Tokenization of Financial Assets

FINAL REPORT

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1. Executive Summary

This Report reflects the observations from a monitoring exercise conducted by IOSCO through its Fintech Task Force (**FTF**), which had set up a Financial Asset Tokenization Working Group (**TWG**)[1] to conduct research and gather information on the current state of development and adoption of tokenization and distributed ledger technology (**DLT**) in capital markets products and services.

The main purpose of the TWG is to develop a shared understanding among IOSCO members on the adoption and current use-cases of asset tokenization in capital markets, and how regulators have prepared and responded to these developments. This Report identifies some potential implications from tokenization activities on market integrity and investor protection.

In recent years, the financial sector has been experimenting with the use of DLT for the delivery of financial services. Proponents suggest that in seeking to achieve features such as fractionalization, programmability, composability, and atomicity, tokenization might create efficiencies in the financial system, help expand availability of financial products and services, and reduce market frictions. However, the adoption of different technologies and arrangements in financial services may present novel risks or amplify existing risks which need to be understood and appropriately addressed by regulators to safeguard investors' interests. This Report provides some perspectives based on the analysis of existing examples of tokenization arrangements and notes that IOSCO's principles and guidance may be applicable to tokenization arrangements, given their technology-neutral approach.

In developing this Report, the FTF gathered evidence through literature review, regulatory surveys, and stakeholder outreach. The FTF observed that there are varying degrees of commercial adoption of tokenization arrangements, depending on the objectives, associated benefits, and challenges of their specific applications.

The FTF found that, while the evolution of lifecycle activities from tokenization appears to be quite incipient and incremental, there is evidence of growing commercial interest, though the projected growth trajectory is uncertain and uneven across asset classes, with some examples of fixed income products and money market funds taking the lead in commercial adoption. The tokenization ecosystem is still nascent, with a lack of cross-blockchain interoperability and credible settlement assets limiting the scalability of

[1] The TWG is led by staff from the Monetary Authority of Singapore (MAS) with members from the Australian Securities and Investments Commission (ASIC); Brazil's Comissão de Valores Mobiliários (CVM); Germany's Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin); Securities and Exchange Board of India (SEBI); the Central Bank of Ireland (CBI); Italy's Commissione Nazionale per le Società e la Borsa (CONSOB); the Securities Commission Malaysia (SCM); Mauritius' Financial Services Commission (FSC); Morocco's Autorité Marocaine du Marché des Capitaux (AMMC); Québec's Autorité des Marchés Financiers (QAMF); Spain's Comisión Nacional del Mercado de Valores (CNMV); the United Kingdom's Financial Conduct Authority (FCA); and the United States Securities and Exchange Commission (SEC).

tokenization arrangements in the financial sector.

The impact of tokenization on lifecycle activities varies by implementation model and the degree of integration with DLT. Based on this:

(a) While creation and issuance processes of digital tokens to represent financial assets have evolved, the impact of tokenization on distribution and secondary trading activities for these tokens has been more limited and largely continues to rely on conventional financial infrastructure and intermediaries, due to accessibility and liquidity concerns regarding DLT platforms.

(b) In clearing and settlement activities, the FTF found that DLT-based settlement infrastructure enables faster settlement times, but when given a choice, it appears that market participants continue to favor the use of traditional settlement infrastructure. This is possibly due to a variety of factors, such as the lack of familiarity with the use of DLT-based infrastructure, vulnerabilities that may stem from its digital nature (operational or cyber) or the operation of network effects present in traditional infrastructure.

(c) In asset servicing activities, the FTF observed implementation of digital custody and improvement in collateral mobility (e.g., intraday repo transactions).

Tokenization can have wider implications for the operating environment in which these assets and related services are employed by changing the technologies and infrastructure used for the creation of financial assets. Risks do not manifest in a uniform manner across tokenized arrangements. Rather, such risks are highly specific to the use-case and will depend upon factors such as the choice of the DLT network architecture being used and the tokenization structure adopted for the financial asset.

The analysis shows that the majority of risks arising from the current commercial application of tokenization fall into existing risk taxonomies. Market participants are not unfamiliar with managing such risk types. However, the manifestation of vulnerabilities and risks that are unique to the technology itself may require the introduction of new or additional controls to manage them. Such risks and controls have been acknowledged by issuers and operators in their publications such as public prospectus documents.

Examples include:

(a) Risks relating to the representation of financial assets in the form of tokens. There are currently well-established legal frameworks and structures for the treatment of financial assets created in paper certificate or book-entry form. It can be unclear whether the existing legal treatment for financial assets equally applies to those that are created or represented in the form of tokens, and the activities conducted on those tokens through the blockchain.

For non-native tokens, the range of structuring options for token creation can lead to investor uncertainty about the rights to and ownership of the underlying assets. Thus, despite owning the digital token, investors may not understand the legal aspects of ownership rights and their rights to transfer tokenized financial assets.

(b) Risks relating to the use of DLT-based infrastructure in hosting tokenized financial assets. These assets face operational vulnerabilities and risks unique to this infrastructure, including cyber-attacks on blockchain nodes, congestion in transaction processing, data leakage, market fragmentation, smart contract bugs, and loss of private keys.

As tokenization scales up, regulators should also be cognizant of possible changes in market activities and market structure. The hosting of assets and investments on common DLT networks will also inevitably increase dependencies and interconnectedness among market participants and stakeholders, leading to amplification of the risks currently faced in the conventional markets. Tokenization could also suffer from potential spill-over effects from increased inter-linkages with the crypto asset markets. The analysis reveals early signs of such inter-linkages, such as the increasing use of some tokenized money market funds as "stablecoin"[2] reserve assets or as collateral for crypto-related transactions.

Regulatory considerations

To address the risks arising from tokenization and to provide regulatory clarity, IOSCO members have adopted a range of regulatory responses, including application of existing regulatory frameworks, issuance of specific guidance to clarify the applicability of existing regulatory frameworks, sandbox regimes, and regulatory amendments.

In developing their regulatory responses to asset tokenization in the securities markets, IOSCO members may consider the applicability of IOSCO's standards, which are technology-neutral, principles-based and outcomes-focused, taking into consideration their legal framework and domestic contexts. These include the Objectives and Principles of Securities Regulation,[3] the Recommendations for Crypto and Digital Asset Markets,[4] and the Recommendations for Decentralized Finance.[5]

[2] There is no universally agreed definition of stablecoin. The term stablecoin does not denote a distinct legal or regulatory classification. Importantly, the use of the term "stablecoin" in this report is not intended to affirm or imply that its value is necessarily stable. Rather, the term is used here because it is commonly employed by market participants and authorities.

[3] Available at: https://www.iosco.org/library/pubdocs/pdf/ioscopd561.pdf.

[4] Available at: https://www.iosco.org/library/pubdocs/pdf/IOSCOPD747.pdf.

[5] Available at: https://www.iosco.org/library/pubdocs/pdf/ioscopd754.pdf.

2. Introduction

A. Background

In recent years, the financial sector has been experimenting with the use of DLT for the delivery of financial services. One prominent application of DLT is the tokenization of certain financial assets in the capital markets. Tokenization generally refers to the creation, issuance, or representation of assets on a digital token ledger or a programmable platform.[6]

Broadly, tokenization experiments and commercial use-cases (collectively "**tokenization arrangements**") typically seek to achieve one or more of the following features: [7]

(a) **Fractionalization**, which refers to the division of assets into smaller shares that makes them potentially more accessible to investors.[8]

(b) **Programmability**, which refers to the storage of code-based instructions that will execute automatically in response to predetermined triggering conditions, data or logic.[9]

(c) **Composability**, which refers to the combination and re-use of programmed instructions in new ways, for the creation of new products and transactions.[10]

(d) **Atomicity**, which refers to the execution of multiple steps in a single inseparable transaction.[11]

Proponents suggest that in seeking to achieve these features, tokenization might create

[6] *E.g.,* "the process of generating and recording a digital representation of traditional assets on a programmable platform", Bank for International Settlements (**BIS**) (2024), "Tokenisation in the context of money and other assets: concepts and implications for central banks", available at https://www.bis.org/cpmi/publ/d225.htm ("**CPMI Tokenization Report**"); "the issuance or representation of assets in the form of digital tokens using technologies such as distributed ledgers", Financial Stability Board (**FSB**) (2024), "The Financial Stability Implications of Tokenisation", available at https://www.fsb.org/2024/10/the-financial-stability-implications-of-tokenisation/ ("**FSB Report**"); "the creation of assets or representations of assets on a digital token ledger", International Monetary Fund (**IMF**) (2025), "Tokenization and Financial Market Inefficiencies", available at https://www.imf.org/en/Publications/fintech-notes/Issues/2025/01/29/Tokenization-and-Financial-Market-Inefficiencies-561256 ("**IMF 2025 Report**").

[7] While tokenization is one potential means to achieve these features, it is not the only means to do so. For example, it is often noted that fractionalization can already be achieved through traditional finance, such as securitization or certain types of financial intermediation. FSB Report, *supra* n.6 at 5; IMF 2025 Report, *supra* n.6 at 17.

[8] FSB Report, *supra* n.6 at 5; IMF 2025 Report, *supra* n.6 at 17.

[9] CPMI Tokenization Report, *supra* n.6 at 8; FSB Report, *supra* n.6 at 7; IMF 2025 Report, *supra* n.6 at 4.

[10] CPMI Tokenization Report, *supra* n.6 at 9; FSB Report, *supra* n.6 at 7; IMF 2025 Report, *supra* n.6 at 4.

[11] IMF 2025 Report, *supra* n.6 at 4.

efficiencies in the financial system, support the expansion in availability of financial products and services, and reduce market friction.[12] At the same time, realizing these benefits could entail costs and trade-offs; for example, atomic settlement cycles may reduce settlement risk but also require pre-positioning of settlement assets.[13]

The use of a new technological medium to deliver financial services — as proposed in tokenization arrangements with the use of DLT — should not in itself materially affect the applicability of existing regulatory principles and frameworks.[14] Such arrangements may give rise to the same types of risks that exist in traditional finance. However, some risks, such as technology and cyber risks and other operational risks, might be amplified or materialize in a different manner that are unique to the DLT technology used, with this being dependent on the maturity of the network structure and the structure of tokenization arrangements.[15] For example, operational transfer and final settlement might not coincide in some tokenization arrangements, resulting in settlement risk; the automation of transaction execution might trigger highly correlated movement of funds, creating correlated liquidity risks; the ability for investors to self-custodise their own tokens, instead of going through a custodian, could introduce unique custody risk; and the combination of automated processes across different applications might mean that multiple processes are simultaneously prone to operational disruptions.[16]

At present, the tokenization ecosystem is still nascent and remains a small part of the financial sector, with challenges for interoperability between blockchains resulting in liquidity fragmentation of tokenized products. This is further complicated by a lack of credible settlement assets which are needed to mitigate the counterparty risks involved in DLT transactions. The costs of implementing tokenization arrangements – in the form of system transition costs and potential operational risks – also reduce business incentives to adopt tokenization.[17]

B. Purpose

Recognizing the potential for growth in tokenization and its implications on investor protection and market integrity, the FTF established TWG as a dedicated working group in 2024 to develop a shared

[12] FSB Report, *supra* n.6 at 10; IMF 2025 Report, *supra* n.6 at 9.

[13] IMF 2025 Report, *supra* n.6 at 11. *See also* CPMI Tokenization Report, *supra* n.6 at 13, on the investment trade-offs of tokenization.

[14] Organisation for Economic Co-operation and Development (**OECD**) (2021), "Regulatory Approaches to the Tokenization of Assets", available at https://www.oecd.org/en/publications/regulatory-approaches-to-the-tokenisation-of-assets_aea35466-en.html ("**IMF 2021 Report**"), at 12.

[15] CPMI Tokenization Report, *supra* n.6 at 17; FSB Report, *supra* n.6 at 14.

[16] CPMI Tokenization Report, *supra* n.6 at 18-19.

[17] FSB Report, *supra* n.6 at 12; OECD (2025), "Tokenization of assets and distributed ledger technologies in financial markets: Potential impediments to market development and policy implications" ("**OECD 2025 Report**"), available at https://www.oecd.org/en/publications/tokenisation-of-assets-and-distributed-ledger-technologies-in-financial-markets_40e7f217-en.html, at 10-16.

understanding among IOSCO members on the adoption and current use-cases of asset tokenization in the securities markets.

Given the evolving nature of tokenization, IOSCO considered it prudent to monitor developments in this space to better understand the costs, benefits, and risks to the market. This Report sets out the findings of the FTF TWG's monitoring work.

C. Methodology

To inform this Report, the FTF gathered evidence through literature review, regulatory surveys, and stakeholder outreach, as summarized below.

(a) **Survey of FTF members:** A survey of FTF members was conducted in 2024 to understand the current regulatory approach and expectations of members with respect to tokenization.

(b) **Engagements with Affiliate Members Consultative Committee (AMCC) [18] members:** The AMCC conducted roundtables connected with IOSCO's work on tokenization in Toronto (2024) and Qatar (2025) to obtain its members' views on the costs, benefits, and risks of tokenization.

(c) **IOSCO's industry stakeholder engagement:** The FTF hosted roundtables in Singapore, Tokyo, and Zurich. Attendees represented different roles within the tokenization ecosystem, including Fintech and technology firms as well as academics who had conducted policy research and analysis on tokenization. During each roundtable, participants shared experiences and insights relating to existing tokenization arrangements and the extent to which the projected benefits might have materialized in certain tokenization arrangements.

(d) **Literature review:** The FTF reviewed papers written by international organizations, standard-setting bodies, academics, industry associations, market participants, and other stakeholders on tokenization. This information may help IOSCO members understand the issues, risks, and challenges of tokenization. In addition, the FTF analyzed existing examples of tokenization arrangements in the market.

The Appendix includes a list of working definitions for common terminology used when describing tokenization, to minimize confusion from the fact that some definitions focus on the underlying technology, while others consider the features of tokenization, the types of assets tokenized, and the linkages, if any, between reference assets and digital tokens.[19] However, the definitions are not intended to be comprehensive or exhaustive. Given the present state of tokenization, it is challenging to definitively settle on a singular, universally accepted definition. For the purpose of this Report, it is

[18] The AMCC comprises 74 IOSCO affiliate members. The members represent securities and derivatives markets and other market infrastructures, self-regulatory organizations, investor protection funds and compensation funds, as well as other bodies with interest in securities regulation. There are currently 35 jurisdictions represented in the AMCC, which also includes 14 regional or international associations.

[19] FSB Report, *supra* n.6.

more important to understand the key concepts rather than a set of strictly defined terms.

D. Structure of the Report

Chapter 3 of the Report sets out the level of adoption and commercial interest in tokenization across asset classes, as well as the impact on the life cycle activities for money market funds and fixed income instruments (viz. issuance and distribution, secondary trading, post-trade services (i.e., clearing and settlement), and asset servicing (i.e., custody and collateral management).

Chapter 4 of the Report sets out the issues that can arise from tokenization arrangements and their potential risk implications to market integrity and investor protection, including areas such as recording of ownership, settlement finality, and interoperability across blockchains.

Chapter 5 of the Report summarizes the steps that authorities have taken to manage the risks and regulatory concerns arising from tokenization, including application of existing regulatory frameworks, and issuance of specific guidance to clarify the applicability of existing regulatory frameworks, sandbox regimes, and regulatory amendments.

Chapter 6 of the Report concludes by noting considerations in addressing the issues, risks, and challenges identified in the Report.

3. Adoption of Tokenization in the Capital Markets

This Chapter provides an overview of the state of development and adoption of asset tokenization in the capital markets. It describes the lifecycle activities undertaken across tokenized fixed income products and money market funds (**MMFs**), including a closer look at the impact of tokenization through some existing examples in the market.

While implementation models for tokenization across different firms may vary, the depth and scale of adoption and use-cases remain somewhat limited. In most of the examples analyzed, the change in processes has been more of an evolution than a revolution, given the need to integrate with existing market infrastructure and systems for a seamless process. Nonetheless, tokenization has introduced certain incremental changes to the lifecycle processes and new players or roles to support the ecosystem.

A. Motivations for Tokenization Adoption

Proponents claim that asset tokenization has the potential to address various market inefficiencies present in the lifecycle of financial assets. [20] Market inefficiencies include frictions such as information asymmetries, search problems, transaction costs, and counterparty risks.

A recent report on tokenization and financial market inefficiencies published by the International Monetary Fund ("**IMF Fintech Note**") [21] explains both the positive and negative potential effects of tokenization on financial markets.

For example, shared and programmable ledgers have the potential to reduce market frictions and costs in asset issuance, trading, servicing, and redemption, because a separate record of asset owners may not be needed when every asset is linked to the owner's ledger record. Therefore, the services of a registrar may not be strictly required, at least from a purely technological perspective. [22] Other benefits could include a reduction in certain forms of counterparty risk through atomic settlement, faster distribution of dividends and interest payments and reduced search frictions. While these could have potential cost savings and lessen the need for certain intermediaries, such benefits

[20] IMF 2025 Report, *supra* n.3.

[21] *Ibid.*

[22] From a technological perspective, the services of a registrar are strictly speaking not required because of the inherent nature of the distributed ledger. However, from an implementation and regulatory perspective, a registrar (in the form of a transfer agent) may continue to persist as a feature, and local regulatory requirements may nonetheless require a registrar in the lifecycle of a product.

have yet to be observed widely in the marketplace.

However, shareability and programmability features may facilitate wider and faster spread of shocks across the markets and thereby increase the cost of operational risk events.[23] Increased inter-connectedness may magnify the externalities of market participants on each other.[24]

The core features and value propositions associated with tokenization have also been recently discussed in a report published by the World Economic Forum in May 2025 (the "**WEF Report**").[25]

B. Overview of the Level of Adoption and Commercial Interest in Asset Tokenization

B.1. Overview

Information on the level of adoption and commercial interest in this section was gathered from the IOSCO FTF survey, industry discussions and roundtables, and was substantiated with relevant data published by international bodies.

FTF Survey

The FTF survey responses showed the level of *interest* observed in respondents' jurisdictions for tokenization of capital market products to be split almost equally.[26] However, as to the actual level of *adoption* of tokenization,[27] as reflected in commercialized use-cases, a majority of respondents (91%) indicated nil or very limited tokenization use-cases.

Most jurisdictions have noted a greater proportion of market participants conducting experimentation (57%) than actual use-cases (43%), which covered tokenization of at least one capital market product.

Literature Review

Some reports suggest that commercial interest in financial asset tokenization is growing. For example, a recent survey of over 300 institutional investors, jointly undertaken by EY Parthenon and Coinbase in January

[23] IMF 2025 Report, *supra* n.6, Chapter 4.

[24] An example of a negative externality is the socialization of losses for certain intermediaries, particularly those that are systemically important. An intermediary that has implicit or explicit guarantees of a government bailout can have incentives for excessive risk-taking because it internalizes the full upside of risk (that is, higher profits) but not the full downside, some of which is borne by the public safety net.

[25] World Economic Forum (**WEF**) (May 2025), "Asset Tokenization in Financial Markets: The Next Generation of Value Exchange" ("**WEF Report**"), available at: https://reports.weforum.org/docs/WEF_Asset_Tokenization_in_Financial_Markets_2025.pdf.

[26] In the survey, "interest" refers to market participants' sentiments expressing interest in tokenization of capital market products and their implementation of experiments in such tokenization.

[27] In the survey, "adoption" refers to market participants' tokenization of capital market products and the offering of such tokenized products on a commercial scale.

2025,[28] highlighted that among those who are interested in tokenized assets, 11% are already invested and another 61% expect to invest by 2026.

The apparent interest has also been tempered with skepticism. For instance, some have argued for a thoughtful and balanced analysis of costs and benefits of tokenization, which comes with its own trade-offs.[29] Some market participants have reservations about the actual value propositions of tokenization. When asked why they do not use DLT today in a survey of 26 asset managers conducted by Calastone, 55% of respondents highlighted deployment costs, 19% highlighted a lack of feature benefits, and 10% pointed to a deficit of internal expertise.[30]

Consequently, it has been acknowledged by international bodies, such as the OECD, that the vast majority of tokenized transactions have been part of experimental or pilot programs.[31] This is consistent with the FTF survey responses highlighted earlier. The OECD also noted that the environment is fragmented into pockets of liquid tokenized asset platforms, and live projects have rarely reached a meaningful size.

However, interest in unlocking the potential benefits of the technology with asset tokenization continues to scale up, particularly for certain products[32] and activities. Some of these product types and services are elaborated below.[33]

B.2. Fixed Income Products

There is evidence of steady year-on-year growth in cumulative issuances and amounts issued for tokenized bonds. This issuance has

[28] Coinbase and EY-Parthenon, "2025 Institutional Investor Digital Assets Survey", available at: https://coinbase.bynder.com/m/8362167ae26ecf/original/EY-CB-Institutional-Investor-Survey.pdf. The survey was conducted by Coinbase in collaboration with EY-Parthenon, targeting 352 institutional investors (decision-makers such as COOs, CEOs, Heads of Transformation) with influence over allocation decisions. The survey took place from January 13–24, 2025, and prioritized firms with over $1 billion in assets under management (AUM). The respondent base was primarily from the US (62%) and Europe (28%), with some representation from APAC, Latin America, and Africa.

[29] For example, see "Demystifying Tokenization: Embracing the Future", available at: https://www.world-exchanges.org/our-work/articles/demystifying-tokenization-embracing-future. Therein, the World Federation of Exchanges highlighted among other things that instantaneous settlement is not that simple. The attraction of being able to trade without necessarily having to have all the funds available up front seems to remain strong, even if experimentation with immediate settlement continues. Where settlement is not instantaneous, the cost of having to post margin is generally quite low, with the collateral being returned once the trade is complete.

[30] Calastone, "White paper: Decoding the Economics of Tokenization: Transforming Cost Dynamics in Asset Management", available at: https://www.calastone.com/insights/white-paper-decoding-the-economics-of-tokenization-transforming-cost-dynamics-in-asset-management/#_ftn2.

[31] OECD 2025 Report, *supra* n.17.

[32] Apart from fixed income and MMFs, the issuance of alternative assets such as private equity, commodities and real estate has also seen some impact from tokenization. For the purposes of this note however, the focus is on fixed income products and MMFs. See section 3.1 of the WEF Report, *supra* n.25, for more information.

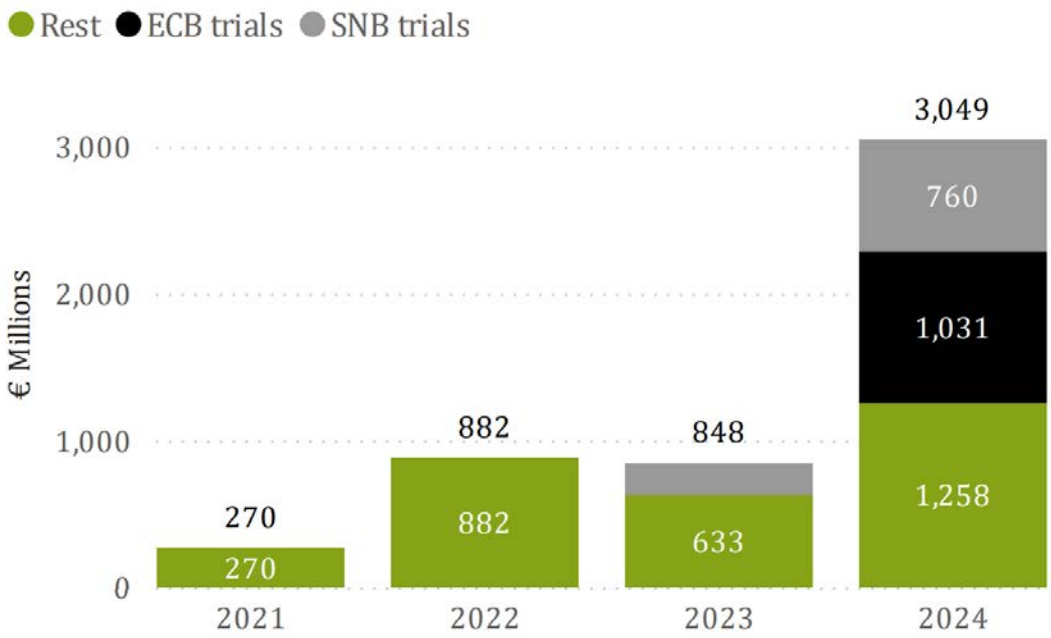
[33] For a discussion of traits or features that make an asset class more ready or suitable for tokenization, refer to WEF Report, *supra* n.25, Figure 6.

been particularly active in the commercial, sovereign, supranational and agency sectors.[34] Yet, the notional value of $10 billion worth of tokenized bonds issued in the last decade remains relatively small compared to the $140 trillion outstanding amount globally.[35] Some market participants believe that there could be further growth in this market – 65% of the respondents of a 2024 survey conducted by the Official Monetary and Financial Institutions Forum opined that bonds are the asset class most likely to be tokenized.[36]

Examples of tokenized fixed income products include UBS AG's CHF375 million bond issued on SIX Digital Exchange in 2022, the Asian Infrastructure Investment Bank's $500 million bond (of which $200 million was raised via a tap issuance in October 2024) issued on Euroclear's Digital Securities Issuance in 2024, digital bonds issued by the City of Lugano, and the World Bank, as well as other corporations, government-related entities, and international organizations.

Chart 1: Issuance of Tokenized Fixed Income Instruments

Amount of tokenized fixed income instruments issued (by type of trial)

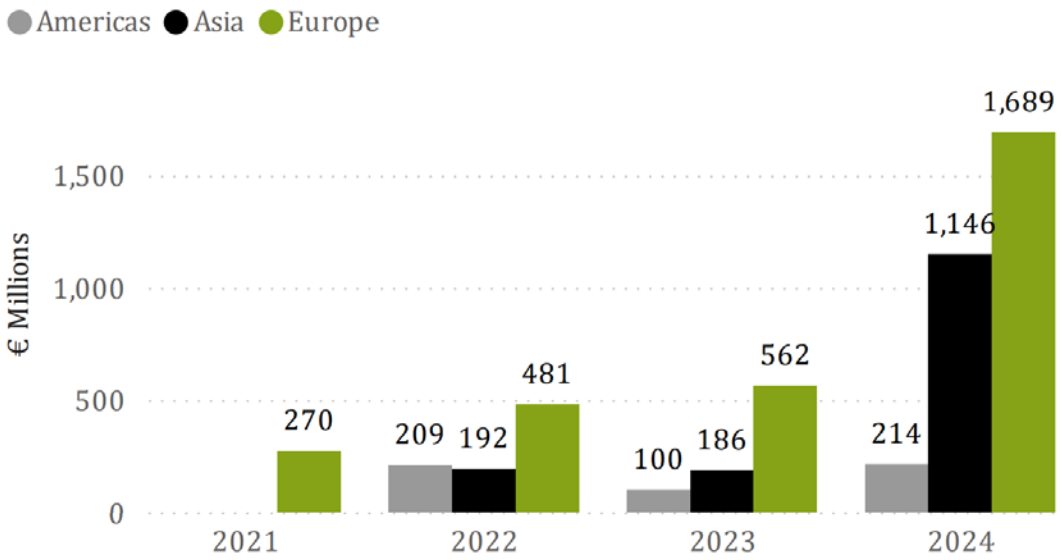


[34] WEF Report, *supra* n.25, citing Aldasoro, I., Cornelli, G. Frost, J., Koo Wilkens, P., & Shreeti, V. (2025), "Tokenization of government bonds, mimeo", and Association for Financial Markets in Europe. (2024), "Use of DLT and tokenization in financial markets".

[35] McKinsey, 20 June 2024, "From ripples to waves: The transformational power of tokenizing assets" ("**McKinsey**"), available at: https://www.mckinsey.com/industries/financial-services/our-insights/from-ripples-to-waves-the-transformational-power-of-tokenizing-assets.

[36] OMFIF Digital Monetary Institute, "Digital Assets 2024 Report", available at: https://pdf.omfif.org/digital-assets-report-2024.

Amount of tokenized fixed income instruments issued (by geography of issuer)



Source: AFME's DLT-Based Capital Market Report 2024

B.3. Repos and Collateral Markets

Repos and collateral have also been identified as potential use-cases in tokenization, and experimentation with DLT-enabled repos is growing across global capital markets. The WEF Report estimates that the global collateral market is worth more than $25 trillion.[37] The global repo market is also very large, with an estimated size of more than $15 trillion in outstanding value and a daily turnover of around $3–4 trillion.[38] According to the same report, programmable ledger-powered collateral management could unlock more than $100 billion annually in capital that might be redeployed for higher efficiency.[39]

Key providers of tokenization solutions for repos and collateral management include Kinexys by J.P. Morgan and Broadridge's Distributed Ledger Repo offering. Kinexys by J.P. Morgan has processed over $2 trillion in tokenized transactions since launch, with daily volumes exceeding $3 billion. According to

[37] WEF Report, *supra* n.25, section 3.3 citing Securities Finance Times "Collateral supply, demand and mobility", available at https://www.securitiesfinancetimes.com/specialistfeatures/specialistfeature.php?specialist_id=802.

[38] WEF Report, *supra* n.25, section 3.3 citing International Capital Market Association, "How big is the repo market?", available at https://www.icmagroup.org/market-practice-and-regulatory-policy/repo-and-collateral-markets/icma-ercc-publications/frequently-asked-questions-on-repo/4-how-big-is-the-repo-market/.

[39] WEF Report, *supra* n.25, section 3.3 citing GFMA (2023), "Impact of distributed ledger technology in global capital markets" ("**GFMA Report**"), available at https://www.gfma.org/wp-content/uploads/2023/05/impact-of-dlt-on-global-capital-markets-full-report.pdf.

Broadridge data, it processes $2 trillion in transaction value monthly,[40] and the LDR Intraday Repo solution delivers a 50-60% average reduction in transaction costs and improved liquidity management.[41]

B.4. Money Market Funds

MMFs are mutual funds that invest in short-term, high-quality money market instruments. Each investor in an MMF is considered a shareholder/unit holder of the investment pool.

In the last two years, tokenized MMFs have attracted billions in assets under management. Issuers of such MMFs include established incumbents, such as BlackRock and Franklin Templeton, as well as fintech start-ups, such as Spiko and Ondo Finance.

Apart from exploring the potential and actual efficiencies of tokenization for such issuances, it is noted that a few tokenized MMFs are now being used as "stablecoin" reserve assets or collateral for crypto transactions.[42] Tokenized MMFs are also used interchangeably with "stablecoins" – tokenized MMFs are used for treasury management and collateral, and "stablecoins" are being used for liquidity and payment – with firms such as Circle seeking to serve both use cases.

B.5. Equities

Relative to other asset classes, the tokenization of equity (stocks) remains quite limited. According to the WEF Report, the market capitalization of tokenized public stocks was estimated at nearly $16 million by March 2025. In contrast, the global public equity market was valued at nearly $115 trillion in 2023.[43] The relatively limited market for tokenized stocks can be attributed to the fact that current public equities markets – especially in advanced economies – are already highly efficient, benefiting from decades of technology modernization and proven intermediary chains.[44]

That said, the market has recently seen the offering of certain tokens with labels and/or descriptions suggesting that the tokens represent ownership in stocks of certain private companies (e.g., "stock tokens").[45] There is no clear consensus on what "stock tokens" mean. However, examples of such so-called "stock tokens" in the market may merely represent a promise by the issuer to provide token holders with monetary gains associated with fluctuations in prices or valuations of these companies, without necessarily providing token holders with any shareholder rights. Product disclosures of such tokens may not always be clear in informing token holders of the rights represented by such tokens,

[40] https://www.broadridge.com/capability/middle-and-back-office-solutions/post-trade-processing/distributed-ledger-repo-solutions.

[41] WEF Report, *supra* n.25, Case Study 6.

[42] See further details in Chapter 3, subsection F2 below.

[43] WEF Report, *supra* n.25, citing Blockworks Research. (2025, March 24).

[44] WEF Report, *supra* n.25, section 3.2; GFMA Report, section 2.1.2.

[45] https://www.bloomberg.com/news/articles/2025-07-12/robinhood-s-private-stock-tokens-lure-investors-draw-scrutiny.

which can pose significant investor protection risks as discussed further in Chapter 4.

As mentioned earlier and also in Chapter 6, the use of a new technological medium (i.e., DLT) to deliver financial services should not in itself materially affect the applicability of existing regulatory principles and frameworks. Consistent with the principle of "same activity, same risk, same regulatory outcomes", the applicability of regulatory frameworks would depend on the economic substance of the token and its substitutability vis-à-vis conventional financial instruments.

C. Lifecycle Activities Across Bonds and Money Market Funds

Publicly available reports and data show that fixed income products and funds are taking the lead in terms of the size and number of tokenized issuances in the market.[46]

This section examines the role of tokenization in the lifecycle activities of both bonds and MMFs. While there is necessarily some degree of difference between the lifecycle activities of bonds and MMFs, they generally fall within the following broad stages discussed below: issuance and distribution; trading and post-trade; and asset servicing (i.e. custody and collateral management).

Proponents have observed that tokenized fixed income products could mitigate certain challenges that bonds face over the course of their lifecycle. These challenges that could inhibit capital market efficiency include siloed data structures, large numbers of agents, fragmented workflows and entrenched manual processes which lengthen settlement periods.[47]

Further, proponents have also suggested that tokenized MMFs may bring about faster settlement, instantaneous transfer, access to new distribution channels and the potential to be used more efficiently in the collateral management space. Though traditional fund structures have enjoyed widespread adoption, they may face cost inefficiencies, limited transparency, and uneven degrees of accessibility to end investors.

Accordingly, within each lifecycle stage discussed below, the focus is on two main aspects: (i) how tokenization may change the lifecycle process and/or roles of market participants therein; and (ii) to what extent existing examples in the market align with the potential changes.

D. Issuance and Distribution

How Tokenization May Change the Lifecycle Process and Market Roles

The issuance and distribution of securities traditionally involve three main steps: origination, structuring, and distribution. The process can involve some inefficiencies, including high costs, lengthy timelines, and operational

[46] GFMA Report, *supra* n.39, section 3.1.

[47] See generally, JP Morgan and BCG, "The Future of Distributed Ledger Technology in Capital Markets", Exhibit 3.

risks.[48] For example, the origination of new securities can be slowed by extended settlement periods. Structuring requires the preparation and reconciliation of numerous documents across organizations, which may create delays. Distribution relies on transaction managers to generate primary market liquidity through various means, but workflows can remain fragmented across asset classes.

For funds, the lifecycle essentially mirrors that of securities, beginning with fund design and setup, which includes regulatory compliance and legal approvals, followed by the distribution phase, where investors can subscribe or redeem units. Issues may arise from setup, the complex web of intermediaries, increasing demand for faster service, limited accessibility due to high minimum investments, and potential inaccuracies in information transmission.[49]

The impact of tokenization on issuance and distribution varies depending on the implementation model and the degree of integration with DLT. Three models are commonly discussed for fixed income products: [50]

(a) "Books and records" model: [51] This approach is relatively limited, supporting only pre-issuance workflows and serving primarily as an introduction to DLT for institutions and regulators.

(b) "Digital twin" model: Such tokens often referred to as digital representations of financial asset(s) that were originally issued off-chain. This model has been explored or adopted to bring off-chain assets on-chain to enhance certain activities pertaining to the asset such as collateral mobilization and post-trade efficiency, with primary issuance remaining largely unchanged.

(c) "Digital native" model: These tokens are seen as digital representations of financial assets issued directly on-chain. It aims to unlock the full spectrum of benefits that DLT and tokenization offered, such as reduced issuance costs and the creation of new security types.

For funds, tokenization can similarly occur at different levels: [52]

(a) Tokenization of the fund: Also referred to as last mile tokenization, while the fund units/shares are represented by tokens, the underlying assets of the funds are managed traditionally. Only at the point of investor subscription or redemption are tokens issued or burned to represent ownership. The official register (of unitholders) can either be fully on-chain (token holders) or a hybrid of on-chain/off-chain registers.

(b) Tokenization of underlying assets: In this model, the underlying assets themselves

[48] See generally, GFMA Report, *supra* n.39, section 2.1.1.

[49] Guardian Funds Framework, sections 4.2 – 4.3.

[50] Guardian Fixed Income Framework, section 4.1.1.

[51] This refers to the arrangement where DLT is used only for documents and administration associated with issuance and distribution.

[52] Guardian Funds Framework, section 3.4.

are also tokenized, with the motivation to enable more efficient trading, registry, and settlement, and simplify regulatory requirements by reducing layers of cost and intermediation.

(c) Tokenization of value flows: In this model, the entitlements to value flows are also tokenized, with the motivation to allow for the creation of financial products derived from underlying flow commitments, supporting a unified, self-executing model across assets.

Proponents suggest there are several anticipated effects and benefits from tokenization in this context.[53] Particularly where routine or repeated issuances are concerned, DLT-based issuance could be lower-cost and/or faster than traditional alternatives. Second, fractionalization could broaden access to traditionally illiquid assets by lowering minimum investment sizes, helping to improve liquidity and diversify risk. Third, improved transparency and efficiency could result from DLT's single, immutable record accessible to all parties, reducing reconciliation needs, trade errors, and information discrepancies. This could free up resources for more value-added activities and potentially reduce portfolio cash drag for investors. Fourth, greater product innovation, as tokenization supports the creation of bespoke instruments, automated income flows, streamlined asset servicing, and improved ESG tracking.

In terms of roles and responsibilities, for fixed income issuances, existing activities performed by market participants to originate, structure, and distribute securities will likely persist. Nonetheless, if tokenization results in streamlined processes, there could be a shortening of iteration and response times to market conditions.[54] For MMFs, tokenization could likewise reduce the time and complexity of activities in the fund lifecycle, as well as reducing the involvement of intermediaries often required in conventional transaction processes. While this could provide investors with greater flexibility, transparency, and efficiency, it also comes with attendant risks as discussed in Chapter 4.[55]

Although empirical data is still emerging, the available data suggests that the potential benefits of tokenization are not merely theoretical. For instance, Leung et al. (2023) found that tokenized bonds had underwriting fees 0.22% lower, yield spreads 0.78% lower, and bid-ask spreads 0.035% lower than comparable conventional bonds.[56] As acknowledged in the IMF Fintech Note, these reductions are economically significant, representing 25.8% of average underwriting fees, 23.9% of average yield spreads, and 5.3% of the average bid-ask spread, respectively. A report published by J.P. Morgan and Apollo (under the auspices of Project Guardian), suggested that portfolio

[53] GFMA Report, *supra* n.39, section 2.1.1.2; Guardian Funds Framework, section 3.4.2.

[54] Guardian Fixed Income Framework, section 4.1.1.

[55] Guardian Funds Framework, section 3.4.

[56] Hong Kong Monetary Authority (**HKMA**), "Research Memorandum 04/2023 on An Assessment On The Benefits Of Bond Tokenization" ("**HKMA Research Memorandum**"), available at: https://www.hkma.gov.hk/media/eng/publication-and-research/research/research-memorandums/2023/RM04-2023.pdf.

managers can be fully invested more consistently due to the programmability of DLT, which allows for automated portfolio deployment of cash. This means that managers' portfolios would experience less cash drag.[57] Assuming the average manager holds ~3% cash and a balanced portfolio could generate ~8% over cash in the long-term, the net result for a client is a ~24bps reduction in costs.[58]

Observations from the Analysis

IOSCO observed that tokenization could offer efficiency gains for fixed income products. However, the process and roles of participants are largely unchanged in fixed income issuance and distribution.

This is illustrated by the UBS digital bond issued on SIX Digital Exchange in 2022. As explained in Boxed Example 1 below, the main parties and workflows remain the same for digital bonds issuance.

While some empirical research suggests a reduction in underwriting fees and costs of investments, some examples do not tend to clearly or conclusively show if these and other aforementioned benefits have been achieved as issuers do not tend to publicly disclose actual quantifiable efficiency gains, if any.

Boxed Example 1 – UBS Bond on SDX

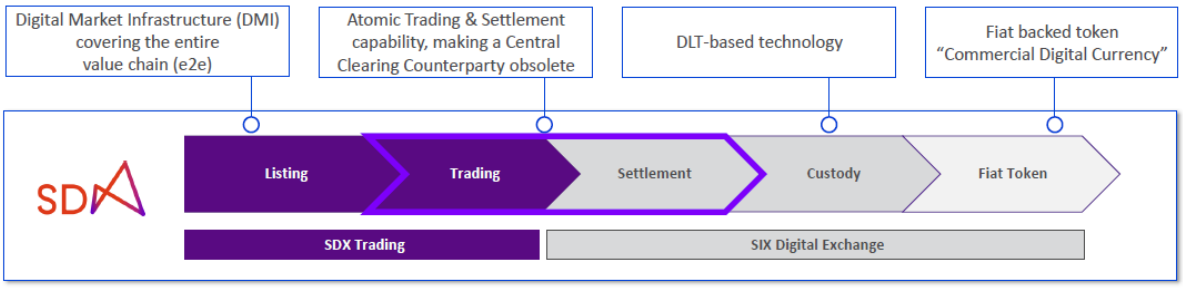
The UBS digital bond is a senior unsecured digital bond (ISIN: CH1228837865) issued by UBS AG, London Branch on SIX Digital Exchange ("**SDX**"). It is a native token that is directly created on SDX's DLT network. The UBS bond has the same instrument structure, legal status and rating as a conventional UBS bond. The token representing the digital bonds is dual listed on both SDX Trading AG ("**SDX Exchange**") and SIX Swiss Exchange, allowing for trading at both venues. However, from 1 June 2025, digital bonds issued on SDX solely trade on SIX Swiss Exchange, leveraging the live operational link between SIX SIS and SDX (explained below).

SDX is the digital market infrastructure covering the entire value chain for tokenized products, as seen in the flow diagram below.[59] SDX is part of the exchange services division of SIX group and operates alongside the traditional SIX Swiss Exchange. There is an operational link to SIX SIS (traditional CSD) that allows for SDX digital bonds to be held and settled at SIX SIS, thereby allowing for interoperability between conventional and tokenized infrastructure.

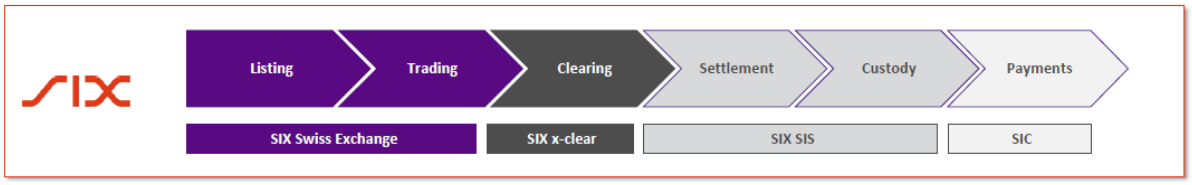
[57] J.P. Morgan. (2023), "Portfolio management powered by tokenization. Kinexys by J.P. Morgan", p 16, available at: https://www.jpmorgan.com/kinexys/documents/portfolio-management-powered-by-tokenization.pdf.

[58] *Ibid*.

[59] Available at: https://www.six-group.com/dam/images/events/2023/sibos-2023/20230317-sdx-digital-securities-brochure.pdf.



SIX Swiss Exchange, on the other hand, is the conventional market infrastructure that also covers the entire securities value chain, as seen below.



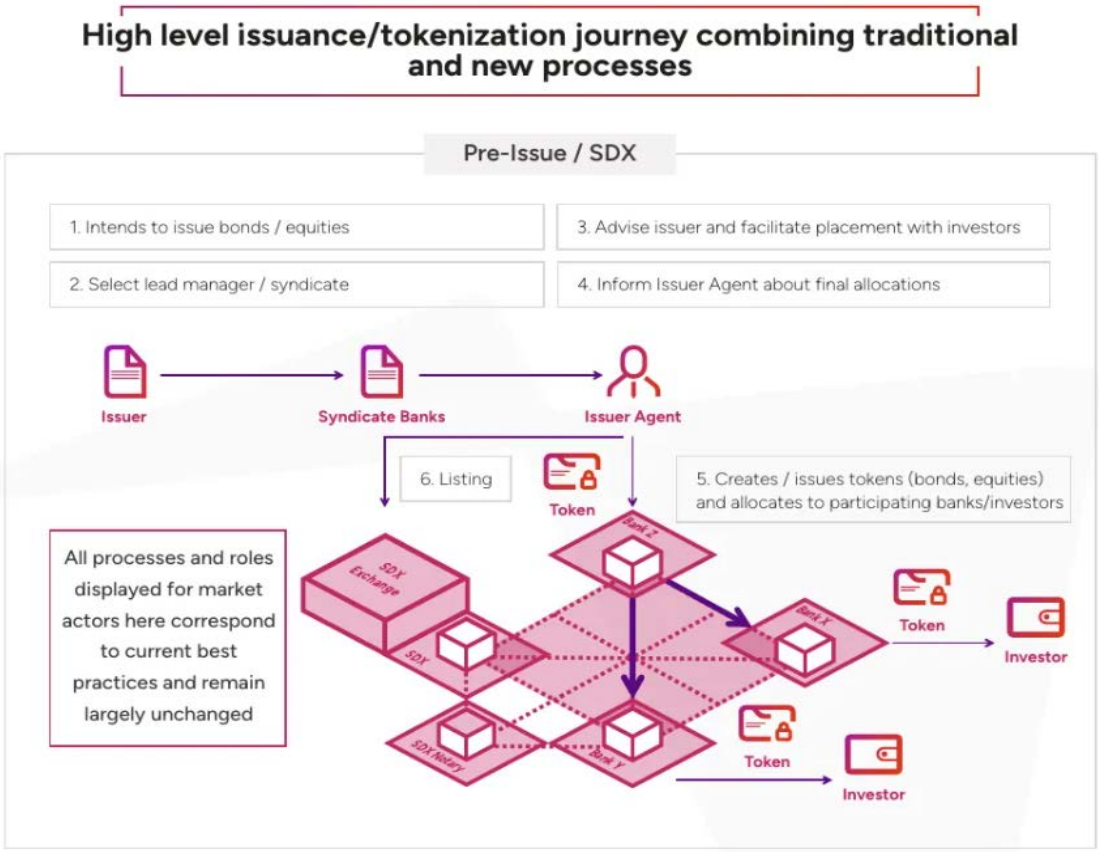
The key features of the bond are summarized in the table below.[60] As explained below, the legal status of the debt securities is unchanged. Tokenization is not a change of form of the debt securities, but the format in which those tokenized intermediated securities are held and cleared.

Issuer	UBS AG, London Branch
Expected Issue Rating	Aa3 / A+ / AA- (Moody's / S&P / Fitch)
Status	Senior unsecured
Currency	CHF
Maturity	3 years
Coupon	2.33% p.a, fixed for life
Use of Proceeds	The net proceeds will be used by UBS AG for general corporate purposes of its group
Assurances	Pari passu clause, events of default clause
Issuer Calls	Tax Event
Form	Uncertificated securities (einfache Wertrechte) in accordance with article 973c of the Swiss Code of Obligations. Intermediated securities by entry into the main register on SDX distributed ledger
Main Register	SDX
Denominations	CHF 50,000
Governing Law	Swiss law, place of jurisdiction Zurich
Documentation	Standalone prospectus, closely aligned to UBS AG EMTN
Selling Restrictions	United States and U.S. Persons, European Economic Area, United Kingdom, Australia, Austria, Ireland, Japan, Singapore, HK, PRC, Belgium, Spain, France, Italy
Listing	SDX Trading and SIX Swiss Exchange
Settlement and clearing	SDX CSD and SIX SIS (via operational link)

Key digital bond features

[60] Available at: https://www.ubs.com/global/en/investor-relations/investors/bondholder-information/digital-bonds/digital-bonds-content.onlycontent.html.

The issuance process of the UBS bond on SDX is outlined in the diagram below.



(a) As noted in the diagram, the processes and roles for market participants in the issuance remain largely unchanged from conventional infrastructure. The issuer (in this case, UBS AG, London Branch) appoints an agent to facilitate its issuance ("**issuer agent**") on the SDX platform on its behalf. This process of appointing an issuer agent takes place for traditional SIX Swiss Exchange issuances as well. The issuer agent must be a member of SIX Digital Exchange AG (**SDX CSD**).[61]

(b) The issuer agent is responsible for creating digital bonds and initiating the issuance process on the SDX platform. This involves setting up the digital bond on the SDX portal and ensuring that all necessary details and documentation are in place.

(c) On the day of issuance, the issuer agent on SDX's DLT network issues tokens representing the digital bonds and allocates/distributes them to participating SDX CSD member banks who hold these tokens on custody on behalf of the end investors.

From the legal perspective, the tokenization of bonds happens via the creation of uncertificated securities becoming intermediated securities by entry into the main registry on

[61] https://www.sdx.com/securities-services/.

SDX's distributed ledger. This is no different from other traditional UBS bonds being registered with a traditional CSD such as SIX SIS, except that the main register is a DLT network instead of a centralized electronic system. This type of conventional security is converted into a digital token in the securities accounts that the SDX participants store on their node at SDX. The token represents the intermediated security and is deposited in the member bank's nodes on the SDX network. Therefore, there is no difference between a digital and a traditional bond, and the legal status is unchanged.

There is no clearing process for trades matched on SDX Exchange, as all trades are settled atomically (T+0). This means that investors' accounts will have to be fully funded at the point of order placement, and "delivery-versus-payment" ("**DvP**") settlement takes place immediately on SDX's DLT network once a trade is matched via an exchange of the tokenized UBS bond and a tokenized settlement asset.

In terms of the settlement asset, SDX members can choose between tokenized CHF ("tCHF") issued by SDX or production wCBDC.

- tCHF: Members of SDX CSD will have to maintain a CHF account with SIX Interbank Clearing AG, where at the member's request, SDX CSD will mint CHF tokens for the member on SDX's DLT network and deduct the corresponding amount from the member's SIX Interbank Clearing AG account. The CHF tokens reflect 1 to 1 CHF reserves held by SDX in its SIC (central bank settlement account) and are the main settlement asset used for DvP when SDX was initially launched.

- wCBDC: More recently, as part of the Helvetia Pilot, the SNB is providing wCBDC on SDX, enabling financial institutions to settle transactions involving digital (token-based) assets directly on the SDX CSD with wCBDC. The Pilot, running until at least June 2026, may be extended based on future assessments. Therefore, wCBDC can also be used for settlement on SDX. The wCBDC is considered as a risk-free settlement asset unlike tCHF, and members of SDX should be automatically eligible for settlement using wCBDC.

With respect to tokenized MMFs, the examples show that tokenization is being applied at the fund level only (as opposed to other parts of the transaction value chain), with shares issued on blockchains as part of the ownership record. This approach combines blockchain and traditional recordkeeping (resorting to a hybrid of on-chain/off-chain registers), with the aim of delivering operational efficiencies. Where offered to retail, there is potential for increased flexibility due to the possibilities for 24/7 trading[62] and fractional ownership. The question as to which share record is the official legal source as regards to ownership is explained in the respective Boxed Examples below.

[62] Provided that the product is available for trading, which depends on the product structure and applicable law.

In this regard, in the very common case of hybrid solutions based on both on-chain and off-chain ledgers, it is essential to understand which of the two ledgers (or what combination of those ledgers) is the official legal record of ownership and, therefore, should be taken as a reference in the event of discrepancies. If the official legal record of ownership is exclusively the off-chain register, this may impede the single immutable features offered by using DLT, and issuers will need to operate concurrently with traditional centralized data storage systems.

Boxed Example 2 – Franklin OnChain U.S. Government Money Fund

The Franklin Onchain U.S. Government Money Fund (the "**Fund**") is a Delaware company that is a registered investment company under the Investment Company Act of 1940 ("**1940 Act**"). The offer and sale of its shares is also registered under the Securities Act of 1933.

The Fund is a government money market fund and, as such, invests in very liquid assets, primarily in U.S. Government securities, particularly U.S. Treasuries, and seeks to maintain a stable net asset value. The Fund's shares are issued in tokenized form on blockchains, such that the record of ownership of shares is maintained in part on blockchains.

The Fund's shares are issued directly on a blockchain. The BENJI token (representing the shares in the fund) is now issued on eight blockchains, including Stellar.

The current recordkeeping system combines features of the blockchain and a traditional book-entry record, such that the blockchain functions as an integral part of the primary record. The internal off-chain book-entry system records private shareholder information (e.g., name, DOB, or SSN), and the blockchain records transactional and other non-private shareholder information—purchases, redemptions, dividend rates, dividend distributions, net asset value, trade dates, and transaction memo information—as well as the complete transactional and operational history of the Fund. Thus, an on-chain transfer involving whitelisted wallets has immediate effect (i.e., it does not need to be reconciled to an off-chain record for a transfer of ownership to be effectuated).

The Fund has essentially created a permissioned system for the issuance and transfer of its securities on top of public, permissionless blockchains. However, the transfer agent retains full control and administrative rights with regard to the DLT-integrated recordkeeping system for the securities that are issued, which are effectuated through the use of certain blockchain-based technologies, including smart contracts. Thus, the transfer agent has unilateral control over all transactions involving the securities and can, for example, take corrective measures where erroneous or impermissible transactions have occurred or where the private key associated with an investor's wallet has been lost or stolen. Given its registered status, the Fund's shares are fully accessible to retail investors.

Analysis of existing examples noted potential fragmentation of entities involved in the core phases of tokenization, such as the issuer, asset manager, provider of the tokenization platform and wallet management solution. This fragmentation risks compromising one of the main potential benefits of using DLT, namely disintermediation that was purported to be able to reduce the number of subjects involved in the overall value chain of the securities markets.

E. Trading and Post-Trade

E.1. Secondary Trading

How Tokenization May Change the Lifecycle Process and Market Roles

Secondary trading in fixed income markets is already highly efficient across many centralized execution venues, so tokenization is not expected to immediately disrupt existing market structures or trading workflows.[63] As observed in some examples, DLT-based securities may continue to be traded on centralized execution venues,[64] with settlement subsequently occurring on distributed ledgers.

Nonetheless, there may be some adaptations. For instance, empirical studies support the view that tokenization can improve liquidity for bonds. As mentioned above, research indicates that tokenized bonds exhibit bid-ask spreads that are 5.3% lower than those of conventional bonds.[65] This improvement doubles to 10.8% when tokenized bonds are accessible to retail investors. These liquidity gains are derived from tokenized bonds settling faster, trading without intermediaries and fractionalizing into smaller amounts that lower the barrier to entry. However, it has also been noted that native securities have thus far exhibited low levels of secondary market liquidity.[66] This is largely because industry experimentation has focused on core DLT infrastructure, primary market issuance, settlement processes, and repo transactions, rather than active secondary trading. The resulting lack of liquidity disincentivizes investors from holding native securities for active trading.

For funds, the development of secondary markets could offer several potential advantages. By enabling the creation of secondary pools of liquidity and facilitating collateralization, secondary markets for fund tokens could improve price transparency and reduce information asymmetry, provided that timely, high-quality disclosures are made.[67] This is especially relevant for private asset investments, where transparency and liquidity have traditionally been limited. Key potential improvements include:[68]

63 Guardian Fixed Income Framework, section 4.2.1.

64 Centralized execution venues may also not be able to benefit from DLT if they are required to operate centralized execution protocols under their existing regulatory permissions.

65 HKMA Research Memorandum, *supra* n.56.

66 GFMA Report, *supra* n.39, section 2.1.2.

67 Guardian Funds Framework, section 4.4.

68 *Ibid*.

(a) Increased liquidity: For fund tokens, secondary markets provide investors with the ability to sell their fund tokens at any time, particularly beneficial during periods of market volatility or when investors need to rebalance their portfolios.

(b) Price discovery: Trading fund tokens on a secondary market can reduce information asymmetry between buyers and sellers, as all transactions are transparently and immutably recorded on the ledger, leading to more efficient price discovery.

(c) Broader investor access: Secondary markets can attract a wider range of investors — including retail investors, family offices, and institutions—that may not have traditionally participated in such assets.

(d) Fractional ownership: Tokenization allows for the buying and selling of smaller portions of assets, making high-value investments more accessible to a broader audience.

(e) Market intelligence: By monitoring secondary market activity, fund managers can gain valuable insights into investor sentiment and asset valuations.

Two categories of execution venues may emerge for secondary trading. The first is the traditional execution venue, which transacts at the ISIN (International Securities Identification Number) level. Such venues may incorporate tokenized products with targeted modifications to accommodate the unique features of such instruments. The second category consists of execution venues designed specifically for DLT-based products, which transact at a token identifier level. These platforms are built to support DLT-enabled features such as programmability, atomic settlement, and fractionalization.

Observations from the Analysis

Trading of tokenized bonds may take place through traditional or DLT-based infra-structure which co-exist in the current ecosystem. For example, a core feature of the UBS digital bonds issued on SIX Digital Exchange is that the bonds are dual listed on both traditional and digital exchanges (viz. SIX Swiss Exchange and SIX Digital Exchange respectively), allowing for trading at both venues, as explained in Boxed Example 1.

There is some evidence that tokenized MMFs offer advantages in broadening investor access and fractional ownership, but many of the promised benefits — particularly around secondary market liquidity — are not clearly evidenced in the use-cases yet.

For example, in the case of BUIDL, it seems broadly that a substantial part of the order / trading flows from existing conventional infrastructure remains (see Boxed Example 3 below). Security holders of BUIDL must register through the transfer agent's website (viz. Securitize, LLC) to become whitelisted by the transfer agent prior to being able to register for securities. When a BUIDL token transfer is executed on a blockchain (e.g., Ethereum or Solana), the transfer is recorded in that ledger once the block is confirmed and finalized. This record is then updated in an off-DLT relational database system that is operated under the sole discretion of the fund's transfer agent whose system of record serves as legal record of ownership. Once whitelisted, security holders may engage in transactions with other whitelisted entities, provided that they continue to meet the minimum ownership threshold. Any on-chain transaction involving whitelisted entities does

not have legal effect unless and until the transfer agent reconciled the on-chain record with the off-chain record.

Boxed Example 3 – BlackRock USD Institutional Digital Liquidity Fund

BlackRock USD Institutional Digital Liquidity Fund Ltd. (the "**Fund**" or "**Issuer**") is a limited company incorporated under the laws of the British Virgin Islands, (**BVI**), operating as a professional fund as defined under section 55 of the BVI's Securities and Investment Business Act, 2010 (**SIBA**). The Fund's investment manager is Blackrock Financial Management Inc., a Delaware corporation registered as an Investment Adviser with the SEC pursuant to the US Investment Advisers Act of 1940.

The Fund is not subject to public reporting obligations under SIBA and qualifies for an exception to registration as a US investment company under section 3(c)(7) of the US Investment Company Act of 1940. Under such an exception, each of the Fund's investors must be an "accredited investor" and either a "qualified purchaser" or a "knowledgeable employee," in each case as defined under applicable U.S. federal securities law or a non-US person (as defined in Regulation S under the U.S. Securities Act of 1933) that is outside of the United States at the time it acquires the Fund's shares (together, the "**eligible investors**").

The Fund has essentially created a permissioned system within public, permissionless blockchains for the following activities: issuance, recording ownership, custody of tokens in client wallets, secondary market trading between whitelisted qualified investors, dividend payment, and initiation of the redemption process.

To invest in shares of the Fund, an eligible investor must register through the Fund's transfer agent's website. To streamline purchases and redemptions, a third party provides a facility to certain investors that enables investors to use stablecoins such as USDC to subscribe to shares of the Fund.[69] Further, investors may be able to exchange BUIDL tokens for USDC in near-instant on-chain transactions with other Fund investors, as opposed to redeeming with the Fund and waiting for off-chain settlement in fiat currency.

When a token transfer is executed on a blockchain, the transfer is recorded in that on-chain ledger once the block is confirmed and finalized. This record is then reconciled with an off-

[69] Securitize, "Securitize Integrates with Zero Hash to enable purchase of BlackRock's Tokenized BUIDL Fund via USDC Conversion", at https://securitize.io/learn/press/securitize-integrates-with-zero-hash-enables-purchase-of-buidl-fund-via-USDC-conversion.

chain database that is operated under the sole discretion of the transfer agent. It is this off-chain system that serves as legal record of ownership.[70]

In addition to fulfilling eligible investor requirements, all prospective security holders must be whitelisted by the transfer agent prior to being able to register for securities. Subscriptions must be notified to the transfer agent for transactions to be recorded on the transfer agent's books and records and be recognized as having officially taken place.

Once whitelisted, security holders may be able to engage in transactions with other whitelisted qualified investors.

E.2. Clearing and Settlement

How Tokenization May Change the Lifecycle Process and Market Roles

Traditional clearing and settlement processes for both bonds and MMFs involve multiple intermediaries including clearing agents, brokers and central clearing houses, to manage counterparty risks and ensure a smooth settlement process. However, this can also result in operational frictions such as additional back-office costs, settlement lags, and suboptimal capital usage, particularly in time-sensitive transactions like repos and collateral transfers.

Clearing

To date, the use of DLT in the clearing and settlement workflow has mainly focused on DLT-based settlement, and atomic settlement in particular. With atomic settlement, clearing and settlement activities are synchronized into a unified workflow (see below for more details on DLT-based settlement), which could eliminate the need for certain clearing activities (e.g. trade confirmation, margining).

However, atomic settlement may not be appropriate or desirable for all asset classes, transaction types and use-cases, as it also presents risks and costs (see discussion on atomic settlement below). Therefore, where clearing activities of tokenized financial assets are still needed and hosted on DLT-based infrastructure, this could facilitate the automation of existing clearing functions and processes.[71] For example:

(a) In relation to post-trade processing, the use of DLT could enable relevant participants to use a single source of data, reducing the need for sequential processing (e.g. affirmation, confirmation, match messages) and reconciliation between legacy systems.

(b) Another area in the clearing chain where the use of DLT could enhance existing processes is in risk management. In margining, with real-time information on positions available in a DLT-based system, this could facilitate more frequent and

[70] GFMA, "Deep Dives – Impact of DLT in Capital Markets" ("**GFMA Deep Dive**"), p. 54, at https://www.gfma.org/wp-content/uploads/2025/08/3.-deep-dives-impact-of-dlt-in-cap-mkts-final.pdf.

[71] GFMA Report, *supra* n.39, p.86, 87, 89.

precise margin calculations, facilitating more efficient margin management. Furthermore, the reduction in the time gap between margin calls and posting of margins through the use of DLT (see below for more details on DLT-based settlement) could help to reduce risk exposure to the clearing house. In default management, this could facilitate a swifter updating of positions of defaulting and non-defaulting members as positions are liquidated.[72]

However, these purported improvements to clearing remain largely theoretical at the moment, as the hosting of clearing activities on DLT-based infrastructure has not seen commercial adoption in this nascent stage of the market, and with the use of DLT focused on settlement instead.

Settlement

The hosting of settlement activities on DLT-based infrastructure presents opportunities to facilitate greater accessibility and programmability of settlement processes.

In relation to accessibility, DLT allows for a shared, synchronized ledger (accessible to all participants) to record transactions as well as for financial assets and settlement instruments to reside on the same ledger, which conceptually eliminates the need for participants to maintain and reconcile separate ledgers.

In relation to programmability, DLT supports the programming and automation of multiple legs of transactions based on pre-defined rules/conditions.

Possible benefits to DLT-based settlement arising from these attributes include reduced time and failure rates for settlement.[73] The technology allows for options such as atomic settlement—where both sides of a transaction occur at the same time—or locking tokenized securities on the ledger until all settlement conditions are met. These features could reduce the rate of failed trades, shorten settlement delays, and minimize the risks that typically arise during legacy settlement periods. As a result, traders benefit from improved outcomes and potentially lower operational risks and costs.

In the same vein, atomic or near-instantaneous settlement enabled through tokenization could also reduce counterparty risk and operational expenses. This means that unsettled positions could be largely eliminated, which streamlines back-office processes and decreases exposure to market and credit risks.

The availability of faster settlement options through DLT could enhance capital allocation and efficiency.[74] Shortened settlement cycles reduce the duration for which collateral is locked, allowing for more effective liquidity management. This is discussed further in the sub-section on collateral management.

[72] Fernando Cerezetti, Max Chan, and Rafael Plata. (2023), "Decentralized Clearing? An Assessment of the impact of DLTs on CCPs – EACH Forum Paper", p 12, available at: https://eachccp.eu/wp-content/uploads/2023/03/Decentralized-Clearing-An-Assessment-of-the-impact-of-DLTs-on-CCPs-February-2023.pdf.

[73] GFMA Report, *supra* n.39, section 2.1.2.2.

[74] IMF 2025 Report, *supra* n.6, p 11.

Nevertheless, it is important to note that implementing DLT-based settlement is not without risks or challenges. There are also risks relating to pre-funding of cash in some cases. The promise of shorter or real-time settlement may require a combination of quicker deployment of funds, real-time valuation, and instantaneous execution of orders. The associated risks relating to pre-funding of cash and pre-positioning of assets are addressed in greater detail in Chapter 4.

DLT-based settlement workflows can be implemented to varying degrees based on the nature of the assets being settled, to mitigate some of these frictions. Three main models can be summarized as follows: [75]

(a) Books and records: At the baseline level, DLT can be used primarily for recordkeeping where DLT acts as a database facilitating updates between participants, but settlement execution and finality remain with the CSD and must be reconciled on existing systems. In this model, no DLT-based products are issued, and no DLT-based payment instruments are used.

(b) Partial DLT integration: Hybrid settlement using traditional and digital assets. DLT-based financial assets would settle on a distributed ledger, but payment would be coordinated through existing payment systems (e.g., FedWire) or in commercial bank model (prevalent among international central securities depositories, such as ClearStream). This is one model which commercial issuances currently utilize.

(c) DLT-native settlement: End-to-end DLT processing without traditional intermediaries, using programmable tokenized instruments. Here, the financial assets and settlement instruments would either settle on the same distributed ledger or settle on one distributed ledger, with payment coordinated through interoperability with a separate distributed ledger. This model would facilitate tokenized settlement instruments such as commercial bank money (including deposits), and DLT-based payment instruments issued by a central bank (e.g., a CBDC).

In terms of the roles of market participants, the following changes could occur: [76]

(a) Central counterparties (CCPs): In the long term, CCP processes like netting could be encoded in smart contracts, thereby altering the operational role of a CCP. In DLT-based markets for specific asset classes and transaction types, CCPs could fulfil standard setting and governance functions. Participants could develop distributed financial market infrastructure, where CCP responsibilities (e.g. for managing default funds and setting margin requirements) are shared among market participants via predefined smart contracts or encoded in market-wide infrastructure.

(b) Central securities depositories (CSDs): In the DLT-based ecosystem, a key open question is around where settlement finality and beneficial ownership will be recorded. If settlement finality is recorded using DLT, CSDs could evolve to be a

[75] GFMA Report, *supra* n.39, section 2.1.3.2.

[76] GFMA Report, *supra* n.39, section 2.1.3.2.

governor of DLT-based settlement systems. However, in most models, they may remain a central actor in DLT-based settlement.

(c) Custodians: Custodians could gain operational efficiencies in asset classes and transactions moving to DLT-based settlement. Smart contracts can automate the generation, notification, and validation of settlement instructions, streamlining straight-through-processing. Custodians will likely continue handling cash settlement through traditional systems to manage the payment leg. However, if tokenized assets and DLT-based payment settle on the same ledger, custodians may shift to managing conversions between cash and DLT-based payment instruments, provided legal certainty around finality is ensured.

Accordingly, it has been observed that DLT-based clearing and settlement is expected to function as an additional, complementary channel alongside existing infrastructure.[77] In this regard, it has been suggested that repos and OTC derivatives, where collateral payments play a key role, may present the most significant opportunity for DLT-based settlement,[78] such as addressing challenges in common processes, including posting collateral for repo transactions[79]

Observations from the Analysis

Tokenized bonds provide evidence of atomic trading/settlement capability, and the synchronization of clearing and settlement. For example, with the UBS bond offered on SDX Exchange, all trades are settled atomically (T+0), and the clearing process is no longer necessary. As explained in Boxed Example 1, members of SDX CSD can choose between tokenized CHF ("tCHF") issued by SDX or production wCBDC for a settlement asset. In addition, SDX also provides an option for transactions to be settled through SIX SIS, where the process follows that of a traditional non-tokenized product and takes place on a T+2 timeline.

In light of the options for settlement available, it bears noting that the selection of a particular option might be premised on the preference to harness the benefits of DLT-based settlement infrastructure as described above, or to continue placing reliance on traditional infrastructure due to a variety of factors such as greater familiarity in processes or the operation of network effects, amongst other things.

The analysis of Spiko EU T-Bills Money Market Fund illustrates some of the issues relating to DLT-based tokenized MMF settlement assets. The official share register is maintained on distributed ledgers. The blockchain transaction which updates the distributed ledger is the legal record of ownership, which is valid except in cases of fraud. Subscribers can request subscriptions and redemptions in both fiat currency and stablecoins. Please refer to Boxed Example 4 below for more details.

[77] GFMA Report, *supra* n.39, section 2.1.3.2.

[78] *Ibid*.

[79] See Boxed Example 6.

Boxed Example 4 – Spiko EU T-Bills Money Market Fund

The Spiko EU T-Bills Money Market Fund (the **"Fund"**) is a sub-fund that sits below the Spiko SICAV umbrella fund, which is incorporated in France. The Fund is managed by Twenty First Capital SAS (the **"Fund Manager"** or **"Twenty First Capital"**), a portfolio management company authorized by the AMF. The Fund Manager is responsible for the management of the unitholder register and has a technical assistance service-level agreement with Spiko Finance SAS (**"Spiko Finance"**) for this purpose (which does not constitute a delegation of liability management). The Fund's shares are distributed by the Fund Manager and Spiko Finance SAS, which is a registered financial investment advisor and appointed by the Fund Manager as a distributor of the Fund.

The Fund is a euro-denominated money market fund. The objective of the Fund is to offer investors capital preservation and consistent performance matching or exceeding the capitalized €STR (Euro Short Term Rate) at the conclusion of the recommended minimum investment period of one day, after deducting all fees billed to the Fund.

The official share register is maintained on distributed ledgers. The ownership of the Fund's shares is recorded on the Ethereum blockchain and other Ethereum-compatible blockchains, to which the Fund Manager has access via the tokenization platform provided by Spiko Finance.

The transfer of ownership (or the exact moment of the creation or destruction of the securities) is recorded as soon as the transaction is included in a block that is validly added to the blockchain (and, thus, there has been a change in the holding address).

Under French law, the blockchain register is only valid as proof of ownership if there is no fraudulent activity. If the blockchain or the investors' access to their accounts were compromised, the Fund Manager could request through the tokenization platform a correct version of the register to be restored, by burning compromised tokens (or even the whole issuance if needed) and then re-creating and allocating new tokens to the correct addresses.

F. Asset Servicing[80]

F.1. Custody[81]

How Tokenization May Change the Lifecycle Process and Market Roles

Broadly, custody can be understood as consisting of two core types of activities. First is record-keeping, which entails maintaining records of positions and transactions by conducting post-trade reconciliation among custodian, asset manager, sub-custodian, and CSD ledgers. Second is account management, which entails safekeeping of clients' assets and monies in accounts segregated from the custodian's own assets and liabilities.[82] For the purposes of this Report, the focus is on the custody of the digital tokens, not the underlying assets.

The impact of DLT on custody depends on whether financial institutions opt for a books and records only approach or a fully digital custody approach.[83] Under the books and records only model, assets and cash will remain within traditional market infrastructure, with DLT serving as a reference tool for record-keeping. Under the fully digital custody model, safeguarding involves both digital twins and digital native tokenized assets in addition to the current account-based custody model.

Proponents suggest that digital books and records could be deployed to potentially help make record-keeping more efficient.[84] DLT used across the custody chain could simplify post-trade reconciliations that currently occur between participants, which proponents suggest could lead to greater operational efficiency through less manual intervention, enhanced data transparency, and auditability. However, DLT may introduce new reconciliations with existing databases as the records become a sub-ledger native to a financial institution's general ledger reporting.

Digital custody can be multi-layered, with digital assets stored in different ways.[85] For example, it can also be safekept in "decentralized" ways via investors' own wallets or centralized via wallet-account structures consolidated by intermediaries. Where investors do not hold keys directly, a digital asset custodian will undertake responsibilities, including holding investors' private keys, and monitoring the process to approve transactions.[86] However, beyond the safe-keeping of the private keys in the wallet, it is crucial that the custodian is able to exercise

[80] Asset servicing refers to the operational support of investment funds across its lifecycle activities including custody, valuations, accounting, compliance reporting and transaction processing like dividend or income distribution. For the purposes of this Note, the focus is on custody and collateral management.

[81] Custody is defined as the safekeeping and administration of securities and other assets on behalf of asset managers, asset owners, and trading firms.

[82] GFMA Report, *supra* n.39, section 2.1.4.1.

[83] For a discussion on tokenized fund share registers forms, see Guardian Funds Framework, section 5.1.1.

[84] Guardian Fixed Income Framework, section 4.2.

[85] Guardian Funds Framework, section 4.6.4. For an overview of different types of custodial arrangements (viz. full custody, shared custody, hosted custody and self-custody), refer to WEF Report, *supra* n.25, Table 2.

[86] Guardian Funds Framework, section 4.5.

possession and control of the digital assets if these tokens are also under custody. Accordingly, digital custody could introduce a new infrastructure for DLT-based asset safekeeping via the wallet-and-key model, relying on private keys for transaction authorization.[87] That being said, it has been observed that new infrastructure is less likely to displace the account-based custody model in the near or medium term given the prevalence of traditional assets, presence of tokenized assets that require traditional backing, and regulatory requirements for security accounts in various jurisdictions.[88]

As for changes to the role and responsibilities of CSDs or custodians, much will depend on the design and structure of the tokenized assets in question In the case of digital twins, the local custodian or participant could propose transaction and ownership changes to the distributed ledger. [89] The CSD or custodian would need to verify regularly that the record of ownership for the traditional asset exactly matches the record of ownership for the digital twin, as shown in the illustrative diagram below.[90] For these reconciliations, the traditional CSD ledger could likely remain the golden source of truth, given its legally established nature today. Accordingly, the purported benefits of tokenization in this regard may be negated to a certain extent for as long as traditional and DLT-based infrastructure continue to run in parallel. It has been observed that this will likely remain the case in the short to medium term given the nascent state of DLT compared to the entrenched traditional infrastructure.[91]

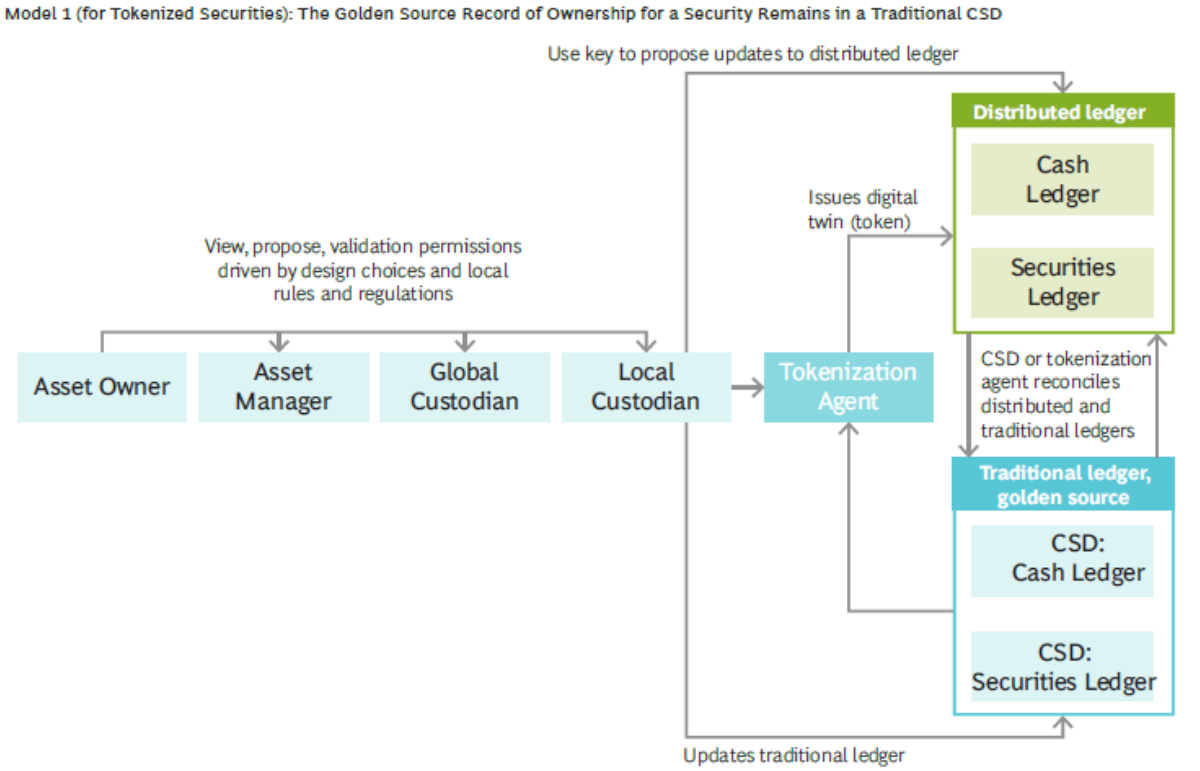
87 Guardian Fixed Income Framework, section 4.2.

88 GFMA Report, *supra* n.39, section 2.1.4; Guardian Fixed Income Framework, section 4.1.2.

89 GFMA Report, *supra* n.39, section 2.1.4.2.

90 GFMA Report, *supra* n.39, Exhibit 2.1.13.

91 GFMA Report, *supra* n.39, section 2.1.4.2.

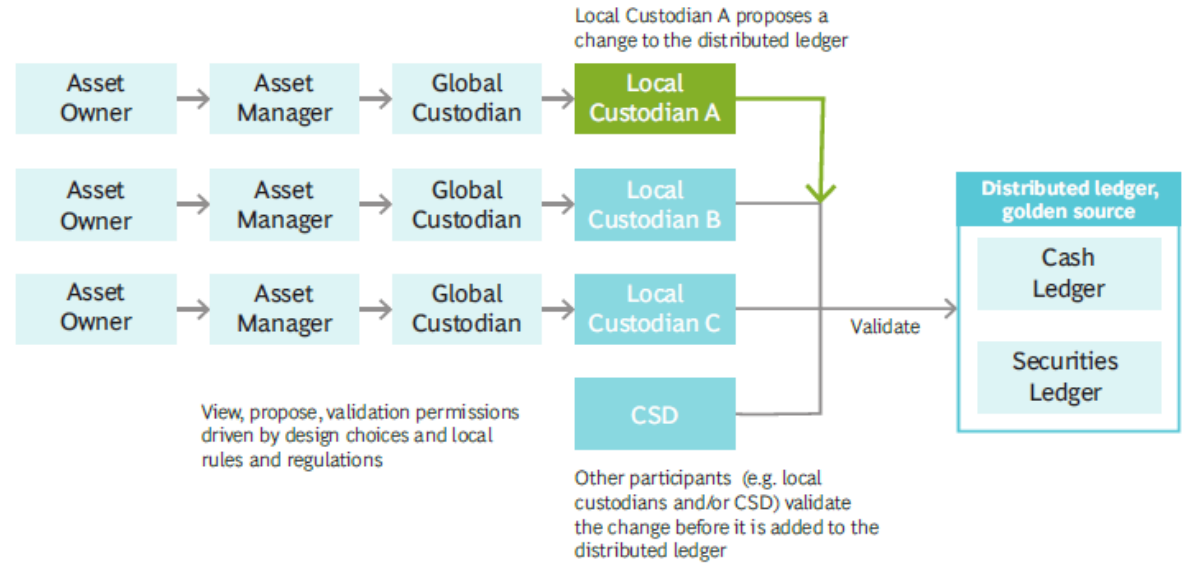


In the case of digital native assets, where ordinarily the distributed ledger becomes the only source of truth, the CSD role may shift toward governance while custodians and other intermediaries play a larger role in validating transactions on the distributed ledger.[92] Governance activities could include enforcing data standards, determining validation mechanics, and arbitrating disputes. In terms of updates to the distributed ledger, several options are possible. Custodians, brokers, or other direct DLT participants could be responsible for both proposing and validating updates to the shared ledger of ownership as seen in the illustrative diagram below.[93]

[92] Depending on the legal requirements in different jurisdictions, alternative models may also be possible where a CSD may not be required.

[93] GFMA Report, *supra* n.39, Exhibit 2.1.14.

Model 2 (for Security Tokens): The Golden Source of Ownership Exists Solely on the Distributed Ledger, Managed by CSD or Custodians, or Both



Source: BCG analysis

The evolution of custody as outlined above (whether under the digital twin or digital native model) could also have consequences for costs, though any savings could take time to materialize clearly or fully. On the one hand, simplifying reconciliations could lower the total cost to service clients.[94] On the other hand, upfront operational and capital expenditures will be necessary to build custody platforms and link legacy and DLT-based platforms for reconciliations (at least in the short/medium term).[95]

Observations from the Analysis

With respect to tokenized bonds, the analysis suggests that custody-level changes have been applied for books and records and there is evidence of digital custody using both self-custodied and third-party wallets.

In the case of the UBS bond issued on SDX, ownership records are updated via direct entries to SDX's distributed ledger, which is the main register (*Hauptregister*) and serves as the definitive record of ownership under the Swiss law. SDX CSD is regulated and responsible for supporting the issuance, settlement, custody and ownership recording of the digital bond into the main registry on its DLT network.

Likewise, in the case of bonds issued on Euroclear's Digital Securities Issuance service, Euroclear is regulated as a CSD in Belgium and responsible for recording the ownership of the tokenized bonds. Please refer to Boxed Example 5 below for more details.

94 GFMA Report, *supra* n.39, section 2.1.4.2.

95 *Ibid*.

Boxed Example 5 – Euroclear

Euroclear Bank's Digital Securities Issuance service (**D-SI**) supports the issuance, distribution, primary market settlement and redemption of digitally native notes (**DNN**) on DLT.

The D-SI is part of the Digital Financial Market Infrastructure (**D-FMI**) initiative connected to the traditional securities settlement system of Euroclear Bank for settlement of secondary market transactions conducted OTC or on trading venues, granting investors full access to trading venues and liquidity management facilities.

The D-SI service covers:

(a) the acceptance of DNNs as dematerialized securities with the automatic ISIN allocation,

(b) the issuing agent authorizing the creation of DNNs,

(c) the DVP settlement in EUR or USD. Once issued, DNNs are held directly by participants through Securities Wallets on the D-FMI component,

(d) the transfer of the securities and cash proceeds from the D-FMI component to the traditional component of Euroclear's securities settlement system to settle secondary market transactions, safeguarding the liquidity.

Under the D-SI service, the deal is priced, the new securities are distributed, and the primary market activity all settle on the same day.

Secondary market transactions are settled in the traditional securities settlement system of Euroclear. Euroclear performs core CSD services (as defined in Section A of the Annex to CSDR) in full compliance with the existing regulatory framework (including Central Securities Depositaries Regulation (CSDR) and Settlement Finality Directive (SFD)), both on D-FMI and the legacy system.

In terms of settlement finality, the European Settlement Finality Directive applies to settlements within the D-FMI as the D-FMI is part of the securities settlement system of Euroclear Bank which is recognized as a "system" under the Settlement Finality Directive. DNNs issued and settled in the D-FMI can be fully listed and traded on EU regulated markets.

With respect to tokenized MMFs, there is also evidence of implementation of digital custody whereby different custody options are offered, as mentioned in the respective Boxed Examples above.

F.2. Collateral Management and Repos

How Tokenization May Change the Lifecycle Process and Market Roles

Apart from fixed income products and MMFs, tokenization has also been applied in the domain of collateral management and repos. The WEF Report has identified collateral and repos as a key application of tokenization.[96] As noted in the same report, collateral is fundamental to managing counterparty risk and ensuring the smooth functioning of financial markets by mitigating credit risk. Ideal collateral would be free from credit and liquidity risks, maintain a stable value, and not correlate with the provider's credit risk.

The motivation for tokenization in the area of collateral management is to reduce operational burden of existing processes, for both fixed income products and MMFs. It has been noted by both the WEF and GFMA that the current workflows for collateral and repo markets face various inefficiencies.[97] Manual and fragmented workflows can rely on outdated and disconnected systems, leading to delays, errors and costs. Additionally, settlement inefficiencies may result from the many intermediaries coordinating complex transactions – rapid buy and sell orders – that have led to longer settlement cycles and liquidity constraints. Deferred settlement may cause collateral to be kept from other productive uses and create counterparty credit risk, which requires higher collateral value to mitigate. Rehypothecation and collateral reuse can also be slow and operationally complex. Delays in collateral release may further have knock-on effects for the next trade, resulting in trade failure.

DLT-based securities have been the focus for use in the intra-day repo market because of the potential speed of settlement.[98] It has also been suggested that DLT-based repos could improve the degree of visibility regulators have in relation to the sources and uses of securities in collateral agreements, thereby improving their ability to mitigate potential risks.

The commercial application of tokenization in collateral markets is also seen significantly in the use of tokenized MMFs. MMFs in tokenized format could enable collateral portability without requiring redemption for cash movement. Information such as valuation, liquidity, and credit ratings of the underlying MMF securities could also be made available to better reflect information on counterparty risk.

Observations from the Analysis

Kinexys by J.P. Morgan, the firm's blockchain business unit, has deployed tokenization in collateral management. The Kinexys Digital Assets platform is a multi-asset tokenization platform for institutional assets like MMFs, repos, and bonds. As of November 2024, the platform had processed more than $1.5 trillion in notional value since its inception in 2020 through its intraday repo and collateral

[96] WEF Report, *supra* n.25, section 3.3.

[97] WEF & Boston Consulting Group (**BCG**) (May 2021), "Digital Asset, Distributed Ledger Technology and the Future of Capital Markets"; GFMA Report, *supra* n.39, section 3.2.

[98] GFMA Report, *supra* n.39, section 3.2.1.

services.[99] It processes an average of more than $2 billion daily in transaction volume. Please refer to Boxed Example 6 below for more details.

Boxed Example 6 – Kinexys by J.P. Morgan

The Kinexys Digital Assets platform was established in 2020 and enables the tokenization of money market fund shares using block chain technology, allowing for settlement of transactions and transfers of collateral ownership without moving tokenized assets in underlying ledgers.

The Kinexys Digital Assets platform is used worldwide by asset managers, institutional investors, financial institutions and fintech companies, and enables them to efficiently pledge or transfer tokenized ownership interest in money market fund shares as collateral. The current focus is on institutional and large corporate clients, with the criteria and review processes aligned to that of the firm's traditional business.

As alluded to earlier, it appears that a small number of tokenized MMFs are also being used as collateral for crypto transactions.[100] BUIDL is an example which is being used as tokenized collateral in various financial and crypto market settings. In June 2025, it was announced that BUIDL will be accepted as collateral on leading crypto exchanges such as Crypto.com and Deribit.[101] Accordingly, institutional traders can post BUIDL tokens as margin for leveraged trades, earning yield on the underlying U.S. Treasuries while using the token as collateral. Further, Ethena Labs recently launched the USDtb Liquidity Fund, allowing investors to swap BUIDL for the USDtb stablecoin. As of June 2025, the largest holders of BUIDL tokens - USDtb ($1.3 bn); Spark ($800 mn); and Ondo ($150 mn) – were firms which used BUIDL tokens as collateral assets in their products and

[99] https://www.jpmorgan.com/insights/payments/payment-trends/introducing-kinexys.

[100] Based on publicly available information, there are news announcements which suggest that other MMFs are also being deployed for collateral, though these do not seem to have garnered the same traction or attention as BUIDL. For example, see BENJI token used as collateral for derivatives transaction: https://www.businesswire.com/news/home/20241121236302/en/Nonco-and-SwapGlobal-Complete-Industry-First-Crypto-Derivatives-Transaction-Using-Franklin-Templetons-BENJI-Token.

[101] https://securitize.io/learn/press/BlackRocks-BUIDL-Tokenized-by-Securitize-Accepted-as-Collateral-on-Cryptocom-and-Deribit.

services.[102] There is also growing integration of tokenized MMFs with permissionless DeFi, which purportedly is being done in such a way that the MMF is able to maintain compliance with its regulatory obligations (including with regard to the qualified purchaser requirement falling under U.S. law). This is representative of a larger trend in tokenization, which involves enabling investors in permissioned assets (e.g., securities) to use such assets more freely in DeFi.[103]

It is also noted that the Global Markets Advisory Committee (GMAC) of the CFTC, which includes industry participants and experts, has voted to recommend the use of tokenized non-cash collateral (including MMF tokens) and has advanced these recommendations to the full CFTC for consideration.[104] At the time of writing, the CFTC has not voted on or formally enacted these recommendations.

G. Summary Observations

Notwithstanding that the evolution of lifecycle activities from tokenization appears to still be quite incipient and incremental, there is evidence of growing commercial interest. The following paragraphs set out some projections regarding the trajectory of tokenization. As stated at the outset, while it is important to have an eye on the market's perception of the trajectory regarding tokenization, it is not the purpose of the Report to encourage or endorse tokenization. As will be observed below, estimates of potential tokenization growth vary across studies.

On the one hand, according to McKinsey's report of June 2024, the tokenized market capitalization across asset classes could reach about $2 trillion by 2030 (excluding cryptocurrencies and stablecoins).[105] The pessimistic and optimistic scenarios range from about $1 trillion to about $4 trillion, respectively. According to Citi, tokenization of securities is expected to reach up to $4-5 trillion in value by 2030, assuming 1% of corporate and quasi-sovereign bonds, 7.5% of real estate funds, 10% of PE/VC funds and 2% of repo, securities financing and collateral markets are tokenized.[106]

On the other hand, according to a joint report published by Ripple and BCG in April 2025, tokenization across real-world assets is projected to grow from around $0.6 trillion in 2025 to $18.9 trillion by 2033 in the midpoint

[102] As seen in the Etherscan blockchain explorer for the two BUIDL token contracts, https://etherscan.io/token/0x7712c34205737192402172409a8F7ccef8aA2AEc#balances (for Ondo) and https://etherscan.io/token/0x6a9da2d710bb9b700acde7cb81f10f1ff8c89041#balances (for USDtb and Spark). USDtb's holdings are held in three custody accounts (associated with three separate blockchain addresses) with Copper, Komainu, and Zodia: https://usdtb.money/transparency.

[103] *See, e.g.,* RWA News: Securitize, Gauntlet Bring Apollo's Tokenized Credit Fund to DeFi With Leveraged Yield Strategy. *See also* Securitize | #HyFi Meets Horizon: RWAs Go Native in DeFi.

[104] https://www.cftc.gov/PressRoom/PressReleases/9009-24.

[105] McKinsey, *supra* n.35.

[106] Citi GPS (March 2023), "Money, Tokens, and Games: Blockchain's Next Billion Users and Trillions in Value," p 15., available at: https://www.citifirst.com.hk/home/upload/citi_research/rsch_pdf_30143792.pdf.

scenario.[107] The conservative scenario postulates a size of $12.5 trillion while the optimistic scenario puts it at $23.4 trillion. Another report jointly published by Standard Chartered Bank and Synpulse posits that overall tokenized real-world assets are expected to reach up to $30.1 trillion by 2034, with trade finance assets being in the top three tokenized assets.[108]

While the precise scope, method and bases for each report varies, it suffices to note that the trajectory perceived by industry analysts and participants is generally one of growth, though the rate and scale differ.

[107] Ripple and BCG (7 April 2025), “Approaching the Tokenization Tipping Point”, available at: https://www.finews.asia/images/download/approaching-tokenization-at-the-tipping-point.pdf.

[108] Standard Chartered and Synpulse (June 2024), "Real-World Asset Tokenization: A Game Changer for Global Trade", available at: https://www.hkdca.com/wp-content/uploads/2024/07/rwa-tokenization-game-changer-global-trade-synpulse.pdf.

4. Financial Asset Tokenization and its Potential Implications

While tokenization is purported to bring about benefits across different stages of the capital markets lifecycle process, whether and how these benefits would materialize, as well as its impact on the broader financial markets, have yet to be seen. Despite this, risks can continue to manifest or be amplified in the course of adopting tokenization arrangements due to their unique characteristics as discussed in Chapter 3, along with the nascent and evolving application to financial products and services.

This Chapter discusses the issues that may arise from tokenization arrangements and their potential risk implications to market integrity and investor protection. The discussion in this section is informed by IOSCO's information gathering efforts, focusing on the observations from the analysis of existing examples in the market, and supplemented with insights gathered from industry engagements and a literature review of relevant papers on the subject.

A. General Observations

From the analysis, it is observed that there are few, if any, substantive differences in the economic substance of financial assets that are being created through tokenization arrangements as compared to financial assets created through conventional means. Likewise, the economic purpose of activities that are being conducted in relation to such tokenized financial assets are typically also the same or similar to the majority of activities that are already taking place in the conventional market.

In this regard, it follows that many of the risks present in conventional products and activities may also be present in the tokenized financial products and tokenization arrangements. The primary difference however is the use of a new technological medium such as DLT to create and represent financial assets, and to perform activities pertaining to these assets, which could improve the delivery of financial services and address current market inefficiencies.

These changes in the technologies and infrastructure used for the creation of financial assets can have wider implications for the operating environment in which these assets and services are deployed. For instance, some activities such as clearing might become less relevant in the context of atomic or near-instantaneous settlement whilst the performance of other activities such as custody might be vastly different as highlighted in Chapter 3. Tokenization can also introduce new process flows or intermediaries with new roles such as token minters, DLT platform developers, etc.

Such changes can in turn cause risks present in conventional products and activities to manifest in a different form under tokenization arrangements or result in other risks being amplified. It is therefore important to understand how such risks manifest in a

capital market specific context given the potential implications for market integrity and investor protection. Specific to this context, it is worth highlighting the following general observations from the analysis conducted:

(a) **The manner in which the risks eventually manifest likely is not uniform across tokenized assets and arrangements.** Instead, such risks are highly contextual to the use-case being contemplated and will depend upon a number of factors, including but not limited to the choice of the DLT network architecture being used, the tokenization structure adopted for the financial asset, the activities that the tokenized financial asset is being used for, and the manner in which the asset interacts with other assets and activities in a tokenized environment.

(b) **Not all the risks will eventually manifest or manifest in the form discussed.** This is given that tokenized financial assets and tokenization arrangements are still relatively nascent, and its scale and trajectory of eventual adoption is highly uncertain given that the underlying DLT and broader ecosystem is still evolving.

The diversity in the risks surfaced from the literature reviewed vis-a-vis the examples analyzed exemplifies this point. For instance, it is observed that risks from the examples tend to be product- or activity-focused, manifesting based on the tokenization application at that specific point in time. In contrast, the risks highlighted in the literature reviewed contemplate a more scaled-up future state tokenized eco-system.

The unique characteristics of tokenization arrangements that can give rise to salient issues, and the potential risk implications of these issues to market integrity and investor protection, are discussed in detail in the sub-sections below. These are grouped by issues that are observed to be more salient in the analysis of the examples vis-a-vis those that are discussed more extensively in the literature but are nascent or have yet to be observed, as this forms a natural differentiation between issues/risks that are of immediate concern to current commercial tokenization application against those where their manifestation will depend on the trajectory and scale of tokenization adoption.

B. Potential Implications Observed

The analysis shows that the nature of risks arising from the current commercial application of tokenization fall into existing risk taxonomies (chiefly legal, operational and technology risks, and to a lesser extent, credit and liquidity risks). Market participants are not unfamiliar with managing such risk types, but tokenization may also result in the manifestation of vulnerabilities and risks that are unique to the technology itself, some of which would require the introduction of new or additional controls to manage them. This has been acknowledged by issuers and operators in their publications including public prospectus documents. The issues giving rise to these risks are discussed below.

B.1. Representation of Financial Assets in the Form of Tokens

There are currently well-established legal constructs and structures for the treatment of financial assets created in paper certificate or book-entry form, along with the activities conducted in relation to these assets on conventional market infrastructure, to ensure

adequate protection of investor rights and interests in the event of disputes.

It can be unclear if current practices applied in the conventional market are also equally applicable to financial assets that are created or represented in the form of tokens, and the activities conducted on these tokens through the blockchain. For non-native tokens, investors can also be uncertain around what ownership of the underlying assets could mean in relation to token ownership given the range of structuring options available.

These can give rise to investor protection risk where the legality of ownership and transfers of tokenized financial assets might not be transparent or aligned with what is perceived by investors. Such risks could arise in the following situation:

(a) Legal recognition of creation and transfer of tokens – Most jurisdictions have historically mandated in their legal frameworks how ownerships and transfers of financial assets such as shares and debentures should be recorded or performed in order for it to be legally recognized [109]. The use of the DLT to record and perform such ownership and transfers might not feature or fit cleanly within these framework requirements as such technologies were not contemplated at the time the legislation was created. Investors face legal risks if ownership or transfers made using tokens on the DLT are invalidated or not recognized as envisaged. This is further complicated in cross-border transactions given the wide variation in jurisdictional approaches to recognizing DLT-based token ownership and transfer.

Given the variation in jurisdictional approaches, it has been observed from the analysis that different operators have taken different approaches to maintain the authoritative source of ownership for financial assets they have tokenized. For instance, some operators continue to maintain off-chain records as the official legal source of ownership records which takes precedence over the on-chain records; some have combined features of off-chain book-entry records on centralized systems with on-chain records as the official legal source of ownership; still others have primarily relied on on-chain records as the official legal source of ownership with off-chain records as back-up. Such differences in approaches might confuse investors investing in tokenized assets on what is the authoritative record of ownership for their asset, and potentially lead to disputes, if not properly disclosed. Please refer to Boxed Example 7 below for more details.

[109] X Lavayssière, "Legal Structures of Tokenised Assets". European Journal of Risk Regulation, available at https://doi.org/10.1017/err.2024.88.

Boxed Example 7 – Different approaches by tokenized MMFs in recording ownership

BlackRock USD Institutional Digital Liquidity Fund (BUIDL): The official record of ownership is maintained in the transfer agent's off-chain books and records.

Franklin Onchain U.S. Government Money Fund: The Fund's shares are issued directly on a blockchain, and this serves as the official record of ownership. The Fund's recordkeeping system combines features of the blockchain and a traditional book-entry record, such that the blockchain functions as an integral part of the primary record. However, the transfer agent has unilateral control over all transactions involving the securities and can, for example, take corrective measures where erroneous or impermissible transactions have occurred.

Spiko EU T-Bills Money Market Fund: The official record of ownership is maintained on distributed ledgers. It is valid as proof of ownership if there is no fraudulent activity.

There could also be uncertainties amongst issuers and market participants on whether their tokenized financial assets and activities fall within current regulatory frameworks and how the regulatory requirements would apply. On this front, regulatory authorities have considered a variety of additional regulatory measures, including risk disclosures. These are discussed further in Chapter 5.

(b) Investor rights to underlying assets of non-native tokens – The rights of investors to the underlying assets that non-native tokens are meant to represent, and the linkages between the tokens and the assets, can be subject to wide variations depending on the tokenization structure being adopted by the non-native token issuer. This might not always be made transparent to investors via appropriate disclosures, or easily understood by investors even if disclosed, hence posing significant risks where investors could mis-perceive their actual holdings in relation to their non-native token investment.

For instance, some non-native tokens could be structured to represent synthetic exposure to the assets that the token claims to represent whilst others are backed by actual exposure where the token issuer holds the underlying asset on behalf of the investor. For the former, the non-native token could merely represent a promise by the token issuer to provide token holders with monetary gains associated with fluctuations in prices or valuations of these assets and counterparty risk exposure is to the token issuer to fulfil its obligations instead of the underlying asset issuer, which might not always be clear to investors (see Chapter 3 on “stock tokens”). For the latter, such structures can be akin to conventional fractionalization or securitization arr-angements. However, token issuers might not always put the same level of

protection in place as for conventional securitized products. For example, issuers might not use bankruptcy-remote structures to hold the underlying assets to protect investors but instead hold the underlying assets on their own balance sheet. This exposes the investor to additional counterparty risk against the token issuer on top of that faced with the underlying asset issuer. In addition, investors may also be exposed to custody risks, which could include the issuer's loss of title to the underlying asset or the sale of the underlying asset without investor knowledge or recourse.

The FSB has also noted that non-native tokens can be exposed to liquidity and maturity mis-match risks,[110] which can result in redemption runs on either the underlying assets and/or non-native tokens in the event of a liquidity crunch. This can also compromise the integrity of the market, where irrational liquidity runs can lead to disorderly trading and impact proper price discovery.

Whilst the risks described above are also present in conventional markets due to the similarity between securitization and non-native tokenization arrangements, some of these risks could be further amplified in tokenization arrangements due to the unique characteristics discussed in Chapter 3. For instance, tokenization can improve product access to investors via lower costs of asset issuance and platform onboarding, increase the velocity of transactions through programmability, and support the development of a wider variety of complex products and arrangements via composability.

(c) Finality of DLT-based token transfers: Settlement finality is a legally defined moment to provide users with confidence that their transactions cannot be revoked or unwound upon final settlement. The CPMI Tokenization Report has noted that the operational transfer of tokens on the DLT coinciding with final settlement as legally defined can be unclear depending on the technology features and design choices.[111]

Even if the financial institution overseeing the governance of the DLT network clearly defines in their rules, procedures and contracts the point at which final settlement occurs in accordance with the stipulated legal frameworks, the inherent feature of probabilistic settlement embedded in the network configurations for some permissionless networks could still result in uncertainties around the settlement status of transactions on that network.

In addition, there can also be potential uncertainties for tokenization arrangements that adopt multi-layered networks. For instance, it is not always clear whether finality of settlement can be taken to be achieved when a few blocks are added to the block containing a given transaction on the Layer 2 network chain or whether this can only be considered when that block has been included in a checkpoint on the Layer 1 network.

[110] FSB Report, *supra* n.6

[111] CPMI Tokenization Report, *supra* n.6.

Investors face significant legal risks on this front as their transactions can be reversed or subject to dispute, even if the transfers of tokens have been successfully completed on the DLT network that the tokenized financial asset is hosted on. Please refer to Boxed Example 8 below for more details.

Boxed Example 8 – Different approaches towards settlement finality

Euroclear and SDX: Both operators use a private, permissioned blockchain with deterministic transaction processing, which ensures that once a transaction is recorded on the ledger, its outcome is final and cannot be changed.

Franklin Onchain U.S. Government Money Fund: Settlement finality is achieved once a transaction is validated and recorded to the blockchain, it is considered legally and operationally final, eliminating the need for downstream reconciliation or duplication in internal systems.[112]

BlackRock USD Institutional Digital Liquidity Fund: Settlement finality is achieved when a change in ownership is synchronized with the Fund's off-chain records maintained by its transfer agent which is intended to occur on a continuous and near real time basis.

Spiko EU T-Bills Money Market Fund: The Spiko MMF tokens can be issued on various public permissionless blockchains, including Layer 1 networks (such as Ethereum) and selected Layer 2 networks, which are scaling solutions of Layer 1 networks.

From the analysis, it is observed that the Spiko MMF (and also a broader tendency among market operators) considers finality to be achieved when the block containing a given transaction is added to the Layer 2 blockchain, or, at most, after a certain number of blocks have been added to that block, but still on the Layer 2 network.

These Layer 2 transactions are then bundled and sent to Layer 1, along with a proof of their correctness. In the counterpart Layer 1 blockchain, smart contracts verify the proof received. Depending on the type of Layer 2, verification of the proof (and thus of the Layer 2 transactions) occurs instantaneously in the case of zero-knowledge rollups, or only following a dispute in optimistic rollups. If the verification fails, the block is rejected by the Layer 1 and the state transition on Layer 2 is reverted.[113]

[112] GFMA Deep Dive, *supra* n.70.

[113] For example, since it has its own consensus protocol, Polygon is typically considered a sidechain Layer 2. In Polygon, transactions are sent on Ethereum and considered final (i.e., consolidated in Polygon jargon) after the proof has been verified (see: Transaction finality - Polygon Knowledge Layer).

This issue could also be relevant for other issuers and market operators who use Layer 2 solutions.

B.2. Use of DLT-Based Infrastructure in Hosting Tokenized Financial Assets

As with all technologies, the underlying DLT-based infrastructure that hosts tokenized financial assets can also be exposed to operational vulnerabilities and risks unique to the technology itself. Such vulnerabilities and risks can broadly surface through three avenues:

(a) DLT Networks: The vulnerabilities in DLT networks can vary depending on the network type used and are exhibited via the following:

(i) **Node management:** A fundamental feature of DLT networks is that a consensus has to be reached between nodes for a transaction to be recorded on chain. Such a feature can lead to the occurrence of forking in public permissionless blockchains, where the chain is split into two, due to protocol changes or because of disagreement amongst participants on the governance of the chain. This can give rise to uncertainties around which chain is the official legal source of asset ownership, which can in turn lead to potential volatile trading of the asset or even asset loss.[114]

This feature also subjects the network to the risk of cyberattack, as malicious parties might seek to gain control of over 50% of the total consensus power of the blockchain and seek to alter transactions on the chain. Such attacks are not just restricted to public permissionless blockchains but can also impact permissioned chains.[115] This is given that nodes in permissioned chains face elevated concentration risk as the network is controlled by a defined number of parties who share the same operator vulnerabilities. Malicious parties can exploit such vulnerabilities through traditional security breaching avenues to take control of the devices that host the nodes to gain control over the entire network.

In addition, it is worth mentioning that issues with DLT infrastructure may not be immediately identifiable or identified, creating a time window of vulnerability whose effects may not be undone by off-chain business continuity and disaster recovery solutions. For instance, an off-chain payment may be completed in exchange for a tokenized security. If the transfer of the security is nullified at a later time due to a fork or other events (e.g., eclipse attacks, etc.), recovering the money of the off-chain payment may be unfeasible.

[114] BIS (2024), "Novel risks, mitigants and uncertainties with permissionless distributed ledger technologies" ("**BIS DLT Report**").

[115] HKMA (2024), "Distributed Ledger Technology in the Financial Sector: A Study on the Opportunities and Challenges" ("**HKMA 2024 Report**").

Another potential vulnerability is the exploitation of "maximal extractable value" (i.e., value that can be extracted from a blockchain transaction beyond standard fees by reordering, inserting, or censoring transactions before they are confirmed on-chain), which could negatively affect fair and orderly trading.

(ii) **Network speed and costs:** The same consensus feature can also result in public permissionless blockchains struggling to process large volumes of transactions.[116] This can cause undue delays and uncertainties around the eventual processing and settlement of transactions on the chain, which could in turn expose investors to liquidity and market risks from delayed receipt of their assets and funds.

Apart from investor risks, the payment of transaction fees for network usage on public blockchains could also expose the financial institution operating the network to various forms of risks. For instance, transaction fees can be subject to extreme volatility depending on the scale of network usage, hence resulting in significant uncertainties around operational costs projections. In addition, as transaction fee payments are made via the network's native digital asset, financial institutions are also subject to AML/CFT risks as they might have to source from and make payment using these assets to unknown individuals. Such activities can also pose regulatory risks if the digital native asset is deemed to be a regulated product and the operator is considered to be conducting regulated activities in relation to the product.

(iii) **Data:** Financial institutions operating DLT networks for tokenized financial assets can also face an inherent conundrum between data privacy and transparency.

For instance, the in-built immutability and transparency features of DLT networks, particularly for public blockchains, could cause unintended user confidentiality breaches and pose compliance issues with jurisdictional specific data requirements such as the EU's GDPR "right to forget" requirements.[117] Research has also indicated that the transparency of public chains can cause liquidity and market integrity risks where visible transaction flows can exacerbate redemption runs, with a case in point being the Terra/Luna crash.[118]

At the same time, DLT networks can enhance pseudonymity; by replacing identifying information with an

[116] Hillary J. Allen (2023), "Hearing on Next Generation Infrastructure: How Tokenization of Real-World Assets Will Facilitated Efficient Markets" ("**Allen**"), available at: https://docs.house.gov/meetings/BA/BA21/20240605/117392/HHRG-118-BA21-Wstate-AllenP-20240605.pdf.

[117] WEF Report, *supra* n.25.

[118] BIS DLT Report, *supra* n.114.

artificial identifier, which can complicate KYC checks. Besides potentially exposing financial institutions to non-compliance with AML/CFT and sanctions regulations, this can also amplify market integrity risks as a trader can easily engage in self-dealing and wash trading by quickly buying and selling the same asset from different addresses to generate fictitious volumes and temporarily inflate prices. [119]

(iv) **Interoperability:** The proliferation of DLT networks that are competing and non-interoperable can cause assets and users to be fragmented, result in liquidity being locked up across multiple networks, leading to liquidity bifurcation and fragmented trading across different venues.[120] Fragmentation also creates a need for more bilateral linkages between networks, which can give rise to heightened operational and technological risks similar to those faced in conventional markets. For instance, the use of APIs and smart contracts (which "lock up" tokenized assets) as bridges between networks can be a source of potential vulnerability which malicious actors can target for cyber-attacks.

Besides introducing additional market inefficiencies and undermining the benefits that tokenization is purported to achieve, the same risks described above can also apply if current infrastructure and DLT networks operate in a fragmented and non-interoperable manner.

At present, there has been a wide proliferation of DLT networks to support tokenized financial products and activities,[121] with financial service entities having adopted at least 72 distributed or programmable ledgers and driven 10 market forces that are accelerating the deployment of individual networks based on WEF statistics collated as May 2025. [122] The OECD also notes that the majority of entities have leveraged private permissioned DLT networks, and not all of these networks are inter-operable.[123]

In this regard, there has been growing recognition by the industry of the risks and challenges that fragmentation poses to the scaling up of tokenization initiative, with solutions emerging to address the issue.

Please refer to Boxed Example 9 and Boxed Example 10 below for more details.

[119] Le Pennec et al.(2021) "Wash trading at cryptocurrency exchanges", available at: https://www.sciencedirect.com/science/article/abs/pii/S1544612321000635.

[120] IMF 2025 Report, *supra* n.6.

[121] WEF Report, *supra* n.25.

[122] WEF Report, *supra* n.25.

[123] OECD 2025 Report, *supra* n.17.

Boxed Example 9 – Interoperability between traditional and DLT infrastructure

AIIB bond issued on Euroclear: The D-SI is part of the D-FMI initiative connected to the traditional securities settlement system of Euroclear Bank for settlement of transactions conducted OTC or on trading venues, granting investors full access to trading venues and liquidity management facilities. The AIIB bond as DNN is listed on the Luxembourg Stock Exchange and is admitted to trading on the regulated market of Luxembourg Stock Exchange.

The DNNs are cleared and settled through the D-FMI. The DNNs are immobilized in the Securities Wallet of Euroclear in its capacity as central securities depository. The bonds are then held by Euroclear for investors holding and transferring interests in the DNNs through the securities clearance accounts of direct participants in the conventional non-D-FMI component of the Euroclear System.

Clearing is also possible on the Hong Kong Monetary Authority's Central Moneymarkets Unit (**CMU**) and SIX Swiss Exchange which have an account at Euroclear Bank as investor CSDs. Leveraging traditional CSD links, CMU and SIX are able to make the DNNs available at their securities settlement system without the need to interact with the D-FMI.

Boxed Example 10 – Interoperability between DLT infrastructures

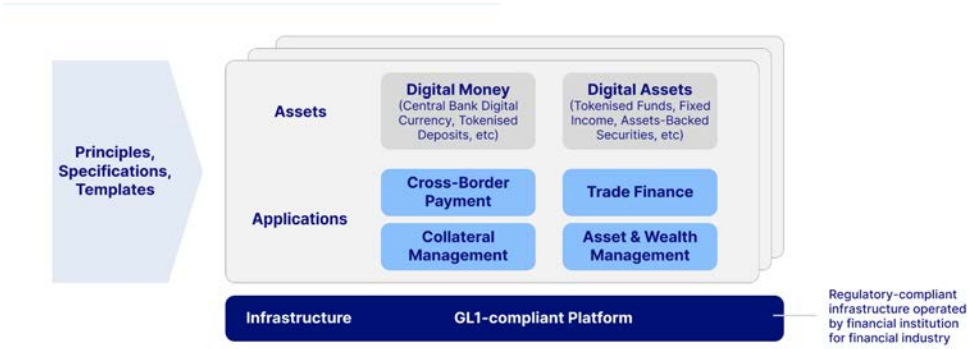
Canton network: The Canton network is designed as a "network of networks" for smart contract applications. With Canton, the entire ledger for a network of applications is not replicated across parties on the network and thus not publicly available. Instead, each user of an application maintains a ledger of only the data it is permissioned to see by that application. The Canton protocol ensures that this data is valid and current. As a result, everyone works from a unified ledger without being in possession of the entire ledger. Instead, each user is only in possession of their portion of the ledger.

This is useful in financial workflows, where a unified ledger can eliminate costly reconciliation but where user application data nonetheless needs to be private. Canton enables the synchronization of data and transactions across independently operated applications and synchronizers, while implementing privacy and control capabilities.

Canton is being used by financial institutions to reduce issuance time of securities, reduce settlement risk, and increase efficiency. One example is the processing of over $1.5 trillion of repo transactions per month.[124]

Global Layer One: Global Layer One (GL1) is a collaborative initiative[125] between the public and private sectors to foster the development of open, interoperable, shared ledger infrastructures for hosting tokenized financial assets and applications.

Given the complexity of global markets, no single infrastructure could realistically serve the financial industry's diverse needs. Therefore, GL1 focuses on building an ecosystem of compatible platforms. In collaboration with policymakers and financial institutions across jurisdictions, GL1 aims to develop common principles, specifications and templates for platforms, to enable interoperability between platforms and the seamless flow of tokenized assets across networks (see diagram below).

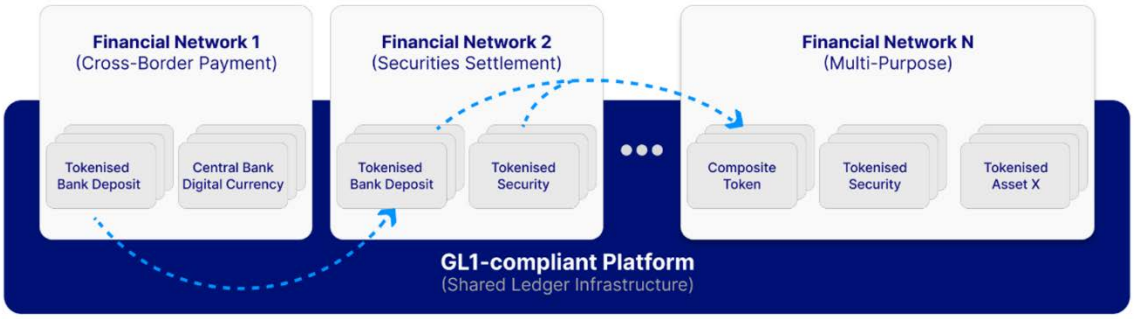


GL1 will provision core functionality and common libraries that can be leveraged upon by the financial industry, such as: (i) GL1's Programmable Compliance Toolkit, which provides a framework for automated compliance checks and the enforcement of policy and regulatory requirements, such as capital flow management and anti-money laundering measures, in real-time; (ii) GL1's Market Infrastructure Toolkit, which provides a framework for financial institutions and market infrastructure providers to validate their services against internationally recognised principles and regulatory requirements.

Platforms that meet these specific data and operational standards will be designated as GL1 compliant. As can be seen in the diagram below, multi-asset and multi-currency transactions could be executed between different financial networks on platforms designated as GL1-compliant, with new applications also being able to be composed by building upon applications originating from multiple financial networks.

[124] Manoj Ramia (2024), "Canton Coin: A Responsible Approach to Digital Tokens".

[125] Further details on the initiative can be found on the GL1 website at the following link: https://global-layer-one.org/.



(b) Smart contracts: Smart contracts are an important part of tokenization arrangements to enable programmability and automation, but their use also comes with risks.

Firstly, inadequately designed smart contracts or errors in the coding process can result in missing essential functionalities or performance issues that might result in transactions not executing as intended. Due to the speed of execution brought about by programmability, existing operational and market risks can be amplified if such deficiencies and errors remain undiscovered upon smart contract deployment, with this not being easily rectified particularly for public permissionless blockchains.

Secondly, bugs and loopholes in the smart contract code deployed on public blockchains can also make them susceptible to exploitation by malicious actors. As the functioning of some smart contracts place reliance on information outside the chain, such as external price feeds, through the involvement of service providers known as oracles, this creates exposure to a single point of failure or corruption where the oracles can be subject to manipulation, fraud or control by unknown parties who are not subject to third-party audit or evaluation.[126]

Thirdly, there can also be variations across jurisdictions in the legal status of smart contracts that are written in code. This creates uncertainties around the enforcement of such contracts once executed, posing risks to the legal rights of investors that place reliance on such contracts.[127]

(c) Tokens: As highlighted in Chapter 3, the custody of tokenized financial assets deployed on DLT networks is conceptually and operationally different from that of conventional markets, as tokens stored on-chain can be transferred only through private keys. In

[126] HKMA 2024 Report.

[127] DTCC, Clearstream, Euroclear (2024), Building the Digital Asset Securities Ecosystem, Digital Asset Control Principles: A Framework for Adoption.

turn, these private keys are stored in digital wallets.

Tokenized asset custodians are responsible for the safeguarding of these private keys, with such activities giving rise to different manners in which risks can manifest. For instance, investors holdings can be compromised through a variety of situations including through fraud or theft where malicious actors exploit security vulnerabilities to gain control over the private keys, or due to the loss or destruction of private keys arising from human oversight, hardware failure or inadequate back-up systems.

That being said, the impact of the loss of private keys in the context of tokenized financial assets might not always be as severe as compared to crypto assets where such loss typically signifies a loss in the asset given the bearer nature of the crypto token. This is given that most tokenized financial assets are issued in registered form where the official legal source of ownership of the asset is recorded via a register instead of through mere bearing of a token. Nevertheless, loss of private keys still poses significant operational disruption and can result in a loss of confidence from investors as they will not be able to gain access or initiate transactions in relation to their asset whilst recovery measures are being initiated, which could take some time.

B.3. Settlement Assets on DLT-Based Infrastructure

There has been overwhelming consensus in the literature and from industry engagement feedback that without the availability of reliable on-chain settlement assets,[128] the scaling of tokenized assets will be challenging as simultaneous and seamless DvP cannot be conducted at the post-trade stage of tokenized transactions. Significant risks are also posed to investors if this increases their exposure to less reliable payment mediums as compared to conventional transactions.

At present, options for on-chain settlement assets are still in development. Whilst central bank money would serve as an ideal riskless settlement asset,[129] a scaled roll-out of wholesale central bank digital currencies would require central banks to address the operational considerations around the mode of such a roll-out, as well as the broader governance and policy questions around its provision.[130]

Although tokenized deposits could serve as a viable alternative similar to how commercial bank money is currently used in conventional payment systems and financial market infrastructure, there are challenges that come with their use. For instance, there is a high likelihood of market fragmentation where every bank seeks to launch on different private chains with their own bespoke

[128] WEF Report, *supra* n.25.

[129] According to the CPMI/IOSCO Principles for Financial Markets Infrastructures (PFMIs) a financial market infrastructure (FMI) should conduct its money settlements in central bank money, where practical and available, and if central bank money is not used, an FMI should use a settlement asset with little or no credit or liquidity risk, such as commercial bank money.

[130] OECD 2021 Report, *supra* n.6; CPMI Tokenization Report, *supra* n.6.

standards[131] given the lack of interoperability and common standards in the space, leading to significant operational risks as described in Section 4B.2.

Thus far, it appears that stablecoins have gained the most momentum in the market as a potential on-chain settlement asset. However, they can expose investors to additional risks as compared to conventional settlement processes. For instance, the OECD has noted that stablecoin transactions are private initiatives which might lack proper audit and assurance over the availability of funds.[132] Amongst other issues, the BIS has also pointed out that stablecoins are not being settled in central bank monies, and investors can be exposed to price fluctuations given their availability for trading.[133] Where such risks are not properly managed, these could expose investors to significant counterparty and market risks, which are potentially exacerbated through concentration exposure to a single or few stablecoin issuers due to network effects. The CPMI and IOSCO have jointly issued guidance on the application of the Principles for Financial Market Infrastructures (PFMI) to systemically important stablecoin arrangements. Under this guidance, stablecoins used as alternative settlement assets in financial market infrastructures should also fulfil the key considerations of Principle 9 on cash settlement.

Whilst use-cases have emerged where off-chain payment rails are connected and used to settle against on-chain tokenized assets, it has been observed that this creates additional operational complexities and risks to the process and introduces frictions that negates some of the intended purported efficiencies from adopting tokenization.

C. Additional Issues that Could Arise as Tokenization Scales

To ensure a holistic discussion of the issues and risk implications from tokenization, this sub-section sets out a high-level discussion of the additional issues noted from IOSCO's analysis work that could bear further monitoring.

The majority of these issues have been surfaced from the review of the relevant literature and relate to broader potential changes in market activities and structure which could potentially materialize more saliently with a wider-scale shift towards adoption of tokenized financial assets and DLT-based infrastructure. It is worth noting that such materialization and the eventual form that it would take might not be as what is being discussed, given that the scale and trajectory of tokenization adoption is still evolving and highly uncertain.

C.1. Changes in Market Activities

Tokenization could bring about changes to how current market activities are conducted, which may in turn give rise to changing forms

[131] Zennon Kapron (2025), "Tokenized Deposits vs Stablecoins: The Quiet War for Cross-Border Money," *Forbes*.

[132] OECD 2021 Report, *supra* n.6; CPMI Tokenization Report, *supra* n.6.

[133] CPMI Tokenization Report, *supra* n.6.

of risk. Two examples of such activities are highlighted below:

(a) Trading: The trading of financial assets has typically taken place through centralized exchanges which facilitate the matching of orders between buyers and sellers. However, the hosting of both assets and investors on a common DLT network with programmable features can give rise to different manners in which trading activities with respect to tokenized financial assets can be conducted.

One such example is the automated market maker (**AMM**) model, which has its origins in crypto-asset trading but could also facilitate the trading of tokenized assets. Under such a model, liquidity pools are formed where liquidity providers contribute assets to the pool, which are in turn used as liquidity for trades with traders. Instead of trading bilaterally, traders trade against the pool where the price of assets is determined using a stipulated formula based on demand and supply.

The purported benefits that are not present in conventional trading models and that AMMs seeks to bring about include: liquidity provision in a disintermediated environment, where AMMs can ensure liquidity is always available to traders given the formation of a liquidity pool; and counterparty risk reduction, as trading is carried out against the liquidity pool eliminating the need for trust between buyers and sellers. However, this comes with its attendant trade-offs and risks which can manifest in a different form from conventional trading models where a study conducted by the Bank of Canada and the Ontario Securities Commission has shown that AMM models can cause investor harm and comprise market integrity through unique and complex channels.[134]

Whilst the adoption of AMM models for trading activities has yet to be widely observed in current tokenization initiatives, their development could warrant further monitoring where there might be merits to evaluate if the risks are adequately addressed through existing regulatory frameworks if such models are observed to be adopted at scale.

(b) Clearing and Settlement: Although atomic or near instantaneous settlement can currently be achieved with current infrastructure, tokenization could potentially enable this process at a lower cost hence changing how clearing and settlement activities are being conducted.

Whilst some of the purported benefits of doing so could include decreased settlement risks and reduced intermediation which could in turn reduce costs, the CPMI Tokenization Report has also noted that it can also inadvertently make liquidity management more complex due to the need for the pre-positioning of assets and the elimination of netting arrangements, [135] hence

[134] Bank of Canada, Ontario Securities Commission (2024), "The Ecology of Automated Market Makers, Staff Discussion Paper 2024-12".

[135] CPMI Tokenization Report, *supra* n.6.

amplifying liquidity and operational related risks.

From the analysis,[136] it does not appear that tokenization would lead to a substantive increase in adoption of atomic or instantaneous settlement at this juncture. Instead, this is still likely to be subject to considerations that might evolve over time as the tokenization landscape is still developing and could depend on factors including whether tokenization arrangements evolve to address current limitations in the pre-position of assets and netting of assets[137] and/or whether there are certain asset classes or activities that could benefit from the increased programmability and velocity features that tokenization arrangements bring (e.g. short term or intra-day collateral and repo transactions).

Adoption could scale if participants assess the benefits brought about from atomic or instantaneous settlement, such as the increased availability of assets and funds due to faster transaction velocity, outweighs the liquidity and operational challenges and could likewise be an area of monitoring to evaluate the risks and implications from such a scaling up.

C.2. Changes in Market Structure

Tokenization could also bring about broader-based changes in current market structure as follows:

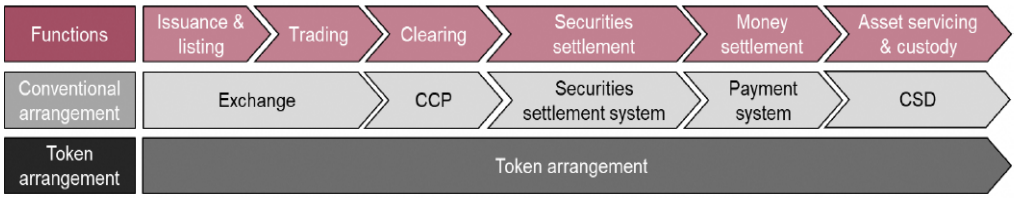
(a) Integration of Existing Functions: The hosting of both assets and investors on a common DLT network could also make the collapsing of segregated and distinct capital markets functions into a continuous arrangement more operationally feasible (see diagram extracted from the CPMI Tokenization Report).[138]

[136] For instance, the analysis of SDX shows that market participants prefer to transact on traditional infrastructure for various reasons (e.g. network effects, liquidity availability) instead of through leveraging on the atomic settlement features made available through trading on DLT based infrastructure.

[137] For instance, this could include whether it would be possible for settlement assets to be made available only at point of trade execution or for settlement assets to earn yield up till the point of execution to offset the costs of pre-positioning via programmability features.

[138] CPMI Tokenization Report, *supra* n.6.

Figure 1. Financial market functions and conceivable arrangements[6]



CCP = central counterparty; CSD = central securities depository.
Source: Adapted from BIS, SIX and SNB (2020) and GFMA (2023).

On the one hand, doing so could result in changes to the current market structure and the role of existing market intermediaries, hence reaping efficiency gains. On the other hand, these changes could also potentially give rise to unmanageable conflicts of interests when inherent controls in place through segregation are removed, such as when actors trade on their own account and settle their own transactions as well as transactions of other participants. [139] Concentration and competition risks can also be significantly exacerbated where investors are exposed to singular entities for the conduct of activities across the entire value chain.

(b) Introduction of New Roles: Tokenization could also give rise to new intermediaries and roles to support the asset lifecycle process.[140]

The OECD has noted that it can be difficult to ascertain with certainty whether such intermediaries are currently captured within the regulatory perimeter given the novel nature of these roles and the processes.[141] If not captured, it bears consideration on whether existing regulatory frameworks will have to be expanded to capture such intermediaries given the nature of the risks involved.

Gaps in regulatory treatment could give rise to regulatory arbitrage within and across jurisdictions and expose investors to the risks of forgoing protection under the regulatory frameworks for dealing with non-regulated entities. In this regard, some jurisdictions have expanded their regulatory perimeter to capture new intermediaries that provide DLT-related services for tokenized financial assets[142] amongst other additional regulatory measures taken, some of which are discussed in Chapter 5.

(c) Increased Financialization and Investor Access: The composability features of tokenization could lead to an increased financialization of assets, [143] whilst also

[139] IOSCO (2023), "Policy Recommendations for Crypto and Digital Asset Markets: Final Report".

[140] See section 5.3 of WEF Report, *supra* n.25.

[141] OECD 2021 Report, *supra* n.6.

[142] *Ibid*.

[143] Allen, *supra* n.116.

resulting in the creation of more complex financial products that can be less transparent or easily understood (see discussion in section 4B.1).

At the same time, the increased digitalization of financial services from tokenization can enable retail investors to conduct self-directed trading of tokenized financial assets on DLT-based networks without needing to go through an intermediary, similar to the crypto-asset markets. The IMF has observed that this could exacerbate retail investor internalities, where such investors are more likely to insufficiently diversify idiosyncratic risks from their portfolios when making trading decisions, as they will be less incentivized to seek the advice of qualified intermediaries given the additional search effort and costs involved.[144]

This combination of factors could lead to amplified investor protection risks compared to conventional markets, as investors will be more exposed to engage in excessive risk-taking activities given enhanced access to trading in markets without advice and coupled with the increased variety of and complexity of financial products available that lack transparency or are not easily understood.

C.3. Increased Dependencies and Interconnectedness

Lastly, the hosting of both assets and investors on common DLT networks will also increase dependencies and interconnectedness between stakeholders, leading to amplification of risks currently faced in the conventional markets.

(a) Third party dependencies: As the use of DLT leverages on specialized infrastructure and intermediaries for service delivery, this could subject financial market participants to higher operational risks given their exposure to a smaller group of service providers. Where public chains are used, operational risks are concentrated in the market participant itself as there will not be a contractual third party available to place reliance on, and alternative solutions might not be viable in the event of infrastructure down times or disruptions.[145]

(b) Financial market interconnectedness: The literature has also noted that tokenization characteristics such as programmability and composability could also give rise to greater interconnectedness between financial market participants which exacerbate transmission channels for market related shocks,[146] which can harm investors and compromise market integrity.

Tokenization could also lead to closer inter-linkages with the crypto market. Early signs of these were observed, with tokenized financial assets such as MMFs increasingly being used as stablecoin reserve assets or collateral for crypto-related transactions. This could eventually

[144] IMF 2025 Report, *supra* n.6.

[145] FSB Report, *supra* n.6; IMF 2025 Report, *supra* n.6.

[146] FSB Report, *supra* n.6; IMF 2025 Report, *supra* n.6.

lead to the transmission of crypto-related volatilities and shocks to conventional financial assets and markets.

D. Summary

Based on the analysis above, it is observed that the risks may evolve for financial institutions that elect to adopt and transition from their current systems and infrastructure to the use of new technologies such as DLT.

This transition is likely to take place at a more evolutionary, instead of revolutionary, pace as the process of integration might take some time. In the meantime, both existing and new infrastructures are likely to continue to co-exist for the foreseeable future, and as the transition progresses and asset tokenization scales up, risks will continue to evolve.

5. Steps that Authorities have Taken to Manage Risks and Regulatory Concerns

IOSCO surveyed its Members on regulatory responses to the tokenization of capital markets products in their jurisdictions. This section provides an overview of existing and proposed responses of surveyed IOSCO Members.[147] Although this section highlights those responses, it does not endorse any particular approach or make policy recommendations.

Most Members surveyed indicated that they applied existing regulatory frameworks to tokenized capital markets products and their associated activities. This is because most Members generally sought to adopt a technology-neutral approach, where the focus is on examining the underlying economic substance of the product offered, rather than evaluating the specific technology or manner used to issue or represent the product. As outlined in Chapter 3, empirical observations suggest that tokenization, in its current stage of development, has not substantially changed the nature of the products offered nor the associated activities conducted at this juncture.

Some Members reported that they have also taken initiatives and steps to complement their existing regulatory frameworks. For example, these include developing:

(a) Specific guidance to clarify existing regulatory frameworks;

(b) Sandbox regimes; and

(c) New or amended laws and regulations.

A.1. Specific Guidance

Although tokenized capital markets products and their associated activities fall within the regulatory perimeter of existing regulatory frameworks, some Members have issued guidance to either:

(a) Clarify the application of existing regulatory frameworks to tokenized capital markets products, or

(b) Address how the risks arising from tokenized capital markets products can be mitigated for the purposes of meeting regulatory obligations under existing frameworks.

A.2. Sandbox Regimes

Some Members have adopted sandbox regimes to facilitate the development of DLT-based capital market activities while creating a pathway to full regulatory compliance. This allows regulators to better understand whether existing regulatory requirements

[147] Further details of the survey findings can be found in the Annex.

remain relevant, or whether changes are needed to address any legal and regulatory gaps.

In this regard, Members may develop a temporary regulatory framework to allow sandbox entities to experiment with tokenized financial products within a limited scope such as the following:

(a) Controlled environment: This typically means there are defined to the scale of the sandbox entity's activities (e.g. caps on the number of users and transaction volumes of the sandbox entity). This may also include a time-bound limit to the sandbox experimentation.

(b) Limited period: Sandbox entities may be required to meet regulators at defined points during the sandbox duration to review the progress of the sandbox entity's experimentation as well as its ability to comply with regulatory requirements.

A.3. New or Amended Laws and Regulations

Some Members indicated that they had implemented or considered implementing new laws and regulations, in addition to existing regulatory frameworks, that are applicable to tokenized capital markets products and their associated activities.

Members indicated a number of reasons for issuing new laws and regulation:

(a) To remove impediments or provide clarity on the regulatory treatment of tokenized capital markets products;

(b) To scope in and/or include a definition of tokenized capital markets products;

(c) To scope in participants and activities involving tokenized capital markets products; and

(d) To address risks arising from tokenized capital markets products and their associated activities.

Some Members have also adopted hybrid approaches by combining complementary measures from the different approaches. For example, some jurisdictions have issued new laws to establish a certain legal basis for tokenized capital market products while also implementing a sandbox regime to facilitate the development of DLT-based financial market infrastructure.

Overall, the measures that some Members have undertaken beyond their existing regulatory frameworks in response to tokenization are consistent with the findings in Chapter 4 on the risks and issues arising from tokenization. In particular, the purported intent for such additional measures has primarily been to address risks and issues particular to the use of DLT and tokenization which have already manifested, namely those relating to the legal recognition and/or structuring of tokenized financial assets using DLT, and/or operational issues in relation to use of DLT based infrastructure.

Please refer to Appendix B for examples of the steps mentioned in this section.

6. Conclusion

A. State of Development

A.1. Adoption of Tokenization

This Report observes how tokenization of financial assets continues to grow steadily. Several tokenized products have been issued in select jurisdictions, in compliance with regulatory frameworks and with increasing investment amounts.

A growing body of financial institutions is becoming familiar with the use of DLT for tokenization. These institutions have served in various capacities – as issuers, intermediaries and investors in tokenized financial assets.

At present, tokenization arrangements remain a small part of the financial sector. While there is some evidence of broader investor access, many of the promised benefits — particularly concerning secondary market liquidity — appear not to be fully achieved for now.

A.2. Tokenization Across Lifecycle Activities

The impact of tokenization on lifecycle activities varies depending on the implementation model and the degree of integration with DLT, as follows:

(a) While creation and issuance processes of digital tokens to represent financial assets have evolved, the impact of tokenization on distribution and secondary trading activities has been limited and largely continues to rely on conventional financial infrastructure and intermediaries, due to accessibility and liquidity concerns regarding DLT platforms.

(b) In clearing and settlement activities, while DLT-based settlement infrastructure enables faster settlement times, it appears that market participants continue to favor the use of traditional settlement infrastructure. This is possibly due to a variety of factors, such as the lack of familiarity with the use of DLT-based infrastructure, vulnerabilities that may stem from the digital nature (operational or cyber) or the operation of network effects present in traditional infrastructure.

(c) In asset servicing activities, the FTF observed implementation of digital custody and improvement in collateral mobility (e.g., intraday repo transactions)

A.3. Tokenization of Money Market Funds

MMFs are typically tokenized at the fund level, with tokens issued on blockchains representing ownership of fund shares or units, while the fund's assets are managed in the same manner as conventional funds.

Depending on the specific case, the blockchain records may serve as proof of ownership or merely as a back-up record. Issuers and transfer agents typically have the ability to correct blockchain records where needed, such as in the case of fraud.

While tokenized MMFs may be issued on public blockchains, secondary trading of

tokenized MMFs is limited and restricted to whitelisted investors. For transaction settlement, the use of Layer 2 solutions may improve efficiency but also create ambiguity for settlement finality.

A.4. Tokenization of Bonds

Tokenized bonds are typically issued directly on the blockchain, with the tokens issued on blockchains representing ownership of the bonds. Tokenization operators appear to have taken steps to provide greater assurance of settlement finality, such as through the involvement of regulated CSDs.

Nonetheless, the trading and post-trade activities of tokenized bonds are also integrated with traditional exchanges and clearing houses to provide investors with the option to use traditional financial infrastructure. In practice, investors continue to exhibit a preference for the traditional financial infrastructure.

A.5. Interlinkages with Traditional Finance

In line with the findings of other international organizations, such as the FSB, this Report identifies early signs of inter-linkages between the crypto asset sector and the traditional finance sector.

Particularly, tokenized MMFs are increasingly being used as reserve assets in "stablecoins" or as collateral for crypto-related transactions.

A.6. Structural Challenges

The key structural challenges faced in scaling up of tokenization are the lack of interoperability across blockchains and the lack of high-quality settlement assets.

There are ongoing experiments aimed at addressing these challenges. For example, Project Agora and Global Layer One seek to build shared ledger infrastructure upon which financial institutions can develop their tokenization applications; Project Helvetia and SGD Testnet allow settlement of tokenization transactions with wholesale central bank digital currency. These experiments were beyond the scope of this review.

B. Regulatory Considerations

The analysis found that the economic substance and risks from financial assets created through tokenization are similar to conventional financial assets (chiefly legal, operational and technology risks, and to a lesser extent, credit and liquidity risks), although risks could manifest differently due to their different structures. Tokenization may also result in the manifestation of vulnerabilities and risks that are unique to the technology itself.

With this in mind, members studied generally applied existing regulatory frameworks, with some complementing existing frameworks by taking additional measures to address risks arising from the commercial application of tokenization.

In accordance with the principle of "same activities, same risks, same regulatory outcomes", members may consider the applicability of IOSCO's Objectives and Principles for Securities Regulation and relevant supporting IOSCO standards, recommendations, and good practices, as appropriate, to tokenized financial assets and tokenization arrangements, taking into consideration their domestic contexts.

For example, given that **IOSCO's Recommendations for Crypto and Digital Asset Markets** were developed in the context of the use of blockchain technology and address the specific investor protection and market integrity risks arising from its use, members may consider their applicability in the context of tokenized financial assets.

Furthermore, while the analysis showed that relevant regulatory authorities continued to be able to identify responsible persons for the various roles in the value chain and to impose the necessary regulatory requirements, members may consider **IOSCO's Recommendations for Decentralized Finance** in identifying the persons and entities who are responsible for the regulated activities in the tokenization value chain.

7. Appendix

A. Terminology

As noted in the Report, this is a list of working definitions for common terminology. The definitions are not intended to be comprehensive or exhaustive – indeed, it is acknowledged that given the present state of tokenization, it is difficult to definitively settle on a singular, universally accepted definition. For the purpose of this Report, it is more important to understand the key concepts rather than a set of strictly defined terms.

In relation to the type of tokens issued as part of a tokenization arrangement:

(a) **"Native tokens**" refer to tokens that are issued solely on the distributed ledger on-chain. [148]

(b) "**Non-native tokens**" or "**digital twins**" refer to tokens that are issued on the distribution ledger and are digital representations of physical assets or existing assets that were originally issued off-chain.

In relation to the type of blockchains used for tokenization:

(a) "**Programmable platforms**" refer to technologies that allow eligible participants to develop and execute applications that update a common ledger. Blockchains are one example.

(b) "**Private blockchains**" refer to blockchains which restrict access to authorized participants and are typically governed by rules agreed by, and that apply to, all users.

(c) "**Public blockchains**" refer to blockchains where data are openly accessible and readable by the public, and which can be further categorized as either "permissioned" or "permissionless".

  (i) "**Public permissioned blockchains**" refer to public blockchains with certain permissions and controls in place that can vary by design (e.g., authentication is used to restrict writing and validation privileges to pre-determined users only).

  (ii) "**Public permissionless blockchains**" refer to public blockchains with no other permissions and controls in place (e.g. anyone can participate in the consensus process).

In relation to the type of technological layers involved in tokenization:

[148] In the context of tokenization arrangements, "native tokens" should be distinguished from other blockchain-native tokens that are not issued as part of a tokenization arrangement, such as ETH or BTC.

(a) "**Access layer**" or "**application layer**" refers to the layer that governs how end users and applications interact with the blockchain. This layer includes wallets, API gateways, and user interfaces.

(b) "**Service layer**" or "**smart contract layer**" refers to the layer where on-chain logic is executed, enabling additional functionalities such as identity verification, compliance checks and transaction processing through smart contracts. "**Smart contract**" refers to a collection of code and data (sometimes referred to as functions and state) that is deployed using cryptographically signed transactions on the blockchain network. The smart contract is executed by nodes within the blockchain network; all nodes must derive the same results for the execution, and the results of execution are recorded on the blockchain.

(c) "**Asset layer**" or "**token layer**" refers to the layer where the digital tokens that represent real world or native digital assets are created and managed.

(d) "**Platform layer**" or "**settlement layer**" refers to the layer responsible for maintaining the blockchain's consensus state (e.g., recording transactions, storing account balances and enabling interaction between participants and smart contracts), which include:

    (i) "**Layer 1**" or "**foundation layer**", which forms the foundation of the distributed ledger network, providing the core protocols, consensus mechanisms, and network architecture enabling the creation and maintenance of the distribution ledger.

    (ii) "**Layer 2 solutions**", which operate on top of Layer 1 and aim to address scalability and efficiency issues by enabling off-chain or parallel transaction processing, with final settlement anchored to the underlying Layer 1 blockchain.

B. Examples of Steps Taken by Authorities

Specific Guidance

Below are some examples that illustrate how various jurisdictions have issued guidance to address the application of existing regulatory frameworks and risks arising from tokenized capital markets products:

(a) **Hong Kong:**

(i) On 2 November 2023, the SFC issued its Circular on intermediaries engaging in tokenized securities-related activities ("Tokenized Securities Circular").[149] The Tokenized Securities Circular reaffirmed the position that the existing legal and regulatory requirements governing the traditional securities markets will continue to apply.

(ii) The SFC also highlighted certain new risks to be managed that are not typically associated with traditional securities, including: (i) how ownership interest relating to tokenized securities is transferred and recorded; and (ii) technology risk in activities involving tokenization.

(iii) For custodial arrangements, intermediaries should take into account certain additional features and risks in deciding on the appropriate custodial arrangements.

(iv) On 2 November 2023, the SFC also issued its Circular on tokenization of SFC-authorized investment products ("Tokenized Products Circular").[150] The Tokenized Products Circular set out the requirements under which the SFC would consider allowing tokenization of investment products authorised by the SFC under Part IV of the Securities and Futures Ordinance for offering to the public in Hong Kong.

(b) **Canada:**

(i) CSA Staff Notice 46-308, "Securities Law Implications for Offering of Tokens", was issued by Canadian regulatory authorities in 2018, in response to inquiries on the applicability of securities laws to offerings of tokens.[151] The Notice provides guidance that the offering of tokens may involve the distribution of securities, because the offering involves the

[149] *Tokenised Securities Circular*, available at: https://apps.sfc.hk/edistributionWeb/gateway/EN/circular/doc?refNo=23EC52.

[150] *Tokenised Products Circular*, available at: https://apps.sfc.hk/edistributionWeb/gateway/EN/circular/doc?refNo=23EC53.

[151] *CSA Staff Notice 46-308 "Securities Law Implications for Offering of Tokens"*, available at: https://www.osc.ca/en/securities-law/instruments-rules-policies/4/46-308/csa-staff-notice-46-308-securities-law-implications-offerings-tokens.

distribution of an investment contract, and/or the offering and/or the tokens issued are securities. The Notice emphasizes that businesses and their professional advisors should assess the economic realities of the offering as a whole, with a focus on substance over form.

(ii) The Notice also clarifies that the distribution of tokens that involve the distribution of securities would be subject to relevant prospectus requirements and persons dealing in such tokens would be subject to relevant dealer registration requirements under securities laws.

Sandbox Regimes

Below are examples of how various jurisdictions have employed sandbox regimes to achieve different regulatory objectives:

(a) **European Union:**

(i) The DLT Pilot Regime entered into force in June 2022 and opened for applications in March 2023.[152] It was developed in response to perceived and actual regulatory barriers in the context of digital securities infrastructure.[153]

(ii) The DLT Pilot Regime is structured as an EU-wide regulatory framework that allows certain market infrastructure providers to apply for greater regulatory flexibility. It aims to enable regulated institutions to develop DLT-based infrastructure for the trading and settlement of securities.

(iii) Eligible applicants (broadly authorized investment firms, market operators and CSDs) may apply for exemptions from certain requirements under EU financial services regulations that are specifically identified in the DLT Pilot Regime, where those requirements are incompatible with the proposed use-case. Unauthorized firms can apply for temporary authorizations alongside their applications to the DLT Pilot Regime.

(b) **Singapore:**

(i) The Fintech Regulatory Sandbox was launched by MAS in 2016 to facilitate live experimentation with innovative financial products or services in a live but controlled environment. Under this regime, the sandbox is open to any entity that is looking to apply

[152] EU DLT Pilot Regime, available at: https://www.esma.europa.eu/esmas-activities/digital-finance-and-innovation/dlt-pilot-regime.

[153] For example, the requirement under the Central Securities Depositories Regulation (EU) No 909/2014 ("CSDR") that a transferable security that is traded on a trading venue must be cleared at a CSD and the general restriction that a CSD may not also be a trading venue.

technology, including but not limited to tokenization, in an innovative way to provide new financial services and products that are regulated by MAS.[154]

(ii) Importantly, the sandbox allows MAS to provide clarity to sandbox entities on how existing rules and regulations would be applied to the proposed financial services and products being tested.[155]

(iii) A sandbox entity that succeeds in its experimentation and is able to fully comply with the relevant legal and regulatory requirements would be able to deploy its services on a broader scale. Conversely, the sandbox will be discontinued if the sandbox entity is unable to fully comply with the relevant requirements at the end of the sandbox period.

(c) **United Kingdom:**

(i) The Digital Securities Sandbox (DSS) is the UK's first Financial Market Infrastructure (FMI) sandbox and will facilitate the use of developing technology such as DLT in the trading and settlement of traditional securities.[156] The applicant would need to be applying to operate a trading venue and/or carry out central securities depositary activities (i.e., notary, maintenance or settlement).

(ii) It does so by allowing participating firms to operate under a temporarily modified legislative and regulatory framework. This includes a relaxation of certain regulatory requirements, but also strict limits on trading volumes. Where legislation is unchanged, participating entities will need to meet the same regulatory requirements as currently in place

(iii) Although the DSS is by its nature a temporary regime (limited to five years), it is the shared intention of the regulators and HMT that a smooth transition should be available for successful sandbox entrants into any new permanent regime introduced when the DSS closes.

New or Amended Laws and Regulations

Below are examples of how jurisdictions have issued new laws and regulations:

[154] MAS Fintech Regulatory Sandbox, available at: https://www.mas.gov.sg/development/fintech/regulatory-sandbox.

[155] For example, in relation to a sandbox entity that was experimenting with an Automated Market Maker (AMM) business model to facilitate the exchange of tokenized capital market products, the sandbox allowed the relevant supervisory teams to understand the nature and risks of the AMM, in order to determine that MAS' markets regime was best suited to addressing the risks that arose from such a model; and to assess that the AMM manifested certain risks (e.g. market integrity risks) differently from traditional financial markets. The DSS therefore clarified the kinds tools the entity was expected to have in place to mitigate risks in order meet regulatory requirements to which traditional financial markets were also subject.

[156] Digital Securities Sandbox, available at: https://www.fca.org.uk/firms/innovation/digital-securities-sandbox.

(a) **Germany:**

(i) The German Act on Electronic Securities in 2021 introduced the category of "electronic securities" and, amongst others, allows for the issuance of bearer bonds, registered shares and fund units on DLT.[157] A key principle of the new law is to give the owners of electronic securities the same comprehensive protection as owners of physical securities, especially in cases of insolvency and foreclosure.

(ii) The Act also established a regime for registrars for electronic securities entered into a DLT-based register. A financial service license requirement to act as the registrar was introduced. As a consequence, the security registrar is subject to the existing prudential supervision.

(b) **Japan:**

(i) Following amendments to the Financial Instruments Exchange Act (FIEA) in 2020, security tokens (which represent shares, bonds or fund interests in tokens) are deemed to be securities under the FIEA.[158] The existing legal and regulatory requirements governing the traditional securities markets will continue to apply.

(c) **Italy:**

(i) The Fintech Decree (Decree n. 25/2023), which was issued in March 2023, introduced into Italian law a new regime for the issuance and circulation of financial instruments, an alternative to the existing ones. The new regime applies to financial instruments issued through distributed ledger technologies, so-called "digital financial instruments".

(ii) The Fintech Decree establishes that the issuer's verification of entitlement to exercise the rights associated with digital financial instruments is performed on the basis of the entries in the register.

(iii) Digital financial instruments must be registered on a DLT market infrastructure pursuant to the EU DLT Pilot Regime if they are intended for trading on a trading venue provided for by EU Directive 65/2014. For digital financial instruments not registered on a DLT market infrastructure, the Fintech Decree provides that the issuance must take place on a distributed ledger held by a "Registry Manager".

(iv) The "Registry Manager" is a legal entity subject to supervision that is responsible for ensuring the integrity and security of the system and that can carry out its activity only

[157] German Act on Electronic Securities, available at: https://www.bafin.de/SharedDocs/Veroeffentlichungen/EN/Fachartikel/2021/fa_bj_2107_eWpG_en.html.

[158] FIEA, available at: https://www.fsa.go.jp/en/laws_regulations/index.html.

after having obtained registration in a public register from CONSOB (the Italian Securities and Markets Authority).

(v) Obtaining this registration is subject to verification by CONSOB of compliance with a series of requirements (including on the characteristics of the distributed ledger used) established by the Fintech Decree.

(d) **Spain:**

(i) The Securities Markets and Investment Services Act, which was issued in 2023, replaced the existing law governing Spanish securities markets and investment services to adapt the legal framework to consider new technological and economic realities, such as digitization.

(ii) In particular, the Act introduces a legal regime for securities represented or registered through DLT systems and allows for the issuance, registration, transfer and custody of such securities through DLT systems.

(iii) Issuers of securities represented or registered through DLT systems are required to designate an entity responsible for the safekeeping and administration of these financial instruments for the accounts of clients. Such entities will, among other functions, manage the identification of the holders of the rights over the DLT Securities, and will be subject to the supervision of the Spanish National Securities Market Commission.

(e) **Switzerland:**

(i) The DLT Act, which came into force in 2021, enables the introduction of ledger-based securities that are represented on a blockchain.[159] In particular, "registered uncertificated securities", which are securities that are registered in a DLT protocol and transferred within this protocol, have been enshrined into law. Under this new law, tokens can be issued and transferred as registered uncertificated securities within the token's register and DLT system without the need for such a procedure, providing a legal basis for the ownership and transfer of rights through electronic registers.

(ii) To facilitate the secondary trading of such securities, a new regime for DLT facilities was introduced in the Financial Market Infrastructure Act (FMIA). While generally subject to similar rules and regulations as other trading facilities, a key aspect of this new license category is that DLT trading facilities under the FMIA are also permitted to provide custody and settlement services for registered uncertificated securities on a DLT protocol, without needing additional licensing. This is in contrast to conventional trading facilities, which typically rely on a central securities depository to perform such functions.

[159] Swiss DLT Act, available at: https://www.sif.admin.ch/en/blockchain-dlt-en.

An official website of the United States government Here's how you know

STATEMENT

Statement on Tokenized Securities

Division of Corporation Finance, Division of Investment Management, Division of Trading and Markets

Jan. 28, 2026

Introduction

As part of an effort to provide greater clarity on the application of the federal securities laws to crypto assets,[1] the Division of Corporation Finance, Division of Investment Management, and Division of Trading and Markets are providing their views[2] on the taxonomies associated with tokenized securities.[3] A tokenized security is a financial instrument enumerated in the definition of "security"[4] under the federal securities laws that is formatted as or represented by a crypto asset, where the record of ownership is maintained in whole or in part on or through one or more crypto networks. There are a variety of models used to tokenize securities and they vary in terms of structure and the rights afforded to holders. Tokenized securities generally fall into two categories: (1) securities tokenized by or on behalf of the issuers of such securities; and (2) securities tokenized by third parties unaffiliated with the issuers of such securities.[5] This statement is intended to assist market participants as they seek to comply with the federal securities laws and prepare to submit any necessary registrations, proposals, or requests for appropriate action to the Commission or its staff. We stand ready to engage regarding any questions.

Issuer-Sponsored Tokenized Securities

An issuer may tokenize a security by issuing it in the format of a crypto asset.[6] To accomplish this, the issuer (or its agent) integrates DLT into the systems that it uses to record owners of the security (the "master securityholder file"), such that a transfer of the crypto asset on the crypto network results in a transfer of the security on the master securityholder file. Consequently, the only difference between a security issued in this manner and securities issued in traditional format is that instead of maintaining the master securityholder file through conventional, offchain database records, the issuer (or its agent) maintains the master securityholder file on one or more crypto networks, which functionally are onchain database records. As part of this recordkeeping system, the issuer (or its agent) uses onchain database records alongside offchain database records and associates the onchain information (*e.g.*, wallet address, quantity of security owned, and issue date) with relevant offchain information (*e.g.*, security holder name and address).

A single class of securities could be issued in multiple formats, including tokenized format. Similarly, an issuer may permit security holders to hold a security in different formats and convert the security from one format to another. The format in which a security is issued or the methods by which holders are recorded (*e.g.*, onchain vs. offchain) does not affect application of the federal securities laws.[7] For example, regardless of its format, the Securities Act requires that every offer and sale of a security must be

registered with the Commission unless an exemption from registration is available. Similarly, stock is an "equity security" under the Securities Act and the Exchange Act regardless of its format.[8]

On the other hand, the tokenized security could be of a different class of securities from those issued in traditional format. For example, an issuer could issue one class of common stock in traditional format and issue a separate class of common stock as a tokenized security. However, if the tokenized security is of substantially similar character as the security issued in traditional format and holders of the tokenized security enjoy substantially similar rights and privileges, the tokenized security may be considered of the same class as the security issued in traditional format for certain purposes under the federal securities laws.[9]

Alternatively, an issuer (or its agent) may tokenize a security without a crypto network constituting, or being part of, the master securityholder file. Under this model, the issuer issues the security offchain and issues a crypto asset to security holders. The crypto asset does not convey any rights, obligations, or benefits of the security, and the crypto asset and its onchain database records are not directly integrated into the master securityholder file for the security.[10] Instead, the crypto asset may be used indirectly to effect transfers of the security on the master securityholder file. In this case, the transfer of the crypto asset, which is a securities transaction, operates to notify the issuer (or its agent) to record the transfer of ownership of the security on the master securityholder file. Because the offchain database records constitute the master securityholder file, the issuer (or its agent) will use the onchain database records to update the offchain database records to record the transfer of ownership of the security.

Third Party-Sponsored Tokenized Securities

In addition to issuer-sponsored tokenized securities, third parties unaffiliated with an issuer of a security could tokenize the unaffiliated issuer's security. The models that third parties are using to tokenize securities vary, and the rights, obligations, and benefits associated with the crypto asset may or may not be materially different from those of the underlying security. In addition, the crypto asset may or may not represent an ownership interest in or contractual obligation of the issuer of the underlying security and, as such, may or may not confer upon the holder of the crypto asset any rights as a holder of the underlying security. Further, holders of the crypto asset may be exposed to risks with respect to the third party, such as bankruptcy, to which a holder of the underlying security would not necessarily be exposed.

We have observed two models where a third party tokenizes securities issued by another person: custodial tokenized securities and synthetic tokenized securities. Under the first model, the third party issues a crypto asset representing the underlying security, such as a tokenized security entitlement.[11] The underlying security is held in custody, and the crypto asset evidences the holder's ownership interest (whether direct or indirect) in the underlying security being held in custody. Under the second model, the third party issues a crypto asset representing its own security that provides synthetic exposure to the underlying security, such as a tokenized linked security or a tokenized security-based swap.[12]

First Model: Custodial Tokenized Securities

Tokenized Security Entitlement

A third party may tokenize a security issued by another person by creating a security entitlement that is formatted as a crypto asset.[13] Similar to the issuer-sponsored model discussed above, the third party may accomplish this by integrating DLT into the systems that it uses to record entitlement holders, such that a transfer of the crypto asset results in a transfer of the security entitlement on the third party's records. Under this model, the crypto asset represents the holder's indirect interest in the underlying security via the security entitlement.[14] The format in which the security entitlement is issued does not affect application of the federal securities laws.

Alternatively, a third party may tokenize a security entitlement without a crypto network constituting, or being part of, the systems that it uses to record entitlement holders. Under this model, the crypto asset may nonetheless be used to transfer the security entitlement on the third party's records similar to the issuer-sponsored model discussed above.[15] Because the records are maintained offchain, the third party will use the onchain database records to update the offchain database records to record the transfer of the security entitlement.

Second Model: Synthetic Tokenized Securities

Linked Security

A third party may tokenize a security issued by another person by issuing a "linked security" formatted as a crypto asset. A "linked security" is a security issued by the third party itself that provides synthetic exposure to a referenced security, but it is not an obligation of the issuer of the referenced security and confers no rights or benefits from the issuer of the referenced security. The return on a linked security is linked to the value of the security it references or events relating to the referenced security. A linked security may be a debt security (such as a structured note[16]) or an equity security (such as exchangeable stock). Under certain circumstances, as discussed below, a linked security may be a security-based swap. The crypto asset representing the linked security is similar to the crypto assets discussed under "Issuer-Sponsored Tokenized Securities" above.

Security-Based Swap

A third party may tokenize a security issued by another person by issuing a security-based swap formatted as a crypto asset.[17] A security-based swap is a security that generally provides synthetic exposure to, among other things, either a referenced security or certain referenced events relating to an issuer of a security. A security-based swap typically does not convey to the holder any equity, voting, information, or other rights with respect to the referenced security. The third party may not offer or sell the crypto asset representing the security-based swap to persons who are not eligible contract participants[18] unless a Securities Act registration statement is in effect as to the crypto asset,[19] and the transactions in the crypto asset are effected on a national securities exchange.[20] The crypto asset representing the security-based swap is similar to the crypto assets discussed under "Issuer-Sponsored Tokenized Securities" above.

The term "security-based swap" is defined in Section 3(a)(68) of the Exchange Act. The definition of "security-based swap" includes any agreement, contract, or transaction that is a swap (as defined in Section 1a of the CEA)[21] and is based on: (1) an index that is a narrow-based security index, including any interest therein or on the value thereof; (2) a single security or loan, including any interest therein or on the value thereof; or (3) the occurrence, nonoccurrence, or extent of the occurrence of an event relating to a single issuer of a security or the issuers of securities in a narrow-based security index, provided that such event directly affects the financial statements, financial condition, or financial obligations of the issuer. If a financial instrument formatted as a crypto asset is a swap and it satisfies one of the three prongs of the definition of "security-based swap," then the crypto asset may represent a security-based swap. For example, if the crypto asset provides on an executory basis for the exchange, on a fixed or contingent basis, of one or more payments based on the value of a security, but does not also convey a current or future direct or indirect ownership interest in an asset or liability that incorporates the financial risk transferred, that crypto asset may represent a security-based swap.[22] Similarly, if the crypto asset provides for payments that are dependent on the occurrence, non-occurrence or extent of occurrence of an event or contingency that is associated with a potential financial, economic, or commercial consequence, does not fall within one of the specified exclusions, and meets any of the three prongs of the security-based swap definition discussed above, that crypto asset may represent a security-based swap.[23]

Security-based swaps and linked securities are economically similar, although certain additional or different provisions apply to the regulation of security-based swaps under the federal securities laws, including with respect to transactions with persons who are not eligible contract participants as noted above.[24] The assessment of whether a financial instrument is a security-based swap or a linked security depends, in part, on the exclusions from the definition of "swap." There are several exclusions from the definition of "swap" relating to securities.[25] To the extent a financial instrument falls into one of these exclusions, it is not a swap and, therefore, is not a security-based swap. For example, any note, bond, or evidence of indebtedness that is a security, as defined in Section 2(a)(1) of the Securities Act, is excluded from the definition of swap.[26] Similarly, any put, call, straddle, option, or privilege on any security, certificate of deposit, or group or index of securities, including any interest therein or based on the value thereof, that is subject to the Securities Act and the Exchange Act, is excluded from the definition of swap.[27] When assessing whether a financial instrument formatted as a crypto asset satisfies one of these exclusions, the economic reality of the instrument rather than the name given to the instrument determines whether it is excluded.[28]

Further Information

If you have inquiries for the Division of Corporation Finance, please submit your questions to the Division's Office of Chief Counsel using the Corporation Finance Request Form for Interpretive Advice and Other Assistance. If you have inquiries for the Division of Investment Management, please review the Division's Contact Information page for relevant contacts. If you have inquiries for the Division of Trading and Markets, please call (202) 551-5777 or email tradingandmarkets@sec.gov.

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[1] For purposes of this statement: a "crypto asset" is any digital representation of value that is recorded on a cryptographically secured distributed ledger; and a "crypto network" is a blockchain or similar distributed ledger technology ("DLT") network. In addition, for purposes of this statement, "onchain" refers to transactions or data that are processed and recorded directly on a crypto network and "offchain" refers to transactions or data that are processed and recorded outside of a crypto network. The foregoing definition of "crypto asset" is identical to the definition of "Digital Asset" in Section 2(6) of the Guiding and Establishing National Innovation for U.S. Stablecoins Act, Pub. L. No. 119-27, 139 Stat. 419 (2025).

[2] This statement represents the views of the staff of the Division of Corporation Finance, Division of Investment Management, and Division of Trading and Markets. It is not a rule, regulation, guidance, or statement of the U.S. Securities and Exchange Commission ("Commission"), and the Commission has neither approved nor disapproved its content. This statement, like all staff statements, has no legal force or effect: it does not alter or amend applicable law, and it creates no new or additional obligations for any person.

[3] Tokenization is the process of creating a digital representation of a tangible or intangible asset using DLT.

[4] The term "security" is defined in Section 2(a)(1) of the Securities Act of 1933 ("Securities Act"), Section 3(a)(10) of the Securities Exchange Act of 1934 ("Exchange Act"), and Section 2(a)(36) of the Investment Company Act of 1940 ("Investment Company Act").

[5] Both federal and state law govern the activities, transactions, and relationships among the parties involved with tokenizing securities. For purposes of this statement, we assume that the activities and transactions by the parties described in this statement are in compliance with applicable law and any governing documents. For example, we assume that tokenized securities are not subject to any restriction on transfer imposed by the issuer and are properly issued and transferred under applicable state law, and that, in each instance, a transfer of the crypto asset results in a transfer of control of the security or security entitlement and/or ownership of the security or security entitlement via an effective indorsement, instruction, or entitlement order, as the case may be. *See* Article 8 of the Uniform Commercial Code.

[6] It is possible to tokenize any type of security, including stocks, bonds, notes, investment contracts, options on securities, and security-based swaps. This statement assumes that the crypto asset created to represent the security is not itself a separate security.

[7] An issuer that is subject to the Investment Company Act and issues its securities in different formats, including in tokenized format on different crypto networks, may raise multi-class issues under Section 18 of the Investment Company Act.

[8] *See* Section 3(a)(11) of the Exchange Act, Rule 3a11-1 under the Exchange Act, and Rule 405 under the Securities Act.

[9] *See, e.g.,* Sections 12(g)(5) and 15(d)(1) of the Exchange Act.

[10] This statement assumes that the crypto asset created to represent the security is not itself a separate security.

[11] We are aware of a tokenization model known as "digital custodial receipt." Based on our current understanding of this model, we do not view it as separate or distinct from the tokenized security entitlement model and, therefore, do not address it separately in this statement.

[12] Under this model, depending on the facts and circumstances, the third party may be deemed to be an investment company under the Investment Company Act.

[13] For a more fulsome description of the indirect system of ownership, *see Concept Release on the U.S. Proxy System*, Release No. 34-62495 (Jul. 14, 2010), 75 FR 42982 (Jul. 22, 2010). *See also The Depository Trust Company* no-action letter (Dec. 11, 2025), available at https://www.sec.gov/files/tm/no-action/dtc-nal-121125.pdf.

[14] This statement assumes that the crypto asset created to represent the security is not itself a separate security.

[15] *Id.*

[16] *See* Office of Investor Education and Advocacy, *Investor Bulletin: Structured Notes* (Jan. 12, 2015), available at https://www.investor.gov/introduction-investing/general-resources/news-alerts/alerts-bulletins/investor-bulletins-76 .

[17] This is not the only circumstance in which a tokenized security could result in a security-based swap. Depending upon the facts and circumstances, securities tokenized by or on behalf of the issuers of such securities also could result in a security-based swap.

[18] The term "eligible contract participant" is defined in Section 1a(19) of the Commodity Exchange Act ("CEA"). In 2012, the Commission and the Commodity Futures Trading Commission, in consultation with the Board of Governors of the Federal Reserve System, jointly further defined the term "eligible contract participant." *See Further Definition of "Swap Dealer," "Security-Based Swap Dealer," "Major Swap Participant," "Major Security-Based Swap Participant" and "Eligible Contract Participant,"* Release No. 34-66868 (Apr. 27, 2012), 77 FR 30596 (May 23, 2012).

[19] *See* Section 5(e) of the Securities Act. Alternatively, the offer and sale of the crypto asset to eligible contract participants could be conducted pursuant to an exemption from the registration requirements of the Securities Act.

[20] *See* Section 6(l) of the Exchange Act. Transactions in the crypto asset among eligible contract participants do not need to be effected on a national securities exchange. For example, such transactions could be effected bilaterally or on a security-based swap execution facility.

[21] The term "swap" is defined in Section 1a(47) of the CEA and consists of six prongs and specified exclusions. *See* Section 1a(47)(A) and (B) of the CEA, respectively. If a crypto asset satisfies one or more of the prongs of the definition of "swap" and does not fall within one of the statutorily specified exclusions, the crypto asset is a swap.

[22] *See* Section 1a(47)(A)(iii) of the CEA and Section 3(a)(68) of the Exchange Act.

[23] *See* Section 1a(47)(A)(ii) of the CEA and Section 3(a)(68) of the Exchange Act.

[24] *See* footnote 18 above and accompanying text.

[25] *See* Section 1a(47)(B) of the CEA.

[26] *See* Section 1a(47)(B)(vii) of the CEA. Structured notes typically fall within this exclusion.

[27] *See* Section 1a(47)(B)(iii) of the CEA.

[28] *See Tcherepnin v. Knight*, 389 U.S. 332, 336 (1967) (noting that in searching for the meaning and scope of the word "security," form should be disregarded for substance, and the emphasis should be on economic reality).

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Project Samara Research Paper

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Executive Summary

Project Samara is a collaborative initiative between the Bank of Canada (BoC); RBC Capital Markets (RBC); RBC Investor Services Trust (RBC IS); TD Securities, a division of The Toronto-Dominion Bank (TD); and Export Development Canada (EDC). Project Samara evaluates how distributed ledger technology (DLT) can improve bond issuance, settlement and life-cycle management. The Project tested the feasibility and implications of a DLT-based platform for capital markets, using a Canadian dollar–denominated tokenized bond issued by EDC and settled in wholesale central bank digital money (W-CAD).

The Samara Platform was designed to support end-to-end transaction workflows—including primary issuance, secondary trading and life-cycle events—on a permissioned DLT infrastructure. Built using Hyperledger Fabric, the platform integrates separate bond and cash ledgers and enables atomic settlement through smart contracts and interledger protocols.

The issuance stage of the experiment revealed both the potential benefits and limitations of DLT in a real-world financial setting:

- Efficiency gains: Automation, reduced reconciliation and same-day (T+0) settlement improved operational efficiency. A single source of truth enhanced the integrity of data and streamlined workflows across participants.
- Operational and governance complexity: Efficiency gains were partially offset by greater system complexity, higher liquidity costs (due to pre-funding requirements) and the need to develop and implement new governance structures. Decentralized architecture created challenges for coordination, reporting and platform oversight.
- Risk management: Atomic delivery versus payment (DvP) across independently governed ledgers reduced counterparty and settlement risk but introduced new operational risks related to key management, auditability and fallback mechanisms that require mitigation.
- Regulatory and legal considerations: Close engagement with regulators of capital markets was required to address issues such as legal status, custody arrangements and compliance frameworks. The expectation for centralized roles—such as a marketplace operator, custodian and reporter—highlighted gaps between the current regulatory framework and DLT principles.
- Adoption barriers: Despite it being technically feasible, high infrastructure costs, integration challenges and market participants' reluctance to make changes to core infrastructures may affect broader adoption. Market uncertainty about the technology demonstrates the need for an ongoing role for central authorities or intermediaries.

Overall, Project Samara provided valuable insights into the practical application of DLT in capital markets. Although the technology shows promise for improving efficiency and resilience, its benefits remain uncertain. Due to the nature of a limited experiment involving the issuance of a single security to a closed investor group, the net impact remains uncertain. Additional experimentation, regulatory clarity and market engagement will be essential to determine whether DLT can deliver meaningful transformation in financial infrastructure.

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1. Introduction and Project Scope

1.1. Background

Secure value transfer is foundational to modern financial markets, spanning activities from securities trading to cash payments, and is typically facilitated by intermediaries for a fee. Despite decades of operational experience and refinement, inefficiencies and risks persist, revealing clear opportunities for improvement. For example:

- transaction costs remain elevated due to the layered involvement of intermediaries in execution, settlement, and custody, increasing both operational risk and reporting burdens;
- bond and cash settlements are not fully integrated, relying instead on separate systems and multiple interfaces;
- the institutional complexity and number of actors involved remain high, even as other areas have seen efficiency gains and reduced complexity (see Figure 1).

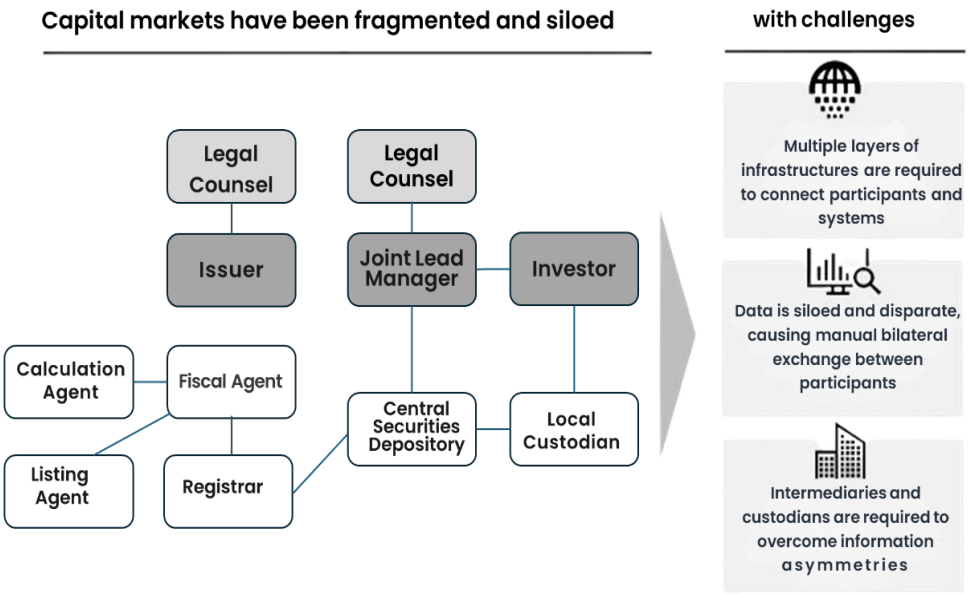

Figure 1: Challenges in the Debt Capital Markets

Knowledge of how emerging technologies can enhance capital markets infrastructure has advanced rapidly in recent years. DLT, in particular, is seen as a promising tool for improving efficiency by synchronizing ledgers across participants and automating complex, multi-party workflows.

A substantial body of academic and policy work has examined the role of DLT, cryptocurrency and tokenized central bank money in financial transactions. According to the 2023 survey by the Bank for International Settlements, 94% of 86 central banks were researching, experimenting with, developing, piloting, or operating a retail or wholesale central bank digital currency (BIS, 2024). Some of this work also involved exploring the potential for DLT innovations to improve payment and securities settlement at the wholesale level.

The BIS Innovation Hubs have been actively looking at potential improvements in cross-border payments (see for example, Projects Nexus). At the same time, the Swiss National Bank (Project Helvetia and its work with the SIX exchange) and the Banque de France have been advancing real-world experiments and pilot programs.

The BoC has been a pioneer in this field, having engaged in public-private partnerships on a multi-phased financial technologies experiment (Project Jasper) since 2016.[1] Its primary focus was to investigate opportunities leveraging DLT to support settlement and promote innovation in the payment and financial market infrastructure ecosystem. Early phases, conducted in partnership with Payments Canada, R3, Accenture and a selected set of Canadian commercial banks (including RBC and TD), focused on interbank payments and securities settlement. In later phases of the work, the BoC partnered with the Monetary Authority of Singapore and the Bank of England to work on cross-border, cross-currency settlement. That joint collaboration combined Project Jasper and Singapore's Project Ubin to explore faster, lower-cost international payments.[2]

Building on the Project Jasper series of experiments, BoC, commercial banks (TD and RBC), and EDC joined together (the "Consortium") to launch Project Samara (the "Project").

The Project involved the development of a consolidated DLT-based platform comprising: (i) the issuance by EDC in Canada of a Canadian dollar bond that was created, traded and managed throughout its life cycle in a legally valid manner, and (ii) atomic settlement of trades of such bonds in W-CAD. Currently all this functionality is spread across several platforms and intermediaries. Combining functionality (in this case primary market issuance, secondary market trading, life-cycle event management, and post-trade clearing and settlement) into a common platform is one of the primary benefits of the DLT movement. The W-CAD, issued by BoC, is only accessible by the banks and wholesale

[1] Project Jasper was the first time in the world that a central bank participated in a distributed ledger technology ("DLT") experiment in partnership with the private sector. This collaborative research initiative between the public and private sectors aims to understand how DLT could transform the wholesale payments system. For more information on this multi-phased W-CAD exploration, see https://www.bankofcanada.ca/research/digital-currencies-and-fintech/projects/.

[2] Jasper-Ubin Design Paper: Enabling Cross-Border High Value Transfer Using DLT, May 2019

investors authorized to participate on the permissioned private capital markets platform.[3] The platform is composed of the cash ledger and the bond ledger, collectively referred to as the "Samara Platform."

1.2. Project Rationale

Project Samara examines the integrated use of DLT-based tokenized assets and digital currency across bond issuance, securities settlement, and life-cycle management. As part of the initiative, EDC issued a Canadian dollar–denominated (CAD) bond governed by Canadian law using DLT, with payments settled in a W-CAD issued by the BoC specifically for this transaction. The bond was sold and traded and will be managed throughout its life cycle on the Samara Platform, which combines both cash and bond ledgers.

The Project also explores secondary market functionality—including market-making and request for quote (RFQ) workflows—to assess the platform's capacity to support key features of a well-functioning market. More broadly, Project Samara aims to deepen understanding of DLT's potential impact on capital markets and payment infrastructure.

Project Samara builds on several exploratory digital innovation initiatives led by its participants:

- For BoC, Samara continues the research initiated under Project Jasper in 2016 to understand the value proposition and consequences of DLT in the financial system. While previous phases confirmed DLT's technical viability for capital market transactions, Project Samara provides a production-level test of its potential advantages over existing systems in terms of cost, efficiency, governance, and risk. It may also help to better identify and understand barriers to broader adoption of decentralized DLT based systems beyond the cryptocurrency space.
- For RBC, as a joint lead manager (JLM) and bond lender platform operator, Samara follows RBC's participation in Project Jasper and the World Bank's Project Bond-I (World Bank, 2018a,b) and adds experience from its role in the European Investment Bank's 2023 digital bond issuance denominated in pounds sterling.
- For TD, as a JLM, Samara builds on TD's involvement in Project Jasper, Project Bond-I with the World Bank (World Bank, 2018a,b), its role in the inaugural digital native note issuance on Euroclear's "Digital Financial Markets Infrastructure" with World Bank in 2023, and BIS Innovation Hub experiments into the Regulated Liability Network and the new Project Agora, which explores how tokenization can enhance wholesale cross-border payments.

[3] Open systems are those that accept all interested entities that have the technical ability to participate. Closed or permissioned systems have additional membership criteria that must be satisfied for an entity to be permitted to operate a node (Mills et al., 2016).

- For EDC, as issuer, Samara represents an opportunity to participate and contribute to the development of DLT and digital currency. It also provides an opportunity to understand the nuances and the possible risks involved in the new platforms being developed worldwide. Full engagement and direct issuance bring about a strong focus on all aspects of the securities life cycle and examines the benefits and challenges that new technologies can bring.

1.3. Market Overview: Participant Challenges and Potential Benefits

The overarching objective of the Consortium members was to deepen their understanding of the potential benefits and challenges of using DLT in financial market clearing and settlement. One potential benefit of a distributed infrastructure model based on a common source of truth disseminated across participants is the possibility of reducing the risks posed by single points of failure that are inherent in centralized systems. Another potential benefit is a reduction in the fragmentation of capital markets and their relative inefficiency due to separate, non-standardized systems that give rise to unexpected costs, delays, and risks. Separate systems in the traditional space often require complex, time-intensive coordination to achieve secure settlement, typically measured in days. The resulting complexity has created a costly chain of intermediaries and infrastructure that are required to overcome information asymmetries, manage investments, and connect disparate systems.[4] Decentralized systems that interoperate well, especially if they can execute atomic transactions across component sub-systems, may reduce types of failure that could lead to broader market-wide shocks in the event of a crisis.

In capital markets more broadly, blockchain technology is widely expected to reduce fragmentation and complexity, thereby lowering operational risks, delays, and costs. Figure 2 outlines both the theoretical benefits of large-scale DLT adoption and the specific expectations of Project Samara participants.

[4] There are additional potential benefits of a decentralized model, including greater transparency and easier auditability.

 **Issuers**	**Issuers may get lower cost execution, increased efficiency, faster time to fund, investor insights, real-time market feedback on debt supply and secondary market liquidity.**
 **Investors**	**Investors get access to a comprehensive view of the debt market investment opportunities, with built-in analytics, treasury and custodial services.**
 **JLM / Dealers**	**JLMs/dealers get access to a more efficient tool to orchestrate and manage primary issuance processes, thus reducing capital cost associated to execution, settlement and operational risks.**
 **Market Makers**	**Market makers benefit from digital nature of such marketplace, which can enhance price discovery and visibility; this can lead to an ecosystem with deeper liquidity and reduced risks.**
 **Custodians**	**Custodians will have access to a ubiquitous market utility that allows for efficient custody services across multiple jurisdictions, asset classes and currencies.**
 **Regulators Central Banks**	**Access to comprehensive real-time market activity delivers efficient and effective regulatory oversight and control.**

Figure 2: Potential benefits of DLT compared to the current organization and functioning of capital markets from a practitioner's perspective

The short and long-term expected or potential benefits for the participants can be summarized as follows:

Issuers may benefit from faster settlement times, reduced reconciliation efforts, and fewer settlement discrepancies. Additional potential advantages include lower execution costs, improved funding timelines, and real-time insights into investor behavior and market conditions.

The BoC gains a controlled environment to evaluate the practical implications of a W-CAD and blockchain-based securities settlement. Key areas of focus include settlement

mechanics, large value payment efficiency and security, legal frameworks for digital platforms, and applications such as programmable payments using smart contracts.[5]

JLMs could see gains through real-time market making, streamlined regulatory reporting, reduced book-building delays, reduced back-office reconciliation, and real-time settlement.

Investors are expected to benefit from self-custody capabilities, enhanced visibility into debt market opportunities, and integrated treasury and custodial services.

Regulators may gain access to better information, enabling more effective oversight. The distributed nature of blockchain technology would also potentially improve operational resilience of the platform, a clearly desirable feature for systemically important systems.

At a broader level, DLT is supposed to offer a globally trusted ledger without relying on a central authority, opening the door to new business models and operational paradigms in capital markets.

1.4. Project Samara Objectives

The Project tested four hypotheses related to the use of native digital assets and W-CAD in a real-world capital markets transaction:

a) Efficiency Gains: DLT has the potential to reduce operational, execution, and administrative (such as reconciliation and reporting) costs across all participants, including central banks, issuers, investors, JLMs and regulators.

b) Risk Mitigation: Atomic settlement and the elimination of physical documentation and wet signatures may help reduce operational risk across the transaction life cycle.

c) Market Innovation: DLT could enable new business models by lowering barriers to entry, increasing competition, and tightening integration between primary and secondary markets.

d) Enhanced Settlement Infrastructure: DLT-based cash settlement using W-CAD may offer significant advantages over existing payment rails by ensuring settlement finality[6] and accelerating transaction timelines for wholesale market participants.

---

[5] Smart contracts and programmable payments refer to computer code that will automatically execute on the blockchain once certain prespecified conditions are met.

[6] Settlement finality refers to the point at which a transfer of funds or securities becomes irrevocable and unconditional, meaning that the transaction is complete and cannot be reversed.

Project Samara was structured as a limited experiment, involving the issuance of a single security to a closed investor group. Any assessment of its benefits relative to traditional bond issuance in Canada therefore remains preliminary and largely illustrative of potential future outcomes if DLT-based systems were to be adopted more broadly.

Given its scope, the Project did not address all theoretical advantages of DLT and W-CAD in large-scale capital markets. For example, it did not incorporate full interoperability with existing payment and accounting systems, automated sanctions screening, fraud detection, or integration with external data sources, such as oracles.[7] Similarly, client interactions with correspondent banking channels remained unchanged.

1.5. Potential Cost Savings

In terms of potential operational cost savings for network participants, Figure 3 outlines some potential areas where savings could be realized by having the full life cycle of the bond on a single DLT platform.

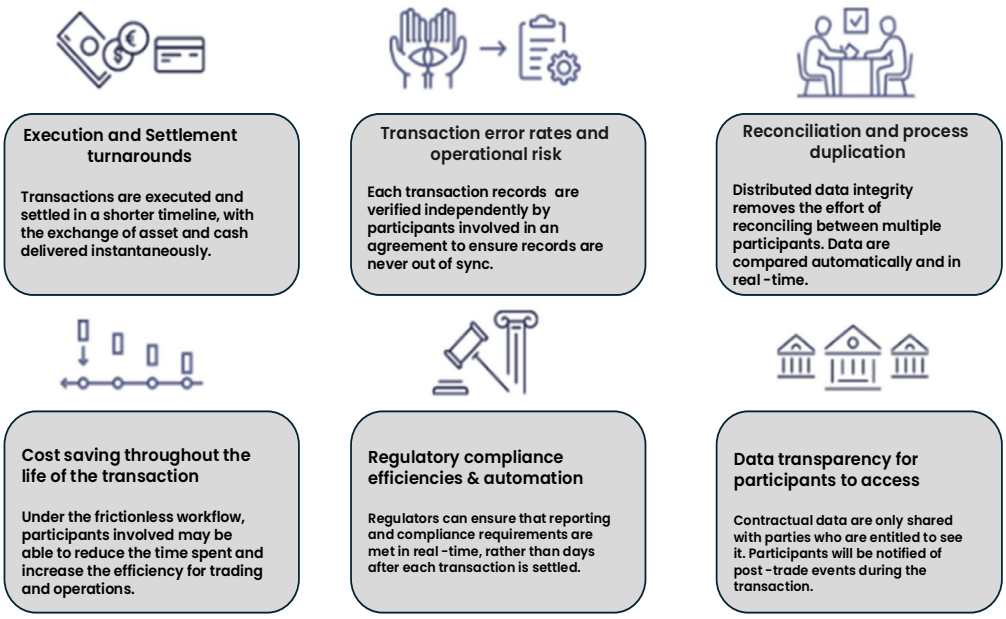

Figure 3: Potential savings for participants

[7] Blockchain oracles are entities that connect blockchains to external systems, thereby enabling smart contracts to execute based upon inputs and outputs from the real world.

2. Proposed Financial Transaction

2.1 Overview of Transaction Based on DLT: Primary Market

A transaction flow is provided below in Figure 4 to describe the difference between the conventional CAD bond and the Samara bond.

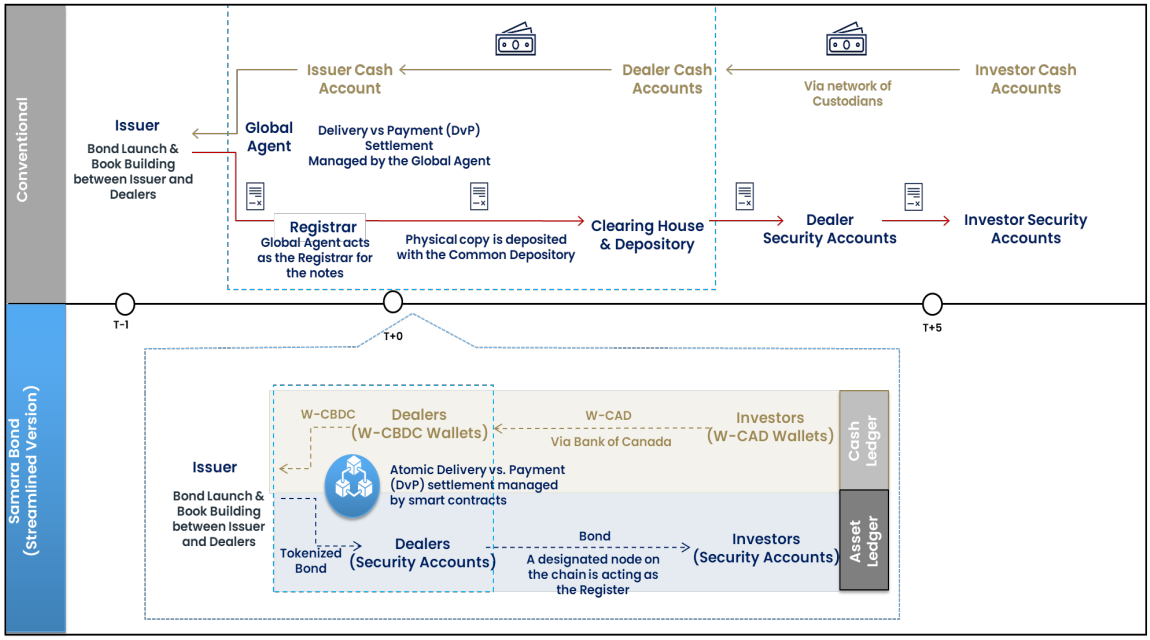

Figure 4: Conventional CAD Bond vs. Samara Bond Issuance Process

2.2 Comparison Between a Traditional Canadian Bond and the Samara Bond

This section outlines the key differences between the Samara bond issuance and a bond issuance in the Canadian market (see Figure 5). Traditional CAD bond issuance is a complex, manual process involving multiple intermediaries—such as a registrar, fiscal agent, paying agent and transfer agent, clearing house, central securities depository (CSD), custodians, and one or more dealers, legal counsels, and agents—operating on different systems to authenticate and deposit signed notes. Due to legal documentation and settlement procedures, the process typically requires 3 to 5 business days (T+5) to complete.

In the Samara bond issuance, the use of tokenized securities, W-CAD, smart contracts, and an interledger protocol enabled same-day (T+0) settlement. This approach eliminated the need for many intermediaries, reducing execution and administrative costs. Atomic DvP occurred shortly after bond creation. The roles of registrar, fiscal agent, paying agent and transfer agent, clearing house and CSD were replaced by the platform operator and its node, which served as the authoritative record of the issuance and associated settlements.

Real-time data access reduced the need for reconciliation, and the shortened settlement cycle with atomic DvP reduced settlement risk.

	Traditional Issuance	Samara Issuance
Number of Parties Involved	Multiple Players Working on Different Systems: • Issuer, Dealers, Investors, Paying Agent, Registrar, Common Depository, Clearing House, Multiple Custodians, and Regulators	Streamlined Participation: • Issuer, Dealers/Investors, Central Bank, and other Regulators (each may hold a node on the DLT platform
Number of Steps	Manual & Time Intensive Multiple-Step Issuance Processes: • Manual due diligence during bond launch, creation etc. • Physical copy of the bond is deposited with the common depository • Settlement occurs via a layer of custodians operating in different time zones	Simplified & Efficient Processes: • More automated issuance process • Digitized workflows using smart contracts allow automated and efficient settlement process
Documentation & Record Keeping	Complex & Time-Consuming Process: • Manual steps involved in drafting and finalizing a long list of legal documents that contribute to a long settlement cycle • Time-consuming reconciliation process among participating systems	Automated Documentation on a Single Platform: • Final term sheet can be generated, approved and shared on the platform on issuance date • One single version of bond records removes the need for reconciliation
Time	Long Clearing & Settlement Cycle (T+5 or more): • Settlement cycle can take up to 10 days depending on the legal documentation and settlement setup requirements	T+0 Settlement: • Streamlined issuance and settlement processes enable a same-day atomic DvP settlement
Transparency & Risks	Less Transparency leading to more risk: • Less transparent with limited audit trail due to the involvement of Intermediaries and multiple systems • Potential operational and counterparty risk due to the long and complex settlement processes	Increased Transparency with reduced risk • Increased transparency and immutability in transaction record keeping • Automation and improved settlement cycle reduces operational and counterparty risks

Figure 5: Structural differences between CAD Bond and Samara Bond

3.0 Samara Operational Framework

This section outlines the operational framework of the Samara Platform and discusses details related to the primary and secondary markets, coupons and redemption, and risk controls.

3.1 Operational Expectations

Project Samara explores how DLT can streamline and automate operational tasks, enhance communication workflows, and reduce processing times compared to the current systems used in Canadian bond issuance. The Project also examined potential operational benefits such as reduced reconciliation needs through a single, shared ledger; improved data governance via distributed nodes; fewer market intermediaries; and automated reporting capabilities.

This section focuses on key operational considerations, including:

- the impact of DLT on settlement mechanics of digital securities, including timing and the benefits of DvP,[8] using W-CAD;
- the effects on the security and efficiency of large-value payments in bond markets;
- the implications for oversight of payment, clearing, and settlement systems;
- enhancements to payment monitoring capabilities; and
- changes to workflow procedures for various bond market events.

3.2 Primary Market Bond Issuance

The bond issuance process involves a series of multi-party workflows that must be carried out in sequence to complete issuance and settlement. Project Samara aimed to demonstrate how these workflows could be streamlined and automated using DLT. The Samara Platform supports most primary issuance steps on-chain, with the exception of certain pricing and legal documentation tasks, which still require manual input and document uploads to the platform's repository.

In contrast to conventional CAD bond issuance, Samara integrates key multi-stakeholder processes—such as term sheet generation, deal announcement, book-building, bond allocation, settlement instruction set-up, and atomic settlement (DvP) in central bank money into a single platform. All participants can be onboarded to the platform directly, reducing the need for bilateral reconciliations and manual validations at each step. The

8 Glossary__Committee on Payments and Market Infrastructures, BIS: https://www.bis.org/cpmi/publ/d00b.htm?selection=26

platform also minimizes reliance on off-chain artifacts like email confirmations, contributing to a more streamlined and efficient process.

A detailed comparison between the traditional and Samara issuance workflows is provided in Appendix I.

3.2.1 Primary Market Settlement (T+0)

In the Canadian debt securities market, the standard settlement process typically takes 5 business days following the trade date, including clearing and settlement of the bonds in CDS and the final settlement of payments through designated bankers and the Lynx system, ultimately settling at the BoC. In contrast, the Samara Platform enables same-day (T+0) settlement within a DLT-based environment, allowing for the direct real-time exchange of digital bonds and W-CAD. This improves record keeping and significantly reduces settlement time while enhancing controls related to review, confirmation, and approval—key elements in mitigating operational risk (see Section 5.6).

The Samara settlement workflow is divided into on-chain and off-chain components. On-chain activities—executed and recorded on the Samara blockchain—include the bond launch, book-building, allocation, and atomic DvP. Off-chain activities, such as issuer-JLM negotiations, investor coordination, pricing calls, and final documentation, occur outside the platform. A summary of both workflows is provided in Appendix II.

All transactions on the Samara Platform are settled on a real-time gross basis using DvP Model 1, eliminating intra-day credit and counterparty risk. One drawback of DvP Model 1 is that it may increase liquidity costs for participants. While netting mechanisms have been explored in other DLT initiatives (e.g., Project Jasper Phase 2 and Project Ubin Phase 2), they were not implemented in Samara. Further research is needed to evaluate the trade-offs between reduced settlement risk and increased liquidity demands.

3.2.2 Atomic Swap (Bond vs. Cash DvP)

The Samara Platform enables atomic DvP settlement, where digital bonds and W-CAD are exchanged instantaneously using a Hashed Time Lock Contract (HTLC) protocol (see Figure 6). Smart contracts on the bond and cash ledgers coordinate the validation and execution of key tasks, including account balance verification, transaction validation, bond creation in the issuer's account, ownership confirmation, and execution of the asset exchange.

The settlement process occurs in two sequential stages. In Stage 1, the issuer delivers the bond to the settlement bank—one of the JLMs—which also acts as the billing and delivery (B&D) agent. In Stage 2, the B&D JLM delivers the bond to the allocated primary market

investors. This two-step atomic DvP process ensures secure and efficient settlement across all parties.

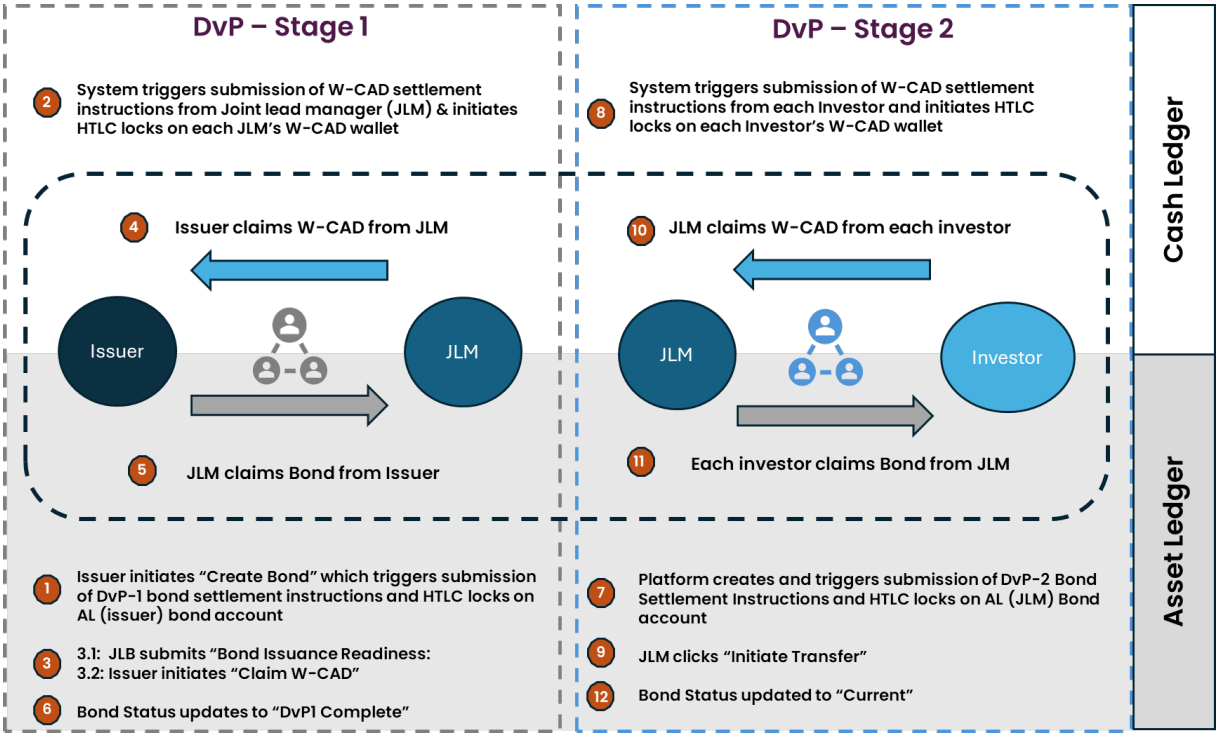

Figure 6: Samara DvP Workflow

3.3 Secondary Market Transactions

A key feature of the Samara Platform is its support for secondary market trading and settlement of digital securities directly on-chain. The platform enables investors to initiate RFQs, allows market makers to respond, and facilitates trade execution and settlement through smart contracts and the HTLC protocol. Upon execution, bond holdings are updated in real time.

To participate in secondary market transactions, users must pre-fund their wallets with sufficient W-CAD to ensure successful atomic DvP settlement. Unlike traditional platforms, Samara eliminates the need for post-trade workflows or dedicated settlement operations, enabling same-day (T+0) settlement and significantly reducing processing time.

3.4 Post-Issuance Life Cycle

3.4.1 Coupon and Redemption Payments

3.4.1.1 Record Date—Achieving a shorter cut-off for payments

For the Samara bond, coupon and redemption payment workflows begin one business day before the settlement date—significantly shorter than the conventional 4–5 business day lead time typically required for payment confirmations with agents and intermediaries. The platform uses a record date cut-off, set at 5:00 PM Eastern Time, to capture a snapshot of bondholders and automatically generate payment instructions based on their holdings. Coupon amounts are calculated using standard Canadian market conventions.

The Samara Platform facilitates seamless coordination between the bond and cash ledgers, providing real-time visibility into payment status for all participants, including the issuer, investors, and JLMs.

3.4.1.2 Payment Schedule

The Samara bond is structured as a fixed-rate coupon instrument, with its full payment schedule—covering both coupon and redemption events—available immediately after primary market settlement. This schedule is accessible to all parties involved, including the issuer, primary market investors, and JLMs, via their respective dashboards on the graphical user interface for the bond ledger. Investors who acquire the bond through secondary market transactions can also view the relevant payment schedule for their holdings upon successful trade execution.

3.4.1.3 Payment Instructions

Once the record date cut-off is reached, the platform automatically generates payment instructions, which are made available for review through the payments schedule menu on the bond ledger user interface. The issuer can review and validate these instructions and is responsible for ensuring that its W-CAD wallet is sufficiently funded before the settlement date. Investors can also view their respective payment instructions for upcoming coupon or redemption entitlements based on their holdings.

3.4.2 Bond Maturity

Once the final coupon and redemption payments are successfully processed on the scheduled maturity date, the bond ledger automatically updates the bond's status to "matured," confirming the completion of all issuer obligations. This update is triggered by an automated batch process scheduled for 5:00 PM Eastern Time on the maturity date.

The Samara Platform is designed to handle various maturity scenarios, including those falling on weekends or holidays, by applying multiple bond status indicators such as "settled" or "yet to be settled." These ensure accurate tracking and continuity across different conditions.

All participants—issuers, investors, and JLMs—can view the bond's maturity status on their respective dashboards. The platform also issues timely dashboard and email notifications to keep all parties informed without disrupting workflow.

3.5 Operational Controls

During the design and implementation of the Samara Platform—across both the bond and cash ledgers—a range of operational controls were established to mitigate risk. These include due diligence during user onboarding, acknowledgment of platform rules, segregation of duties, and a four-eye (maker-checker) validation process. Additional safeguards, such as audit trails, system notifications, and platform-generated reports, support oversight throughout the bond issuance life cycle.

The Consortium also implemented business continuity processes to address potential disruptions, with mitigation strategies tailored to different failure scenarios.

While Samara remains an experimental platform, and some risks may emerge due to the novelty of the technology, these operational controls and continuity measures are designed to reduce exposure and maintain platform integrity.

3.5.1 Platform Operator Roles (Bond Ledger and Cash Ledger)

The Samara Platform design includes a designated super-user role—referred to as the platform operator—for each of the bond and cash ledgers. The platform operator serves as the central point of contact for all platform functions within their respective ledger, overseeing user onboarding, managing workflow execution, and supporting error resolution and validation processes.

3.5.1.1 Bond Ledger—Platform Operator

On the bond ledger, a dedicated business unit within RBC—separate from its role as JLM—serves as the platform operator to ensure segregation of duties and avoid conflicts of interest. The bond ledger platform operator is responsible for:

- onboarding participants, including the issuer, JLMs, and investors, including by granting access to the bond ledger through a secure UI
- accessing payment instructions and other read-only data related to issuance, coupons, and redemptions

- executing specific functions to support manual interventions if system errors or exceptions occur, subject to consultation with, and agreement by, the issuer, such as:
    - manually generating coupon or redemption payment instructions if the automated batch process fails
    - transferring bond ownership in the event of an interruption during atomic DvP settlement
    - updating bond status to "Matured" if the automated process does not complete as scheduled
    - submitting payment instructions on behalf of the issuer in cases of system access issues

3.5.1.2 Cash Ledger—Platform Operator

On the cash ledger, a designated unit within the BoC—issuer of W-CAD—acts as the platform operator. The cash ledger platform operator has read access to user-level transactions and is responsible for:

- validating and approving W-CAD minting (settlement balances to W-CAD) and withdrawal (W-CAD to fiat) requests from onboarded institutional cash wallet users
- overseeing transaction activity within the cash ledger for audit and regulatory compliance
- managing administrative tasks, including the onboarding of new institutions to the cash ledger, including by granting access through a secure UI

3.5.1.3 Platform Administrator

The Consortium selected IBM Canada Limited ("IBM") as the technology service provider to develop the Samara Platform in accordance with their specifications. Having developed the Platform, IBM was well-positioned to provide cloud and node administration services (in this capacity, the "platform administrator") with respect to both the bond ledger and the cash ledger.

The Samara Platform was designed to permit participants to select their own technology providers for cloud and node administration. However, for the purposes of this experimental bond issuance, IBM was selected as both the cloud and node administrator for most of the nodes on both the bond ledger and the cash ledger. IBS was also selected to secure the cryptographic keys that control the movement of bonds and W-CAD on each ledger.

If a participant wished to execute a transaction on the platform, the participant's authorized user transmitted its instructions through the bond ledger UI, which automatically mapped the transaction instructions received to the key(s) to that participant's on the bond ledger. RBC, as bond ledger platform operator, did not intermediate this process and therefore had no opportunity to prefer certain orders. While RBC was ultimately responsible for supervising the platform administrator in its role

as custodian of the private keys to bond ledger wallets, the execution of transactions on the bond ledger was conducted by authorized users on behalf of each participant directly through the bond ledger UI, without the intervention of the platform operator or platform administrator.

3.5.2 Cash Ledger Account Set-up, Funding, and Withdrawal

W-CAD wallets on the Samara Platform are funded through participant payments made via the Lynx real-time gross settlement (RTGS) system to the BoC (see Figure 7). Upon receipt of funds in its High-Availability Banking System (HABS), BoC operators credit an internal suspense account designated for W-CAD minting. In a separate manual step, an equivalent amount of W-CAD is issued to the participant's wallet on the cash ledger.[9] Participants receive notifications of balance updates and can monitor their W-CAD holdings in real time through the Samara cash ledger UI.

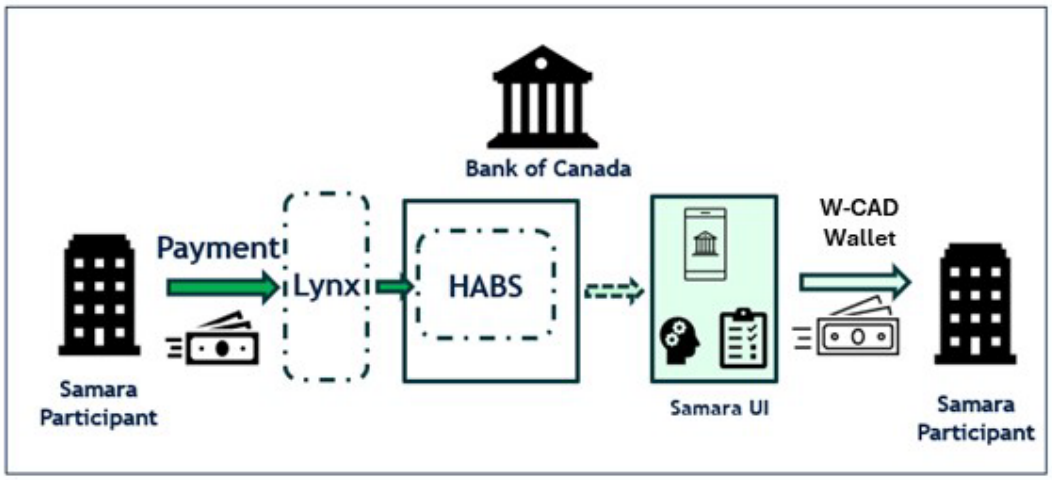

Figure 7: W-CAD Minting Process for Samara Participants

Provided that funds are not locked for an in-progress transaction, participants may initiate a withdrawal of W-CAD from their wallets on the cash ledger at any time (see Figure 8). This functionality allows users to convert their W-CAD balances back into settlement balances for transfer elsewhere. Withdrawal requests are submitted through the cash ledger UI and, once fully authorized within the Samara Platform, the BoC operations team manually initiates the corresponding outgoing Lynx payment.

[9] If the Samara Platform were to move past the experiment stage, then the funding and defunding processes could be fully automated to remove the risks of manual interventions.

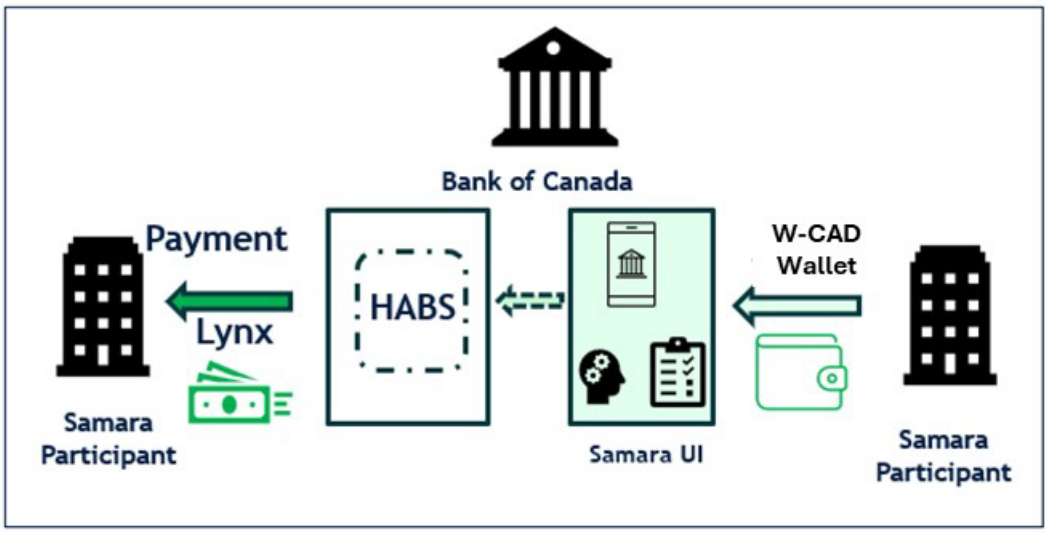

Figure 8: W-CAD Withdrawal Process for Samara Participants

3.5.3 Platform Notifications

Notifications are a key control mechanism on the Samara Platform, designed to inform relevant users of critical events and milestones related to bond issuance, life-cycle payments (e.g., coupons, redemptions), payment statuses, secondary market activity, and administrative actions such as user onboarding and profile updates.

The platform incorporates intelligent checks to detect and flag system or user-generated errors. For example, in the event of a payment failure due to business reasons (e.g., insufficient wallet funds or incorrect settlement instruction details), the bond ledger promptly alerts the relevant participants (e.g., issuer or investor back-office) via on-screen and email notifications. This facilitates prompt investigation and resolution, enabling participants to re-submit instructions without workflow disruption.

3.5.4 Risk Management, Manual Interventions and Controls

During platform development, the Consortium identified key risks that could impact workflow and implemented targeted controls to mitigate them:

Settlement Risk

As a principal risk, settlement risk is addressed through account validation and the use of HTLC within smart contracts for DvP transactions. These smart contracts ensure the presence of sufficient funds or bond quantities in participant accounts and validate settlement instructions prior to execution.

Operational Risk

The Samara Platform's integrated bond life-cycle management, supported by embedded checks and controls, significantly reduces operational risk across platform processes.

As part of its risk management framework, the Samara Platform incorporates robust manual intervention controls through a suite of mitigating actions that can be executed by the bond ledger platform operator, subject to consultation with and agreement by the issuer, if system errors occur. This capability is a key differentiator of the platform (for examples, see section 3.5.1.1).

3.5.5 Asset Protection and Segregation

Generally, market intermediaries are required to hold securities on behalf of their clients and on their own behalf in a manner that achieves safeguarding and segregation standards set by capital markets regulators. Traditionally, securities are held with a custodian that is a clearing member of a CSD. Technologically, the custody solution of the Samara Platform operates through the interaction of certain control functions that are built into its design. Consequently, traditional custodial functions performed by a third-party custodian are performed by the Platform. Segregation is achieved through the unique bond wallet addresses of the participants, and more generally though the closed loop feature of the Samara Platform, which precludes any bond transactions from occurring off-platform. Participants do not have direct access to keys for their wallets on the bond ledger or the cash ledger. Rather, the platform administrator safeguards keys under the supervision of the applicable platform operator.

The key management system for both the bond ledger and the cash ledger includes the capability to generate new keys. The loss of a key will not result in the loss of the bonds or W-CAD held in the wallet associated with that key. Because neither the bonds nor W-CAD can be transferred off-platform (subject to the issuer's exit right in limited circumstances), administrative control over the keys by the platform administrator does not give rise to the custodial risks associated with private keys to public blockchain ledgers. The role of RBC IS, as off-platform recordkeeper, provided an additional layer of asset protection by maintaining an up-to-date copy of the bond register and transaction history, if the Samara Platform malfunctions and cannot be restored.

3.5.6 Reporting Module

A reporting module has been developed to support platform participants to monitor their activity and positions on the bond ledger and cash ledger, fulfilling regulatory reporting requirements, enhancing risk management, and informing internal teams within participant institutions. Key reports—such as daily positions, end-of-day W-CAD balances, and trade history—are essential for:

1. reconciling records between Samara Platform and internal systems at JLM and issuer
2. regulatory reporting
3. generating client statements
4. off-platform record keeping

A notable feature of the module is the introduction of a “Samara Provider” role, assigned to a designated business unit within RBC IS, which was engaged by the bond ledger platform operator to provide off-platform record keeping and reconciliation services to both RBC and TD, as JLMs. This role is distinct from the bond ledger platform operator to ensure segregation of duties. It is configured with appropriate access controls to generate institution-specific reports on the bond ledger, accessible via the bond ledger user interface. These reports may also be used to respond to regulatory inquiries.

On the cash ledger, an “audit-user” role has been created for designated BoC users, enabling them to generate ad-hoc reports on transaction history and wallet balances and to manage subscriptions for automated reporting.

4.0 Samara Technology

The Samara Platform comprises two distinct blockchain ledgers, namely the bond ledger and cash ledger, which seamlessly interact using an interledger protocol (ILP) based on HTLC. The ILP runs on the nodes for both ledgers and allows information to be shared across ledgers, including for the purpose of settling transactions by atomic swap.

4.1 DLT Principles and Potential Benefits

The Samara Platform protocol incorporates core blockchain principles to enhance functionality across both the bond and cash ledgers. These principles are as follows:

- **Consensus-driven:** The platform employs a crash fault tolerant (CFT) consensus algorithm, enabling participants to collectively validate the state of each ledger. This decentralized model was designed to distribute trust across the network, removing dependence on a central authority.
- **Cryptographically secure:** The platform leverages cryptographic techniques—including secure key management, encryption, digital signatures, and hash functions—to safeguard data integrity and prevent unauthorized access or tampering.
- **Immutability:** Once recorded, data on the ledger cannot be altered or deleted. This ensures that no single entity can retroactively modify records, reinforcing the trustless and decentralized nature of the system.[10]
- **Transparency:** Participants independently verify transactions and validate ledger accuracy. This is supported by public key cryptography and distributed consensus, promoting accountability and trust within the network.

4.1.1 Hyperledger Fabric

The Samara Platform leverages the Hyperledger Fabric framework to support both the bond ledger and the cash ledger. Hyperledger Fabric is an open-source, permissioned DLT platform developed under the Hyperledger Project. It provides the structural foundation and operational logic for the ledgers.[11]

A Hyperledger Fabric blockchain network is composed of three key components: peers, orderers, and certificate authorities:

- Peers serve as foundational nodes that host ledger data, execute smart contracts (via chain code), and deliver event notifications such as transaction statuses. Each peer maintains a state database reflecting the current ledger state and a local ledger file containing the ordered blocks of validated transactions.

[10] Note that, as mentioned in the Operations section, Samara is not fully immutable in that the bond ledger platform operator can, under certain special circumstances, manually make adjustments to the ledger.

[11] For further details, refer to the official Hyperledger documentation (Hyperledger Foundation, 2020).

- Orderers implement a deterministic[12] consensus protocol to ensure all peers process transactions in the same sequence. They provide an atomic broadcast service that guarantees total transaction order across the network.
- Certificate authorities manage network membership by issuing digital identities to participants. This supports the permissioned nature of the network, enabling secure and controlled access.

Hyperledger Fabric provides a modular and flexible architecture for implementing consensus algorithms. By default, it supports CFT consensus using the Raft protocol. It also offers the capability to integrate byzantine fault Tolerant consensus mechanisms. The Samara system uses Raft as a consensus protocol.

4.1.2 Fabric Token SDK

The cash ledger in the Samara Platform is implemented using the Fabric Token software development kit (SDK), which provides a comprehensive set of application programming interfaces (APIs) and services for developing token-based distributed applications within the Hyperledger Fabric framework.

Key features of the Fabric Token SDK include:

- UTXO Model: The SDK adopts the unspent transaction output (UTXO) model for managing transactions within Hyperledger Fabric.
- Wallet-Based Key Management: Secure and accessible key management is enabled through the use of wallets.
- Privacy Options: The SDK supports multiple privacy levels, from no privacy to advanced zero-knowledge-based implementations that conceal ledger content while enforcing defined invariants.
- Auditability: Built-in support for audit trails ensures transparent and accountable transaction histories.

Two design approaches were considered for the Samara ledgers: a token-based model using the Fabric Token SDK and a direct account-based model. In line with an experimental approach, the cash ledger was implemented using the token model, while the bond ledger adopted the account model.

4.1.3 Hyperledger Weaver

The Samara Platform uses the ILP to enable secure data sharing and asset exchanges between the bond ledger and the cash ledger, leveraging the Hyperledger Weaver ILP implementation (Hyperledger Labs, 2023).

[12] Deterministic finality results from certain consensus mechanisms that guarantee settlement once consensus has been reached. In probabilistic consensus protocols, such as proof-of-work, finality only becomes more likely over time as each block is accepted.

Weaver employs HTLC to preserve data integrity, authenticity, and confidentiality during interledger communication. It transmits encrypted messages, message hashes, and digital signatures between ledgers to ensure secure and verifiable exchanges.

HTLC enables trustless, conditional transactions across networks by using cryptographic hash functions and time locks. Assets are only released when predefined conditions are met within a specified time frame. This mechanism is widely used in payment channels, atomic swaps, and decentralized applications to facilitate secure, conditional transfers without requiring mutual trust.

4.2 Samara Architecture

For this experiment, separate DLT networks were established for the bond and cash ledgers to reflect a realistic deployment model in a heterogeneous DLT environment. This separation ensures that each ledger can independently fulfill its designated functions: the bond ledger records positions and trades in securities, while the cash ledger handles issuance, withdrawals, and payments of cash without dependency on bond ledger management processes.

The platform is deployed on two different cloud providers (Microsoft Azure and IBM Cloud) to evaluate performance, scalability, and resilience under real-world conditions.

Both ledgers are built on a multi-tier Hyperledger Fabric architecture. While they share core components, each has distinct characteristics. For example, the bond ledger network includes nodes operated on behalf of each of RBC and TD, acting as JLMs, dealers, and market makers, as well as the issuer, EDC. The cash ledger includes similar participants, along with a dedicated W-CAD issuer node operated by the BoC.

Each ledger supports multiple orderers to maintain transaction sequencing and ledger integrity, ensuring all nodes have a consistent view of the transaction history. Dedicated certificate authorities manage network membership: BoC for the cash ledger and RBC (as platform operator) for the bond ledger. These authorities issue digital certificates to authenticate and authorize participants, ensuring that only verified entities can access the network, thus preserving system integrity.

Figure 9 illustrates the high-level architecture used by both the cash and asset ledgers. The diagram represents the core components and interactions for a single ledger, as both ledgers follow the same structural design.

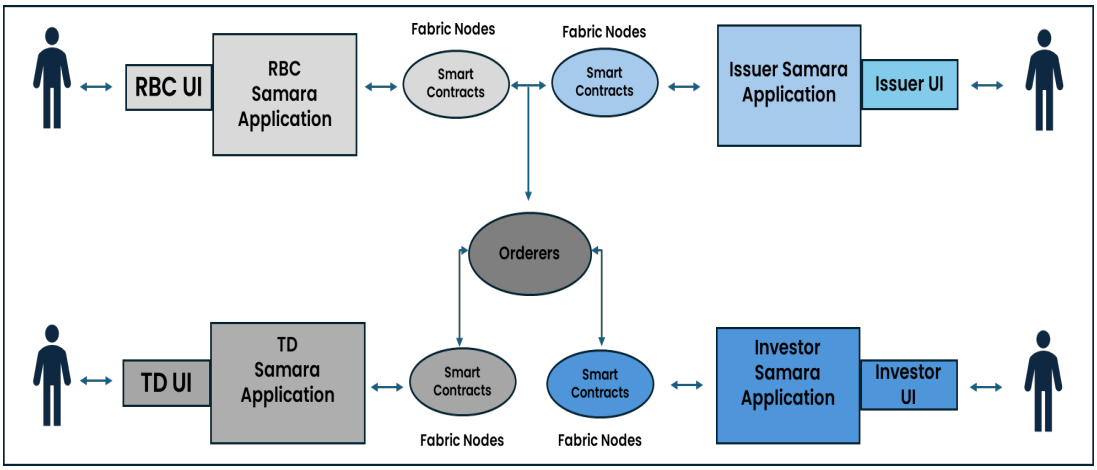

Figure 9: Samara Ledger Architecture

Each participant on the Samara Platform has access to both the bond ledger and the cash ledger, deployed via Kubernetes clusters in the cloud. Each deployment includes multiple nodes across different cloud locations to ensure high availability and disaster recovery.

Investors may choose to run their own nodes or access the ledgers through their JLM. The platform supports full infrastructure segregation, multiple participation models, and deployment flexibility across Microsoft Azure and IBM Cloud. This flexibility has enabled participants to select their preferred cloud provider, with some deploying on Azure and others on IBM Cloud.

A node in the Samara Platform represents a logical grouping of hardware and software resources, encompassing components such as the user interface, APIs/services, network modules, and databases. Figure 10 illustrates the solution stack for the Samara node highlighting the layers and components that enable the Samara node's functionality.

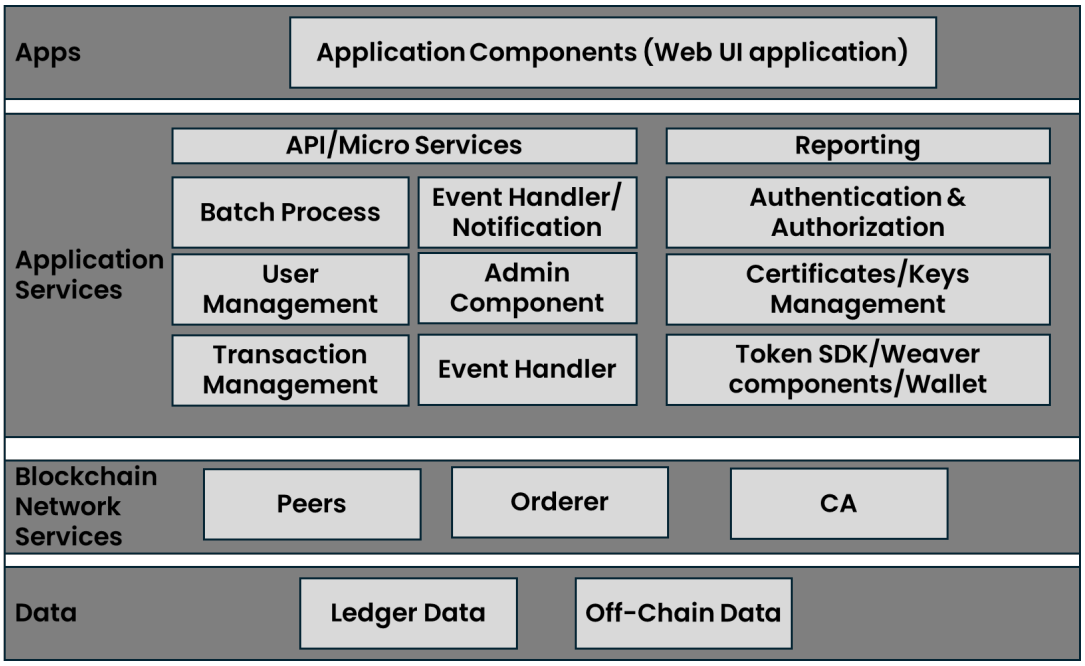

Figure 10: Samara Node Solution Stack

Two deployment models are available:

- Full stack: participants may choose to operate their own full-stack node, offering complete control and privacy over infrastructure and operations. This option involves higher costs but ensures full autonomy.
- Shared stack: participants may opt to access the platform through their JLM's nodes. This cost-free model offers a simplified set-up with reduced control and privacy over system components.

Institution users get access to the platform through a web application (Samara Dashboard UI) that is linked to a node that is operated in either "own full stack" or "shared stack" mode.

The following sections describe the key characteristics of the Samara technical design.

4.3 Fund Models

Samara supports two accounting models for managing digital assets: the account-based model and the UTXO-based model.

The **bond ledger** adopts an account-based model, where transactions are recorded as changes in account balances. This model, commonly used in platforms like Ethereum,

offers a simplified programming structure, supports concurrency control,[13] and facilitates the enforcement of regulatory rules—making it well-suited for managing securities.

In contrast, the **cash ledger** is implemented using the Fabric Token SDK and follows the UTXO model. This model enhances scalability by limiting data processing to participants who are directly involved, supports privacy through transactional anonymity and zero-knowledge proofs, and enables parallel transaction processing for improved throughput. While preserving privacy, the system ensures the BoC receives sufficient information to meet compliance requirements for anti–money laundering, sanctions and countering the financing of terrorism.

To enable interoperability between the two ledgers, Samara uses the Weaver ILP, allowing secure and conditional asset and data exchanges between the bond and cash ledgers.

4.4 Consensus and Endorsement Policy

In Hyperledger Fabric, endorsement and consensus serve complementary roles to ensure transaction validity and ledger consistency.

Endorsement validates transactions against predefined rules before they are submitted for ordering. In Samara, these rules are tailored to each transaction type. For example, a W-CAD transfer requires endorsements from all involved parties, including the BoC, to confirm the transaction's legitimacy and accuracy.

Consensus follows endorsement and ensures that transactions are ordered and committed consistently across the network. Samara uses Hyperledger Fabric's CFT consensus mechanism, which relies on an ordering service to establish a definitive transaction sequence. This guarantees that all peers maintain a synchronized view of the ledger, even in the event of node failures. As long as the transacting parties remain online and connected, the network can continue to operate reliably.

4.5 Key Management

Users access the bond ledger by entering a set of credentials, consisting of a user ID and password, on the bond ledger user interface. When a user logs in successfully, their credentials are linked to the corresponding keys, which grant access to the bond wallet owned by the participant represented by the relevant user.

For the cash component, each end-user is linked to a specific account, and keys are associated with these accounts. Accounts are owned by a dealer, investor, or issuer

[13] Concurrency control involves managing simultaneous access to account data to prevent conflicts and maintain the integrity of transactions.

through a BoC account agreement, which grants them access via a web-based cash wallet. Upon successful login, a user's credentials are mapped to the corresponding keys, enabling access to the relevant accounts, including the ability to transfer or withdraw W-CAD.

The keys used for the cash ledger and the bond ledger are separate, and each ledger employs its own method for linking user credentials to these keys. In the bond ledger, each dealer, investor and issuer has one or more users associated with their identities that are mapped to respective users' keys. In the cash ledger, each user is associated with its dealer's, investor's or issuer's account.

It is crucial to understand that end users never directly access or handle the keys themselves. The keys are securely maintained within a cloud-based secret management service, such as Azure Key Vault. Users are provided only with credentials, which the Platform uses internally to link them to their respective keys.

4.6 Security and Privacy

Access control across all layers of the Samara Platform ensures secure and role-based interaction with both the bond and cash ledgers. Authentication is performed at the UI layer, triggering role-based authorization to validate whether users have the necessary permissions to execute specific operations.

The platform's endorsement and administrative frameworks are designed to support governance across two distinct networks of participants, each with defined roles and responsibilities. These frameworks enforce structured protocols for all transactions and administrative actions, safeguarding system integrity and reliability.

Data privacy is a core design principle for both ledgers. On the bond ledger, Hyperledger Fabric's channels and private data collections restrict data visibility to authorized parties, ensuring that sensitive information is shared only on a need-to-know basis.

On the cash ledger, privacy is maintained through zero-knowledge proofs (ZKPs) integrated into the token SDK. ZKPs allow participants to prove transaction validity without revealing underlying details, ensuring confidentiality while still meeting compliance requirements.

4.7 Settlement of Transactions

4.7.1 Settlement Instructions

Samara leverages settlement instructions that mirror standard practices in traditional securities transactions. These instructions specify the source and destination wallets on each ledger, transaction amounts, and other relevant details.

The BoC cash ledger node provides an access-controlled, four-eyes–approved user interface for:

- issuing W-CAD to participants' wallets upon receipt of funds via Lynx
- approving withdrawal requests to manually initiate outgoing Lynx payments (see Section 3.5.2 for details)

The bond ledger serves as the origin for both bond and W-CAD settlement instructions because the cash ledger maintains only balance information and is not aware of bond life-cycle events.

For bond transactions—such as bond issuance from the issuer to the JLM and onward to investors or secondary market trades between market makers and investors—the platform automatically generates both bond and W-CAD settlement instructions using pre-configured standard settlement data.

In contrast, for coupon and redemption payments, only W-CAD settlement instructions are generated because no asset exchange is involved.

4.7.2 Automated Cross-Chain Transactions

The Samara Platform automates cross-ledger transactions using settlement instructions, smart contracts, and Weaver ILP based on HTLCs.

For bond exchange transactions, the process begins with the submission of bond settlement instructions when the seller initiates a transaction. This triggers the platform to generate a secret, hash it, and place an HTLC lock on the bond amount. The hashed secret is then shared with the buyer.

Subsequently, the platform submits the W-CAD settlement instructions to the cash ledger. A separate secret is generated, hashed, and used to place an HTLC lock on the corresponding W-CAD amount. The hashed secret is also shared with the buyer, and the cash ledger proceeds only after confirmation of a successful lock.

Once both locks are in place, the atomic swap is initiated. The protocol coordinates the secure and conditional exchange of assets, releasing the bond and W-CAD to their respective recipients and completing the transaction.

After the transaction is completed, users can immediately view updated ownership of both bonds and W-CAD, along with the transaction status through the bond ledger UI. The cash ledger UI shows cash positions only.

For coupon and redemption events, the workflow is streamlined. Only W-CAD settlement instructions are generated on the bond ledger and then sent to cash ledger. The final W-CAD transfer status is returned to the bond ledger to complete the process.

5.0 Legal and Regulatory Considerations

5.1 Capital Markets Regulation

The Samara Platform touches a number of capital markets regulatory frameworks, including financial markets infrastructure regulation applicable to marketplaces and clearing agencies, and the investment dealer registration regime.

From an early stage, the Consortium engaged with the principal regulators for the marketplace and clearing agency:

- the Ontario Securities Commission ("OSC"), and
- the Autorité des Marchés Financiers du Québec ("AMF," together with the OSC, the "CSA").

the Consortium also engaged with Canadian Investment Regulatory Organization ("CIRO"), as the self-regulatory organization ("SRO") for investment dealers and regulation service provider for marketplaces.

After the regulators received demonstrations of the Samara Platform and written submissions, it was determined that RBC (as bond ledger platform operator) would require exemptive relief from the requirement to be recognized as a marketplace in Ontario and Quebec and the requirements to be recognized as a clearing agency (settlement system) in Quebec.

The Consortium worked collaboratively with the OSC's Office of Economic Growth and Innovation and the AMF to obtain exemption orders that would allow RBC to operate the bond ledger for a two-year period.[14]

[14] One of the prescribed terms and conditions is that RBC Capital Markets and TD Securities Inc. remain a member in good standing of CIRO and that the Samara Platform upholds applicable core principals of Canada's marketplace regulatory framework.

CIRO staff also conducted a detailed review of all aspects of the Samara Platform. CIRO's objective was to ensure that the securities dealing and marketplace activities on the Samara Platform are broadly conducted in accordance with the CIRO rules. The Consortium articulated Samara Platform's consistency with CIRO's requirements for asset protection, segregation and regulatory reporting through a combination of legal agreements, service provider engagements and detailed technical submissions reviewed by CIRO staff. These included:

- RBC (as bond ledger platform operator) and each of RBC and TD (as dealers) entered into an asset protection agreement to confirm the safekeeping and custody of bonds on the bond ledger.
- RBC IS was engaged to provide off-platform record-keeping services.
- CIRO reviewed technical specifications of the node operations, key management and access, platform ownership and intellectual property and other matters.
- RBC and TD adopted processes to report the primary distribution and all secondary market trades of bonds made on the Platform through the Bloomberg Trade Order Management Solutions ("TOMS") execution and order management system so that CIRO could conduct trade surveillance and supervision using its regular processes.

Overall, CIRO reviewed and approved participation by RBC and TD in the Platform as an "InnovateSafe Tokenized Bond Offering Pilot"[15] within its new "InnovateSafe" regulatory sandbox.[16] CIRO worked collaboratively and expeditiously with the Dealers to finalize terms and conditions that reasonably balance CIRO's market integrity concerns with support for innovation in the capital markets.

5.2 Bond Issuance and Documentation

As a distributed blockchain network, each node on the bond ledger maintains a distinct copy of the current state of the ledger. Transactions on the bond ledger are finalized when there is consensus across all nodes regarding a transfer of bonds from one wallet to another. However, corporate law dictates that a corporation must maintain a securities register and a register of transfers of securities at a location designated by the director of the corporation.

While corporate law contemplates that securities may be uncertificated and maintained in book-entry only form, it does not contemplate the maintenance of records on a distributed ledger. Consequently, to simplify compliance with existing corporate law and

[15] CIRO launches InnovateSafe, a regulatory sandbox designed to accelerate the safe development of transformative technologies | Canadian Investment Regulatory Organization

[16] In connection with its approval, CIRO imposed specific terms and conditions on the dealers relating to scope, responsibilities and accountability, and other items.

related CIRO rules, the copy of the bond ledger recorded on the platform operator's node was designated as the official register of bonds.

The documentation used in EDC's bond issuance was a hybrid of the conventional and the novel. For example, the bonds were issued by way of a customized Deed Governing the Issuance of Canadian Digital Notes, Pricing Supplement and Offering Memorandum. The documentation included provisions explaining how the bonds would be recorded and transferred on the bond ledger on the Samara Platform. As well, the documentation confirmed the location of the definitive register and prescribed mechanisms for transferring the bonds off the platform and issuing the bonds in certificated or book-entry form. The documentation also set out an early redemption option at the election of the issuer if a platform malfunction occurred and could not be cured to the satisfaction of the issuer.

In addition, the Consortium developed and documented protocols for primary distribution and secondary trading that were prescribed in a manual that governs all activities on the Samara platform (the "Platform Manual"). These protocols must be accepted by all participants and their authorized users as a condition of accessing the platform. Similarly, all participants were required to enter into a user agreement with the bond ledger platform operator and a BoC account agreement with the BoC. This off-chain documentation prescribed the rights and obligations of the platform operators and all participants, providing the legal foundation for on-chain processes that occurred on the platform.

5.3 Central Bank Money on the Platform

The BoC operates the cash component of the Samara Platform pursuant to the authority granted to it under the Payment Clearing and Settlement Act (Canada) ("PCSA"). Paragraph 12(c) of the PCSA specifically authorizes the BoC to accept deposits from, and offer accounts to, participants of a Canadian clearing and settlement system. Pursuant to the PCSA, the Platform is a clearing and settlement system because it is an arrangement for the clearing and settlement of bonds (securities) transactions, which also clears payment obligations arising from those securities transactions for the purpose of settlement of such obligations effected through adjustments to the participants' accounts. For the purposes of the Platform, the cash wallets represent the participants' accounts.

As noted above, participants on the cash component are required to enter into a Samara account agreement with the BoC and to accept the terms of the Platform Manual. Pursuant to section 13.2 of the PCSA, the BoC is authorized to enter into agreements with a participant of a clearing house, notably, in respect of the exercise of the BoC's powers

and the performance of its duties and functions. The W-CAD is a digital representation of wholesale Canadian dollars created and managed by the BoC on the cash ledger. The BoC controls access to, and monitors activity on, the cash component as the operator of the cash component.

6.0 Lessons Learned

6.1 Efficiency Gains

Project Samara demonstrated that a DLT-based capital markets platform can generate operational efficiencies across the full bond life cycle. Automation of key processes—such as term-sheet creation, trade booking, settlement instruction generation, and reporting—reduced manual interventions and off-platform coordination. Same-day (T+0) settlement accelerated transaction completion relative to conventional multi-day settlement cycles.

The use of a single, shared ledger architecture provided a common source of truth for all participants, materially reducing reconciliation efforts across dealer, issuer, and investor back offices. Real-time visibility into bond positions and cash balances enhanced data integrity and streamlined workflows across issuance, settlement, and post-issuance life-cycle events. Over the life of the bond, consolidating issuance, settlement, and servicing functions onto a single platform reduced fragmentation relative to traditional infrastructures.

6.2 Operational and Governance Complexity

The efficiency gains noted above were partially offset by increased operational and governance complexity. The decentralized architecture required participants to operate or access distributed infrastructure, increasing set-up, operating, and cyber security costs compared with those of centralized systems. For Samara, the estimated cost of deploying a node was about CAD$65,000, with an additional CAD$15,000 per month in cloud expenses to operate it. Each node-operating participant is also required to have a robust IT framework. Consensus and endorsement mechanisms also duplicated certain processing activities across nodes, raising system-wide operational overhead.

Liquidity costs also increased because of the pre-funding requirements needed to support atomic settlement under a real-time gross settlement model. In addition, decentralized system design required the creation of new governance arrangements, including defined platform operator roles, exception handling procedures, and coordination mechanisms across independently governed entities. Compared with traditional centralized models, these arrangements increased governance and required closer coordination among participants and regulators.

6.3 Risk Management

Atomic DvP across independently governed bond and cash ledgers significantly reduced counterparty and settlement risk by ensuring that securities and cash were exchanged

simultaneously or not at all. Automated validation and straight through processing reduced the likelihood of failed settlements and post-trade disputes.

At the same time, Project Samara also introduced new aspects of operational risk. These included risks related to management of cryptographic keys. Key management forms a risk in any blockchain network because transactions need to be approved and digitally signed by the counterparties. On the Samara Platform, keys are stored and managed via standard key management services in IBM Cloud and Microsoft Azure Cloud. Key management adds to both the complexity of the system relative to traditional password management and the overall operational costs involved.

While these risks were mitigated through layered operational controls, platform operator interventions, and off-platform record-keeping arrangements, they highlight the importance of tailored risk management frameworks for DLT-based infrastructures.

From a resilience perspective, the distributed node architecture reduced reliance on single points of failure. Outages affecting one participant's infrastructure did not necessarily result in system-wide loss of access, contrasting with centralized systems. However, resilience benefits may be partially offset if JLMs emerge as key access points for issuers and investors, reintroducing some degree of functional centralization.

6.4 Regulatory and Legal Considerations

Close engagement with regulators of capital markets was essential to the execution of Project Samara. The designation of RBC as platform operator for the bond ledger enabled the Consortium to obtain exemptive relief from the marketplace and clearing agency (settlement system) requirements of applicable securities laws. This exemptive relief implies that the marketplace and clearing agency functions are, in fact, being performed by the platform operator.

Existing legal and regulatory frameworks governing securities issuance, custody, marketplaces, and clearing agencies are built around centralized intermediaries and required exemptions or adaptations to accommodate a DLT-based model. One instance of this was with regards to the CIRO rules that expect its members to hold securities on behalf of their investors at an "acceptable securities location" (typically at a CSD). Without the involvement of a CSD in Samara, CIRO needed to be satisfied that the Samara Platform is an "acceptable internal storage location" for securities. This was done via legal agreements, service provider engagements and detailed technical submissions (See Section 5.1).

The continued necessity of centralized roles such as a marketplace operator, custodian, and off-platform trade reporting highlighted areas of misalignment between current regulatory frameworks and core DLT principles such as decentralization and consensus-based record keeping. Corporate law requirements for a centralized securities register further constrained the ability to rely exclusively on a distributed ledger. Taken together, these experiences suggest that broader adoption of DLT in capital markets would likely require legal and regulatory evolution in addition to technological change.

6.5 Technical Design Lessons

Project Samara yielded several technical design insights relevant for future DLT-based capital markets platforms.

First, the platform deliberately employed different accounting models across ledgers: an account-based model for the bond ledger and a token-based model for the cash ledger. This design choice was made to test both approaches rather than to promote a single preferred model. The account-based model simplified smart contract design for securities life-cycle management, while the token-based model was better suited to cash settlement, scalability, and privacy requirements. The experience suggests that technical design choices should be driven by functional requirements and use cases rather than a one size fits all architectural preference.

Second, operating a distributed system requires careful consideration of infrastructure and operating costs (see Section 6.2). Participants could choose to operate their own nodes or access the platform via shared infrastructure; running a node involved non-trivial deployment and ongoing cloud costs. These costs may limit full node participation to larger or more frequent market participants, with implications for market structure and access.

Third, the use of cryptographic keys and multiple certificates, while offering enhanced security, presents significant challenges compared to traditional credential systems, such as ledger credentials. Although managed key services and credential-based access can shield end users from much of this complexity, production-scale platforms must still address critical issues, including certificate rotation, key recovery, access control, and compliance requirements.

6.6 Adoption Barriers

Despite technical feasibility, several factors may limit broader adoption of DLT-based capital markets infrastructure. First, there continues to be uncertainty among market participants about the maturity, reliability, and cost-effectiveness of DLT. This would point to a persistent role (at least over a transition period) for central authorities or

intermediaries, which is contrary to the ethos of using a DLT framework. In Samara, there was a reduced reliance on certain traditional intermediaries, but participants generally did not expect fundamental changes to core roles such as JLMs, market makers, or platform operators.

Second, the current legal and regulatory structure is not set up for DLT-based infrastructures. Amendments to corporate law and exemptions from securities regulation will be necessary to accommodate the use of DLT to record ownership and transfers of securities. Exemptive relief under special innovation initiatives or sandboxes can serve as a useful regulatory tool to foster innovation. However, without legal and regulatory certainty, it would be difficult for DLT-based systems to truly show their potential.

As a result, adoption is likely to be gradual, with hybrid models combining decentralized technology and centralized oversight emerging as the most practical near-term path.

7.0 Conclusion

The Samara Project was designed as an experiment to test the benefits and costs of DLT in a real-world financial market setting. The Project revealed many fundamental lessons for participants about the technology and its value for tokenized securities trading and settlement over the full life cycle. Experiments such as this are an important part of the learning process for new technology and are especially useful in a real-world setting as part of a public-private collaboration. The extra effort of building out the system in a real-world setting was valuable at identifying legal, regulatory, governance, operational, cost and risk management issues compared with lessons that could not be revealed by previous tests, such as Project Jasper.

Overall, the main lesson of the work is that DLT seems to offer some promise of net efficiency gains compared with traditional technology, but that benefit is unlikely to be as significant as some argue or believe. There are observable benefits in some areas, but there are costs or increased risks in others that may offset those gains. The cost and complexity of the technology will likely make its wide-spread adoption long and difficult. The overall payoff in many ways is still uncertain and will only be revealed by a large-scale production system that is fully tested by:

- the economic ups and downs of the financial system over the business cycle. and
- the typical operational events that any system would experience during that time.

Continued experimentation and collaboration between the public and private sectors are essential for further advancing understanding and informing future developments. Future experiments could usefully look at leveraging smart contracts to enable complex derivatives on DLT. The role of the regulator on a DLT platform (to improve its information access and oversight while respecting the confidentiality expected by participants) would be another avenue for investigation. Fully automated links to traditional systems and participant internal systems was not explored in the Samara Project but would be an essential bridge towards wider adoption of the technology.

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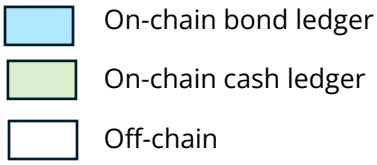
Appendix I: Comparison of Current Process for Issuing Bonds against. Samara Platform Process

Process	Current			Samara
	Timing	Description	Timing	Description
Draft Term sheet	T-1	Draft term sheet (docx, pdf) is exchanged by email for review and comments by issuer and JLMs.	T+0	Draft term sheet is created digitally on the platform for review and comments by the issuer and JLMs
Deal Announcement	T-1	Email, Bloomberg	T+0	On Samara Platform, email and Bloomberg
Book Building	T+0	e-Book platform (investors send orders to JLMs, and JLMs enter them in the e-Book)	T+0	On Samara Platform, Direct entry by investors
Allocation	T+0	Allocation review is typically done with the e-book extract (spreadsheet) and finalized through emails	T+0	Draft allocation shared via Samara Platform for the issuer to directly comment or update; Final allocation released by JLMs on-platform after incorporating issuer's comments
Pricing	T+0	Recorded phone line	T+0	Recorded phone line
Final Term Sheet	T+0	Final term sheet is sent by email for review and approval by the issuer	T+0	JLMs update the final pricing information on the Samara 'digital' term sheet and send it for the issuer's review and approval on-platform
Legal Documents	T+4	Reviewed and finalized offline	T+0	Reviewed and finalized offline except for the final term sheet; Relevant finalized documents uploaded to Samara Document Repository and viewable by appropriate parties
Trade Booking	T+0	Manually booked in a separate system	T+0	No separate booking; Final term sheet translates into the digital bond on the platform and is updated on the bond and cash ledgers

Trade Review	T+1	Operations team reviews trade booking for accuracy post-booking	T+0	Operations team can concurrently review the final term sheet on-platform even while in draft stage; four-eye check is in place before final term sheet approval
Settlement	T+7		T+0	



Appendix II: Summary T+0 Settlement Events in both Cash and Bond Ledgers

Off-Chain	On-Chain	
	Bond Ledger	**Cash Ledger**
JLM vs. Issuer negotiation and signing of Final Terms [Process initiated prior to T+0]		
Advance preparation of fiat settlement accounts (at BoC) by all parties	• Upload the Platform Rules and Procedures • Participants onboarded by bond ledger-platform operator • JLMs initiate indicative term-sheet • Issuer reviews and approves indicative term-sheet	• Participants onboarded by cash ledger platform operator • Advance preparation and set-up of W-CAD and bond settlement accounts by all parties
	JLMs announce issuer-approved bond launch with initial economics	
Marketing of the deal	Investors and JLM submit Expression of Interest (EOI) through their dashboards	
	Book allocation is reviewed and confirmed	Investors/JLM transfer fiat to fund wallets
	Investors agree to the bond purchase	BoC mints appropriate W-CAD to fund Investor/JLM wallets
Pricing call	Final term sheet is agreed on and distributed	
	Bond settlement process is reviewed	Smart contract triggers verification and locking of W-CAD
Confirmation	Investors approve the total settlement	Releases lock on unused prefunded amounts
	Bond created in issuer's account	
	Security Instruction DvP ready	
Finalized and signed legal documentation	Final terms (with authorized signatures) are uploaded	
Off-chain communication by JLM with all participants prior to executing atomic swap	System initiates atomic swap between issuer and JLM [DvP1]—Transfer of bonds from issuer to JLM account	Issuer wallet gets credited and JLM wallet gets debited
	System initiates atomic swap between JLM and investors [DvP2]—Transfer of bonds from JLM to Investor(s) account	JLM wallet gets credited and investors' wallets get debited
	Notification of final DvP status to all participants	Confirmation of successful W-CAD transfer

Headnote

OSC LaunchPad -- Application for time-limited relief from marketplace requirements -- relief sought to allow the Filer to operate a limited scope experimental research endeavour that seeks to evaluate the use of distributed ledger technology for the issuance, distribution, management and trading of Bonds and atomic settlement of trades in such Bonds -- relief granted subject to certain conditions set out in the decision, including that for purposes of the Project proof of concept, the uncertificated Bonds will trade exclusively on the Platform and the only investors will be RBC and TD -- relief from marketplace requirements is time-limited for pilot testing purposes -- relief granted based on the particular facts and circumstances of the application with the objective of fostering innovative in Canada's capital markets--decision should not be viewed as precedent for other filers in the jurisdictions of Canada.

Applicable Legislative Provisions

Instrument, Rule or Policy cited

National Policy 11-203 *Process for Exemptive Relief Applications in Multiple Jurisdictions*, s 3.4

National Instrument 21-101 *Marketplace Operation*, 15.1

National Instrument 23-101 *Trading Rules*, s. 12.1

National Instrument 23-103 *Electronic Trading and Direct Access to Marketplaces*, s. 10

March 2, 2026

IN THE MATTER OF
THE SECURITIES LEGISLATION OF ONTARIO AND QUÉBEC

AND

IN THE MATTER OF
THE PROCESS FOR EXEMPTIVE RELIEF APPLICATIONS IN MULTIPLE JURISDICTIONS

AND

IN THE MATTER OF
RBC DOMINION SECURITIES INC.
(the Filer)

DECISION

Background

The Filer proposes to operate a private, permissioned electronic platform that uses distributed ledger technology to issue, distribute and facilitate the trading of bonds among a small group of institutional market participants (the **Platform**). The Platform arises from a collaborative experimental research endeavour of

the Filer, the TD Securities division of the Toronto Dominion Bank (**TD Bank**), TD Securities Inc. (together with TD Bank, **TD**), the Bank of Canada (**BoC**) and Export Development Canada (**EDC**).

The Ontario Securities Commission (the **OSC**) through its Office of Economic Growth and Innovation engages with businesses that have innovative products, services or applications to support responsible capital markets innovation. The OSC's LaunchPad is a support program designed to help businesses navigate regulatory requirements and, where appropriate, work with businesses to develop flexible regulatory approaches to allow them to test their innovative business models.

To foster innovation, the OSC and the Autorité des marchés financiers have considered the Filer's application for the Requested Relief (defined below) to allow the Filer to test the Platform and evaluate the use of distributed ledger technology for the issuance, distribution, management and trading of the Bonds (defined below) and atomic settlement of trades in such Bonds. The overall goal of the Filer seeking the Requested Relief in connection with the testing of the Platform is to facilitate innovation in the Canadian capital markets, while upholding the regulatory mandate of promoting investor protection and fair and efficient capital markets.

This decision (the **Decision**) is based on the unique facts and circumstances of the Filer and for the limited purpose of allowing the Filer to operate its proof-of-concept Platform as described herein. Accordingly, this Decision should not be viewed as a precedent for other filers.

Relief Requested

The securities regulatory authority or regulator in each of Ontario (**Principal Regulator**) and Québec (together with the Principal Regulator, the **Coordinated Review Decision Makers**) has received an application from the Filer (the **Application**) for a decision under the securities legislation of those jurisdictions (the **Legislation**) exempting the Filer from the whole of National Instrument 21-101 *Marketplace Operation* (**NI 21-101**), National Instrument 23-101 *Trading Rules*, and National Instrument 23-103 *Electronic Trading and Direct Access to Marketplaces* (the **Requested Relief**).

Under National Policy 11-203 *Process for Exemptive Relief Applications in Multiple Jurisdictions*:

(a) the OSC is the Principal Regulator for this Application; and

(b) the Decision evidences the decision of each Coordinated Review Decision Maker.

Interpretation

Terms defined in National Instrument 14-101 *Definitions* have the same meaning if used in this Decision, unless otherwise defined.

In this Decision, the following terms have the following meanings:

"**Bond**" means a Canadian dollar (**CAD**) denominated bond issued by the Issuer (defined below) in uncertificated form as represented by the debt security tokens recorded on the Bond Ledger.

"**Dealer**" means each of the Filer and TD, in that capacity, as well as any other dealer that may be granted access to the Platform in accordance with the terms of this Decision, and "**Dealers**" means, together, the Filer and TD, as well as any other dealer that may be granted access to the Platform in accordance with the terms of this Decision.

"**Issuer**" means the issuer of the Bonds, namely EDC.

"**Ledger**" means each of the Bond Ledger and the Cash Ledger (each as defined below) or any one of them, as the case may be.

"**Node**" means an instance of the Project's (defined below) application software that operates a version of a Ledger and functions to: (i) check if transactions on the Ledger are valid; (ii) validate blocks of transactions; and, (iii) broadcast information relating to validated transactions to other Nodes for the purpose of synchronizing their respective versions of the relevant Ledger.

"**Transfer Event**" means certain conditions set out in the Bond (including if the Issuer has reasonable concerns regarding the viability, performance, integrity, availability or security of the Platform or determines that transferring the Bonds off-Platform is required to protect Investors), which upon the occurrence thereof, the Issuer is permitted to transfer the Bonds off-Platform.

"**W-CAD**" means a digital representation of wholesale Canadian dollars created and managed by the BoC on the Cash Ledger for the purposes of the Project, held in a Cash Wallet, and exchangeable into money in the Lynx payment system.

Representations

This Decision is based on the following facts represented by the Filer:

The Filer

1. The Filer is a corporation incorporated under the federal laws of Canada with its principal office in Toronto, Ontario.

2. All of the outstanding common shares of the Filer are held by RBC Dominion Securities Limited, a subsidiary of the Royal Bank of Canada.

3. The Filer does not have any securities listed or quoted on an exchange or marketplace in any jurisdiction inside or outside of Canada.

4. The Filer is registered as an investment dealer in all jurisdictions of Canada and is a member of the Canadian Investment Regulatory Organization (**CIRO**).

5. The Filer is not in default of securities legislation in any jurisdiction of Canada.

The Project

6. The Filer, TD, BoC and EDC have collaborated on an experimental research endeavour that seeks to evaluate the use of distributed ledger technology for the issuance, distribution, management and trading of Bonds and atomic settlement of trades in such Bonds in W-CAD (the **Project**). The Project will evaluate certain agreed research hypotheses and publicly share key findings in research publications.

7. The Project utilizes two private distributed ledgers: one for the Bonds (the **Bond Ledger**) and one for the W-CAD (the **Cash Ledger**) and application software that allows for information to be exchanged between the Bond Ledger and the Cash Ledger to facilitate atomic settlement of transactions (the **Inter-Ledger Protocol**).

8. The Bond Ledger is distributed across a series of Nodes hosted on a cloud server, each of which operates a version of the Bond Ledger and the Inter-Ledger Protocol (the **Bond Ledger Nodes**). Each Bond Ledger Node is accessible, on a permissioned basis, through the internet via a user interface (the **Bond Ledger UI**). The Platform is comprised of the Bond Ledger Nodes and the

Bond Ledger UI and is maintained and operated by the Filer (in such capacity, the **Platform Operator**).

9. The Cash Ledger is distributed across a series of Nodes hosted on cloud servers, each of which operates a version of the Cash Ledger and the Inter-Ledger Protocol (the **Cash Ledger Nodes**). Each Cash Ledger Node is accessible, on a permissioned basis, through the internet via a user interface (the **Cash Ledger UI**). The BoC operates the Cash Ledger Nodes and the Cash Ledger UI (in such capacity, the **Cash Ledger Operator**).

10. The Project involves: (a) the issuance by the Issuer of Bonds on the Platform; (b) the issuance of W-CAD by the BoC on the Cash Ledger; (c) atomically settled trading of Bonds through the Inter-ledger Protocol linking the Bond Ledger and the Cash Ledger to facilitate Platform transactions; and, (d) the management of the Bonds on the Platform throughout their entire life cycle, including redemption and the payment of interest.

11. The Bonds will not be issued or traded to the public. While the Platform is designed to accept third-party investors, for purposes of the Project proof of concept, the only investors will be (i) Royal Bank of Canada Treasury, as a client of RBC Dominion Securities Inc., and (ii) The Toronto-Dominion Bank (collectively, and together with any other investor that may thereafter be granted access to the Platform in accordance with the terms of this Decision, the **Investors**).

12. The Bonds issued by the Issuer qualify for distribution under section 2.34 of National Instrument 45-106 and section 73(1) of the *Securities Act* (Ontario) (the **Act**), as they constitute debt securities issued or guaranteed by the Government of Canada. EDC, the Issuer, is for all purposes an agent of His Majesty in right of Canada and has the full faith and credit obligations of the Government of Canada. For the same reason, the dealer registration requirement does not apply pursuant to the exemption set out in section 8.21(2) of National Instrument 31-103 *Registration Requirements, Exemptions and Ongoing Registrant Obligations* and section 35(1) of the Act.

Platform Operations

13. The Filer and TD, as Dealers, are joint lead managers of the Bond offering and will act as market makers to facilitate secondary market trading in Bonds on the Platform, with RBC Treasury and TD Bank, as Investors.

14. The Platform Operator authorizes participating Dealers and Investors (collectively, **Participants**) to access a designated Bond Ledger Node on the Platform through the Bond Ledger UI. Each Participant is assigned a unique, cryptographically secured digital storage and access mechanism on the Bond Ledger (a **Bond Wallet**). The Issuer is also authorized to access the Platform through the Bond Ledger UI and is assigned a Bond Wallet, but has limited rights commensurate with its role as Issuer of the Bonds.

15. The Cash Ledger Operator authorizes Participants to access a designated Cash Ledger Node through the Cash Ledger UI. Each Participant is assigned a unique, cryptographically secured digital storage and access mechanism on the Cash Ledger (a **Cash Wallet**). The Issuer is also authorized to access the Cash Ledger through the Cash Ledger UI and is assigned a Cash Wallet.

16. The Platform is only accessible to the Dealers, Investors and the Issuer through the Bond Ledger UI using login credentials. The Filer, as Dealer, has the authority to direct that appropriate access

be granted to its Investor. TD, as Dealer, has the authority to direct that appropriate access be granted to its Investor.

17. The Dealers will complete the initial purchase of Bonds from the Issuer on the Platform and subsequently resell the Bonds to the Investors.

18. W-CAD is the digital representation of Canadian dollar currency used to effect transactions on the Platform. Participants and the Issuer will fund their respective Cash Wallets by transferring fiat currency in Canadian dollars to the BoC, which will then be reflected as W-CAD in the equivalent amount in the relevant Cash Wallet. W-CAD transactions will be validated, recorded and broadcasted to the Cash Ledger.

19. The Inter-ledger Protocol is application software that runs on each Node. The Inter-ledger Protocol synchronizes, on a transaction-by-transaction basis, movements of Bonds and W-CAD between the Bond Ledger and the Cash Ledger. The Inter-ledger Protocol validates buy orders by confirming that there is sufficient W-CAD to fund the purchase price of the Bonds in the buyer's Cash Wallet, and validates sell orders by confirming that there are sufficient Bonds in the seller's Bond Wallet to atomically settle the trade. Upon such validation, the orders match, the assets are settled and broadcasted to all Nodes.

20. All secondary market trading in Bonds must take place on the Platform. The Dealers will act as market makers and respond as principals to any request for quote (**RFQ**) message received through the Platform from Investors seeking to buy or sell Bonds. The quotes, if accepted, will become binding on the Dealer responding to the RFQ. To execute and settle the ensuing trade, the Platform will engage its atomic settlement features through the Inter-ledger Protocol to make the necessary transfers on the Ledgers.

21. Dealers and Investors can enter orders to buy or sell Bonds by logging into the Bond Ledger UI, and can fund their Cash Wallets by logging into the Cash Ledger UI. Both user interfaces are protected by multi-factor authentication. Dealers and Investors and their authorized users are required to keep their login credentials secure and perform Platform activities in accordance with their respective organizations' cybersecurity policies and procedures that apply generally to their operations, and in particular, to fixed-income trading operations.

22. Interest payments, principal repayments and redemptions of Bonds will be funded on notice by the Issuer to a Participant. Payment will then be funded by the Issuer distributing W-CAD to the Cash Wallets of the relevant holders of Bonds, which can then be subsequently converted by such holders to fiat currency in Canadian dollars. Upon redemption or retirement of Bonds, the redemption payment to the Cash Wallet will be accompanied by the transfer to the Issuer of the Bonds on the Platform, following which the Bonds will be removed from the Bond Ledger and cancelled.

23. The Platform is a facility that brings together orders for bonds of multiple buyers and sellers and uses established, non-discretionary methods under which orders interact with each other and buyers and sellers agree to the terms of a trade. As a result, the Platform is a "marketplace" as defined in the Act and NI 21-101.

Platform Administration and Key Management

24. The Filer, TD and BoC selected a third-party development vendor to develop the application software for the Project. The Platform Operator has engaged the third-party vendor to provide cloud and software administration services for all Bond Ledger Nodes (the **Platform Administrator**). The Platform Administrator also provides cloud and software administration services for the Cash

Ledger Nodes designated to each of the Filer, TD and the Issuer. The BoC administers its own Cash Ledger Node.

25. The Platform Administrator provides the cloud environment that hosts all Bond Ledger Nodes and all Cash Ledger Nodes, other than the BoC's Cash Ledger Node.

26. Transfers of Bonds between Bond Wallets on the Bond Ledger and atomic settlement of Bonds and W-CAD pursuant to the Inter-ledger Protocol are controlled by cryptographic keys (**Keys**).

27. If a Dealer or Investor wishes to execute a transaction on the Platform, the Dealer's or Investor's authorized user will transmit its instructions through the Bond Ledger UI, which automatically maps the transaction instructions received to the Key(s) to that Dealer's or Investor's Bond Wallet. The Platform Operator does not intermediate, and is not actively involved in, this process.

28. The Platform Operator has delegated to the Platform Administrator responsibility for safeguarding and administering the Keys to all Bond Wallets, assisting authorized users with password resets and transmitting instructions through the Bond Ledger UI.

29. The Platform's key management system includes the capability to generate new Keys. The loss of a Key to a Bond Wallet will not result in the loss of the Bonds held in that Bond Wallet. Similarly, the loss of a Key to a Cash Wallet will not result in the loss of the W-CAD held in that Cash Wallet. Because the Bonds cannot be transferred off-Platform (subject to a Transfer Event) and the W-CAD cannot be transferred off the Cash Ledger, administrative control over the Keys by the Platform Administrator does not give rise to the custodial risks associated with private keys to public, permissionless blockchain ledgers.

30. While the Platform Operator is ultimately responsible for supervising the Platform Administrator in its role as custodian of Keys, the execution of transactions on the Platform is conducted by authorized users on behalf of each Dealer or Investor directly through the Bond Ledger UI, without the intervention of the Platform Operator or Platform Administrator.

Recordkeeping and Controls

31. The Platform prevents off-chain movement of Bonds and performs safekeeping, transaction management control and asset administration.

32. The Dealers will hold Bonds on their own behalf in unique Bond Wallets in the names of the Dealers. Additionally, Dealers will hold Bonds on behalf of Investors in unique Bond Wallets in the name of each Investor. All Bonds will be clearly recorded in each Bond Wallet on the Bond Ledger as being separate and apart from the assets of the Platform Operator and each Dealer. The definitive register of Bonds will be kept by the Platform Operator on its designated Bond Ledger Node.

33. If error entries occur on the Platform, they will be resolved according to an "Error Correction Protocol" agreed to by the Filer, the Issuer, and the Participants, which sets out various agreed protocols for resolving errors in the Bond Ledger and for handling any disputes arising therefrom.

34. RBC Investor Services Trust, a trust company regulated by the Office of the Superintendent of Financial Institutions and an affiliate of the Filer, will perform off-Platform recordkeeping and post-trade reconciliation services for Bond positions and transactions on the Platform.

Decision

Each of the Coordinated Review Decision Makers (including the Principal Regulator) is satisfied that the Decision in respect of the Requested Relief satisfies the test set out in the securities legislation of its

jurisdiction for the relevant regulator or securities regulatory authority to make the Decision in respect of the Requested Relief.

The Decision of each Coordinated Review Decision Maker under the securities legislation of its jurisdiction is that the Requested Relief is granted, provided that:

A. The Filer remains registered as an investment dealer in all jurisdictions of Canada and a member of CIRO in good standing.

B. For so long as TD is a Dealer on the Platform, The Toronto-Dominion Bank remains a Schedule 1 bank under the federal laws of Canada in good standing, and TD Securities Inc. remains registered as an investment dealer in all jurisdictions of Canada and a member of CIRO in good standing.

C. The Filer, as Platform Operator, will limit the assets made available for trading by Participants on the Platform to the Bonds issued by the Issuer. The Platform will not facilitate the trading or settlement of any digital assets created on other platforms or that are able to be traded outside of the Platform.

D. The Bonds will trade exclusively on the Platform (subject to the occurrence of any Transfer Event).

E. The Filer, as Platform Operator, will not permit unreasonable discrimination among Participants when responding to RFQs.

F. The Filer will not unreasonably prohibit, condition or limit access by the Participants to the Platform.

G. The Filer will establish written standards for access to the Platform.

H. The Filer will have internal controls over systems that support RFQ entry, RFQ acceptance and trade execution, including controls provided by third parties under outsourcing arrangements.

I. The Filer will provide at least 45 days' advance notice to the Coordinated Review Decision Makers of any material or significant change to the operations of the Platform or the standards for access to the Platform.

J. The Filer will have information technology controls, including controls relating to operations, information security, change management, problem management, network support, cyber resilience and system software support, including controls provided by third parties under outsourcing arrangements.

K. The Filer will notify the Coordinated Review Decision Makers of any systems failure, malfunction, delay or security breach on the Platform that has a materially negative effect on Investors. Such notification will be provided within a reasonable time following the occurrence thereof, having regard to the nature and the impact of any such event.

L. The Filer will keep books, records and other documents reasonably necessary for the proper recording of its business, including:

   (a) a record of all Participants granted or denied access to the Platform;

   (b) daily trading summaries of Bonds traded and transaction volumes and values;

   (c) records of all RFQs, quotes and trades, including the price, volume, times when the RFQs are entered, answered and accepted; and

   (d) a copy of all information posted by the Filer or the Issuer on the Platform.

M. In addition to any other reporting required by securities legislation, the Filer will provide, on a timely basis, any report, document or information to the Coordinated Review Decision Maker that may be requested by such Coordinated Review Decision Maker from time to time for the purpose of monitoring compliance with the Legislation and the conditions in the Decision, in a format acceptable to such Coordinated Review Decision Maker.

N. Before granting access to the Platform to any Dealer other than the Filer and TD, or to any Investor other than RBC Treasury and TD Bank, the Filer shall obtain prior written approval from the Coordinated Review Decision Makers.

O. This Decision may be amended by the Principal Regulator from time to time upon prior written notice to the Filer.

P. This Decision shall expire on December 31, 2027.

"Benjamin Matthews"
Vice President, Office of Economic Growth and Innovation
Ontario Securities Commission