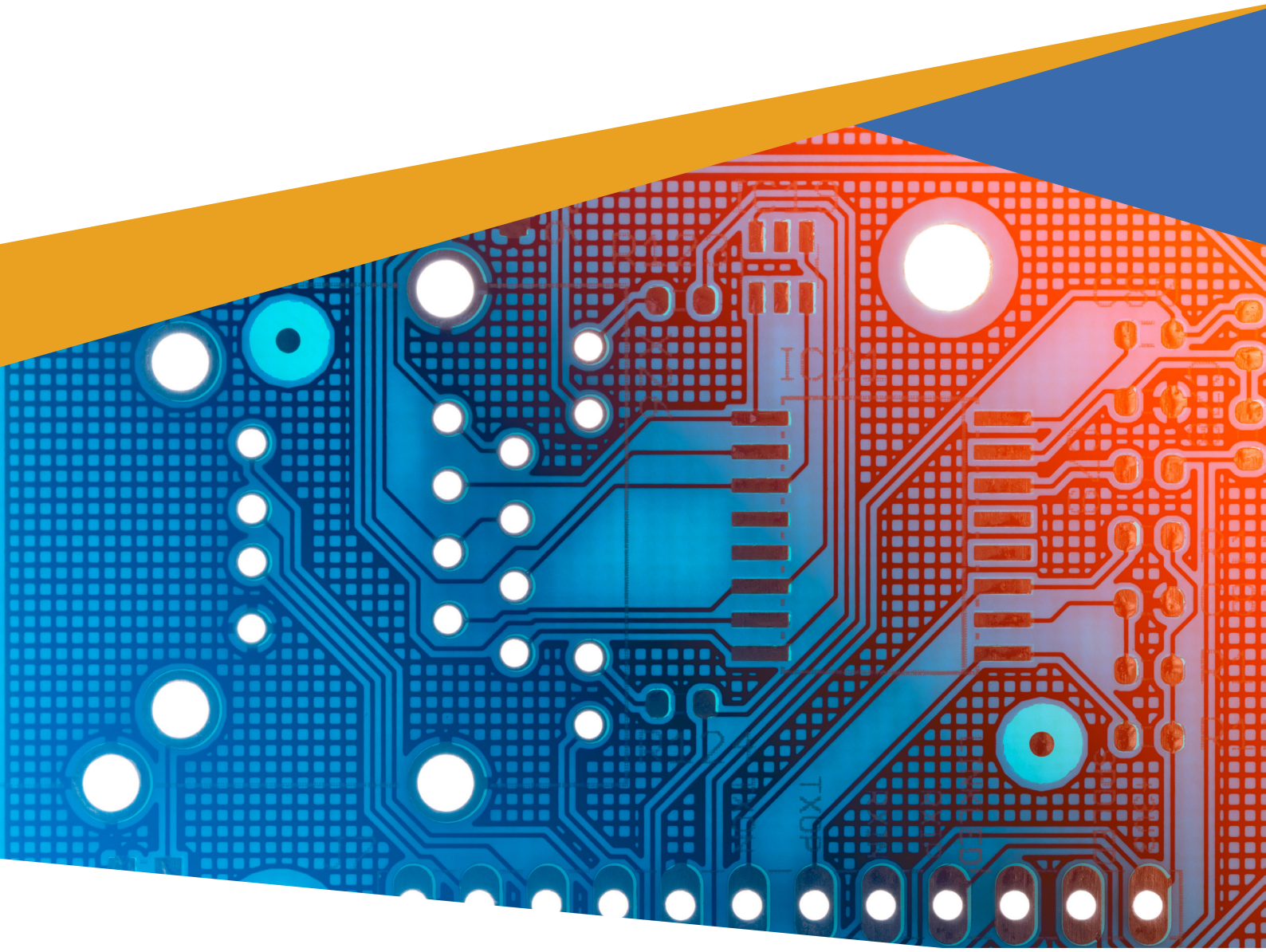

Wholesale central bank money in the context of technological innovation

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1. Introduction

In recent years, there has been a high level of technological innovation in payments and financial market infrastructures, often driven by the exploration of distributed ledger technology (DLT). In previous episodes of technological advancement in payments, a critical enabler of safe and effective innovation has been the ability to integrate new technologies into existing forms of settlement. In this dynamic context, it is crucial for central banks to deepen their understanding of trends in technological innovation and possible new approaches to central bank money settlement. This could support increasing the speed, efficiency and resilience of wholesale settlement.

Interest in what is often referred to as "wholesale central bank digital currency" (wholesale CBDC) has increased among central banks worldwide.[1] However, there is no commonly shared understanding of what is meant by this term. In line with the typical technology-neutral usage of the term "retail CBDC", some have argued that wholesale CBDC – understood as digital central bank money used by financial institutions to settle wholesale transactions – has already existed for decades in the form of reserves held by financial institutions with the central bank.[2] Others either implicitly or explicitly use the term to refer to new forms of central bank money, typically referring to its availability on a DLT platform and/or in tokenised format enabling composability and programmability.[3] This report therefore takes a holistic approach to analysing the implications of technological innovation – and in particular DLT – for the settlement of wholesale transactions in a domestic context, with a focus on the role of central bank money.

The key messages of the report are set out in Section 2 and the underlying analysis can be found in subsequent sections. Section 3 provides an overview of key concepts. The rationale for providing central bank money to settle wholesale financial transactions is set out in Section 4. Section 5 is a discussion of the interplay between central bank money settlement and technological innovation. Section 6 is a deep dive into the particular case of tokenisation as an innovation with possible implications for central bank money settlement. Section 7 discusses dimensions for central banks to consider when deciding on their approach towards tokenisation in wholesale financial transactions. Section 8 presents a taxonomy of possible central bank approaches. Section 9 discusses policy considerations driving central bank choices about possible approaches, and key trade-offs between them. Section 10 concludes and discusses possible follow-up work.

2. Key messages

The outcome of the analysis of the group of central banks and the Bank for International Settlements can be summarised in the following key messages.

1. **Forms of central bank money.** Central bank money may be issued or represented in the form of digital tokens on a DLT platform and used for the settlement of wholesale transactions between financial institutions. Such a new technical representation of central bank money could be made economically and legally identical to existing forms of digital central bank money used in settlement, eg in real-time gross settlement (RTGS) systems. The term "wholesale central bank money tokens" is used in this report and describes central bank money in a token form that is used as a settlement asset for transactions with commercial bank money and/or other assets represented as digital tokens.

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1 See, for example, Di Iorio et al (2024).

2 Panetta (2022); Bailey (2023); Cipollone (2024).

3 Bank of France (2023); Diehl and Drott (2023); BIS (2023); Durfee et al (2023); Jordan (2024).

2. **Technological innovation and the role of central bank money in settlement.** The members of this group judge that the rationale for providing central bank money settlement as set out in CPSS (2003) remains applicable, namely to facilitate convertibility between different forms of money, and to provide payment and settlement systems with a highly liquid and risk-free settlement asset. While the role of central bank money may vary across different jurisdictions, all jurisdictions in this group recognise the continued importance of central bank money either as a settlement asset or as a way to mitigate risks with private money settlement solutions. Although the CPSS report does not provide indications on the optimal share of central bank money in settlement, for some jurisdictions, a scenario in which the use of central bank money is declining is one that might lead central banks to consider taking measures to ensure the safety and soundness of the financial system.

3. **Private or central bank settlement solutions.** There are three (not mutually exclusive) main ways in which central banks could respond to market innovations related to the settlement of wholesale transactions: (i) supporting and ensuring the safety and resilience of private settlement solutions; (ii) enhancing existing central bank settlement solutions; or (iii) building new solutions. Private settlement solutions may have certain benefits, such as timely market presence and alignment with market needs. Central bank solutions may be preferrable in wholesale settlement to avoid credit and liquidity risk, as well as to achieve possible public policy goals, which may vary by jurisdiction, and may relate to, for example, neutrality, cost and liquidity efficiency, market-wide reach, harmonisation and competition. Enhancing existing central bank settlement solutions may be less costly and faster to implement. Alternatively, new central bank solutions may be introduced to provide features or service levels not present in existing systems, in order to better meet the needs of innovative market players.

4. **Choices for central bank money settlement.** When settlement occurs in central bank money, central banks may decide between certain design features, such as whether to have synchronised or integrated settlement, whether there is a role for third parties as operators and/or providers of technical systems and whether there is a need for a new settlement solution. Considerations for these factors may include:

    a. Integrated settlement solutions potentially offer more utility than synchronised settlement solutions, but they are also potentially more complex and costly, and may take more time to build and launch.

    b. Third-party involvement may help to alleviate costs but may raise challenges and new questions for a central bank related to its role vis-à-vis the third party, eg how central bank objectives are met if the system is not – or not solely – operated by the central bank.

    c. A new settlement solution may offer more utility than can be achieved through changes or additions to existing solutions, but this comes at the expense of increased costs as well as potential liquidity fragmentation between new and pre-existing solutions.

5. **Impact of timing on central bank choice.** When market innovations are in an early phase and/or there is little knowledge about the desired design of a settlement solution, it is possible that a central bank may actively or passively support a solution with a quick time to market. To mitigate lock-in risks of potentially sub-optimal long-term solutions, central banks may choose to consider defining and clearly communicating their vision of the future financial system and designing measures and controls to enable migration from a short-term to a long-term solution.

6. **Jurisdictional differences.** Central bank requirements and choices are likely to differ by jurisdiction, reflecting different legal frameworks and possibly different policy objectives. Therefore, solutions may vary across jurisdictions. International cooperation and/or information exchanges on lessons learned are required in order

to better understand (i) commonalities, differences and trade-offs of different solutions; and (ii) the scope for collaboration on cross-jurisdictional solutions.

3. Overview of key concepts

The scope of the present report can be defined by the intersection of **central bank money**, **wholesale payments** and **tokenisation**. It is therefore important to have a common understanding of these concepts and of the suitable terminology to use for their intersection.

Central bank money is a liability of the central bank and is currently issued in two forms: (i) cash, which is widely accessible, but not digital; and (ii) reserves or balances in deposit/settlement accounts, which are digital, but only accessible by qualified institutions. Other forms of money include commercial bank money, which is a liability of commercial banks held as balances at these institutions[4] and non-bank money issued by non-bank financial service providers that hold balances on behalf of consumers and transfer these balances on their books. Central bank money is the safest form of money and, when practical and applicable, the preferred settlement asset in wholesale financial market transactions since it carries neither credit nor liquidity risk. Today, wholesale settlement is typically synchronised across different financial market infrastructures (FMIs) such as payment systems and securities settlement systems (SSSs). This need not necessarily change in the event of a new settlement infrastructure based on new technology, as new technology does not necessitate the introduction of a new settlement asset.[5]

Payment systems are frequently classified as being retail payment systems or wholesale payment systems. The BIS Committee on Payments and Market Infrastructure (CPMI) defines retail payment systems as handling large volumes of low-value transactions.[6] The CPMI does not define ***wholesale payment systems*** (and instead includes a definition of large-value payment systems), though the term is commonly used to describe *large-value, interbank* payments.[7]

Tokenisation is a term that is used widely, but inconsistently, to describe a variety of related concepts. In the context of money and payments, it can be defined as "the process of generating and recording a digital representation of traditional assets on a programmable platform" (CPMI and BIS (2024)). More specifically, on the platforms in question: (i) claims are represented digitally so that funds ownership and the authorisation of payments are technically inseparable; and (ii) programmability allows for automatic execution of trading and settlement conditional on a range of events or actions.[8] Though there are many technologies that could support such a platform, many private sector and central bank projects are experimenting with DLT.[9] The distributed and programmable nature of DLT platforms potentially allows for new settlement arrangements.

The term ***wholesale central bank money tokens*** can be used generally to describe when central bank money is used as a settlement asset on a programmable platform. Wholesale central bank money tokens differ from traditional reserves in their

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4 The safety of commercial bank money is supported by deposit insurance, regulation and supervision, and access to liquidity from the central bank (Board of Governors of the Federal Reserve (2022)). Central banks further support commercial bank money by allowing commercial banks to settle interbank payments using central bank money and enabling convertibility between commercial and central bank money through banknote provision (BIS et al (2020)).

5 Durfee et al (2023).

6 CPMI (2016).

7 Qualified institutions for direct access to central bank wholesale payments platforms are traditionally depository institutions. Expanding access to corporates is a policy question outside the scope of this note.

8 Other authors may or may not include some or all of these features when they refer to tokenisation.

9 BIS and CPMI (2024, p 4).

technological form, but not in terms of economic characteristics.[10] This report refrains from using the term wholesale CBDC as this term may generate ambiguity and convey distinctions not applicable across jurisdictions. For example, the definition of CBDC used in previous BIS and CPMI documents – "a digital payment instrument, denominated in the national unit of account, that is a direct liability of the central bank, and is different from balances in traditional reserve or settlement accounts" – raises a question as to what the differences with reserves should be. Some may interpret this definition as referring to a difference in legal structure and separate recording on the central bank balance sheet (possibly by analogy with retail CBDC), whereas others would also use the term in cases where the difference is merely technical. This report uses alternative terminology, ie wholesale central bank money tokens, with a clear definition highlighting the distinct technological nature compared with traditional settlement accounts.

4. The role of central bank money in payment and settlement systems

4.1 Current guidance regarding central bank money settlement

The 2012 Principles for Financial Market Infrastructures (PFMI) set out risk management standards for systemically important FMIs.[11] The PFMI, as well as the proliferation of RTGS[12] systems and efforts to expand delivery-versus-payment (DvP) settlement for SSSs,[13] underline the core objectives of enhancing the safety and efficiency of payment and settlement arrangements, and more broadly limiting systemic risk.

Principle 9 of the PFMI states that systemically important FMIs should settle in central bank money "where practical and available". There is a presumption that national SSSs will be systemically important, but it is recognised that not all payment systems will be. The PFMI state that when central bank money is not used, FMIs should minimise and strictly control the credit and liquidity risks arising from the use of commercial bank money as the settlement asset, or from settling on the FMI's books. FMIs that settle on their own books but fund and defund in central bank money are long established and the PFMI speak to their appropriate risk management.

The PFMI note that one reason why central bank money settlement may not be possible is because the FMI's participants cannot access central bank accounts. Central bank access requirements vary across jurisdictions, reflecting factors such as legislative constraints, policy preferences and the evolution of payments ecosystems. In recent years some central banks have taken steps towards more liberal access policies, for instance by granting accounts to non-bank payment service providers.

4.2 Rationale for settlement in central bank money

The 2003 CPSS report on the role of central bank money in payment systems emphasises that use of central bank money in payments is not an end in and of itself for central banks. Rather, the interest of central banks "lies primarily in the use of central bank money at the apex of large-value payment systems, as a complement to the use of commercial bank money in such systems."[14] In relation to these complementary roles of central bank money and commercial bank money, the report describes how central banks typically seek to

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10 See Bank of England (2024).

11 In relation to central bank money settlement, they largely restate earlier (CPMI (2001)) guidance for payment systems (from CPSS, now CPMI) and SSSs (from CPSS/IOSCO).

12 See CPSS (1997); Bech et al (2017).

13 See CPSS (1992).

14 CPSS (2003, p 3).

preserve market choice and to avoid competitive distortions when providing services in competition with the private sector.

As highlighted in CPSS (2003), key factors in favour of central banks offering settlement assets are that the central bank is unique in its ability to: (i) supply a single, risk-free and (subject to access policies) widely available settlement asset denominated in the official unit of account; and (ii) issue a sufficiently large and elastic supply of these monetary liabilities relatively easily. Accordingly, the central bank can expand its balance sheet quickly to provide stability in the presence of (settlement and payment) demand shocks.

In addition to robust regulatory and supervisory frameworks for those issuing private forms of money, the existence of a central bank settlement asset aids in maintaining the singleness (or "uniformity") of different forms of (regulated) money.[15] This means payments denominated in the sovereign unit of account can be settled at par, even if they use different forms of money. In this way, the provision of central bank money provides an important anchor for the financial system and the economy and is a necessary but not a sufficient condition[16] for achieving confidence in money, price stability and thus monetary stability.

4.3 Current practice in central bank money settlement

In practice, central banks in the largest jurisdictions typically run RTGS systems directly. In a few jurisdictions, in addition to central bank-run systems there are also private sector-run wholesale interbank payment systems, often utilising liquidity savings mechanisms (eg EURO1 operated by EBA Clearing). Payment systems may exhibit tiering, in which indirect participants will be exposed to counterparty risk to their correspondent banks even if direct participants avoid exposures amongst each other by settling in central bank money.[17]

Consistent with the PFMI, one option for SSSs to settle DvP is by using central bank money. Alternatively, when settlement occurs in commercial bank money or on the books of the FMI, SSSs should minimise or strictly control credit and liquidity risk. There are a variety of DvP models for SSS, with gross or netted exposures of either or both the cash and securities legs (so-called DvP models 1,2 and 3).[18]

If allowed by law, central banks may also choose to promote payment system safety and efficiency, or other public policy objectives, through operating low-value, high-volume payment systems and offering access to central bank accounts and services to private sector retail payment arrangements. The growth of instant retail (single credit transfer) systems in the last 15 years, many of which settle in central bank money on an RTGS basis, is one example.[19]

Central banks employ various models for settlement, which differ along two dimensions: gross versus net settlement, and direct versus indirect submission. Further details on the resulting models are provided in Appendix 1.

In recent years, some central banks have added the omnibus accounts model to support innovative market players. **Omnibus accounts** allow different entities' funds to be co-mingled in a single account held by a payment system operator. Funds on this account may legally belong to the operator[20] or to its participants (through eg a fiduciary or trust set-up). This offers a method of settling payment obligations that is fully funded

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15 CPSS (2003); Brunnermeier and Landau (2023); BIS (2023); Rivadeneyra et al (2024).

16 CPSS (2003).

17 CPSS (2003).

18 CPSS (1992).

19 Bech et al (2017).

20 As in the case of CLS.

with central bank money, even though the settlement asset remains private money on the books of the payment system operator. In principle this model could enable a wide range of innovative use cases, including PvP and DvP settlement models if combined with integrated settlement. These models are potentially more liquidity efficient, but in aggregate the use of omnibus accounts may lead to a fragmentation of liquidity across the financial system. However, this approach creates a functional dependence on a third party in the form of the payment system operator, both operationally and in terms of a claim in the event of default by the payment system operator. A key question is therefore whether settlement under this model reduces risk to the same extent as settlement in central bank money, which may be determined by the precise details of the system in question, such as whether the funds in the omnibus account fall into the bankruptcy estate of the operator or not.

5. Interplay between central bank money settlement and technological innovation

Central banks have a mandate for delivering monetary and financial stability in their jurisdictions. In some jurisdictions, the central bank also has a mandate related to economic growth or employment. Technological innovation represents both novel opportunities and risks to central banks' abilities to fulfil these mandates. Stemming from their monetary policy and financial stability objectives, central banks may also implicitly or explicitly have a mandate to foster a safe and efficient payment system, including by acting as a catalyst for improvements to payment system safety and efficiency. One way in which central banks discharge this mandate is through the provision of wholesale settlement in central bank money. This activity may be impacted by technological innovation – both positively and negatively. These opportunities and risks are explored in more detail below.

5.1 The opportunities of innovation for the provision of central bank money settlement

Technological innovation, including that unlocked by greater automation and digitalisation, represents an opportunity to modernise and improve platforms used for central bank money settlement. Improving the resilience, functionality, speed and efficiency of domestic settlement systems could extend benefits to the broader payment and settlement ecosystem, beyond the central bank infrastructure. In addition to delivering improvements to the operation of the base layer infrastructure, modernisation of settlement systems, coupled with lower barriers to entry driven by technology innovation, can be an enabler of broader innovation in the financial system. Benefits can also accrue at the systemic level. Technological innovation may reduce risks in the financial system eg by enabling the unbundling of payment chains and reducing points of concentration of systemic risk in single entities.

Improvements to settlement platforms can lead to improvements in terms of wider interoperability. For example, the use of application programming interface (API) technologies provides new ways of accessing central bank infrastructure. This can deliver numerous benefits such as the opportunity to improve access to payment and liquidity data, enabling more efficient payment and settlement through smoother processing and automated liquidity management, or the ability to connect to external networks to effect synchronised transactions and achieve atomic settlement, with a view to positively affecting economic growth.

5.2 Potential risks of innovation in money settlement for central bank objectives

Innovation may also represent risks to central banks' abilities to meet their objectives, for example if it is undertaken beyond the boundaries of regulated financial infrastructure and in a way that does not readily interact with existing central bank infrastructure. In some jurisdictions, an intervention from central banks may be deemed necessary, for example, if market innovation leads to fragmentation or is considered to threaten the singleness of money. Since undesired effects of technological innovation may appear gradually, central banks may choose to guide the rate of adoption of new technologies by the financial industry, eg through measures by supervisors or overseers, thereby ensuring the possibility of monitoring its impact, and of countering potential negative effects. Managing the adoption rate of new technologies, as well as continuously assessing their benefits and drawbacks, may also be advantageous because innovative technologies do not always fulfil their original promises, as evidenced by technology hype cycles.

The inverse scenario, in which a lack of engagement from the central bank stymies innovation, can also produce risks to central banks' objectives. In some scenarios, if central banks are slow to adapt and respond to external innovation and fail to modernise their infrastructures, market participants may stall the adoption of new technologies due to central bank money settlement not being available. This inactivity may come with opportunity costs in terms of failure to realise the elements of innovation which may be beneficial for central bank objectives. For example, new market structures may be able to improve systemic resilience by reducing single points of failure,[21] reducing operational incidents[22] in FMIs operating on legacy systems, or reducing counterparty exposures accumulated during costly and inefficient[23] post-trade settlement processes.

6. Tokenisation as an industry innovation with potential implications for central bank money settlement

One technological development that has become the focus of many industry initiatives to improve wholesale financial services is tokenisation. Such industry initiatives may or may not require a central bank response, and the central bank response may differ between jurisdictions. As discussed further in the next section, one factor that central banks may consider in their approach is how these initiatives are connected to central bank money.

6.1 Industry initiatives to improve wholesale financial services

As stated in the BIS-CPMI joint report on *Tokenisation in the context of money and other assets: concepts and implications for central banks,* tokenisation has the potential to reduce frictions in financial markets and the infrastructures that support them through increased automation, straight-through processing and transparency, as well as risk reduction and cost efficiency.[24]

For example, financial institutions have launched initiatives to synchronise their internal systems to allow for on-us transactions to be executed even outside normal banking hours.[25] Seeking to reduce their reliance on intermediaries and improve market transparency, multiple banks have experimented by issuing bonds on new platforms.[26] In

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21 CPMI (2016).
22 Bank of England (2024).
23 Bank of England (2020).
24 BIS and CPMI (2024).
25 Eg JPM Coin, HSBC FX Everywhere, Citi Token Services.
26 See, for example, Santander (2019); EIB (2021).

light of assets being issued in new forms, institutions are exploring ways to efficiently provide the cash asset for a new form of asset purchase, potentially allowing for improved automation.[27]

Some initiatives also explore the potential for tokenisation to address frictions in cross-border payments,[28] including some initiatives involving central banks, such as the BIS Innovation Hub Project Agorá.[29] This is mentioned here for the sake of completeness but is otherwise out of scope of the current report which focuses on domestic considerations.

6.2 Ways to address areas for improvement: new technology and new arrangements

Many current industry initiatives aiming to improve wholesale transactions are using some form of DLT for their new platforms. According to the FSB report *The financial stability implications of tokenisation*, tokenisation using DLT may improve efficiency and expand the availability of financial products and services.[30] For example, programmable DLT platforms could help to consolidate trade and post-trade functions, potentially creating more efficient post-trade processes and reducing settlement risk. Moreover, if relevant conditions are met, they may facilitate simultaneous settlement of multi-asset transactions, potentially reducing settlement and counterparty risk (though possibly increasing liquidity risk if mechanisms are used that require high levels of liquidity eg through prefunding). The technology may also allow for records to be more transparent, potentially reducing the need for reconciliation.

An example of institutions using technology for new arrangements to improve wholesale transactions is through the development of shared platforms. These platforms may allow institutions to create bilateral settlement networks outside traditional FMIs.[31] They may also allow for assets that are currently on separate platforms to co-exist on a single platform and to support DvP and PvP settlement.[32,33] This type of arrangement may allow institutions to use a single funds account for multiple types of asset transactions, possibly helping institutions with their liquidity management.

It is important to note that not all areas for potential improvement are related to legacy technology. Policy choices and market conventions, such as operating hours and access, also play an important role. Yet new technology, such as DLT, may spur interest in new arrangements that – within the confines of the law – may lead to solutions that also address non-technology areas in need of improvement.

An area in which technology solutions (including DLT) are used to address a non-technology friction are projects that enable instantaneous 24/7 transactions. Developing 24/7 internal platforms may help to synchronise internal systems that seek to provide 24/7

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27 Eg Fnality (2023); SIFMA (2024).

28 FSB (2020) highlighted seven frictions (fragmented and truncated data formats, complex processing of compliance checks, limited operating hours, legacy technology platforms, funding costs, long transaction chains and weak competition) that contribute to the challenges identified in cross-border payments (speed, cost, transparency and access).

29 See BIS (2024).

30 See FSB (2024). The report notes that "many of the purported benefits of tokenisation have yet to be fully proven, may not be uniquely achievable through tokenisation, and may involve trade-offs that might negate the benefits."

31 See, for example, Wells Fargo (2021).

32 See, for example, Partior (2023).

33 It is possible that new technology and platforms may allow for new types of transactions to occur that are prohibitively expensive in existing systems. Still, it is important to keep in mind that new platforms may not reduce certain risks associated with a particular DvP or PvP transaction and these risks may be the reason that these transactions do not occur on platforms today.

on-us transactions.[34] The development of 24/7 interbank platforms may allow for instantaneous transactions across financial institutions.[35] Additionally, some developments are considering solutions for 24/7 instantaneous PvP and DvP.[36]

6.3 Industry projects' connections to central bank money

Similar to existing FMIs in the private sector, some new industry developments prefund their platforms with central bank money, using omnibus accounts, and settle on their own books in private money that is backed by central bank money.[37]

Other industry projects are partnering with a central bank so that transactions can be settled in central bank money. These projects may include central banks issuing money directly onto the platform in the form of wholesale central bank money tokens or providing the legal structure to allow for central bank money to be represented on the platform (even if it is not directly issued there).[38]

Finally, some industry projects rely on commercial bank money funding from direct deposit accounts to settle in private money. Should such a platform scale, the importance of central bank money in settlement might decline. A key point of CPSS (2003) is that it is essential to preserve a mix of central and commercial bank money. Although the report does not provide an optimal share of central bank money in settlement, for some jurisdictions, a scenario in which central bank money declines significantly might lead central banks to consider taking measures to maintain the safety and soundness of the financial system.

7. Dimensions for a central bank to consider

The emergence of new (technical) forms of existing asset classes raises the issue of if and how central banks may respond to innovations. A need for central banks to respond to private sector innovations is not a new phenomenon. Different market developments in the past have resulted in new services being offered by central banks. The most recent example here is the introduction of fast payment systems in many jurisdictions following the increased use of instant payments by the general public. When deciding how to act, central banks are likely to take their existing policies for central bank money as a starting point. Different jurisdictions currently have different models for central bank involvement in the settlement systems that include central bank money.[39]

To identify the range of potential options available to central banks to respond to private sector innovations, a number of aspects may be considered: (i) the settlement asset; (ii) settlement in the same or separate systems; (iii) system owner, system operators and/or service provider; and (iv) the need to create a new system. Choices within these dimensions are likely to differ by jurisdiction as different jurisdictions have different legal frameworks for central bank money and potentially different policy objectives that they must achieve. Options may also differ by use case, and it is therefore likely that there is no one-size-fits-all solution.

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34 Eg JPM Coin.

35 Eg Regulated Liability Network.

36 Eg Fnality

37 See, for example, Fnality (2023). Central banks may disagree as to whether the settlement asset is central bank money in this case.

38 See for example, SNB (2023).

39 See, for example, the BIS financial market infrastructures and critical service providers data which can be found at: www.bis.org/statistics/payment_stats/rb_qual_inf_table_ps1.pdf.

7.1 Settlement asset

When responding to industry developments, central banks may have to decide if central bank money should and could be made available as a settlement asset. In cases where central bank money is not available as a settlement asset, central banks may additionally consider if and how central bank money could be used to reduce risks that occur when private money is used as a settlement asset.

In line with PFMI Principle 9, FMIs that settle in private money, especially ones that are considered to be systemically important, should include risk mitigation tools in order to make private money safer, such as using pre-funded and omnibus accounts holding central bank money.[40] An example of an existing settlement system settling in private money and interacting with central bank money is the Clearing House Interbank Payments System (CHIPS) in the United States.

As a general rule, whenever the settlement asset is not central bank money, there are connection points between central bank money and private money. In the jurisdictions contributing to this report there are no onshore FMIs for wholesale transactions that currently operate without using central bank money in some capacity.

7.2 Settlement in same or separate systems

Another important consideration for central banks may be whether central bank money as a settlement asset is available on the same settlement system with other potential settlement assets. For the purpose of this report, having central bank money and other settlement assets on the same settlement system is referred to as integration. Without integration, central bank money and other assets would be on separate systems that would need to be synchronised to ensure DvP/PvP settlement.

Some central banks may prefer integration to synchronisation because by design, settlement results in a single source of truth. Having all legs of a transaction executed on the same platform may also better facilitate programmability (programming or automating actions) and composability (bundling several actions).[41]

On the other hand, some central banks may see a risk of liquidity fragmentation if central bank money is integrated into multiple platforms. Additionally, if a central bank is concerned about ownership and operations of a platform by other parties, it may prefer designs that synchronise rather than allow for integration on a private sector platform (whereas it may still consider implementing integration on a central bank platform).

Examples of existing SSSs that use integration of securities and central bank money on the same platform include central bank owned and operated systems such as T2S (Eurosystem), FedWire Securities (Fed) and BOJ-NET JGB Services (BOJ), as well as third-party owned and operated systems including Euroclear Sweden. A new system using an integrated settlement model is the SIX Digital Exchange (SDX) platform used in the Helvetia pilot in Switzerland. Examples of existing SSSs using synchronised movements of central bank money in RTGS include Euroclear UK & International, and SIX SIS in Switzerland.

7.3 System owner, system operator and/or service provider

Central banks may also have to decide on the role of third-party actors in a settlement system using central bank money as a settlement asset. One possible choice is to limit central bank money to the systems owned and operated by the central bank. An

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[40] These are not the only ways to design an FMI and are meant to be demonstrative rather than exhaustive.

[41] See BIS (2023).

alternative is to allow third-party systems to hold central bank money as a settlement asset. Third-party systems can in turn be separated into regulated private sector actors and public sector entities.

This decision may be influenced by how ownership and operational governance are already organised in a jurisdiction. Today, in some jurisdictions, the central bank owns, operates and determines the rules of the settlement system, without the involvement of the private sector. In other jurisdictions, ownership and operations is split up between the public and private sector or allocated to the private sector entirely. The ability to divide roles and responsibilities between the central bank and the private sector may have implications for approaches that a central bank may be able to take. As an example, in the United States, central bank money, in the form of reserves, is only transferred on payment systems owned and operated by the Federal Reserve. By contrast Switzerland's Swiss Interbank Clearing (SIC) payment system is operated on behalf of the Swiss National Bank by a private entity, SIX Interbank Clearing Ltd. Another example of a central bank using a third-party system is RIX INST: Sveriges Riksbank's settlement service for instant payments in Swedish krona that uses the multi-currency settlement system for instant payments, TARGET Instant Payment Settlement (TIPS), which is operated and owned by the Eurosystem.[42]

7.4 Creation of a new platform for central bank money

Another consideration for central banks if they decide to provide central bank money as a settlement asset is whether the desired arrangement can use existing settlement systems (eg RTGS) or whether it requires a new central bank money settlement system. An integrated system where assets and forms of money (including central bank money) are recorded as tokens would have to be new, since current RTGS systems are not based on technology supporting tokenisation. By contrast, synchronisation could be enabled with either an existing system (with possible changes or additions) on the central bank money side, or a new one (potentially one where the central bank money takes the form of tokens).

Existing laws, regulations and policies about central bank money and the systems that provide for its transfer are likely to be considered. Different jurisdictions may come to different conclusions about limitations regarding their existing systems and whether new systems – such as ones enabling settlement in wholesale central bank money tokens – may be needed.

8. Approaches

The four considerations described above yield six approaches that a central bank may take as the industry continues to innovate.[43] These approaches are illustrated in Graph 1.[44] All approaches are technology neutral and are meant to demonstrate features of an arrangement rather than the technology underpinning it.[45] This section provides several examples of existing systems, which are described in more detail in Appendix 2.

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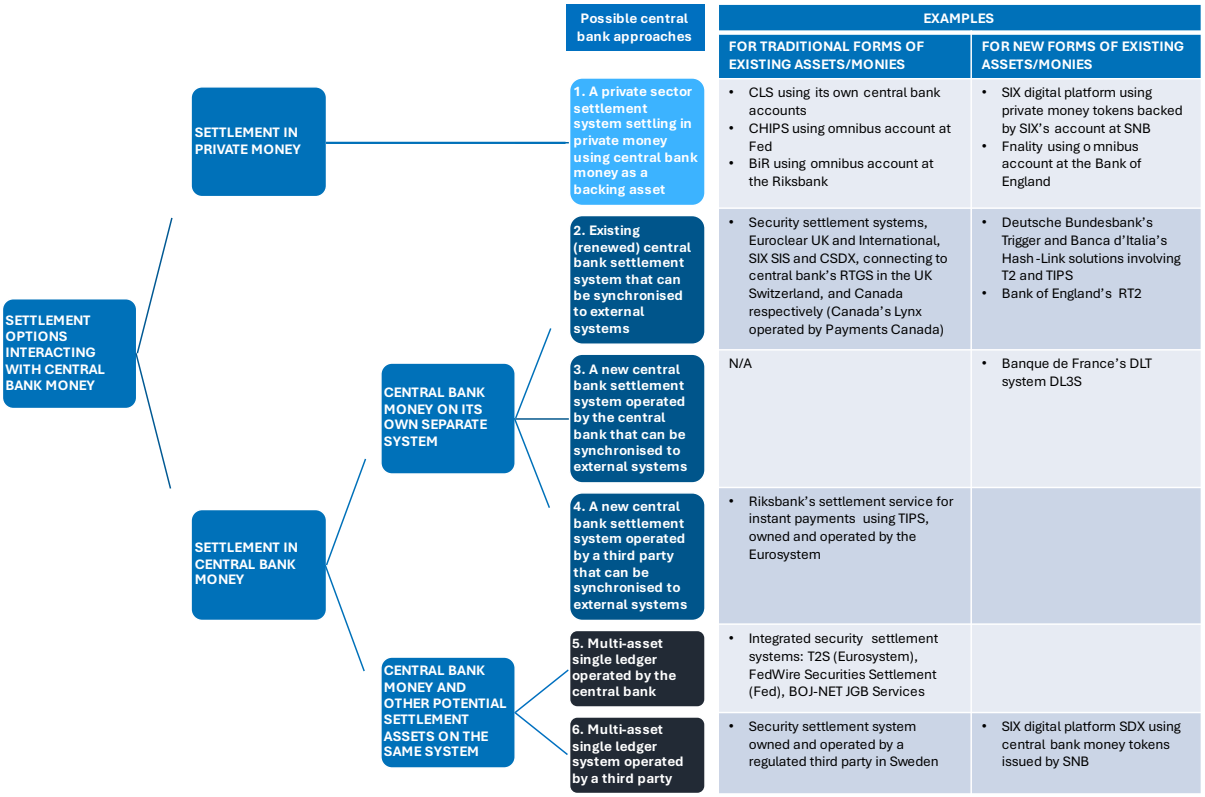
42 Sveriges Riksbank (2022).

43 Early experimentation projects, such as the Bank of Canada's Project Jasper and ECB-BOJ's Project Stella, tested the technical feasibility of new technologies for securities settlement. Since they did not specify roles and responsibilities between the central bank and private sector, we do not categorise them as a particular approach.

44 Central bank decisions do not necessarily have to be in the order depicted in Graph 1.

45 Whether certain technologies are more conducive to certain arrangements is outside the scope of this report.

Graph 1: Possible approaches to private sector developments by central banks involving central bank money



1. **A private sector settlement system settling in private money using central bank money as a backing asset.** A central bank may decide that central bank money cannot be made available as a settlement asset for a new private sector infrastructure. In this case, the private sector platform may rely on central bank money for some part of its funding mechanisms, minimising credit and liquidity risks in settlement, as suggested by PFMI Principle 9. Additionally, existing regulatory landscapes may cover new platforms, ensuring that they are properly risk managed for the safety and soundness of the payment system.

   Existing examples of this approach in the context of tokenisation include the Bank of England's policy of offering omnibus accounts to facilitate private money settlement in a regulated private payment system.[46] The Swiss National Bank has considered similar setups as a policy option ("bankruptcy-remote private token money").[47] In the context of other innovations, Sveriges Riksbank offered an omnibus account to a regulated private payment system to facilitate the settlement of instant payments in private money until the settlement was migrated to a system settling in central bank money in 2024.[48]

2. **An existing (renewed) central bank settlement system that can be synchronised with external systems.** A central bank may decide to keep its central bank system and choose to create a technical interface between its platform for funds settlement and one or more new external asset platforms. This approach does not require a

[46] See Bank of England (2021)

[47] SNB (2023).

[48] See Sveriges Riksbank (2024).

deviation from the jurisdiction's existing practices towards RTGS systems. In jurisdictions that prefer to outsource the operator's role, there is nothing that stops the central bank doing the same here.

Central banks have conducted technical experiments to explore the feasibility of this approach. For example, the Deutsche Bundesbank and the Bank of Italy developed the Trigger Solution and the TIPS Hash-Link, respectively, both of which were also tested in the context of the Eurosystem's exploratory work on new technologies for wholesale central bank money settlement.[49] In addition, the Bank of England is taking forward work to develop synchronisation functionality in the newly launched RT2 system, which would enable conditional settlement across accounts in RT2 and movements on another ledger.[50]

3. **Settlement occurs on a new central bank money platform operated by the central bank that connects to other settlement asset platforms.** A central bank may decide to create a new platform for wholesale central bank money tokens, that it operates, to connect to external platforms via a technical interface.

   Bank of France experimented using this approach, including in the context of Eurosystem exploratory work mentioned above.[51] In this setup, central bank money circulated exclusively on the DLT platform operated by Bank of France (DL3S), which interfaced with other DLT platforms where securities circulated to enable joint execution of the central bank money transfer and the securities transfer.

4. **A new central bank settlement system operated by a third party that can be synchronised with external systems.** In particular, in jurisdictions that currently use a third party, either a regulated private sector actor or public sector entity, to operate central bank money platforms, central banks may choose to employ a similar arrangement for wholesale central bank money tokens. Similar to the above approach, central bank money would circulate on a platform separate from other settlement assets.

5. **A multi-asset single ledger operated by the central bank.** Some jurisdictions may choose arrangements in which central banks operate settlement systems that include both wholesale central bank money tokens and other assets. For those central banks already operating integrated platforms today, applying a similar approach to money and assets in the form of tokens could be considered a continuation, albeit based on technologies different from those underpinning existing systems, in order to derive some sort of additional benefit that cannot be achieved today. Additionally, this approach may be more appropriate for situations in which private sector platforms have not yet been created.

6. **A multi-asset single ledger system operated by a third party.** A central bank may choose to issue its central bank money on a platform that is operated by a third party and also includes other assets, in order to provide the funds settlement asset in a transaction. Some central banks are exploring this option, eg through participation in BIS Innovation Hub projects. For example, in the Helvetia pilot, the Swiss National Bank currently issues Swiss franc wholesale central bank money tokens on the SDX platform, enabling the atomic DvP settlement of tokenised asset transactions.[52]

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49 ECB (2024).

50 RTGS 2: a launchpad for innovation – speech by Victoria Cleland | Bank of England

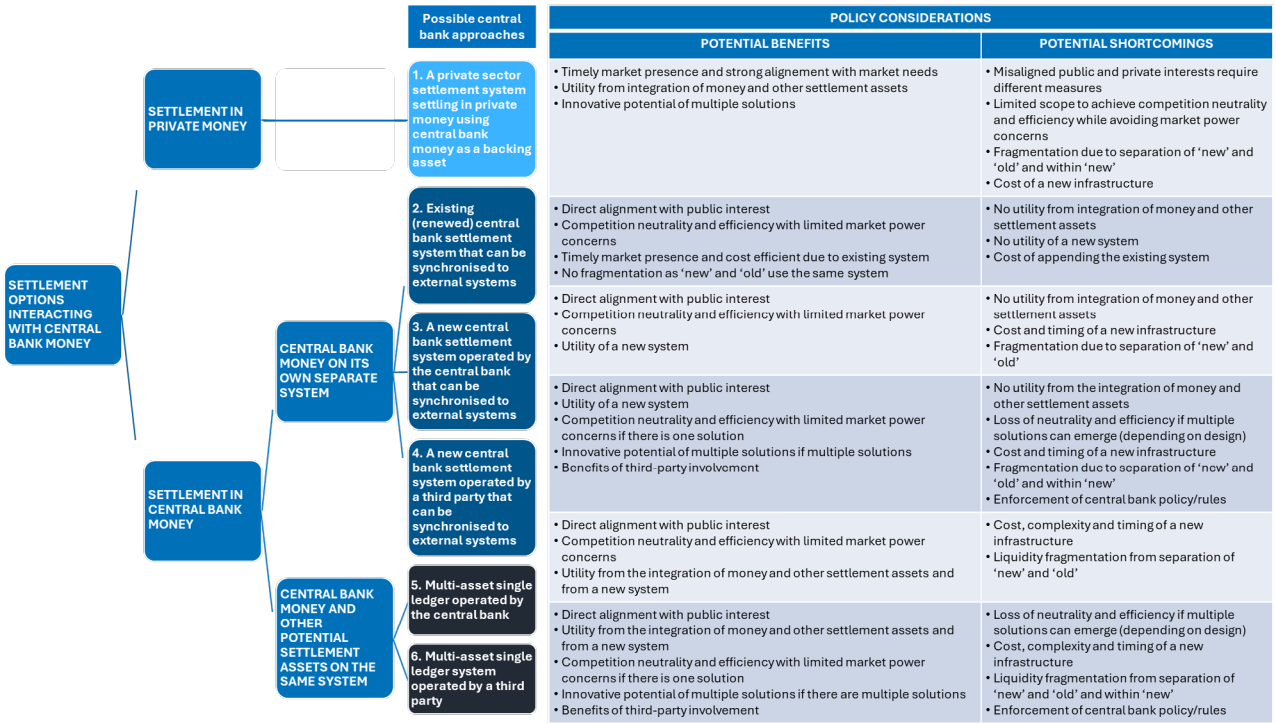
51 See Bank of France (2023); ECB (2024).

52 See SNB (2023).

9. Policy considerations

As pointed out in the previous chapters, central banks are likely to take their existing policies for central bank money as a starting point when deciding how to respond to new innovations. While existing policies differ somewhat across jurisdictions, some key considerations are shared. Typically, there is no single policy that will satisfy all of these considerations. Accordingly, jurisdictions must consider various trade-offs leading to potentially different policy outcomes between jurisdictions.

Graph 2. Approaches and their relative trade-offs



While noting that some innovations may lead to the integration of settlement with other functions in SSSs, this report focuses on policy considerations for settlement options. The main policy considerations are summarised in Graph 2 and described in more detail in the following subsections.

9.1 Appropriate management of credit and liquidity risks

All settlement options outlined in the previous chapter interact with central bank money and can be compliant with Principle 9 of the PFMI. Those settling in central bank money either via synchronisation or integration (ie approaches 2–6) follow Principle 9 directly. Those settling in private money but using central bank money to minimise credit and liquidity risk are also compliant with Principle 9, provided that settlement options settling in central bank money are not available or are impractical for a given use case (ie approach 1 if approaches 2–6 are unavailable).

9.2 Appropriate allocation of responsibility for money settlement

Settlement in private money (ie approach 1) means that the responsibility for money settlement, including establishing legal finality of settlement, lies outside central banks. Private settlement solutions may have certain benefits, such as a quick time to market and alignment with the needs of the market. Indirect central bank influence over private

settlement solutions may be achieved via oversight, supervision and regulation as well as by setting rules for the use of central bank money as a backing asset. Central banks may also act as catalysts for increased harmonisation and interoperability in this case, but their influence may be more limited compared with cases in which central banks are directly responsible for settlement.

Settlement solutions settling in central bank money mean that central banks take on direct responsibility for money settlement. To fulfil this responsibility, central banks exercise control by setting rules and, among other things, decide on the allocation of operational responsibilities. For instance, central banks may decide to act as operators themselves (ie approaches 2, 3 and 5) or involve other actors as operators (ie approaches 4 and 6). The decision to allocate certain operational responsibilities to other actors does not take away central banks' overall responsibility for money settlement but may have important implications for central banks. These are discussed in the next subsection.

Central banks' direct responsibility for settlement is desirable when there are public benefits that may be hard to achieve otherwise.[53] In general, central banks follow public policy goals and in doing so internalise negative externalities that private actors may disregard in the absence of regulation, supervision and oversight. Central banks may also be in a unique position to offer efficient market-wide services in a non-discriminatory and competition-neutral way. Central banks' direct involvement also provides direct means for them to promote harmonisation to achieve improved interoperability and a more competitive, level playing field. Increased harmonisation and interoperability may be especially important in the context of FMIs using new technologies that do not have globally accepted implementation standards.

9.3 Appropriate allocation of operational responsibilities in case of central bank money settlement

When deciding between different settlement options in central bank money, central banks must take into consideration not only their ability to set the rules for money settlement, but also their ability to enforce these rules in practice. In addition, central banks must consider their ability to carry out their other tasks, such as implementing monetary policy and maintaining financial stability.

These considerations are especially relevant to options in which settlement in central bank money involves third parties, for instance, as operators and/or providers of technical systems (ie approaches 4 and 6). In these cases, central banks may decide to take appropriate measures, including legal, regulatory, contractual and technical measures, to make sure their rules and requirements (eg access criteria, non-discriminatory and competition-neutral service, resilience and business continuity) are enforced in practice. As central bank policies and rules are likely to change over time, it is important that central banks have appropriate governance arrangements in place with concerned parties to make sure their policies and rules can be implemented, even in the future.

9.4 Impact on the demand for liquidity, fragmentation and market structure/competition

Even though central banks have a unique ability to supply liquidity in sufficient amounts, its efficient use is important because a higher cost of liquidity would reduce financial intermediation and may restrict economic growth.

As a general rule, settlement solutions capable of settling transactions from multiple FMIs using a participant's single pool of liquidity are more liquidity efficient than

[53] See, for instance, Board of Governors of the Federal Reserve System (2019).

solutions requiring separate pools of liquidity (eg model 1 requires separate pools of liquidity by design). New forms of existing assets and monies may lead to liquidity fragmentation if separate settlement solutions are created for these new forms of existing assets and monies within a given use case (such as securities settlement). In addition, further liquidity fragmentation may result if multiple settlement solutions exist for new forms of existing assets and monies within a given use case (such as within tokenised securities).

To illustrate, consider liquidity fragmentation in the context of new forms of securities. Unless the same pool of liquidity is used for the settlement of transactions with both traditional and new forms of securities (ie use of the existing settlement system to service both new and old FMIs, as in approach 2), fragmentation of liquidity over multiple pools will occur. This can increase the cost of liquidity. Furthermore, if several new settlement solutions, each requiring a new dedicated pool of liquidity, are created for transactions with new forms of securities, additional fragmentation may occur within this use case (eg approach 1 allows multiple private solutions, as do approaches 4 and 6 depending on how third parties are involved).

In addition to liquidity efficiency, central banks may also factor in any impact that settlement options may have on the market structure of services other than settlement (eg clearing and custody). Settlement options that service multiple FMIs from the same pool of liquidity may stimulate competition, as market participants can change FMIs without the need to create new liquidity arrangements.

Furthermore, settlement solutions that integrate money as well as other settlement assets (eg securities) in the same solution may stimulate competition even further. This is because participants can use different FMIs and still use the same settlement solution for both legs of a transaction (ie approach 5 and potentially approach 6 depending on how third parties are involved).

9.5 Possibility to migrate from a short-term solution to a long-term solution

In some cases, market innovations may be in a phase that is too early to justify the creation of a new settlement service in central bank money. There may also be too little knowledge about the desired design of such a settlement service, including the technological aspects. In this case, central banks may opt for a solution that can still support market innovations but may not necessarily be optimal in the longer term. For example, a central bank may decide not to offer a central bank money settlement service but instead encourage private settlement options that make use of the safety of central bank money (ie approach 1). Alternatively, it may at first decide to enable synchronisation with existing systems rather than developing a new system.

When designing a short-term solution, central banks may need to consider possible future scenarios in which an increasing number and volume of transactions may require a different settlement solution to ensure a long-term steady state. To account for this possibility, central banks may find it useful to define their long-term vision and clearly communicate it to the financial sector and potentially to the general public. Central banks may also find it useful to design different measures and controls to be able to migrate from a short- to a long-term solution.

9.6 Other aspects: cost recovery principle, utility to market participants, complexity and time to market trade-offs

When deciding how to respond to innovations, central banks may also need to consider other aspects, including the utility to market participants, the cost and complexity involved as well as the time it takes to bring a solution to the market. Some central banks may be subject to explicit requirements of full cost recovery over the long run.

The ultimate test of any settlement solution is its usefulness to its users. However, trade-offs between utility, complexity, cost and the time it takes to bring a solution to the market are likely to exist. Integrated settlement options may offer more utility than synchronised ones, but they are likely to be more complex and costly to build and maintain, with implications for cost recovery and the time it takes to bring them to the market. Similar trade-offs may exist when deciding between using existing rather than building new settlement systems. While a new solution may offer more utility, existing revenue will be diluted between the existing and new solutions – resulting in total costs increasing. Even within a new solution, trade-offs are present. A new solution with basic functionalities is easier and quicker to bring to the market, but the need to append the system later on with more advanced functionalities may be challenging, as it is typically easier to build from scratch rather than append or adjust.

To navigate and understand these trade-offs, a close consultation and proper experimentation with different stakeholders, including market participants, may be required. Experiments using different solutions, preferably involving actual market participants and real transactions, may also contribute to a better understanding of trade-offs between utility, cost and other aspects.

10. Conclusions

Against the backdrop of the financial industry adopting new technologies for wholesale transactions, the coexistence of private and public forms of money raises important policy questions. In view of the potential implications for their ability to fulfil their mandates, central banks need to consider the implications of such technological innovation on the ways in which they provide central bank money for settling wholesale transactions.

Industry initiatives have led to the development of new platforms for payments and securities settlement making use of DLT and tokenisation. Many of these can be considered private settlement solutions – settling in private money – and some use central bank money as a backing asset to mitigate associated credit and liquidity risks. Some central banks offer omnibus accounts that FMIs can use to hold such backing assets. There are also industry tokenisation initiatives that have partnered with central banks to enable central bank money settlement, either by making central bank money available in the form of tokens on a DLT platform ("wholesale central bank money tokens") or through synchronisation between existing central bank systems (such as RTGS systems) and industry platforms.

The group of central banks and the Bank for International Settlements contributing to this report consider that regardless of differences in technological design, different types of digital central bank money (eg reserves in RTGS systems or wholesale central bank money tokens) should be indistinguishable in their core economic characteristics. Different technological forms of central bank money may, however, differ in the extent to which they can enable the potential benefits of tokenisation and DLT. Relevant factors include programmability and composability.

Central banks have a number of policy considerations to contemplate when deciding how to facilitate money settlement for transactions from innovative FMIs.

First, central banks must consider whether to offer a central bank settlement solution or to rely on private sector settlement solutions. Supporting and ensuring the safety and resilience of private settlement solutions may have certain benefits, such as timely market presence and strong alignment with the needs of the market. Private settlement solutions may be especially suitable over the short term, when the case for settlement solution in central bank money is still uncertain. However, private settlement solutions also have shortcomings as it may be difficult to achieve certain public benefits, such as achieving an efficient market-wide settlement service in a non-discriminatory and competition-neutral way. Private settlement solutions may result in a concentrated market outcome with market power concerns. In the short term, multiple competing solutions

may emerge, but this increased competition comes at the expense of fragmentation and lower overall efficiency. In view of this, central banks may find it useful to guide the market in line with their long-term vision. In addition, for some jurisdictions, not providing a central bank settlement solution may hamper the uptake of technological innovations, to the extent that market participants become reluctant to rely fully on private money settlement.

Second, if a central bank decides to design a settlement solution in central bank money, it must consider several design aspects.

An important design aspect is whether to offer synchronised or integrated settlement solutions. Integrated settlement solutions potentially offer more utility than synchronised settlement solutions, but they are also potentially more complex and costly, and take more time to build and launch. Indeed, by definition, integrated platforms using tokenisation are new platforms.

Within synchronised solutions, a decision must be made about whether a new settlement solution needs to be built or not. A new settlement solution may offer more utility, but existing revenue will be split between the existing and the new solutions, and total costs will increase. A new system will also lead to liquidity fragmentation as transactions within a given use case such as security transactions are split between the new and old systems.

Another design aspect is the involvement of third parties. This is relevant in cases when a new system is built, irrespective of whether it is a synchronisation or integration solution. The involvement of third parties may have some benefits, such as better alignment to the needs of the market, but there are also important implications for central banks. Central banks that decide to involve third parties must consider different governance measures to make sure they can enforce their settlement rules in practice. Due care should also be devoted to ensuring that central banks' statutory tasks, such as implementing monetary policy and maintaining financial stability, can be achieved. Depending on how third parties are involved, there may also be risks to liquidity fragmentation if multiple competing solutions can emerge.

In order to better understand the trade-offs, there are benefits from international cooperation and information exchange on lessons learned from pursuing different options. Multi-jurisdictional experiments involving actual market participants and central banks may also contribute to a better understanding of trade-offs between utility, complexity, cost and other aspects.

International cooperation and information exchange are of particular value with regard to cross-border transactions, although this was beyond the scope of this report. In a next step, it would be useful for central banks to build on the analysis carried out so far (including in this report) and dive deeper into the policy considerations applicable to cross-border transactions. Cross-border payments is one of the areas in which industry initiatives – as well as those of central banks – are exploring the potential for tokenisation to address existing frictions. Further work could also explore the integration of settlement with other functions – including listing, trading, clearing and custody – and the related trade-offs involved.

References

Bailey, A (2023): "New prospects for money", speech, London, 10 July.

Bankgirot (2024): Our payment system.

Bank of England (2020): *The future of post-trade: findings from the post-trade technology market practitioner panel*.

——— (2021): Bank of England Omnibus Accounts – Access Policy.

——— (2024): "The Bank of England's approach to innovation in money and payments", *Discussion Paper*, 30 July.

——— (2025): A brief introduction to the real-time gross settlement system and CHAPS.

Bank of Canada (2022): An overview of Lynx, Canada's high-value payment system, May.

Bank of France (2023): *Wholesale central bank digital currency experiments with the Banque de France: new insights and key takeaways,* July.

Bank for International Settlements (BIS) (2023): "Navigating the disinflation journey", *Annual Economic Report 2023*, June, Chapter I, pp 1–39.

——— (2024): "Private sector partners join Project Agorá", 16 September.

Beaumont, C, T Mancini-Griffoli, M. S Martinez Peria, F Misch and B Segendorf (2019). "The Diffusion of Payment Innovations: Insights from the Stellar Rise of Swish" (unpublished manuscript).

Bech, M, Y Shimizu and P Wong (2017): "The quest for speed in payments", *BIS Quarterly Review*, March, pp 57–68

BIS, Bank of Canada, European Central Bank, Bank of Japan, Sveriges Riksbank, Swiss National Bank, Bank of England and Board of Governors of the Federal Reserve (2020): *Central bank digital currencies: foundational principles and core features*, October.

BIS and BIS Committee on Payments and Market Infrastructures (CPMI) (2024): "Tokenisation in the context of money and other assets: concepts and implications for central banks", Report to the G20, October.

BIS Committee on Payments and Market Infrastructures (CPMI) (2001): "Core Principles for Systemically Important Payment Systems", January.

BIS Committee on Payments and Market Infrastructures (CPMI) (2016): *Glossary*.

——— (2020): *Enhancing cross-border payments: building blocks of a global roadmap*, Stage 2 report to the G20, July.

Board of Governors of the Federal Reserve System (2015): Designated Financial Market Utilities.

——— (2019): "Federal Reserve actions to support interbank settlement of faster payments", *Docket no OP – 1670*, August.

——— (2022): Money and payments: the US dollar in the age of digital transformation, 10 June.

——— (2023): Fedwire Securities Service Disclosure.

Brunnermeier, M and J Landau (2023): The digital euro: policy implications and perspectives, European Parliament.

Cleland, V (2024): "The Real Time Gross Settlement service: an open platform to drive innovation", speech at the Payments Regulation and Innovation Summit, 25 January.

Cleland, V (2025): "RTGS 2: a launchpad for innovation – speech by Victoria Cleland | Bank of England", speech at UK Finance Digital Innovation Summit, 24 June

CLS (2022): CLS Settlement overview, February.

Cipollone, P (2024): "Modernising finance: the role of central bank money", keynote speech at the 30th Annual Congress of Financial Market Professionals, Genoa, 9 February.

Committee on Payment and Settlement Systems (CPSS) (1992): *Delivery versus payments in securities settlement systems*, September.

——— (1997): Real-time gross settlement systems, March.

——— (2003): The role of central bank money in payment systems, August.

Di Iorio, A, A Kosse and I Mattei (2024): "Embracing diversity, advancing together – results of the 2023 BIS survey on central bank digital currencies and crypto", *BIS Papers*, no 147, June.

Diehl, M and C Drott (2023): "Empowering central bank money for a digital future", *SUERF Policy Note*, no 312, June.

Durfee, J, J Maniff and P Slattery (2023): "Examining CBDC and wholesale payments", *FEDS Notes*, 8 September.

Euroclear (2023): Disclosure framework CPMI-IOSCO 2023, December.

European Central Bank (ECB) (2021): What is TIPS?

——— (2022): What is TARGET2-Securities (T2S)?

——— (2023): What is T2?

——— (2023): Trigger solution documentation, December.

——— (2023): TIPS Hash-Link service description, December.

——— (2024): Exploratory work on new technologies for wholesale central bank money settlement.

——— (2024): Service description of the BdF full DLT interoperability solution for the Eurosystem exploratory work.

European Investment Bank (EIB) (2021): "EIB issues its first ever digital bond on a public blockchain" press release, 28 April.

Financial Stability Board (FSB) (2020): *Enhancing cross-border payments: stage 3 roadmap*, October.

——— (2024): *The financial stability implications of tokenisation*, October.

Fnality (2023): "Fnality commences initial phase of sterling payment operations in a world-first for both wholesale finance and digital asset markets", press release, 14 December.

——— (2025): Sterling Fnality Payment System.

Jordan, T (2024): "Towards the future monetary system", speech at an SNB conference, 8 April.

——— (2024): "Project Helvetia III – The Swiss National Bank's pilot for wholesale CBDC", speech at the BIS Innovation Summit 2024, Basel, 6 May.

Panetta, F (2022): "Demystifying wholesale central bank digital currency", speech at a Deutsche Bundesbank symposium on "Payments and Securities Settlement in Europe – today and tomorrow", Frankfurt am Main, 26 September.

Partior (2023): "Transforming financial market infrastructure", November.

Rivadeneyra, F, S Hendry and A García (2024): "The role of public money in the digital age", *Bank of Canada Staff Discussion Paper*, no 11, July.

Santander (2019): "Santander launches the first end-to-end blockchain bond", press release, 12 September.

SDX (2025): The world's leading financial market infrastructure for digital assets.

Securities Industry and Financial Markets Association (SIFMA) (2024): "Members of the US financial sector to explore multi-asset settlement using shared ledger technology", press release, 8 May.

SIX (2023): Disclosure of SIX SIS AG regarding the CPMI-IOSCO principles for FMI in accordance with "Disclosure framework and Assessment methodology, December 2012.

Swiss National Bank (SNB) (2023): "SNB launches pilot project with central bank digital currency for financial institutions", press release, 2 November.

Sveriges Riksbank (2022): *Sveriges Riksbank's FMI disclosure report*, December.

——— (2024): "Swish payments moved from Bankgirot's payment system to the Riksbank's", press release, 6 February.

The Clearing House (2025): About CHIPS.

Wells Fargo (2021): "Wells Fargo and HSBC establish bilateral agreement to settle FX transactions through a blockchain-based solution", press release, 13 December.

Appendix 1: Established models for central bank money settlement

Gross settlement, direct submission. Under this model, holders of accounts at the central bank can submit payments directly to the real-time gross settlement (RTGS) system for individual settlement in real time. This approach is typically used for high-value payment systems as well as for some newer instant payment systems.

This model is suited to high-value or time-critical payments as it minimises settlement risk by reducing the time in which a payment is outstanding. However, this reduction in risk comes at the cost of an increased need for intraday liquidity, as it excludes the possibility of netting unless the RTGS system employs a liquidity saving mechanism. This model also involves challenges in achieving delivery-versus-payment (DvP) or payment-versus-payment (PvP) as it is more complex to achieve the coordinated settlement of multiple payments.

Net settlement, indirect submission. Under this model, account holders submit individual payments to an intermediary infrastructure which passes on the payments to the recipient but does not settle them individually. Rather, it collects a batch of payments made during a specified time period and periodically instructs the central bank ledger to make single individual debits or credits for each participant that net their incoming and outgoing payments. This approach is most commonly, but by no means exclusively, used in retail payment systems.

Settlement cycles can vary in frequency but have broadly become shorter in recent years. This approach can lead to settlement risk if account holders accumulate large obligations over the course of a single settlement cycle. This risk can be managed by requiring account holders to provide collateral (the value of which is typically applied as a cap on the net obligation that an account holder can owe). Net settlement systems are typically more liquidity efficient for individual participants, though these systems can also lead to trapped liquidity for the duration of the settlement cycle eg for account holders who expect to be large net recipients. PvP and DvP settlement can be more challenging to achieve in net settlement systems compared with gross settlement systems, as payments are by definition batched and settled only periodically, making it harder to link them to the movement of another payment or asset.[54]

Gross settlement, indirect submission. This model is not entirely new,[55] but it appears to be gaining traction due to new approaches to synchronisation between ledgers. Under these models, an infrastructure provider can gather payments and asset transfers across multiple ledgers, which are then submitted in a coordinated way that ensures that one asset moves if and only if another asset moves. This "conditional settlement" process is specifically designed to enable PvP and DvP settlement. Further work is required to assess how these models affect liquidity.

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[54] However, there are ways to address this, as can be seen in the operation of CLS.

[55] It exists for example in Switzerland, through the third-party functionality in the Swiss RTGS system SIC, and in Sweden, for direct credits and debits, and a few existing SSSs in other jurisdictions have similar arrangements.

Appendix 2: Short descriptions of payment systems referred to in Section 8

Continuous Linked Settlement (CLS)

CLS Bank International (CLS) is a special purpose bank that is chartered in the United States as an Edge Act corporation and has been designated as a systemically important financial market utility in the United States. CLS is supervised and regulated by the Federal Reserve.[56] It is also overseen by a cooperative oversight arrangement with the central banks whose currencies are settled by CLS. CLS provides payment-versus-payment settlement services for foreign exchange transactions in 18 currencies. Settlement members have a multicurrency account as part of the settlement service that is funded and defunded through CLS's central bank account in each currency via their own accounts or nostro bank accounts.[57]

CHIPS

Clearing House Interbank Payments System (CHIPS) is a real-time, multilateral payment system for large value payments in US dollars. Settlement occurs on the CHIPS ledger backed by funds in the CHIPS account at the Federal Reserve. Participating banks prefund the CHIPS account using the Fedwire Funds Service. The CHIPS account is jointly owned by all of the funding banks that participate in CHIPS, with CHIPS serving as exclusive agent over the account. Once a bank has contributed the requisite prefunding amount, it can send and receive payments.[58] At the end of the day, the CHIPS account is defunded using the Fedwire Funds Service. The Federal Reserve Board is the supervisory agency for CHIPS under the Dodd-Frank Wall Street Reform and Consumer Protection Act.

BiR

During the period 2012–24, Bankgirot owned and operated a private settlement system for real-time payments (BiR).[59] Defunding and funding of participants' settlement accounts in BiR took place in central bank money via a Bankgirot operated omnibus account at Sveriges Riksbank. Settlement of real-time payments took place one by one in real time via transfers between the banks' settlement accounts in BiR.

Euroclear UK & International

Euroclear UK & International is the United Kingdom's central securities depository, which operates and manages the United Kingdom's securities settlement system (CREST).[60] The CREST system provides settlement against payment in central bank money using segregated liquidity held in the Bank of England's RTGS infrastructure.[61]

SIX SIS

SIX SIS is the main Swiss central securities depository. SIX SIS is a subsidiary of SIX Group, which is owned by around 120 domestic and international financial institutions. SIX SIS enables the DvP settlement of financial market transactions using a link to the Swiss RTGS

56 www.federalreserve.gov/paymentsystems/designated_fmu_about.htm
57 www.cls-group.com/media/qxalffzp/clssettlement_overview_feb2022.pdf
58 www.theclearinghouse.org/payment-systems/CHIPS#:~:text=About%20CHIPS,liquidity%20savings%20mechanism%20available%20today
59 www.bankgirot.se/en/about-bankgirot/our-offer/payment-systems/
60 www.euroclear.com/services/en/provider-homepage/euroclear-uk-international.html
61 https://www.bankofengland.co.uk/payment-and-settlement/a-brief-introduction-to-the-real-time-gross-settlement-system-and-chaps

system Swiss Interbank Clearing (SIC System).[62] Foreign currency transactions are settled through commercial bank money accounts of the participants with SIX SIS or through a direct Euro SIC account of the participant.

RIX INST

RIX INST is Sveriges Riksbank's settlement service in central bank money for instant payments in Swedish krona that uses Target Instant Payment Settlement (TIPS), the multi-currency settlement system for instant payments, operated and owned by the Eurosystem.

T2

Launched in 2023, T2 is a new RTGS system owned and operated by the Eurosystem (replacing TARGET2).[63] It is part of TARGET Services, for which four national central banks act as service providers (Bank of Italy, Bank of Spain, Bank of France and Deutsche Bundesbank). T2 settles payments related to the Eurosystem's monetary policy operations and interbank and commercial transactions. Transactions settle in central bank money, which requires parties to a transaction to have accounts at a central bank.

TARGET2-Securities (T2S)

TARGET2-Securities (T2S), is a securities settlement platform owned by the Eurosystem as part of its TARGET Services where delivery-versus-payment settlement occurs in central bank money.[64] Market participants who use the T2S platform to settle securities transactions have both a securities account with one of the central securities depositories (CSDs) connected to T2S and a dedicated cash account with one of the central banks connected to T2S. T2S matches settlement instructions from the CSD and the central bank, settling the transaction on a delivery-versus-payment basis.

TIPS

TARGET Instant Payment Settlement (TIPS) is one of the Eurosystem's TARGET Services. It offers final and irrevocable settlement of instant payments in central bank money.[65] Payment service providers participating in T2 can open a TIPS account with their national central bank and move funds from their T2 account to their TIPS account. The funds in providers' TIPS accounts are then used to settle instant payments via TIPS.

Fedwire Securities Service

The Fedwire Securities Service is a central securities depository (CSD) and real-time DvP securities settlement system (SSS) for US Treasury securities, as well as certain other federal government agency and international organisation securities.[66] Participants may hold one or more security accounts and a master account with a Federal Reserve Bank, meaning that securities transfers made against payment are settled on the books of the reserve banks in central bank money.

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62 www.six-group.com/dam/download/securities-services/clearing/regulatory/consultation-responses/six-sis-iosco-en.pdf

63 www.ecb.europa.eu/paym/target/t2/html/index.en.html

64 www.ecb.europa.eu/paym/target/t2s/html/index.en.html

65 www.ecb.europa.eu/paym/target/tips/html/index.en.html

66 www.frbservices.org/binaries/content/assets/crsocms/financial-services/securities/securities-service-disclosure.pdf

BOJ-NET JGB Services

The Bank of Japan Financial Network System Japanese government bonds (BOJ-NET JGB) Services is a book-entry system for Japanese government bonds. Participants hold both security accounts and current accounts with the Bank of Japan, and DVP is conducted by processing the securities transfers against funds transfers in the BOJ-NET system.

Lynx

Lynx is Canada's high-value payment system which settles in central bank money and is owned and operated by Payments Canada.[67] Lynx is an RTGS system and participants can settle payments using four different settlement mechanisms: real-time mechanism, liquidity saving mechanism, urgent payment mechanism and reserved collateral mechanism, the latter of which can be used to make certain payments to the Bank of Canada. Created by an act of parliament, Payments Canada is a not-for-profit, public-purpose organisation that has more than 100 members, including the Bank of Canada.

Euroclear Sweden

Euroclear Sweden is Sweden's central securities depository. For securities to settle against central bank money, central bank accounts belonging to Sveriges Riksbank are integrated into Euroclear Sweden's system, facilitating settlement in central bank money on the same technical system.[68]

SDX and the Helvetia pilot

SIX Digital Exchange (SDX) is a Swiss stock exchange and CSD based on distributed ledger technology (DLT) and is part of the SIX Group.[69] As part of the Helvetia pilot, the Swiss National Bank is providing tokenised central bank money on SDX. Financial institutions can settle transactions involving tokenised assets directly on the platform with tokenised central bank money. The Swiss National Bank delegates certain contractually agreed tasks to SDX but maintains control and monitoring capabilities over its tokenised central bank money.[70] Economically and legally, the tokenised central bank money used in the Helvetia pilot is equivalent to sight deposits on the Swiss National Bank balance sheet.

The Sterling Fnality Payment System (£FnPS)

The Sterling Fnality Payment System (£FnPS) is a distributed ledger technology-based payment system that is regulated by the Bank of England.[71] It has an omnibus account at the Bank of England, which allows the system to fund wholesale settlement with central bank money.[72]

Bank of England's RTGS2

The Bank of England's Real-Time Gross Settlement (RTGS) service is the infrastructure that holds sterling central bank money accounts for banks, building societies, financial market infrastructures and other institutions such as non-bank payment service providers. The balances in these accounts can be used to move money in real time between these account holders to deliver risk-free settlement. In April 2025, the Bank of England launched a renewed RTGS core ledger and settlement engine RT2 including a new user

67 www.bankofcanada.ca/wp-content/uploads/2022/05/Overview-Lynx-Canadas-High-Value-Payment-System.pdf

68 See Euroclear (2023).

69 www.sdx.com/

70 www.bis.org/review/r240506e.htm

71 fnality.com/payment-systems/british-sterling-payment-system

72 www.bankofengland.co.uk/speech/2024/january/victoria-cleland-speech-on-supporting-payments-innovation-through-rtgs

interface: improving resilience, enhancing functionality, and providing a strong platform for further change.

Deutsche Bundesbank's Trigger Solution

As part of its exploratory work on new technologies for wholesale central bank money settlement, the Eurosystem has explored various mechanisms to connect central bank money to emerging payment platforms, including the Trigger Solution developed and operated by the Deutsche Bundesbank. The Trigger Solution uses a DLT infrastructure that acts as a technical bridge between the central bank payment system and market DLT platforms.[73]

Bank of Italy's TIPS Hash-Link Solution

As part of its exploratory work on new technologies for wholesale central bank money settlement, the Eurosystem has explored various mechanisms to connect central bank money to emerging payment platforms, including the TIPS Hash-Link (TIPS H-L) solution developed and operated by the Bank of Italy. The TIPS Hash-Link (TIPS H-L) solution uses a DLT-agnostic API to connect a market DLT platform with a central bank payment system (in this case, a copy of TIPS).[74]

Bank of France's Distributed Ledger for Securities Settlement System (DL3S)

As part of its exploratory work on new technologies for wholesale central bank money settlement, the Eurosystem has explored various mechanisms to connect central bank money to emerging payment platforms, including the full-DLT interoperability solution developed and operated by the Bank of France. This solution makes use of exploratory cash tokens (ECTs) on a DLT platform (Distributed Ledger for Securities Settlement System (DL3S)).[75] DL3S is a private and permissioned DLT built under Hyperledger Fabric protocol. DL3S may interact with market DLT platforms using hash-timed locked contracts (HTLCs).

[73] www.ecb.europa.eu/press/intro/news/html/ecb.mipnews231213_annex4.en.pdf
[74] www.ecb.europa.eu/press/intro/news/html/ecb.mipnews231213_annex3.en.pdf
[75] www.ecb.europa.eu/press/intro/news/html/ecb.mipnews231213_annex2.en.pdf

Annex: Expert group members

Chair	Piero Cipollone (European Central Bank)
Bank of Canada	Paul Chilcott (until December 2024)
	Scott Hendry
	Diego Zúñiga
	Francisco Rivadeneyra
European Central Bank	Holger Neuhaus
	Mirjam Plooij
Bank of Japan	Naoto Shimoda
Sveriges Riksbank	Reimo Juks
Swiss National Bank	Oliver Sigrist (until February 2025)
	Robert Oleschak (from March 2025)
	Philipp Haene
Bank of England	John Jackson
	Tom Mutton (until December 2024)
Board of Governors of the Federal Reserve System	Jesse Maniff (until January 2025)
Bank for International Settlements	Andras Valko

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