspective of retail and corporate customers. However, new solutions are also needed in the interbank sector. Transactions in the capital markets and related areas that are based on DLT and, to a lesser extent, on tokens are becoming increasingly important. This trend is supported by a series of legislative changes at both national and European level.
- One special feature on the payments side is the need or desire to have many transactions settled in central bank money. Appropriate solutions could therefore be developed in cooperation with the Eurosystem. There are basically three possible models that could give market participants a high degree of security and the necessary delivery-versus-payment mechanisms.
- Firstly, the European Central Bank should consider the opportunities afforded by a corresponding wholesale CBDC in any further activities linked to the digital euro. However, it would be much quicker to tweak the existing TARGET2 architecture so it can meet the corresponding requirements. This would allow the creation of dedicated, private-sector settlement systems that can rely on liquidity deposited with TARGET2, thus giving participating institutions a high degree of security. Another solution might be to expand TARGET2 to include a specific form of trigger solution. As demonstrated by the Deutsche Bundesbank's "Blockbaster" project, this can create an intelligent interlinking of payments in central bank money with DLT-based asset transactions.

8.2 Capital markets developments and the required evolution of central bank money settlement

As early as June 2016, the European Securities and Market Authority (ESMA) launched a discussion paper on the distributed ledger technology (DLT) applied to securities markets and published its final report on 7 February 2017 assessing the benefits, key challenges and risks of DLT application.

On 24 September 2020, the European Commission adopted a digital finance package, which included a digital finance strategy and legislative proposals on crypto-assets, on a pilot regime for DLT market infrastructures and on digital resilience, for a competitive EU financial sector with innovative financial products. The package also supports the EU's ambition for a digital transition, since digital financial services can help modernise the European economy across sectors and turn Europe into a global digital player.

Furthermore, the German government has proposed changing German civil law to introduce electronic securities by way of electronic registers in the form of, inter alia, distributed ledgers. The German Bundestag passed a draft bill on certain categories of securities on 6 May 2021. Other member states are also planning to make similar legislative changes.

Following this development, the application of DLT in relation to capital market products, such as securities and other financial instruments is not only technically feasible but the legal framework will also be in place with these amendments to existing rules. Several market actors, established banks, issuers and start-up companies stand ready to embrace the changes and bring technical innovation to the financial markets. All the required steps on the asset side for the issuing, trading and settlement of DLT financial instruments seem to be have been accomplished.

Furthermore, assets other than securities also have the potential to be tokenised using DLT, being digitally stored and traded. In order to leverage the full potential of tokenised assets, money and – in most cases – central bank money would need to be tokenised using DLT as well. If assets and money are represented as tokens on DLT, they can be exchanged via an atomic swap. In other words, delivery versus payment (DvP) becomes possible, meaning that the delivery of the asset and payment happen instantly and are mutually dependent. Payment is conditional on the delivery of the asset and vice versa. DvP eliminates settlement risk and increases efficiency because the process is "atomic", meaning indivisible. The transaction happens completely or not at all. This concept also applies if both sides of a transaction are tokenised forms of money. Consequently, atomic swaps also become possible in the payment versus payment (PvP) space. In a PvP transaction, the payment in one currency only occurs if the payment also takes place in another currency (or currencies). As with DvP, the two payments are mutually dependent.

However, when it comes to the cash settlement of transactions based on DLT, a huge obstacle exists:

So far, the cash leg cannot be represented on DLT. Settlement still relies on processing in the "traditional" manner, e.g. using central bank money via TARGET2. As a result, capital markets transactions and related business in cross-border FX markets, asset liability management, (re-)funding and collateral management (PvP) cannot fully benefit from the technological advancements in DLT.

Considering the relevance of these applications to the global financial market and the significant potential efficiency gains from the adoption of DLT-based transactions, this is a problem that urgently needs to be tackled.

Not only are there additional complexities and costs (investment and operating costs, need for greater coordination and reconciliation) due to the media discontinuity between the new infrastructure and the traditional one, in addition, the full potential and associated advantages of the new technology cannot be fully developed.

Solving these problems will require uniform standards and solutions, similar to those on the asset leg, for the interbank/wholesale market.

A corresponding monetary unit would guarantee and accelerate interoperability both between market participants and the various FX markets (instant or real-time payments). All parties involved (customers, regulators (especially on reporting), banks and financial service providers) would benefit from the possible synergies. This will make a profound contribution to the strength of the financial market in Europe.

8.3 Three approaches to integrating central bank money settlement

8.3.1 Use of new digital forms of central bank money for interbank settlement

Today, market participants in global FX markets and in securities markets primarily use central bank reserves for the settlement of transactions. Hence, in a tokenised economy, the most intuitive solution would be to tokenise central bank reserves and make them available as a means of payment in this ecosystem. This is what a wholesale Central Bank Digital Currencies (wCBDC) is aiming to achieve. A wholesale CBDC is a tokenised version of today's central bank reserves. It is a liability of the central bank, denominated in the national unit of account. Only banks have access to this form of money. A wholesale CBDC needs to be distinguished from a retail CBDC, which is available to the general public and therefore more of a digital equivalent of cash for households and businesses.

According to a survey from the Bank for International Settlements,[36] the focus of central banks around the world is on retail CBDC rather than on wholesale CBDC. This is also reflected in the number of wholesale CBDC projects, which is lower than that of retail CBDC projects. According to the central banks that participated in the survey, their main motivation in issuing a retail CBDC is to increase payments efficiency, especially in cross-border payments. This is in line with the proposed application of DvP and PvP mentioned above. This strong focus on retail CBDC risks neglecting the importance of a wholesale CBDC for the tokenised economy. There is a tendency towards the tokenisation of (financial) assets. Market participants need a way to settle their trades with these assets. A wholesale CBDC would be an intuitive way of providing the cash leg for the trading of tokenised securities. Additionally, it can increase the efficiency and reduce the risk of cross-border/FX transactions.

8.3.2 Private sector initiatives: pre-funded wholesale payment systems

Alongside central banks, several private-sector actors have been developing their own solutions in order to provide tokenised money applicable for wholesale transactions. Prominent amongst these are initiatives working towards the creation of new pre-funded wholesale payment systems.

These pre-funded wholesale payment systems may provide an alternative to digital currency issued by a central bank. In this model, payment service providers use a token for cash settlement that is matched one-to-one by funds held directly at the central bank. These pre-funded digital payment models would function within the central bank's existing payment environment and provide a digital representation of money held in the central bank account. Assuming that the framework is implemented with suitable regulatory oversight to guarantee that funds correspond one-to-one, the token underpinning such a payment system has risk characteristics similar to those of central bank money. This type of token is sometimes referred to as a 'synthetic CBDC' or 's-CBDC' (see Adrian and Mancini, 2019). However, such systems are very much similar to existing private-sector payment solutions using omnibus or technical accounts within the existing central bank payment system environment.

If based on DLT, such systems can provide an on-chain payment leg that can integrate with other novel tokenised asset systems, or any other system that requires a 'tokenised' representation of money. They offer the opportunity to pay for DLT-based securities on an "atomic DvP" basis for instance, or to settle foreign exchange transactions on an "atomic PvP" basis. This would ensure that either both legs of the transaction occur or neither of them do.

The question remains as to how such "sCBDC" systems could relate to a potential wCBDC issued by the central bank: One could argue that this version of CBDC frees the central bank from playing a bigger and riskier role - that of developing and managing the underlying wCBDC technology along with its implied resilience and performance (as expected of a central bank system), performing due-diligence, offering a reliable settlement platform with suitable interfacing and interoperability (for DvP and additionally across different jurisdictions for PvP). In other words, it might provide a solution to the immediate requirement while not putting the central bank's reputation at risk. By the same token, pre-funded "sCBDC" systems could provide the market with the necessary solutions in the short to medium term and could be maintained as a complementary building block to the long-term vision of wCBDC.

[36] https://www.bis.org/publ/bppdf/bispap114.htm

8.3.3 Functional extension of the existing central bank money clearing system

As we have explored in different instances in this paper, there is a need to be able to create a DvP for digital assets and, specifically, to introduce a cash leg for a potential asset chain. Besides a wholesale CBDC and pre-funded wholesale payment systems, another option that has emerged is known as the trigger solution, which complements established means of central bank money settlement with a DvP-enabling trigger mechanism between the asset leg and TARGETARGET2. In general, a trigger solution allows the payment leg(s) of (a) transaction(s) to be executed by means of "traditional payment rails", while largely preserving the atomic character of the DLT transaction.

A recent test project by Deutsche Bundesbank has shed some light on its possible implementation and application. Here, a trigger chain was implemented as a wrapper on the conventional payment rail provided by TARGET2. Theoretically speaking, this wrapper could be instructed using the underlying payment system's API or SWIFT, or any infrastructure used in the underlying payment system to send or rather trigger payments. The trigger chain operated by the central bank needs to be connected to an asset chain – on which the asset leg of e.g. a DvP transaction is executed – by a transaction agent, typically a third party. The steps taken to facilitate a DvP are that an asset is locked on the asset chain by said third party and then transferred and unlocked after the payment has been successfully performed from one TARGET2 account to another and recorded accordingly on the trigger chain. The trigger chain would be interoperable with different asset chains through the transaction agents. Transactions via the trigger chain would not need any pre-funding as transfers would only happen upon instruction and move between TARGET2 accounts. However, this would rule out the possibility for true atomic swaps. In the trigger solution, only parties with TARGET2 accounts can interact with each other, while other parties need to be connected through said participants. This is very similar to the current system with structures already in place and has the same capabilities as well as limitations as with TARGET2. In theory a trigger chain can be connected to TIPS.

8.4 Outlook and recommendations

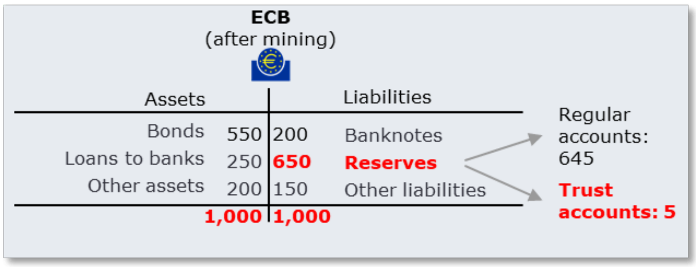
The dematerialisation of securities plays an important role in further digitising the capital market business, particularly where DLT is involved. However, in order to enable the consistent implementation of DLT-based securities settlement, there also need to be amendments to payment systems. This will require the creation of DLT-based infrastructures, which cannot be realised without the support of the European Central Bank. A wholesale CBDC could play a role here. The ECB's current commitment to a retail CBDC is to be welcomed. However, a wholesale CBDC should not be ruled out. In order to reap potential benefits in the short to medium term, the two options outlined above to extend existing TARGET2 settlement mechanisms should be carefully assessed and pursued. We would support these efforts, in particular the extension of a planned project on retail CBDC to include wholesale CBDC, and the German Banking Industry Committee stands ready to discuss further steps.

9 Appendix – Technological blueprints and financial reporting of tokenised commercial bank money

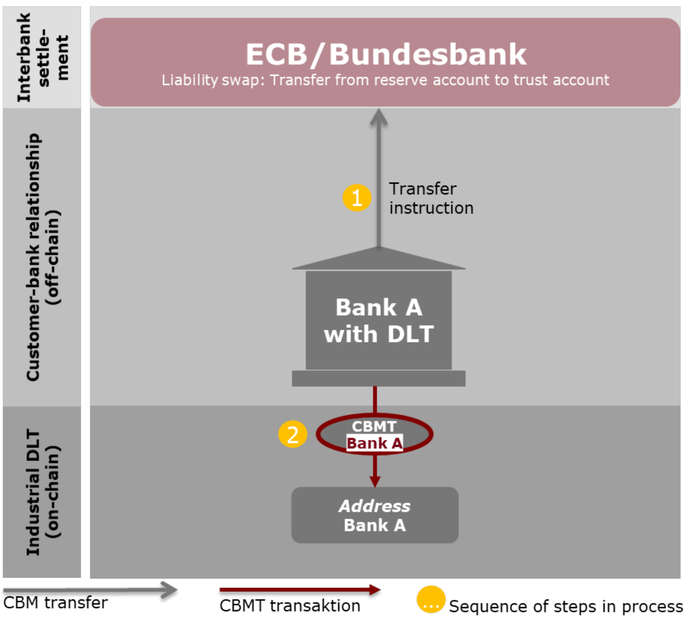
9.1 Tokenised commercial bank money as fully collateralised Stablecoin

A commercial/savings bank enables its customer to use tokenised commercial bank money (CBMT) in the form of a fully collateralised Stablecoin. The tokenised commercial bank money corresponds to an amount of central bank reserves which is retained in a trust account and which cannot be used for normal transaction purposes in interbank transfers. Tokenised commercial bank money is therefore free of individual banking risks. The following balance sheet presentations describe posting processes during the generation and transfer of tokenised commercial bank money and the deposit of tokenised commercial bank money on a current account.

Generation of tokenised commercial bank money as a fully collateralised Stablecoin



Step 1: Mining



Commercial and savings banks use central bank reserves as liquidity for interbank transactions. Reserves on the liabilities side of the ECB's balance sheet[37] are reported in the accounts of the commercial and savings banks concerned. To ensure that the bank can generate tokenised commercial bank money as a fully collateralised Stablecoin, reserve credit balances at the ECB must be transferred to a segregated ECB trust account of the bank concerned. This account is posted on the asset side of balance sheet of the bank concerned[38]. If the reserve balance is not sufficient, the bank can borrow additional central bank reserves in the interbank market or from the ECB. When the reserves are transferred to the trust account, the bank will generate tokenised commercial bank money which will be held in a bank address on the DLT and which will correspond to the reserves held in the trust account (step 1).

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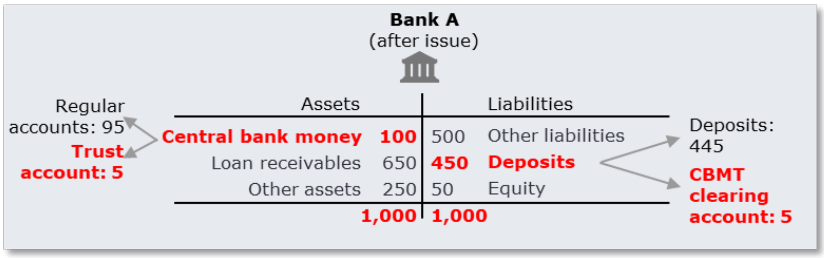
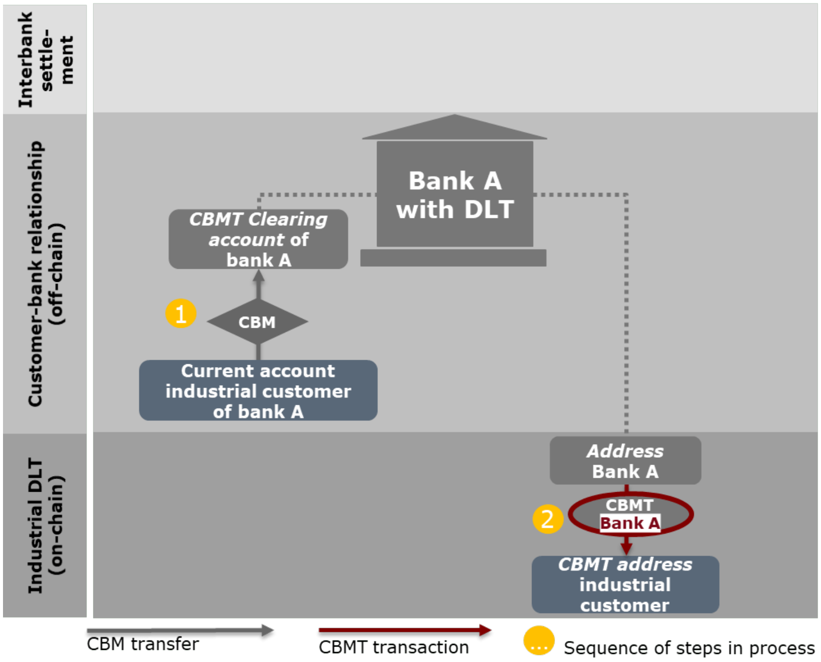
[37] The balance sheet items described are guided by the consolidated balance sheet of the euro system as of 31 December 2020. https://www.ecb.europa.eu/pub/annual/balance/html/ecb.eurosystembalancesheet2020~0da47a656b.en.html

[38] The balance sheet items described are guided by the consolidated balance sheet of German banks as of 31 March 2021. https://www.bundesbank.de/resource/blob/804004/326fc3af24ca25dfd69efcc00c35bbdd/mL/i-bilanzpositionen-der-banken-mfis-in-deutschland-data.pdf



Step 2: Issuance of CBMT and transfer to Industrial customer / Exchange CBM to CBMT



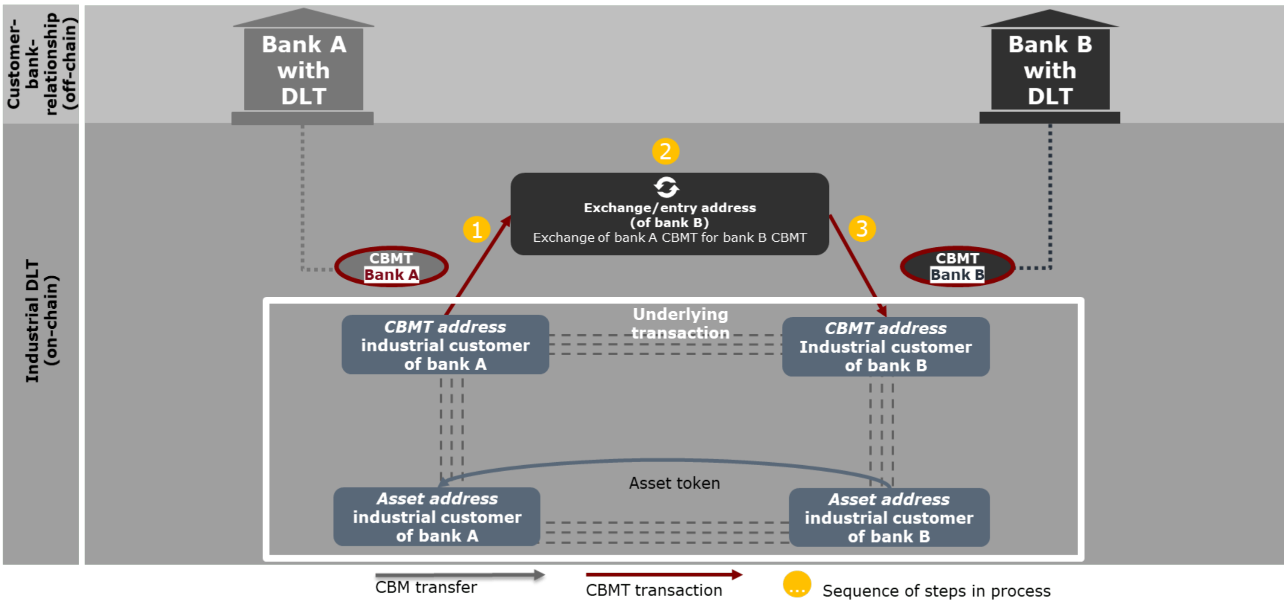
To ensure that the token can be used by the customer, the desired amount of tokenised commercial bank money (CBM) will be debited to the customer's deposit account on the liabilities side of bank and posted on a clearing account for tokenised commercial bank money. The tokenised commercial bank money (CBMT) is then transferred from the bank's address to the customer's address (step 2). After the transfer to the customer's address, the tokenised commercial bank money will correspond to the deposit in the generating bank's clearing account for tokenised commercial bank money that is fully covered by the credit balance in the trust account.

Transfer of tokenised commercial bank money as a fully collateralised Stablecoin

For the transfer of tokenised commercial bank money, there are two options which differ in the way they are reported on the balance sheet. The T accounts presented and the technological blueprints show option B because of the more complex processes involved (recipient bank issues its own tokenised commercial bank money upon receipt of the tokenised commercial bank money).

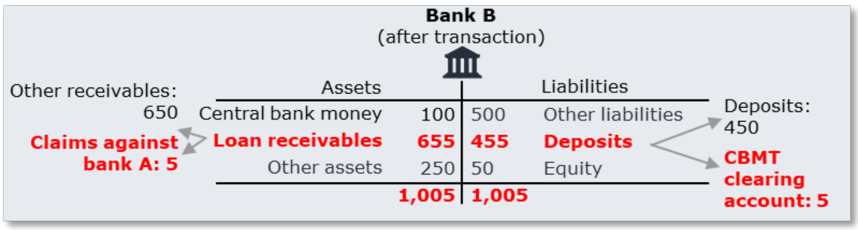
The advantage of using tokenised commercial bank money in the form of a fully collateralised Stablecoin is primarily the fungibility of the token as individual bank risks are eliminated because the tokenised money is fully covered by a trust account of the ECB. Tokenised commercial bank money could therefore be transferred without having to be incorporated in the balance sheet of the recipient bank. Bank customer B would therefore hold tokenised commercial bank money issued by bank A in his wallet and be able to use it as a means of payment (option A). However, because of statutory provisions to be examined (e.g. requirements laid down in the deposit guarantee scheme), it might be necessary to consider that only liabilities of the bank concerned can be held in a wallet infrastructure operated by a commercial or savings bank. It would therefore not be possible for a customer of bank B to hold tokenised commercial bank money of bank A. In this case, when transferring a token of bank customer A to bank customer B, the tokenised commercial bank money would have to be transferred to an address of bank B, and bank B would then have to transfer tokenised commercial bank money of its own to the customer's address. Technically, the recipient bank will make available an exchange/input address for the receipt of the tokenised commercial bank money of bank A and exchange the tokenised money for tokenised commercial bank money of bank B. The prerequisite for bank B would be that it has deposited a credit balance in the ECB's trust account and that it holds the necessary amount of tokenised commercial bank money in its address that can be transferred to the customer.

Option B – Step 3: Issuance of CBMT and transfer to Industrial customer / Exchange CBM to CBMT



Bank B will then transfer its own tokenised commercial bank money to its customer's address for tokenised commercial bank money. The fact that the tokenised commercial bank money of bank A is automatically changed by the intermediate exchange address into own tokens of bank B ensures that customers of bank B will hold tokenised commercial bank money exclusively in the form of liabilities of bank B and not as liabilities of the sending bank (bank A).

On the balance sheets of bank A and bank B, this would create receivables and payables between the commercial and savings banks involved (option B). These receivables and payables can be posted in the commercial and savings banks' accounts which they keep on behalf of the other bank (nostro and vostro accounts) and, if requested, the receivables and payables can be settled via existing payment transaction systems.

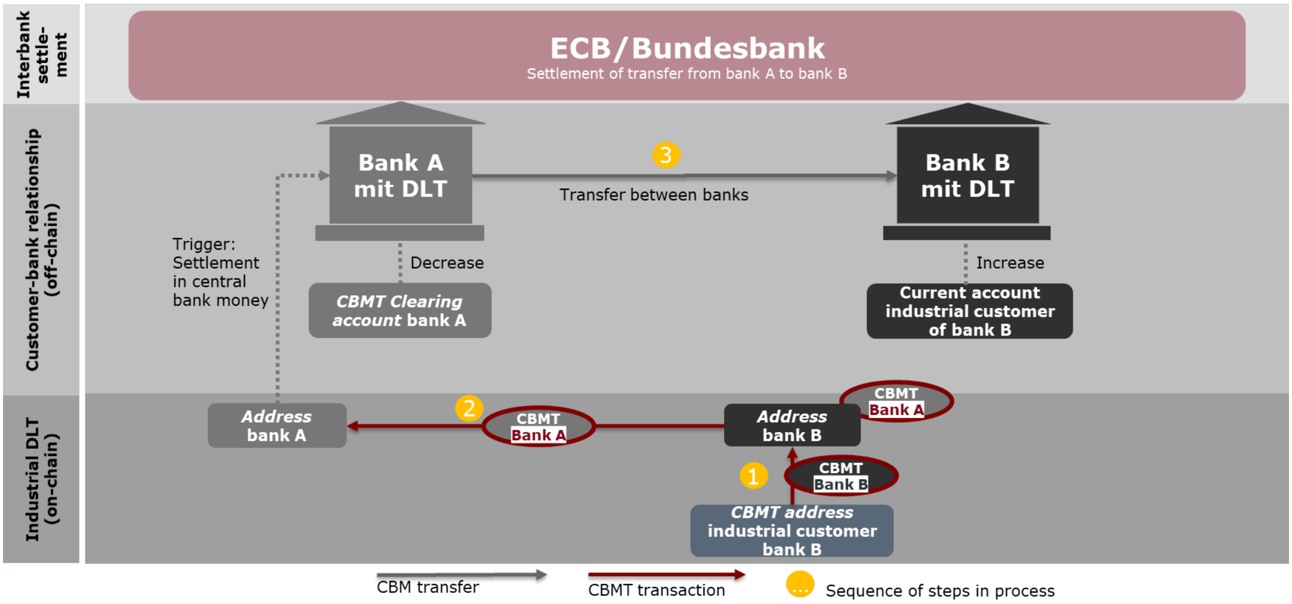


Converting tokenised commercial bank money into commercial bank money

One of the requirements to be met by tokenised commercial bank money is that the convertibility between tokenised commercial bank money, commercial bank money and hence cash must be ensured at any time. One important process step is therefore the conversion of tokenised commercial bank money into commercial bank money, i.e. "depositing" tokenised commercial bank money to the current account. To be able to credit the account, the amount of the tokenised commercial bank money must be transferred by the issuing bank (bank A) to the current account held by the bank customer with the recipient bank (bank B) by means of existing payment transaction systems.

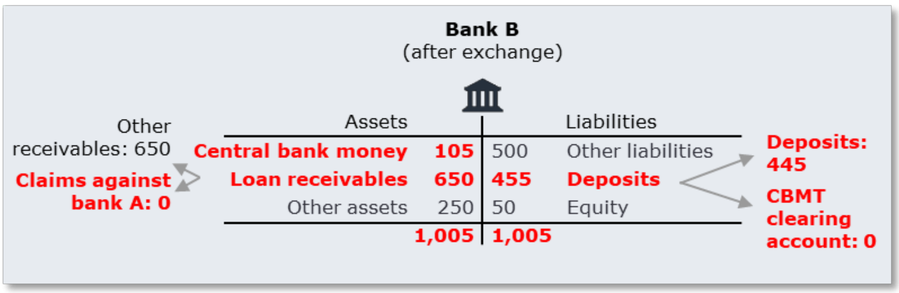
If a customer of bank B wants to exchange tokenised commercial bank money previously received in the underlying transaction from a customer of bank A for commercial bank money, the customer of bank B will first transfer the tokenised commercial bank money to his bank's address (bank B). In option A, in which it is possible, to hold another bank's tokens in a wallet, the bank will send the tokenised commercial bank money of bank A previously received in the underlying transaction to an address of bank A. If it is not possible to hold other banks' tokens (option B), bank B will send the token of bank A, which had already been received in the context of the customers' underlying transactions, to an address of bank A. Upon receipt of the token by bank A, a transfer will be triggered from bank A to bank B (step 4, option B).

Option B – Step 4: Exchange of CBMT into CBM by industrial customer and burning



In the wake of the transfer via Instant Payment (SCTinst), the balance sheet of bank A decreased by the amount transferred. On the liabilities side, the credit balances in the clearing account for tokenised commercial bank money (option A) or the liability due to bank B will be transferred to the bank customer's current account with bank B (option B). This transfer requires central bank reserves which are posted on the assets side as outflow in the normal transaction account with the ECB.

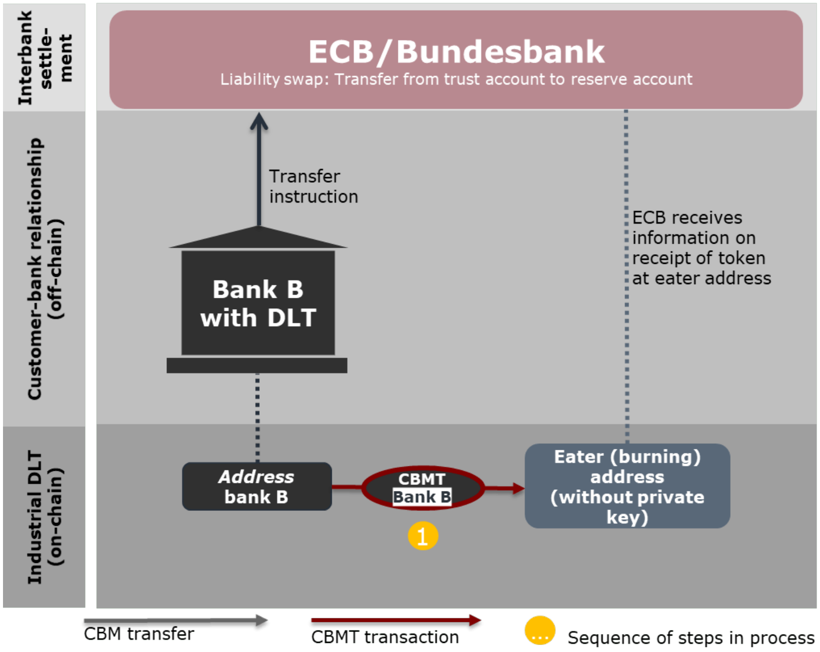
In option A, i.e. in the case of bank-independent wallets, the balance sheet of the recipient bank (bank B) will grow in the same process by the reserves received and by the credit balance in the bank customer's current account. In option B, i.e. in the case of bank-specific wallets, the balance sheet of the recipient bank has already grown in the context of the



transfer of tokenised commercial bank money by the issue of new tokenised commercial bank money. Receivables due from bank A are posted on the assets side, and the clearing account for tokenised commercial bank money increases on the liabilities side.In this scenario, the receivable due from / claim against bank A is settled by the transfer of reserves (asset swap), and the balance of the clearing account for tokenised commercial bank money is posted to the bank customer's account (liability swap).

In this governance model, the balance of tokenised commercial bank money always corresponds to the credit balance in the ECB's trust account. As described above, tokenised commercial bank money can be held either by the bank's customers or by the commercial and savings banks themselves. The balance of tokenised commercial bank money held by customers corresponds to the balance in the commercial and savings banks' clearing accounts for tokenised commercial bank money. The difference between the balances in the trust accounts and the clearing accounts for tokenised commercial bank money corresponds to the amount of tokenised commercial bank money which is held by banks and savings banks and which can be transferred to customers, as required.+

Step 5: Burning



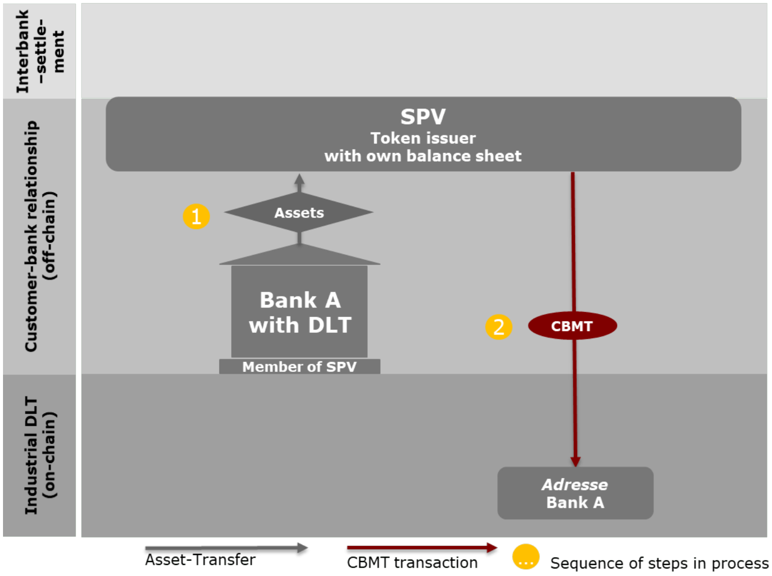
When commercial and savings banks decide to destroy tokenised commercial bank money, the required credit balances will have to be transferred at the bank's request from the trust account to a normal transaction account with the ECB. The token will then be transferred to what is referred to as an "eater address" whose private key is not know to anyone, so that the token will be destroyed (step 5).

9.2 Tokenised commercial bank money issued by a special purpose vehicle (SPV)

An association of commercial and savings banks enables customers to use tokenised commercial bank money through a token issued by a special purpose vehicle (SPV).

Generation of tokenised commercial bank money by an SPV

Step 1: Mining



The purpose of tokenised commercial bank money issued by an SPV is for the token to be independent of specific commercial and savings banks and their risks. This is achieved by using tokenised commercial bank money that is issued by a cross-bank SPV. To achieve the flexibility of the two-tier monetary system, in which commercial and savings banks generate additional commercial bank money by granting loans, commercial and savings banks could transfer loan receivables to the SPV (the legal feasibility of this design still needs to be examined in greater detail). Alternatively, commercial and savings banks could outsource government bonds or other safe assets which would then be held on the asset side of the SPV's balance sheet. On the liability side, the SPV would issue liabilities payable on demand as tokenised commercial bank money. The SPV's balance sheet would increase by the amount of the tokenised commercial bank money issued.

Technically, tokenised commercial bank money is generated as soon as a bank transfers the necessary loan receivables or assets to the SPV. The SPV converts the liabilities payable on demand into tokenised commercial bank money and sends it to the address of the bank on the industrial client's distributed ledger (step 1).

Bank A
(after mining)

Assets			Liabilities
Central bank money	100	500	Other liabilities
Loan receivables	**645**	450	Deposits
Other assets	**255**	50	Equity
	1,000	**1,000**	

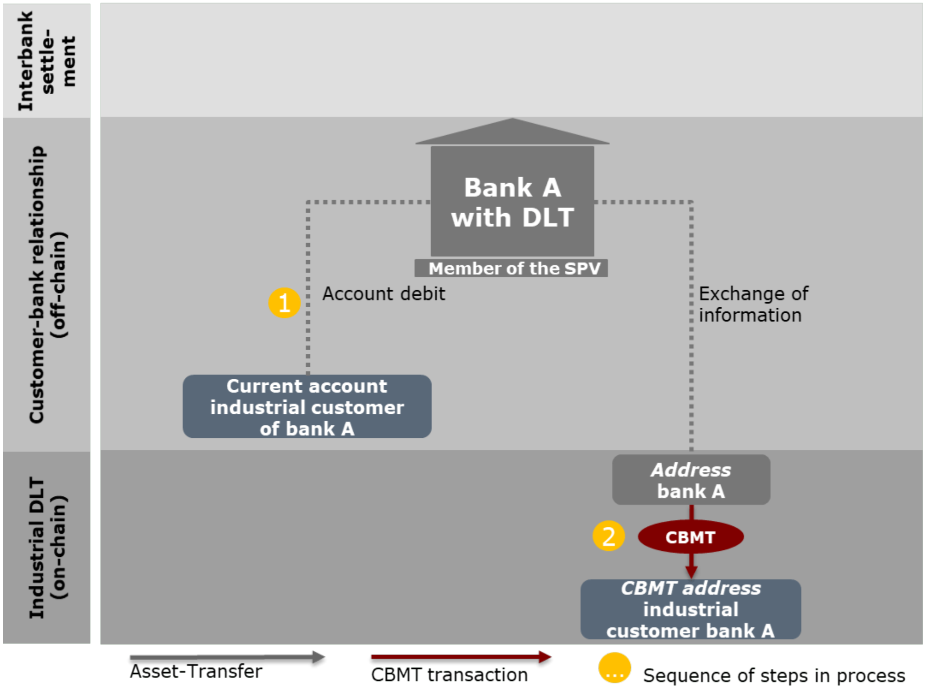
Other assets: 250
CBMT of SPV: 5

SPV
(after mining)

Assets			Liabilities
Loan receivables	**5**	**5**	**CBMT**
	5	**5**	

After the transfer of their assets, the commercial and savings banks will receive at their address tokenised commercial bank money as a receivable from the SPV and recognise it as an asset on their balance sheet. If a bank customer wants to use tokenised commercial bank money, the bank will send the tokenised money to the customer's address and will reduce the customer's account balance by the nominal value of the tokenised commercial bank money (step 2). The result is that the bank's balance sheet will decrease, which resembles the sale of an asset of the bank (e.g. a security) to the bank's customer.

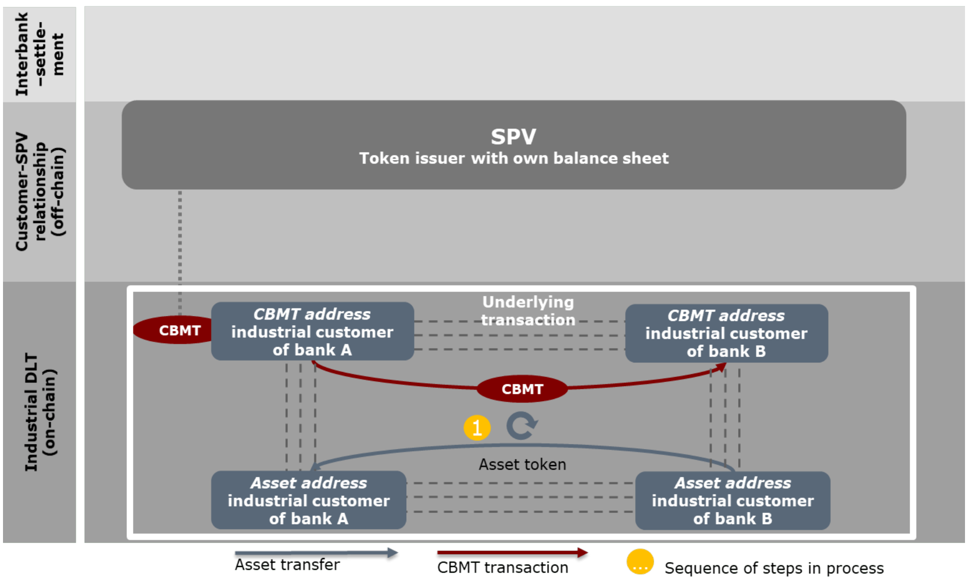
Step 2: Transfer to industrial customer / Exchange CBM to CBMT



Transfer of tokenised commercial bank money within the SPV's balance sheet

When tokenised commercial bank money is transferred, bank balance sheets no longer play a role because the tokenised commercial bank money was not issued by a specific commercial or savings bank and posted in its balance sheet. Commercial and savings banks can provide the connection to the wallet and hold tokenised commercial bank money for their customers outside their balance sheet – similar to a securities account. Consequently, the underlying transaction at the level of the customer is executed on the industrial DLT, independently of commercial and savings banks (step 3).

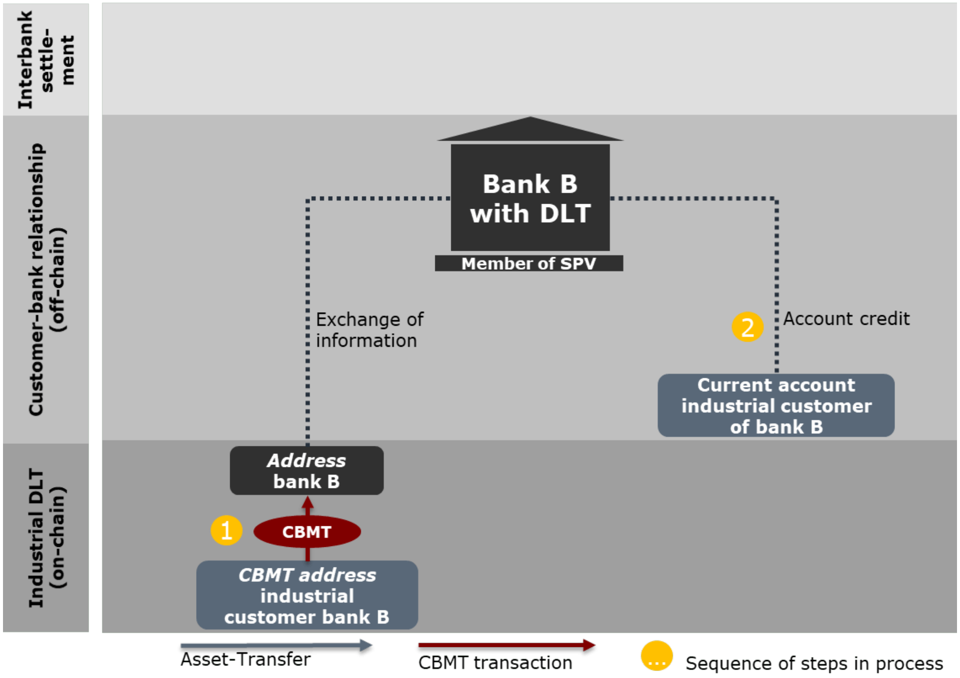
Step 3: CBMT transaction



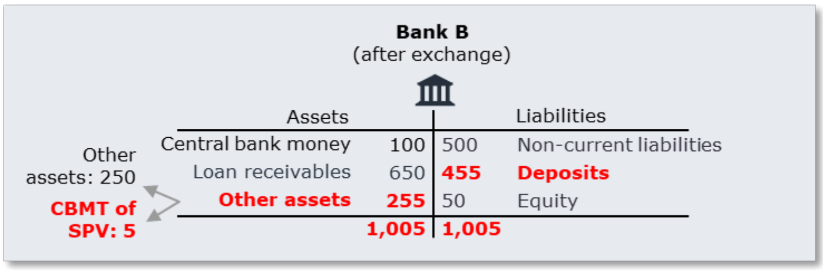
However, it has to be established whether this option is feasible from a regulatory perspective in view of the required AML and CTF processes. Alternatively, the SPV or banks could be given an insight into all participating DLTs, so that the transactions and the amount of tokenised commercial bank money per address could be monitored to ensure compliance with regulatory provisions. For this purpose, there would be an ongoing exchange of information between tokenised commercial bank money addresses and the SPV/ banks.

Converting tokenised commercial bank money into commercial bank money

Step 4: Exchange CBMT into CBM by industrial customer

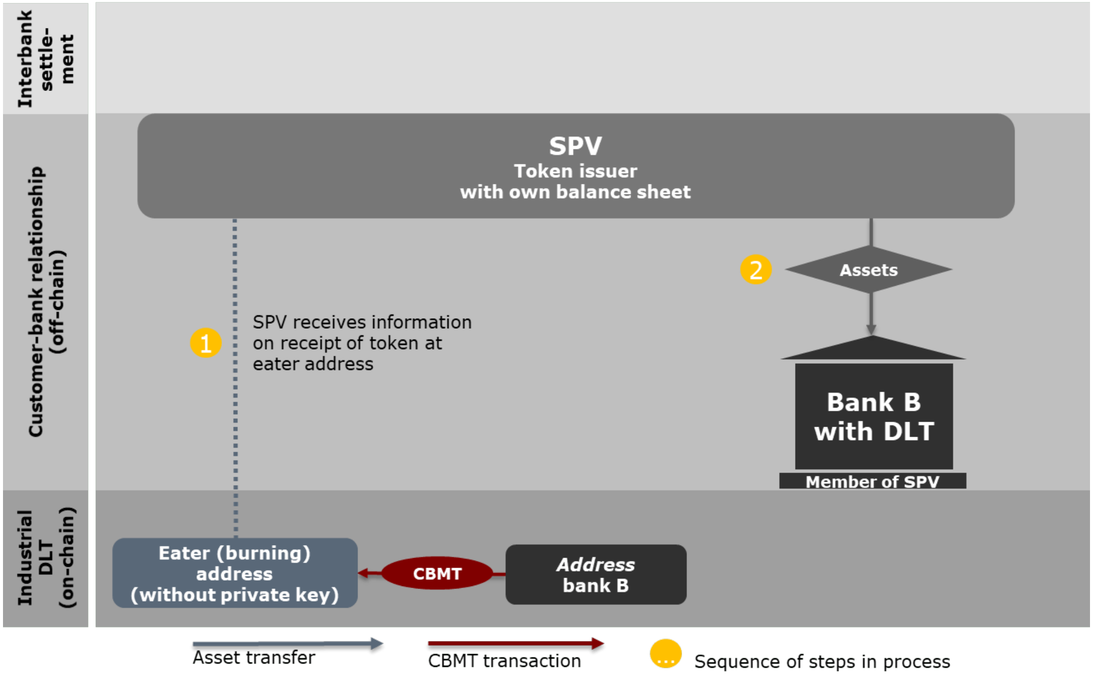


When a customer wants to transfer money in the form of tokenised commercial bank money to his current account, he will send tokenised commercial bank money to his bank's address. The bank then includes the tokenised commercial bank money as an asset on its balance sheet and credits the customer's current account in the amount of the SPV's tokenised commercial bank money (step 4). The process resembles the purchase of an asset (e.g. a security) of the bank by one of its customers. The bank's balance sheet will increase accordingly: The tokenised commercial bank money will be posted on the asset side, and the sight deposits in the customer's current account will increase on the liability side as a liability payable on demand.



The bank can then decide whether it wants to hold the tokenised commercial bank money or convert it back into an asset of the same nominal amount. In this case, the tokenised commercial bank money would be destroyed by the reduction of the SPV's balance sheet and by subsequently sending the token to an eater address whose private key is not known to anyone. Once the SPV has received the information that the token of bank A has arrived at the eater address, the SPV will transfer back the necessary assets to the bank (step 5). An asset swap would take place on the bank's balance sheet, and the tokenised commercial bank money would be exchanged for an equivalent asset of the SPV, e.g. loan receivable or a government bond.

Step 5: Return of CBMT to SPV in return for transfer of assets

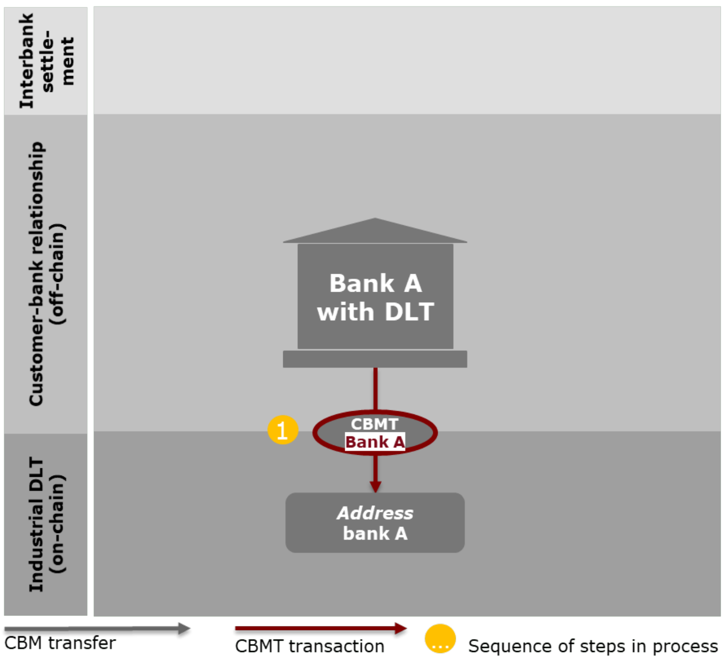


9.3 Tokenised commercial bank money as commercial bank tokens

A third option to ensure the fungibility of tokenised commercial bank money issued by various commercial and savings banks is based on the settlement of interbank payments via central bank money. In this model, the transfer of tokenised commercial bank money does not lead to a simultaneous settlement as in the model of the fully collateralised Stablecoin or that of tokenised commercial bank money issued by an SPV. Instead, this model leads to receivables and payables between commercial and savings banks which are settled via existing payment systems – either when credit lines are exceeded, or by instant payment (SCTinst) or in future via a wholesale CBDC. For this model, a connection of the DLT to existing payment systems is relevant not only for the conversion of tokenised commercial bank money in sight deposits of current accounts as described in the model of the fully collateralised Stablecoin, but whenever the receivables and payables that have arisen between commercial and savings banks are to be settled. The settlement should be triggered automatically, which requires not only performant APIs between the DLT and the payment trigger systems of commercial and savings banks but also a high level of automation concerning the triggering of payments (see analyses in Chapter "Trigger Solutions"). A future settlement by means of wholesale CBDCs will require performant interfaces between the industrial DLT and the interbank DLT which facilitate automated settlement.

Generation of tokenised commercial bank money as a liability of specific commercial or savings banks

Step 1: Mining



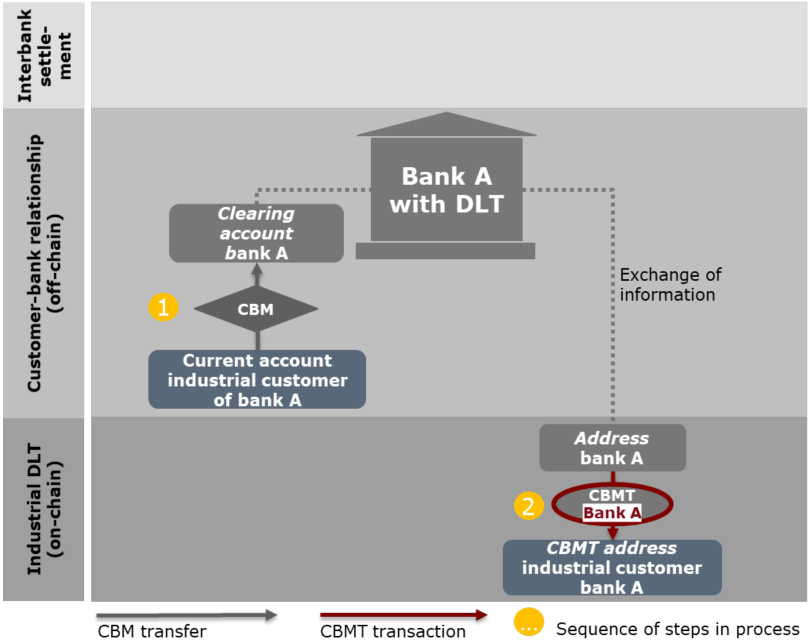
In this model, tokenised commercial bank money is generated on demand from a customer by transferring a credit balance in the customer's current account to a clearing account for tokenised commercial bank money (step 1). Hence, there is a liability swap on the bank's balance sheet. The tokenised commercial bank money is collateralised by the assets of the bank concerned and therefore bears the risks of the generating bank.

Bank A
(after issue)

Assets			Liabilities
Central bank money	100	500	Other liabilities
Loan receivables	650	**450**	**Deposits**
Other assets	250	50	Equity
	1,000	**1,000**	

Deposits: 445
CBMT clearing account: 5

Step 2: Issuance of CBMT to industrial customer / Exchange of CBM into CBMT



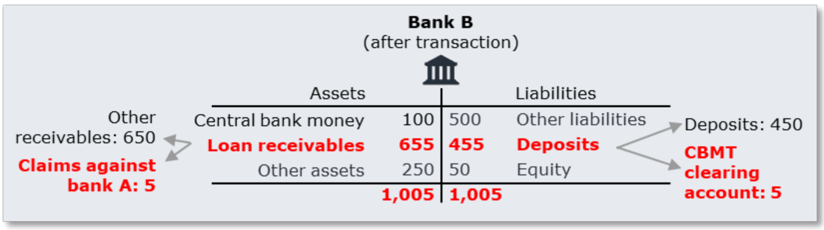
If a bank's customer wants to use tokenised commercial bank money, he will transfer the required amount to a clearing account of his bank for tokenised commercial bank money. In return, the bank will transfer the same amount of tokenised commercial bank money on the DLT to the customer's address (step 2).

Transfer of tokenised commercial bank money

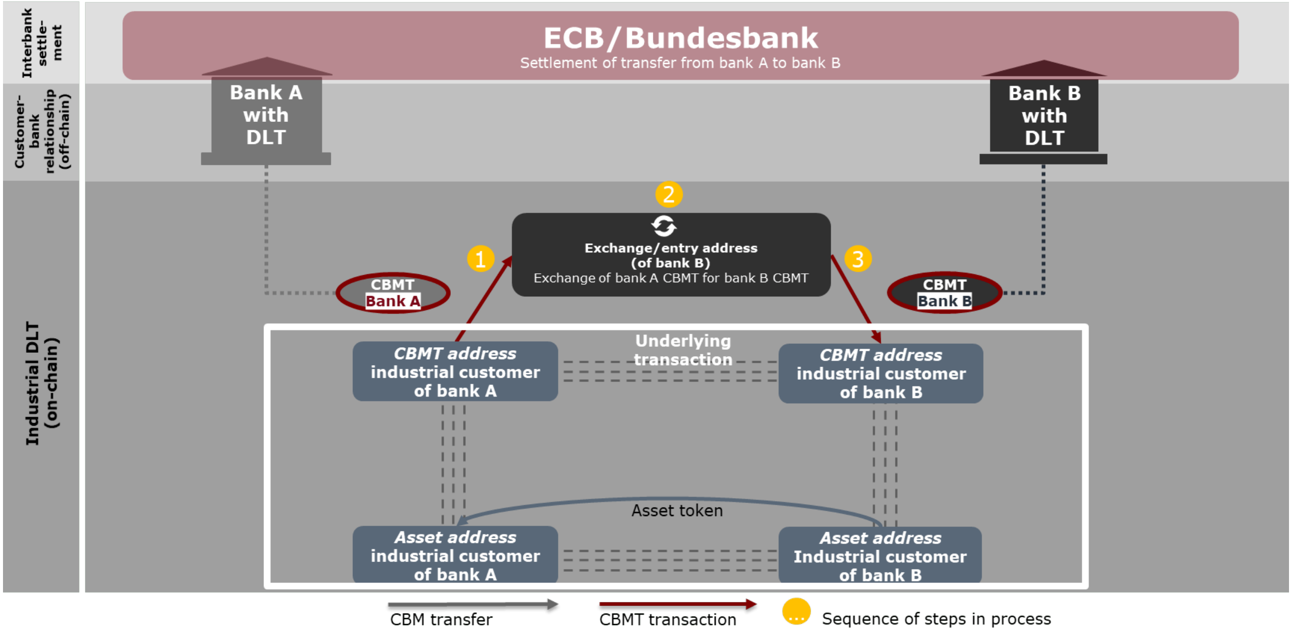
Unlike the fully collateralised – and hence risk-free – Stablecoin, it must be assumed that tokenised commercial bank money, which is a liability of a specific bank, can only be held in wallets of this bank. A customer of bank B can therefore not receive and hold tokenised money of bank A in a wallet provided by bank B. Aside from potential exchange rate differences due to different risk profiles of the tokenised money issued by commercial and savings banks, it is primarily for regulatory reasons that a bank's customers can only hold tokenised money of their own bank in their wallets.

By transferring a tokenised credit balance in the current account, the recipient would automatically become a creditor of the sending bank (bank A), which raises questions regarding deposit protection and the customer relationships of the commercial and savings banks concerned. To avoid this problem, the token will be sent to an address of bank B when tokenised commercial bank money is transferred from bank customer A to bank customer B. Upon receipt, bank B will generate new tokenised commercial bank money of its own and transfer it to the customer's address (step 3). This ensures that customers of bank B will hold tokenised commercial bank money exclusively as a liability of their own bank (bank B) and not a liability of the sending bank (bank A).

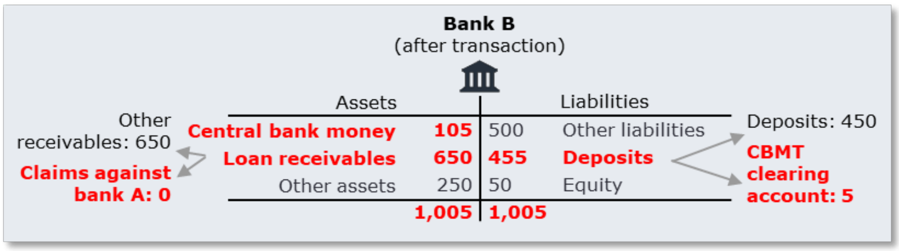
This process leads to receivables and payables on the balance sheets of bank A and bank B. These receivables and payables are posted in the commercial and savings banks' accounts, which they keep on behalf of the other bank (nostro and vostro accounts) and are settled via existing payment transaction systems.



Step 3: CBMT transaction (CBMT is incorporated in balance sheet of recipient bank)

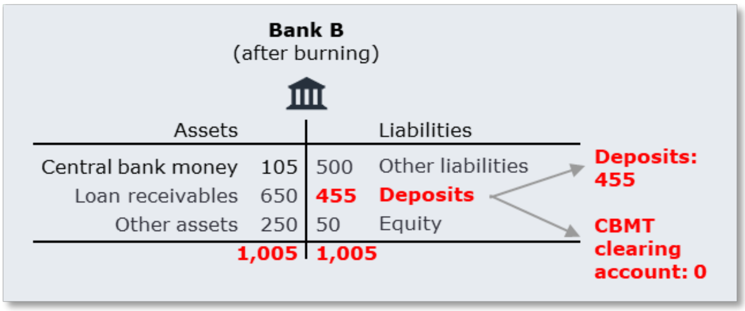


These interbank loans can remain in place until negotiated credit lines are exceeded, when they will be settled by transfers between the commercial and savings banks concerned. Alternatively, instant payments (SCTinst) can be used to mitigate the interbank risk and to prevent the development of receivables and payables. In this case, a payment from bank A to bank B in the amount of the tokenised commercial bank money would be triggered immediately when tokenised money of bank A is converted into tokenised money of bank B. As a result, deposits in bank A's clearing account for tokenised commercial bank money would be transferred to bank B's clearing account for tokenised commercial bank money (liability side of the bank's balance sheet), and reserves would be transferred via the ECB's accounts (asset side of the bank's balance sheet). In future, a wholesale CBDC could further simplify the instantaneous settlement process.



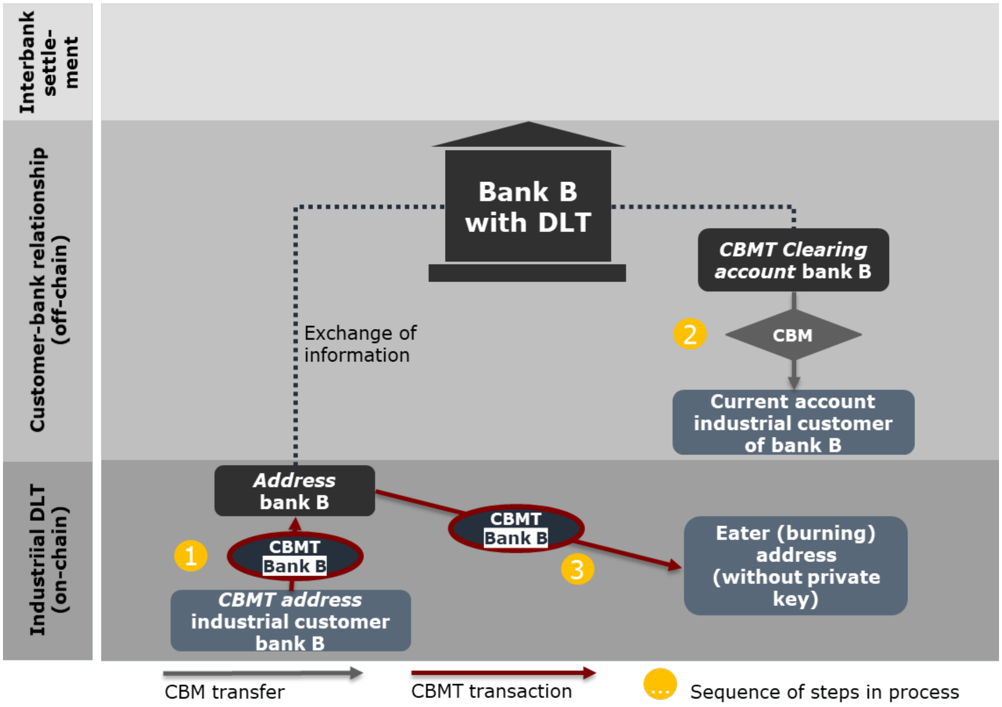
Converting tokenised commercial bank money into commercial bank money

As described above, the transfer of tokenised commercial bank money will lead to receivables and payables between commercial and savings banks, which are either settled instantaneously or after reaching a certain credit line. After the settlement, the recipient banks will have already received the deposits and reserves they need to convert tokenised commercial bank money into deposits in the customer's current account. After the settlement, the exchange can be posted as a liability swap on the recipient bank's balance sheet (bank B): deposits in



the clearing account for tokenised commercial bank money are transferred to the bank customer's current account. In the course of the transfer, the tokenised commercial bank money will be transferred to an eater address whose private key is not known to anyone, so that the token is destroyed (steps 4 and 5).

Step 4: Exchange of CBMT for CBM by industrial customer; **step 5:** Burning



10 Glossar

AMOUNT-BASED SYSTEM	In amount-based systems, payments are aggregated, and after the transfer it is no longer possible to distinguish between the various partial payments. Water analogy: Once two glasses of water are mixed, it is no longer possible to distinguish between the content of glass A and that of glass B.
ASSET-REFERENCED TOKEN	Replicates an asset by means of a token. The token itself does not have an inherent value but merely refers to an asset or assigns a right.
ATOMIC PAYMENT	For the outside world, the transaction is indivisible (see Tanenbaum and van Stehen 2002). A transaction is executed either completely or not at all, and if it is executed, it is executed in one indivisible immediate action. When a transaction is in progress, other processes cannot see any intermediate states of this transaction.
ATOMIC SWAP	Atomic swaps enable parties on different blockchains to exchange tokens (of various kinds). Since an atomic swap is settled by means of a smart contract, there is no need for an intermediary to be involved in the token swap; nevertheless, the two parties are not subject to a risk of loss at any time. In addition, neither the recipient nor the payer has to provide or use their private key, so that atomic swaps are particularly safe. Technically speaking, the technology for many conventional cryptocurrencies is based on Hashed Timelock Contracts (HTLC) and hash functions. HTLC smart contracts ensure that the swap is either completed or not executed at all.
BEARER-INSTRUMENT	Bearer instruments are clearly identifiable, so that the holder of a bearer instrument can enforce a direct claim against the issuer. In the analogue world, cash and cheques are bearer instruments. Purely digital RTGS systems are based on a mirror account with a third party, an intermediary, and cannot be understood as a bearer instrument. A CBDC could be designed as a bearer instrument; either through "possession" of a digital object (= a token) or through the power to dispose of a private key that governs access to the digital objects. Users could execute payments merely by transferring the object with a valid signature, and without the involvement of an intermediary. If such a bearer instrument had offline capability, a CBDC of this kind could be functionally equivalent to cash or an endorsed cheque.

BLOCKCHAIN	A blockchain is a way of storing data, e.g. in a DLT. All the data are combined in a growing list of records, called blocks, and each new block is linked in a tamper-proof manner with the previous block by means of cryptographic concatenation (one-way hash function). The chronological sequence of transactions leads to a steadily growing chain of data blocks (referred to as a "blockchain"). Multiple entities that do not trust each other cannot alter the data without breaching data integrity.
CENTRAL BANK DIGITAL CURRENCY (CBDC)	Central bank money in a digital form already exists today as credit balances held by banks with the central bank. For private households and business enterprises, on the other hand, central bank money only exists in the form of banknotes and coins. They will now also be granted access to central bank money in a digital form (Central Bank Digital Currency: CBDC). To reflect the properties of cash in the application of CBDC as closely as possible, Distributed Ledger Technology will be used in the implementation.
CLEARING	Trading in financial assets leads to debit and credit items. Clearing is the settling of bilateral or multilateral obligations between market participants. The term can also encompass other activities such as trade confirmation. The clearing process therefore establishes mutual receivables, payables and delivery obligations. In the governance of tokenised commercial bank money, clearing would take place on a blockchain, i.e. it would be final and occur in real time.
COMMERCIAL BANK MONEY	Unlike central bank money, commercial bank money (also referred to as book money or scriptural money) is created by credit institutions. It is an integral part of money supply and accepted as a means of payment, but it is not legal tender like cash. Commercial bank money is a claim against the issuing bank.
CONVERTIBILITY	Convertibility describes the free and unlimited exchangeability between different forms of money. Convertible tokenised commercial bank money can be exchanged into commercial bank money, a CBDC or cash. The exchange factor within one currency should always be 1:1, which is indispensable for the currency's stability.
CRYPTO CURRENCY	In the narrower sense, decentrally issued digital money without the involvement of an intermediary (e.g. ECB) and without a central ledger. Instead, cryptocurrencies use

	cryptographic instruments such as hashes and digital signatures to permit a distributed validation of transactions.
CUSTOMER DLT	Digital consortiums set up to settle underlying transactions using a Distributed Ledger, which may in future be operated primarily by industry.
DELIVERY-VERSUS-PAYMENT (DVP)	Delivery of a financial instrument / commodity against simultaneous payment as part of a technical transaction that is executed in real time, which eliminates counterparty risks in the settlement.
DIGITAL ASSET	Asset which is directly available in a digital form and which has an inherent value of its own. Examples of digital assets are, for instance, cryptocurrencies or token-based securities.
DISTRIBUTED LEDGER TECH-NOLOGY	A distributed ledger is a "distributed digital analogue to the traditional bookkeeping journal" (BSI). DLT is characterised by distributed data storage in a peer-to-peer network where data updates are decided jointly by network nodes in a consensus. There is no central communication control or data storage; instead, the network nodes manage local copies of all the data and can add data themselves. A consensus mechanism ensures that the distributed data are up-to-date and consistent in all the nodes. Cryptographic procedures are used to secure network access, data structure and, where applicable, also consensus-building. The best-known DLT design is "the" blockchain, of which different forms exist. Another DLT design is IOTA's "Tangle", which is not a unidirectional chain but a "directed graph". A directed graph is a series of nodes that are interlinked through paths that can only be passed in one direction (e.g. the street map of a city that only has one-way streets would be a directed graph and the crossroads would be the nodes).
ERC-20 TOKEN	A standardised asset based on the Ethereum blockchain created by a smart contract. An ERC-20 token implements a standard interface description for fungible tokens on the Ethereum blockchain and is not a "payment token" like Bitcoin or Ether. A price does not necessarily have to be assigned to an ERC-20 token. This means that an ERC-20 token may not have the store-of-value function which a money token must have according to its definition. However, a "payment token" might be created by means of the ERC-20 token standard and smart contracts.

	Smart contracts can be seen as a programmable / programmed infrastructure, which can assign properties to the ERC-20 token. However, the ERC-20 token is not programmable money because, first of all, it lacks the quality of money (does not necessarily have a store-of-value function), and secondly, an ERC-20 token (and even the Ether payment token) can be issued for any purpose and without any inherent loss of value.
ETHER	Native token of the Ethereum blockchain platform. A payment token which is created during staking. The staker or validator receives Ether as a reward for a correct validation. The Ether token precedes the creation of each ERC-20 token because the execution of a smart contract is rewarded by a fee.
FINALITY	A payment is final if the transfer of ownership has been legally confirmed as being final and irrevocable. In the blockchain, (atomic) payments are always final because payment is inseparably linked with the transaction (“exchange of tokens”). This is due to the fact that there is atomic delivery-vs.-payment on a DLT; the payment and the underlying transaction occur “simultaneously”/“in the same logical second”. The time between the cause of the exchange and the effect (completion of the transfer of ownership/token) is the latency period. Although a DLT payment is therefore immediately final (irrevocable), a certain latency period may lapse before the exchange ends. From the customer’s perspective, a payment is final when the transaction is signed, although the transaction itself may not yet have been closed. From a bank’s perspective, however, it is only final after the completion of the settlement.
FUNGIBILITY	The property of an asset that enables it to be identified and exchanged within the same category. **Fungible tokens** are homogeneous assets; for this reason, they are arbitrarily exchangeable and hence interoperable. Fungible tokens can be created by a smart contract which assigns to the token predefined and/or standardised attributes (e.g. same currency unit). If tokens are fungible, they cannot have individual properties and are therefore not pogrammable money. Consequently, they cannot be used for a specific purpose. However, they can easily be used as tokens in programmable payments.

	Non-fungible tokens are unique assets, such as a work of art (see CryptoKitties). If various money tokens are non-fungible, this may lead to exchange rates between the tokens and other disadvantageous economic effects. Tokenised commercial bank money should therefore be fungible, i.e. it should have the same properties regardless of the issuer and, hence, be exchangeable. **Fungible commercial bank money** can be exchanged 1:1 into tokenised commercial bank money of other issuers (full-service banks).
GOVERNANCE	Steering and management system of an institution or organisation designed to provide guidance. In the context of tokenised commercial bank money, governance is essential to ensure fungibility.
HIGH-PRECISION PAYMENTS	Nanopayments permit the extremely precise settlement of (even larger) amounts with many decimal places after the point, which helps to leverage efficiency gains.
LATENCY PERIOD	The period between the order to execute a transaction and the receipt of payment or the corresponding "receipt" of the equivalent. For example: A transaction is represented by tossing a coin; in return the payer receives an apple. The latency period is the time it takes for the coin to fly through the air until it is caught by the recipient. At the same time, the apple is flying towards the buyer, and no-one can alter the direction of the apple or the coin or stop their movement. The latency period mainly depends on external factors (e.g. regulatory requirements for the CTF audit), and the bank can influence these factors to a limited extent only.
MICROPAYMENT	The term "micropayment" describes a process for the payment of small sums, which occur mainly when purchasing "paid content", i.e. digital products such as pieces of music and newspaper articles, but also when buying bread rolls. According to prevailing opinion, micropayments range between EUR 0.01 and EUR 5.00. Amounts in excess of this are therefore referred to as macropayments. However, this limit is not used consistently in practice or theory. Micropayments in the lower range are often also described as millipayments, nanopayments or picopayments. This range includes, for instance, fixed-line network charges in Germany, which are settled in fractions of a cent.

NANOPAYMENT (PICOPAY-MENT)	Nanopayment or picopayment are terms used for the payment of very small amounts of a few cents or fractions of a cent. The upper limit of micropayments is fluid. While picopayments virtually do not occur in traditional trade, they are conceivable in connection with digital products or services, e.g. for the use of a specialised data base or downloading individual news items. However, their practical relevance is currently low. For years, fixed-line telephone fees have, as a rule, been calculated and charged in fractions of a cent per minute of a call.
NOTARY SCHEME	Technical approach to create interoperability between different settlement systems (blockchains and/or conventional systems). The “notary” is at least one trustworthy authority which supervises several blockchains and triggers an event on a blockchain when a predefined condition is fulfilled. A typical example of a notary scheme is centralised exchanges. In the context of the trigger solution, a notary scheme might be the mechanism between the industrial DLT and traditional payment transactions.
PROGRAMMABLE PAYMENT	Payments which potentially have mechanisms for an inherent logic, defined by a smart contract. If the programmability is used, this can be referred to as a programmed payment. In this case, the payment is a command that triggers the event defined in the smart contract. **Programmable infrastructure:** The resource of a programmable payment or programmed payment can be secured by a programmable infrastructure. A programmable infrastructure could be, for instance, a programmable wallet, an interface or a programmable DLT (smart contracts). To ensure the merger of tokens (1+1=2), the logic of addition could, for instance, be integrated into the infrastructure. In this case, the token itself can be “dumb”; it has no information about the fact that it has been assembled. **Consolidated TF position on tokenised commercial bank money:** Support for programmable payments by tokenised commercial bank money.
PROGRAMMABLE MONEY	DLT- or token-based money that has mechanisms to pursue an inherent logic. Programmability is one property of the token. If this property is exploited, it can be referred to as a programmed token. However, it only becomes programmed money if the token – and ultimately the monetary unit –

	displays certain other properties. For example, it could only be used for a specific purpose or for a specific period of time (stamp scrip). Conceivably, programmed tokenised money could be issued for coronavirus aid payments to be used solely for rent. Another potential application would be a token issued in conjunction with a mortgage loan that can only be used for building materials or for advance payments to craft companies to cover the cost of materials. In this case, the token is more of a "voucher" than money because it is no longer universal like money. Programmed money would be (restricted) money with public (use) properties. For this reason, the distinction between programmable money and programmable payments is conceptual, economic but also essential for communication with customers. **Consolidated TF position on tokenised commercial bank money:** Rejection of programmed money which could only be issued, for instance, for a specific purpose, thereby restricting its universal nature.
RELAY-SCHEME	Technical approach to create interoperability between different settlement systems (blockchains and/or conventional systems). Unlike a notary scheme, a relay scheme does not need a trustworthy authority; instead, the blockchains can interact decentrally. By means of a relay scheme, a blockchain can read another blockchain and validate certain conditions with the help of the standard verification process. BTCRelay, for instance, is a smart contract on the Ethereum blockchain which can read the Bitcoin blockchain; however, this only works as a "one-way street". The Bitcoin blockchain cannot read the Ethereum blockchain by means of BTCRelay. In the context of the trigger solution, a relay scheme might be the mechanism between the industrial DLT and traditional payment transactions.
SETTLEMENT	Settlement fulfills obligations arising from payment and and securities transactions between two or more parties with debt-discharging effect. Both central bank money and commercial bank money can be used to fulfill obligations. Settlement is usually preceded by clearing.
SMART CONTRACT	In the context of blockchains, a smart contract is usually an executable programme whose execution generates a transaction on a blockchain. A smart contract can, for

	instance, trigger a payment once a predefined condition has been fulfilled. The term Smart Contract was introduced by Nick Szabo in 1994 for "computer-aided transaction protocols which execute contractual provisions" and it was revived with the advent of the Ethereum blockchain. Some developers of other platforms use other names and terms for executable programmes on their blockchain. In the case of Hyperledger Fabric, for instance, the name used is "chaincode" or, in a broader sense, "distributed applications" (dAPPs).
STABLECOIN	DLT-based token designed to maintain its value. To avoid volatility, stablecoins are pegged, for instance, to national currencies like the US dollar and (partially) backed by securities, which is intended to confer real value on the stablecoin. In addition, there are stablecoins which use an algorithm to maintain their value and therefore elastically adjust the stablecoin supply in response to demand. In regulation, stablecoins are currently not distinguished from digital commercial bank money, which – based on the MICA Regulation – therefore needs to be additionally backed by minimum reserves in accordance with Basel (= obstacle for commercial bank money).
SYNTHETIC CBDC	An sCBDC (also referred to as a hybrid or indirect CBDC) is a tokenised form of those liabilities of commercial and savings banks which are fully covered in central bank reserves in order to protect the security and risk-free quality of the asset to be settled. Private-sector institutions such as e-money institutions take on many administrative and operational functions. Counterparty risk remains due to private issuers. Benefits of DLT can be used in the financial system (DvP, automated and programmable transactions, faster and more cost-effective settlement). Compared with a "traditional" retail CBDC, the disruption of the current financial infrastructure caused by an sCBDC would probably be significantly weaker because it would not be necessary to create new legal tender with all legal and economic consequences.
TECHNOLOGICAL INTEROPERABILITY	Tokenised commercial bank money must be interoperable across various DLT technologies and between the blockchains of individual banks (interface standards will need to be developed). It is possible to define token standards that are blockchain-agnostic, i.e. independent of the design of the blockchain used.

TOKEN (ECONOMIC DEFINITION)	Clearly identifiable object that represents a value and hence a store of value. A token can be seen as analogous to a clearly identifiable banknote.
TOKEN AND ACCOUNT (TECHNOLOGICAL DEFINITION)	**Token:** Representation of a defined asset on a blockchain. A token is represented by a clearly identifiable hash. The most important properties of a cryptographically strong hash are that, if only 1 bit of input data changes, the resulting hash will change significantly, and that the hash is easy to calculate based on the available data, while it is nearly impossible to derive the underlying data from the hash (referred to as "trapdoor function"). It is therefore difficult to imitate a hash, which is crucial for the integrity of payments on the blockchain. A token has the inherent properties assigned to it by the smart contract. Example: A token based on the ERC-20 standard, a fungible token. **Account:** Address by means of which information is recorded on the blockchain. Conceptually, these account addresses are comparable with conventional bank accounts. The difference compared with traditional accounts is that on the Ethereum blockchain, for instance, accounts and corresponding account balances are stored on the participating network nodes in a distributed and decentralised manner.
TOKEN- AND ACCOUNT-BASED SYSTEMS (ECONOMIC DEFINITION)	From a central bank's perspective and in debates on CBDCs, the terms "token-based" and "account-based" are a dichotomy, describing two types of a conceivable CBDC design. **Token-based system:** Token-based systems are dependent on an object. Access to the token requires proof of information (e.g. a private key) (BIS: "I know, therefore I own"). **Account-based system:** Account-based systems are dependent on an identity. Access to the account requires proof of identity (BIS: "I am, therefore I own"). However, there are two shortcomings in the BIS definition: In jurisdictions with less stringent anti-money laundering regulations, access to the account may require no more than the disclosure of information. Account-based systems therefore need an identifier but not necessarily an identity.

	In addition, the account's back-end / back-up with the corresponding credit balance is at the bank. The wallet is therefore mirrored at least once. In an account-based system, an intermediary is needed to synchronise data, at least temporarily.
TOKENISATION	Tokenisation is the digitalised depiction of an (asset) value, including the rights and obligations contained in this value and its resulting transferability.
TOKENISED COMMERCIAL BANK MONEY	Tokenised commercial bank money is the response of private credit institutions to digital central bank money (CBDC). Commercial bank money can be used by non-banks as a digital means of payment and store of value. Tokenised commercial bank money will continue to be generated by commercial banks through lending or asset purchases or after debiting the customer's current account, and can be exchanged at face value into central bank money at any time. Tokenised commercial bank money is thus expected to have the properties of today's commercial bank money. Tokenised commercial bank money can be transferred "peer-to-peer" (P2P) between persons, institutions, machines, etc. Benefits of DLT can be used in the real economy and in industry (DvP, automated and programmable transactions, faster and more cost-effective settlement, M2M payments, micropayments, etc.).
TRIGGER SOLUTION	Linking of industrial DLT protocols for underlying transactions to existing payment transactions (SEPA, Swift, etc.): During this process, a token is generated which represents a claim to payment via existing payment systems of an amount deposited by the issuing credit institution. The DLT benefits can be used without generating a payment token. A token is linked to a transaction and cannot be re-transferred (e.g. by transferring the claim). The final settlement of the transaction occurs after execution of the payment via the existing payment system.
FIXED UPPER LIMIT	Potential measure by ECB to control the digital euro. A limit of € 3,000 per CBDC account is currently being debated; this limit was proposed in a paper published by central banker Ulrich Bindseil. The higher the fixed upper limit of a CBDC, the more attractive will be its use for the consumer and the greater the likelihood that bank deposits will flow into the digital euro.

WALLET	A wallet stores public keys and corresponding private keys. Similar to a bank app, a wallet controls access to the account address (the public key). As a rule, wallets do not store tokens because tokens are recorded on the blockchain; a wallet could therefore be seen as a kind of "password manager" because it stores private keys. Private keys can be used to sign and correctly execute transactions, and – if valid – to update account balances in the blockchain. In the case of an offline-capable wallet / prepaid model, the credit balance can also be stored locally. A **hot wallet** is permanently linked to the DLT/blockchain structure (online). The risk of loss is lower than with the cold wallet; in return, the cyber risk is greater. A **cold wallet** is offline, i.e. not connected to the DLT network, and the private key for access is on a CD, on paper, or kept on other digital media. A loss of the private key leads to the loss of the assets in the wallet. All the values contained in the wallet would be transferred without being traceable if the wallet is transferred.
WHOLESALE (CBDC)	"Digital interbank money", possibly also digital tokenised central bank credit balances, accessible only for financial institutions. A wholesale CBDC could improve the efficiency and risk management in the settlement process, especially given that wholesale CBDC would also be made accessible to financial market players which currently cannot hold accounts with the central bank. Current projects: Helvetia of SNB, PoCs of the Banque de France, Stella project of the ECB and the Bank of Japan; several projects of the Bank of Canada (Jasper project) and Monetary Authority of Singapore (MAS) (Ubin project), "Inthanon-LionRock" project of the Hong Kong Monetary Authority and the Bank of Thailand, Aber project of the Saudi Arabian Monetary Authority and the Central Bank of the United Arab Emirates.