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Impact of Distributed Ledger Technology

in Global Capital Markets

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About GFMA

GFMA represents the common interests of the world's leading financial and capital markets participants to provide a collective voice on matters that support global capital markets. It also advocates on policies to address risks that have no borders, regional market developments that impact global capital markets, and policies that promote efficient cross-border capital flows to end users. GFMA efficiently connects savers and borrowers, thereby benefiting broader global economic growth. The Association for Financial Markets in Europe (AFME) located in London, Brussels, and Frankfurt; the Asia Securities Industry & Financial Markets Association (ASIFMA) in Hong Kong; and the Securities Industry and Financial Markets Association (SIFMA) in New York and Washington are, respectively, the European, Asian, and North American members of GFMA.

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Foreword

Trust remains a foundational element of effective and robust capital markets. Regulatory policy is a core component of trust, ensuring market participants operate within a set of common rules that appropriately protect all stakeholders and meet the regulatory outcomes of policymakers. Balanced regulatory policy involves weighing growth and innovation with safety and soundness, market integrity, consumer protection, and overall financial stability.

The development of Distributed Ledger Technology (**"DLT"**) and the digital asset ecosystem motivates all market stakeholders to look to the future. Regulatory policy should seek to instill the same stability and protections in digital asset markets that exist in traditional, regulated financial markets, whilst allowing and supporting innovation. DLT holds promise for unlocking efficiencies, driving growth, and harnessing such innovation. Payments, settlement, and lifecycle events may be accomplished with greater safety and more efficiency; access may be expanded to a broader set of participants; and markets and market infrastructure may operate more effectively with improved liquidity. At scale, these developments could benefit the real economy. Where regulatory oversight and institutional risk management exists, this potential should not be ignored nor prohibited.

With this goal in mind, the research published in this report was prepared on behalf of GFMA members by Boston Consulting Group, Cravath, Swaine, and Moore LLP, and Clifford Chance to **evaluate the opportunities and risks of DLT and DLT-based Securities and DLT-based Payment Instruments used in conjunction with such securities.** Based on a ground-up, global analysis across the securities lifecycle, this report assesses the applicability of existing legal, regulatory, and risk management frameworks and outlines the possible benefits of a DLT-based ecosystem in capital markets, one of many potential areas for the application of DLT in financial services. Evaluating the potential of DLT includes ensuring that risks continue to be appropriately managed, and issuer, market, and investor protections are in place for all participants.

Our analysis shows that market participants make decisions around technology across a range of use case–specific considerations, leading to risk profiles that vary depending on these decisions. The selection of appropriate DLT network archetypes carry varying risk implications. "Private-permissioned" networks present limited incremental risk that can be mitigated by leveraging existing regulatory processes and therefore are analogous to technology operating in capital markets today. They introduce efficiencies and a platform for innovation, such as programmable security products. Where the legal nature of a service or a function does not change, the use of DLT-based systems to support or record the provision of that service or function should not result in incremental risk, nor necessitate a change in the regulation or regulatory characterization of that service or function. Policymaking should allow such networks to exist and flourish if demand warrants. Public networks (public-permissioned, public-permissionless) have their own set of network-specific risk considerations that should be evaluated in the context of applicable use cases.. These network archetypes may enable potential benefits for specific use cases, such as expanding broader access to capital markets and increasing levels of interoperability between participants. Capital market participants have developed applications on private-permissioned, public-permissioned, and public-permissionless networks, choosing the specific configuration best suited for their business needs to serve clients efficiently, within their own risk management frameworks. Regulated financial institutions have a continuous track record, from dematerialization, digitization, to off-premises cloud computing, of adopting new technology and implementing appropriate governance, controls , and processes to adequately manage risks as they evolve. Key to the success of DLT-based solutions is support for responsible innovation and flexible best practices for institutions to set controls based on the size, scope, and complexity of a given use case.

To illustrate the potential of DLT in capital markets, we examine three emerging uses cases within (1) Collateral Management; (2) Tokenization of Assets; and (3) Sovereign and Quasi-Sovereign Bonds.

The objective of this report is to support policymakers and market participants across jurisdictions to align on risk management tools and supervisory practices that ensures appropriate stability and protections for both regulated and unregulated market participants, but also allows the industry and economy to harness the benefits of DLT.

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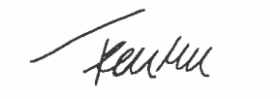

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Scope of this Report

This report explores two different implementation models of DLT for use across the securities lifecycle by regulated financial institutions: "Books and Records", and "Tokenization". They are defined as follows:

1. **"Books and Records":** Existing internal recordkeeping, accounting, reporting, and other back-office functions centrally administered by a financial institution(s), which can be supported by DLT-based infrastructure; and
2. **"Tokenization":** Digital representation of regulated financial instruments and money on a distributed ledger, reflecting an ownership right of the underlying asset, and its transfer between entities intermediated using the ledger. The report assumes that DLT is the enabling technology and catalyst for Tokenization. Although some features of Tokenization can be achieved without DLT (e.g., real-time settlement and fractionalization), this is out of scope for this report given market adoption of DLT.

The core asset classes in scope are the DLT-based forms of traditional equities, fixed income (including asset-backed securities), and derivatives.[1] These assets can exist on a distributed ledger in two formats:

1. **"Tokenized Securities",** which are issued and custodied traditionally, but also converted onto a distributed ledger through a digital twin token that represents the underlying traditional security; and
2. **"Security Tokens",** which are issued and custodied natively on a distributed ledger only, and therefore do not have a traditional security as an underlying basis.

It is important to distinguish between the two because they pose significantly different implications across the securities lifecycle. Where a distinction is not required, they are collectively referred to as **"DLT-based Securities".**

In addition to the core scope of this report, traditional forms of money that are represented on a distributed ledger through Tokenization or otherwise are also considered.[2] These are defined as tokenized commercial bank money, DLT-based deposits (where the ownership of commercial bank deposits is reflected natively on a distributed ledger) and, as may be applicable, special purpose forms of central bank digital currencies (**"CBDCs"**) that may be designed for specific use by wholesale market participants. They will be collectively referred to as "**DLT-based Payment Instruments".** GFMA members underline the importance of DLT-based Payment Instruments to realize the benefits of Delivery-versus-Payment (**"DvP"**) settlement for DLT-based Securities transactions, the distribution of coupons, dividends, and other proceeds on a distributed ledger.[3]

These in-scope assets either meet the classification conditions for **Group 1a** digital assets as set out by the Basel Committee on Banking Supervision (**"BCBS"**) under its new "SCO60: Cryptoasset exposures" standard in the Basel Framework[4], or are acknowledged as out of scope for this framework.[5] In line with this, there is a crucial difference between DLT-based Securities and DLT-based Payment Instruments as defined above, and other digital assets, such as cryptocurrencies, that do not represent traditional assets or fail to effectively link value at all times to traditional assets. Such digital assets are out of scope and not considered in this report.[6]

1 Tokenization also includes the representation of other tangible assets (e.g., commodities) and intangible assets (e.g., copyrights and patents) on a distributed ledger, but this is out of scope for this report. Additional use cases for Tokenization also exist but are out of scope for this report.
2 The use of money and deposits as an asset class in this report does not include Foreign Exchange.
3 ASIFMA, "Tokenised Securities: A Roadmap for Market Participants and Regulators", 2019.
4 The Basel Framework is the full set of standards of the BCBS, which is the primary global standard setter for the prudential regulation of banks.
5 BCBS, "Prudential treatment of cryptoasset exposures," December 2022; see SCO60.3 for specific detail on CBDCs etc.
6 Ibid.

Executive Summary

This report provides a comprehensive assessment of the opportunities and risks posed by Distributed Ledger Technology (DLT) – including DLT-based Securities (both Tokenized Securities and DLT-native Security Tokens) – and associated activities across the end-to-end securities lifecycle. Co-developed with Global Financial Markets Association (GFMA) member firms, the report represents the perspectives of industry practitioners who are pioneering research and real-world applications of DLT use cases across the world.

Innovation continues to redefine the art of the possible. Progress in distributed computing and data encryption – brought together in DLT and the emerging digital asset ecosystem – could play a fundamental role in the next major wave of developments in capital markets. Examined through ground-up analysis in this report, market participants have identified areas where new technology could play a pivotal role in the coming decade and beyond. These areas include new approaches to deliver operational efficiency, cost efficiencies, product innovation, broader market access, and new liquidity pools.

Current discourse is rightly focused on ensuring DLT applications satisfy regulatory requirements and mitigate against any potential risks associated with the use of new technology. To this end, several jurisdictions are rolling out sandboxes or pilot regimes that facilitate firms to experiment with and issue DLT-based products to their clients. At the same time, there are live use cases in capital markets, such as those profiled in this report, that are already starting to capture opportunities and realize benefits for clients, while remaining compliant with applicable rules and regulations.

The emergence of DLT and the digital asset ecosystem presents a critical inflection point. As regulators globally are forming policy to govern the ecosystem, it is essential that policymaking seeks to instill consistent stability and protections in digital asset markets for market participants. The objective of this report, therefore, is to support policymakers and market participants across jurisdictions in identifying regulation, supervision, and risk management practices that support appropriate stability and protections for all industry stakeholders, but also allow the industry and economy to harness the DLT's benefit. To further this objective, the key findings explored in this report, and summarized in the Executive Summary, include the following:

1 | Emerging use cases are proving the benefits possible from a complementary, DLT-based ecosystem. DLT could unlock transformative benefits (e.g., ~$20B USD annually in global Clearing and Settlement costs)[7], and innovation (e.g., a ~$16T USD global market for tokenized illiquid assets by 2030)[8]. Use cases are centering around asset classes, such as corporate bonds (e.g., Project Mars, a European Investment Bank bond issuance), which stand to benefit from the efficiency and liquidity benefits DLT could offer. In the long-term, this could enable a phased evolution towards a complementary, DLT-based capital markets ecosystem, coexisting alongside existing infrastructure. This ecosystem could be marked by broader market access (e.g., through fractionalization that reduces minimum ticket sizes), tailored value propositions to the needs of issuers and investors (e.g., faster time-to-issue for select asset classes), and enhanced risk mitigation (e.g., reduced operational risk throughout post-trade processes) when operating at scale. See Executive Summary Section 1, page 10.

2 | DLT-specific risk management can build on existing oversight frameworks. DLT-specific risk must be assessed across three dimensions, driven by the unique requirements of the use case being developed: (1) the chosen implementation model (Books and Records vs Tokenization); (2) lifecycle activity (Primary Market vs Secondary Market vs post-trade); and (3) the chosen DLT network archetype (private-permissioned, public-permissioned, public-permissionless). Private-permissioned networks are the closest analogue to traditional financial market infrastructure (e.g., settlement systems), but may have limited built-in interoperability. Public networks have a clear scope for broader connectivity and increased access, and therefore have distinguishing risk considerations for which mitigations are in various stages of development and implementation. Financial institutions have a successful track record of integrating transformative technological innovation. Existing regulatory and prudential policy (e.g., liquidity and capital requirements), existing risk management frameworks (e.g., operational and cyber resiliency), and newer DLT-specific risk mitigations as outlined in this paper, provide robust risk management that enables safe and secure innovation. This paper therefore cautions that any punitive, DLT-specific prudential treatment is unnecessary and could serve to be counter-productive, increasing both the regulatory and financial burden of DLT-related innovation by regulated financial institutions. See Executive Summary Section 2, page 15.

3 | Resolving legal and regulatory ambiguity could enable a level playing field that promotes safe and sound innovation. The resolution of legislative constraints and legal ambiguity in the scope and application of regulation, which necessarily varies by jurisdiction, is critical to prevent unintended consequences on the evolution of a DLT-based capital markets ecosystem that is compliant with global regulatory perimeters. A globally-harmonized approach, with jurisdiction-specific nuance and risk-specific distinctions, can help ensure policy development occurs in parallel with an early focus on interoperability to build and improve upon the standard of traditional markets, while protecting from the development of federated and siloed "digital islands". Explored in Executive Summary Section 3, page 30.

Despite the growing momentum in developing DLT use cases, there is still no widespread adoption of DLT-based Securities. DLT-based issuances have been largely experimental, and liquidity in Primary and Secondary Markets remains far below levels of institutional adoption anticipated in the long-term once barriers to adoption are addressed. While experimentation is a necessary intermediate stage in this evolution, there is a danger that siloed approaches, as well as diverging regulatory regimes, could undermine progress towards the tangible, coordinated outcomes required to establish a broader DLT-based ecosystem.[9] Absent this necessary alignment, market participants may have varying degrees of expertise in the operational capabilities required to plan, research, and launch larger-scale initiatives.

7 Santander, Innoventures, Oliver Wyman, Anthemis Group, "The Fintech 2.0 Paper: rebooting financial services", 2015.
8 BCG and ADDX, "Relevance of on-chain asset Tokenization in crypto winter", 2022.
9 ASIFMA, "Tokenised Securities in APAC—A State of Play", 2021.

To build confidence among industry participants a cross-industry consensus is necessary, both to promote development around specific use cases, and encourage stakeholders to work proactively to shape the emerging ecosystem in this foundational state of development. The GFMA and its members have therefore set out five calls to action, for industry participants and regulators alike, to overcome existing barriers to adoption and advance the development of DLT-based capital markets.

Recommendations – five imperatives to achieving network effects.

1 | Harmonize global regulatory and legal frameworks: Current laws and regulations applied to DLT assets are generally those developed for traditional assets, creating inadvertent outcomes - either de facto prohibitions or an imposition of contradictory requirements. Considering adaptations to existing legal and regulatory structures is fundamental in promoting the development of transparent, disciplined, risk-focused, and effective market infrastructure. While different jurisdictions are facing individual and global challenges and as such, legislation is at different levels of maturity, we believe that the development of harmonized and risk-consistent policy positions across different jurisdictions would be a significant benefit both for the market and for governments and regulators.

2 | Enable interoperability | Build consensus on common standards & vision for DLT-based markets: To enable interoperability, participants must build on existing processes and broaden alignment on a framework of standards to guide market-level compatibility. This alignment would include participants agreeing on key areas including technology architecture design, smart contract standards and governance, linkages with traditional infrastructure – alongside risk identification, mitigation, and management – and specific roles and responsibilities. This would also entail exploring initiatives that cover public networks as well as private-permissioned networks, with appropriate risk mitigation.

3 | Pool liquidity | Focus on viable Primary & Secondary Markets for high potential asset classes: By focusing on specific assets and expanding to the full security lifecycle, financial institutions can design solutions that pool more sources of liquidity and increase the chances of attaining a viable market. Industry participants can focus on assets where the inefficiencies are well-documented and the cost of conversion is less onerous.

4 | Technology | Collaborate on the advancement of DLT to promote new technical solutions: Industry practitioners, in collaboration with authorities, are coming together to promote, sponsor, and collaborate on further research and development of DLT-specific solutions. Cross-industry participation distributes the cost behind a joint-venture and can accelerate the timeline to key outcomes, which can encourage smaller institutions with less appetite for capital expenditure to participate, generating positive externalities for capital markets at large.

5 | DLT-based Payment Instruments | Achieve true DvP settlement with DLT-based commercial bank money: DLT-based payment mechanics are a key enabler for settlement for any form of DLT-based capital markets. While DLT-based technology can align settlement of legacy payment tools with delivery of securities, DLT-based Payment Instruments in the form tokenized commercial bank money and deposits (where representation of deposit account balances at commercial banks are reflected on a distributed ledger to support settlement) should be broadly developed to support more efficient and effective payment tools.

Full report preview

The comprehensive report that follows includes: a detailed overview of DLT, including the infrastructure and the digital assets represented on this infrastructure; a phase-by-phase impact assessment across the securities lifecycle; an exploration of live use cases; legal and regulatory considerations and recommendations; and barriers to adoption. To close the report, GFMA members present critical calls to action from all market participants to drive progress towards network effects, working in dialogue across key areas. For regulators, it could help inform efforts around emerging legal and regulatory frameworks, with an aim of protecting markets and promoting innovation. For industry, it provides detailed potential areas for further dialogue to accelerate ongoing research and development.

As an overarching guiding principle, legal and regulatory frameworks should be designed in line with the "same risk, same activity, same regulatory outcome" and "technology-agnostic" risk-based guiding principles that support, rather than deter, industry innovation and adoption. The GFMA and its members underline the importance for all market participants to contribute toward ongoing research and development of DLT, and the representation of regulated financial instruments and money on this infrastructure. Punitive penalties for the use of a particular technology, without clearly defined risk-based justification, could be detrimental to innovation in the market and have unintended consequences on the evolution of a future DLT-based market structure within the regulatory perimeter.

Significant contributions have been made by a wide selection of GFMA members and non-members across the financial services ecosystem, together with industrial and legal advisers. Analysis has also reflected upon regulatory publications across jurisdictions to ensure central areas of concern are evaluated. We hope this provides a value-added perspective that drives public-private dialogue and advances progress on the topic.

For further details, please see the following chapters of this report:

- **Chapter 1: Distributed Ledger Technology (DLT) and Tokenization |** Providing a clear and unambiguous definition of the key terms and concepts required with the goal of providing a consistent cross-industry framework for discussions of DLT, Tokenization, technology, and infrastructure.

- **Chapter 2: Impact of Tokenization Across the Securities Lifecycle |** Examining the impact across the end-to-end securities lifecycle on roles and responsibilities, workflows and activities, technology and infrastructure, financials, and existing levels of risk and potential for DLT to enable incremental mitigation.

- **Chapter 3: Use Cases |** Exploring real-world use cases, developed with GFMA members, to provide insights and best practices on how existing risk-management governance and processes are being used to drive decisions around the role of technology for specific use cases.

- **Chapter 4: Legal and Regulatory Landscape |** Demonstrating where existing regulations sufficiently addresses DLT-enabled operations and Tokenized Securities and highlighting gaps in legal and regulatory frameworks based on the "same risk, same activity, same regulatory outcome" and "technology-agnostic" risk-based guiding principle.

- **Chapter 5: Towards a Future DLT Ecosystem and Barriers to Adoption |** Outlining the additional barriers to adoption cited by GFMA members and other market participants.

- **Chapter 6: DLT Ecosystem Recommendations and Calls to Action |** Pragmatic next steps proposed by industry participants to work toward a desirable DLT ecosystem. Prioritizing focus areas that require cross-industry collaboration and public-private dialogue to unlock and drive progress.

1 | Unlocking Benefits Across the Securities Lifecycle

The case for DLT in traditional capital markets has typically been focused on operational efficiencies in Clearing and Settlement and post-trade activities. However, our research suggests DLT offers technical capabilities that could support broader developments across the end-to-end securities lifecycle. This includes clear opportunities for growth and value creation, as well as incremental risk mitigation. Through a detailed impact assessment, these opportunities have been reviewed across implementation models (Books and Records and Tokenization) and qualitatively scored based on the degree of positive impact. This is synthesized in Exhibit ES.1 below, with an extensive discussion in Chapter 2 of the report.

Exhibit ES.1

Impact of DLT-based Securities on Workflow Efficiency, Financials and Value Creation, and Risk Mitigation Across the Securities Lifecycle

Implementation models Impact shown across both implementation models; detailed breakdown included in Chapter 2	Books and Records + Tokenized Securities				
	Primary Markets	**Secondary Trading**	**Clearing and Settlement**	**Custody**	**Asset Servicing**
Overall DLT Impact	Medium	Medium	High	High	High
Workflow Efficiency	Medium	Low	High	High	High
Financial Opportunity & Value Creation	High	High	High	High	High
Incremental Risk Mitigation	Low	Low	High	Medium	Medium

Low degree of positive impact Medium degree of positive impact High degree of positive impact

Source: BCG analysis

Primary Market Issuance (MEDIUM): Primary issuances include manual and bespoke processes that could benefit from digitization and automation to drive operational efficiencies and mitigate risk.

Secondary Market Trading (MEDIUM): Platforms with features such as Tokenization and fractionalization could help pool and deepen liquidity in Secondary Markets, particularly for illiquid assets.

Clearing and Settlement (HIGH): DLT-based Clearing and Settlement could emerge as a complementary channel alongside infrastructure in traditional markets, with automated processes & risk mitigation.

Custody (HIGH): DLT offers technical capabilities that could help establish "golden-source" records and workflow automation in post-trade processes, mitigating operational risk in Custody.

Asset Servicing and Lifecycle Management (HIGH)[10]: DLT could automate Asset Servicing and Lifecycle Management workflows for corporate actions, tax withholding, & regulatory reporting that mitigates operational & compliance risk.

10 Asset Servicing & Lifecycle Management in this report includes other lifecycle activities such as regulatory reporting for the sake of analysis.

Our research points to the potential for financial outcomes that include lower operating costs, financial resource efficiencies, and innovation-led growth. The gains in operating margin could facilitate broader access to capital markets by issuers and enable smaller-size issuances (e.g., bond origination is traditionally for deal sizes above $300 million USD [11]). This could be particularly impactful in emerging markets where capital market ecosystems are in the early stages of development, broadening access and accelerating innovation. These financial outcomes are broken out below, with figures that should be considered as illustrative and based on a DLT-based ecosystem operating at scale.[12, 13]

1 | Operating Cost Efficiencies: *Back-office efficiencies from workflow automation.*

~$15-20 billion (USD) in annual global infrastructure operational cost savings have been estimated, driven by smart contract-driven process automation in areas such as settlement and corporate action administration.[14] The opportunities for savings are particularly concentrated in fixed-income and private market assets.

2 | Financial Resource Efficiencies: *Freed collateral and other balance sheet efficiencies.*

At the end of 2022, there was an estimated ~$19 trillion (USD) worth of addressable global collateral outstanding across repurchase agreements (repos), OTC derivatives, and securities lending.[15] This opportunity could therefore range well beyond ~$100+ billion (USD) annually in freed financial resources that could be redeployed to generate incremental returns.[16]

3 | Innovation-Led Growth: *New product innovation, expanded liquidity pools, and market access.*

Emerging investor demand for DLT-based Securities is likely focused on two areas. The first is fixed-income, such as corporate bond markets (currently worth ~$41 trillion USD[17], where the transparency and fractional issuance enabled by DLT could broaden access to wider pools of liquidity in "off the run" or non-standardized areas. The second is the Tokenization of illiquid and private asset classes like investment funds. The global value of tokenized illiquid assets is estimated to be worth ~$16+ trillion USD by 2030, from a base of ~$0.3 trillion USD today.[18] New instruments (e.g., tailored frequency income payments) through product innovation may also act as a key value driver to serve client needs.[19]

Use Cases are Demonstrating Early Real-World Benefits

Market participants have been exploring DLT for several years. As of December 2022, ~85% of GFMA members had a use case either at pilot stage or in production, with product innovation and workflow efficiencies the most common drivers cited.[20] Through these developments, an array of DLT-based solutions and platforms are emerging, ranging from proof-of-concepts to full market deployment. These are providing early validation on the value that DLT could unlock while operating within existing regulatory and risk frameworks. A non-exhaustive list of select projects are summarized below:

11 ASIFMA, "Tokenised Securities: A Roadmap for Market Participants and Regulators", 2019.
12 For more details see, for example, an E.U. study on economic benefits: European Parliament, "Increasing European added value in an age of global challenges", 2023.
13 On April 20th, 2023, Mr. Christopher J. Waller, Member of the Board of Governors of the Federal Reserve System remarked on the "considerable promise" of Tokenization citing its ability to be "programable" and enable "atomic settlement" with use of smart contracts. Waller, Speech at the Cryptocurrency and the Future of Global Finance, April 2023.
14 Santander and Innoventures, "The Fintech 2.0 Paper: rebooting financial services", 2015.
15 SIFMA repo factsheet end 2022; ICMA Survey June 2022; ICMA Survey December 2022; ICMA APAC Survey 2022 and 2021; International Securities Lending Association ("ISLA") website; BIS ORC Derivatives statistics at end June 2022; BCG analysis 2023.
16 Security Tokenization survey of GFMA members, November to December 2022; n=39.
17 International Capital Markets Association (ICMA), "Bond market size", 2020.
18 BCG and ADDX, "Relevance of on-chain asset Tokenization in crypto winter", 2022.
19 Security Tokenization survey of GFMA members, November to December 2022; n=39.
20 GFMA member surveys, Nov-Dec 2022.

Collateral mobility | HQLAx's Books and Records Digital Collateral Registry is a platform built on a private-permissioned DLT network provided by R3 Corda. It records the ownership transfers of securities, while the underlying securities remaining in the Custody location of the participating triparty agents and custodians. When collateral needs to be exchanged between participants, the platform enables instant and simultaneous transfers on the platform, so-called Delivery vs. Delivery Delivery (**"DvD"**), swapping ownership of securities and avoiding the traditional Custody chain and settlement cycle. Transactions can be predetermined to occur at precise times through the day. This reduces intraday credit exposures and liquidity requirements to enable capital savings and minimize the scope for trade fails.

Intra-day repos | J.P. Morgan's Digital Financing Application, running on the Onyx Digital Assets DLT platform built on a private-permissioned DLT network, enables true DvP settlement for repurchase agreements (**"repos"**). The platform enables the simultaneous exchange of tokenized deposits and collateral, and settled over $500 billion USD in transaction value by the end of 2022. Precise, and more frequent, intra-day settlement cycles, free collateral that would otherwise be subject to longer, traditional, settlement cycles (e.g., T+2) for productive redeployment. The 24/7 availability of the platform enables borrowers and lenders with uninvested cash or securities at the end of traditional business hours to benefit from its use. J.P. Morgan has also reported operational efficiency gains through a near-zero trade fail rate.

Digital bonds | In January 2023, the European Investment Bank (**"EIB"**) issued the digitally-native, £50 million GBP three-year floating 'Mars' bond on the private-permissioned HSBC Orion platform. The Security Token issuance was mirrored with anonymized details on the public-permissionless Ethereum Mainnet. Along with HSBC, BNP Paribas and RBC Capital Markets were joint-lead managers. The banks reported that the EIB benefitted from a significantly lower issuance cost compared with traditional Primary Markets bond issuance and instant and simultaneous (atomic) DvP settlement. Additionally, in February 2023, the Hong Kong Monetary Authority (**"HKMA"**) announced the successful offering of a $800 million HKD tokenized green bond using the Goldman Sachs GS DAP™ Tokenization platform. HKMA leveraged a private-permissioned network with a special purpose CBDC designed expressly for the purpose of settling the primary placement of this bond.[21] Additional detail on digital bond issuances, and the variety of network archetypes that been used to do so, is included for reference in Annex 2: DLT-based Security Issuances.

As demonstrated by these use cases and those profiled later in the report (see Chapter 3 | Use Cases), implementations of DLT have largely focused on specific asset classes and transaction types such as bonds, over-the-counter (**"OTC"**) derivatives and repo. These share two common drivers: (1) a clear financial opportunity from efficiency gains or innovation; and (2) market readiness for innovation and adoption around specific market structure attributes (e.g., shallower liquidity, relative "opaqueness" trading OTC, long issuance processes), workflow inefficiency, and the maturity of electronification. These projects provide early insights into the expected pattern of DLT adoption in capital markets, which could follow these drivers.

A recent BIS Bulletin report, *The Tokenization Continuum*, provides a similar perspective citing that "Tokenization could bring benefits" to assets and the way transactions and transfers occur, but adoption will occur on a "continuum and highlight a trade-off: where Tokenization is easiest, per-unit gains are likely to be modest" and

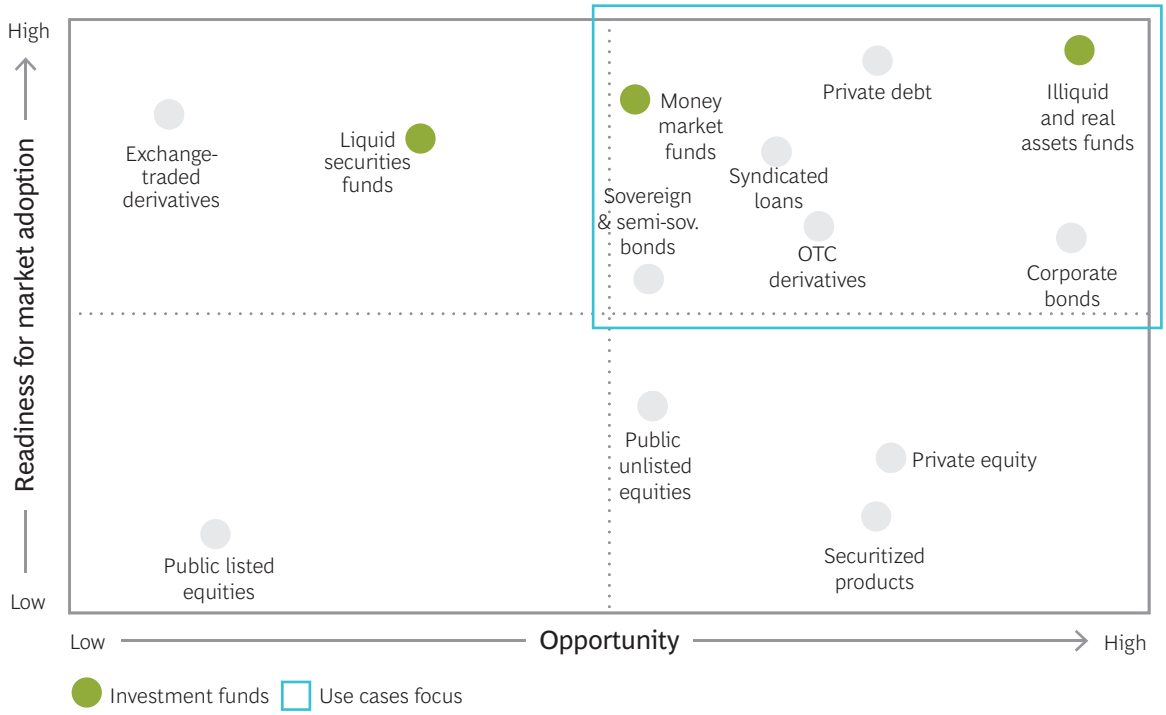
21 Additional information regarding the transaction can be found at the following link: Hong Kong Monetary Authority - HKSAR Government's Inaugural Tokenised Green Bond Offering (hkma.gov.hk).

conversely "where Tokenization is difficult the potential benefits are the largest".[22] As a result, the authors suggest Tokenization efforts to "focus on identifying assets that are suitable for Tokenization" and have enough volume for a sizeable impact.[23]

Liquidity in a DLT ecosystem may therefore pool in specific asset classes where there is clear opportunity and market readiness (see top right quadrant of Exhibit ES.2 below). Homogeneous adoption may be less likely in high-volume, efficient markets such as public equities, where the incremental opportunity is limited.

Exhibit ES.2

Asset-Classes Show Varying Suitability For Adoption Onto DLT



Source: BCG analysis; Adapted from JP Morgan and BCG, 'The Future of Distributed Ledger Technology in Capital Markets', November 2022

22 Aldasoro, Doerr, Gambacorta, Garratt, Wilkens, BIS Bulletin No 72 "The Tokenization continuum", April 2023.
23 Ibid.

Toward a Complementary DLT-Based Ecosystem

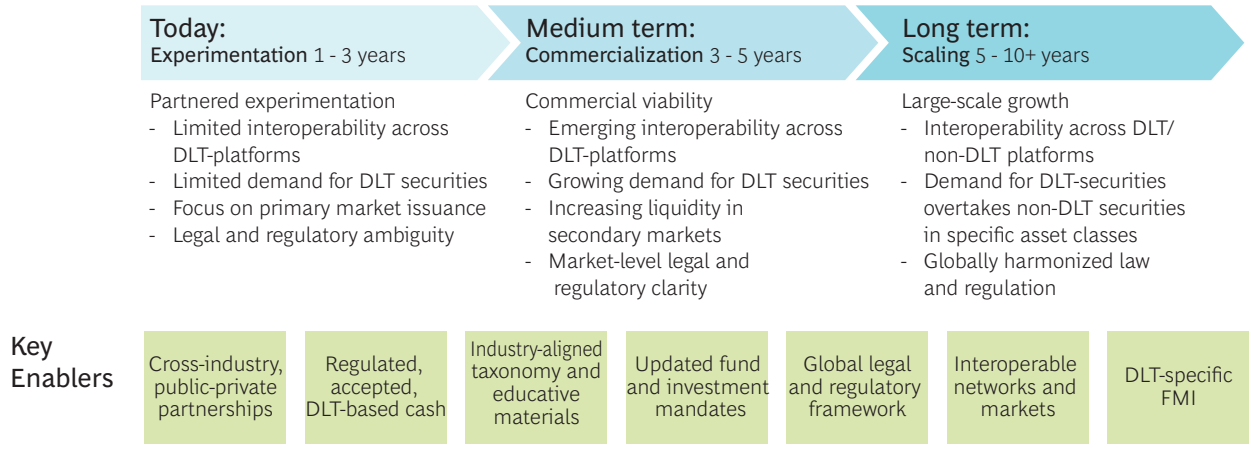
The concentration of use cases in specific asset classes and transaction types are marking the early beginnings of a phased evolution toward a complementary ecosystem that exists alongside traditional capital markets. This ecosystem could offer broad access and value propositions that are responsive to the needs of issuers and investors, underpinned by operational efficiency, financial resource efficiency, new products and services, improved competition, and new risk mitigation approaches when operating at scale.

The evolution is likely to be a phased development, enabled by advancements in technical capabilities, clarity around legal and regulatory frameworks, ongoing lessons learned from live use cases, established approaches to risk management for new considerations, and other areas. These enablers, which could develop in parallel, could significantly impact the speed of progress.

Three major phases are expected along this journey, beginning with **(1) Experimentation** – the current state of play, marked by ongoing research and development with a focus on technical capability development, Primary Market Issuances, and legal and regulatory ambiguity; **(2) Commercialization** – marked by emerging Secondary Market liquidity as issuer and investor demand scales, and ambiguity is resolved; and **(3) Scaling** – marked by the predominance of DLT-based Primary and Secondary Markets for specific asset classes and transaction types with legal and regulatory frameworks that are harmonized across jurisdictions, and interoperability across platforms. This is set out in Exhibit ES.3 below.

Exhibit ES.3

Possible Future Developments of a DLT Ecosystem



Source: BCG analysis, GFMA Member Interviews

To guide the formation of a viable and differentiated DLT ecosystem, consensus is required among all stakeholders on **(1) robust risk management, (2) globally harmonized legal and regulatory frameworks; and (3) key calls to action to achieve network effects.**

2 | A Holistic Understanding of DLT-Specific Risk

The GFMA and its members strongly advocate that the implementation of DLT be operationalized in a manner that meets the high existing standards of regulated capital markets. Safeguards must be ensured for all market participants and mitigants must similarly protect financial markets more broadly. To this end, the GFMA and its members have developed a detailed risk assessment, with preliminary risk mitigations for the introduction of DLT Books and Records and DLT-based Securities related to the use case components outlined above. These recommendations build upon existing governance and control processes in line with the International Organization of Securities Commissions (**"IOSCO"**) *Principles for Financial Market Infrastructure,*[24] *Operational Resilience of Trading Venues and Market Intermediaries During the COVID-19 Pandemic,*[25] *BCBS Principles for Operational Resilience and Principles for Sound Management of Operational Risk,*[26] and related principles from the Financial Stability Board (**"FSB"**),[27] that all collectively provide the tools necessary to (1) explore the potential for DLT-specific risk, and (2) provide mitigations to ensure risks can be mitigated and managed to ensure safe and secure development of DLT. The GFMA and its members recognize the considerable progress in global alignment of operational and cyber resilience frameworks and seek to aid regulators in a journey towards a harmonized, technologically-agnostic, approach for the in-scope digital assets based on the legal and regulatory analysis contained herein..

We believe DLT can play diverse roles in capital markets across three use case considerations that can differ significantly based on (1) implementation model ('Books and Records' vs 'DLT-based Securities'), (2) digital asset type (Group 1a vs. Group 1b/2 in the BCBS crypto asset framework), and (3) lifecycle activity (Primary Markets, Secondary Markets, and post-trade).

A blanket regulatory approach anchored on a specific type of technology could therefore fail to distinguish use cases that are analogous to similar technology and financial market infrastructure already being used in capital markets today. Similarly, regulatory requirements should consider the risks and mitigants entailed in based on the particular use cases of a technology, not on the characteristics of the technology alone.

To help disaggregate this conflation and enable a focused regulatory approach on the associated risk, the research published in this report includes the following findings on key risk drivers:

(1) Implementation Model, (2) Lifecycle Activity, and (3) DLT Network Archetypes.

Market participants will need to adjust their assessment of risk management implications accordingly depending on how each of these three components are configured.

(1) Implementation Model

Books and Records

DLT Risk Assessment: DLT-based Books and Records systems are focused on internal recordkeeping (e.g., collateral management), accounting, reporting, and other back-office operations on private-permissioned networks. Books and Records, along with the book entries recorded on such systems, are operated with risk management that is analogous to traditional Books and Records systems (set out under "DLT Risk Mitigation"

24 BIS-IOSCO, "Principles for Financial Market Infrastructure", April 2012.
25 IOSCO, "Principles on Outsourcing" October 2021, and "Operational resilience of trading venues and market intermediaries during the COVID-19 pandemic", January 2022.
26 BCBS, "Principles for Operational Resilience", March 2021, and "Principles for Sound Management of Operational Risk", March 2021.
27 Such as: FSB, "Recommendations to Achieve Greater Convergence in Cyber Incident Reporting", and Format for Incident Reporting Exchange (FIRE), April 2023; and the FSB's Guidance on "Operational Continuity while in Resolution", August 2016.

below). In line with these characteristics, where the legal nature of a service or a function does not change, the use of DLT-based systems to support or record the provision of that service or function should not result in incremental risk, nor necessitate a change in the regulation or regulatory characterization of that service or function. Indeed, the BCBS have deemed DLT-based Books and Records for: "dematerialized securities that use electronic versions of traditional ledgers and databases that are centrally administered" as out of scope for additional prudential treatment.[28]

DLT Risk Mitigation: Regulated financial institutions are exploring and implementing DLT-based technologies and systems to support their existing internal electronic recordkeeping, accounting, reporting, and other back-office functions ("Books and Records").

Where the legal nature of a service or a function does not change, we do not believe that the use of DLT-based technology to support or record the provision of that service or function should result in a change in the regulation or regulatory characterization of that service or function. The Books and Records systems of regulated financial institutions, and the adoption and use of any new replacement technology, are subject to existing regulatory requirements and ongoing comprehensive supervisory oversight frameworks wherein financial institutions have integrated governance and controls to help identify and mitigate risks.

As regulated financial institutions innovate using DLT protocols to enhance Books and Records capabilities, this should not result in a change in the regulatory characteristics of the assets recorded on such Books and Records systems – including additional punitive capital treatment or creating barriers for responsible innovation. A reclassification of such assets to "tokens" should only be applied where there is a change in the legal nature of the service provided or the function for which it is used. Where one or more firm(s) uses a private-permissioned, internal DLT-based system, the regulatory focus should be on whether the use of that system satisfies the financial institution's regulatory obligations to maintain efficient and effective systems and controls, in a safe and sound manner.

DLT-based Books and Records systems along with the book entries recorded are analogous to currently used Books and Records systems and their records where the following criteria are satisfied:

- The control environment is private-permissioned and internal, with proper security ringfenced within the regulated financial institution's technology and security control environment, in line with regulatory requirements, subject to appropriate supervisory governance standards, and where the regulated financial institution is the only entity with direct read/write access[29];
- The Books and Records systems record debits, credits, and other asset transfers on behalf of the financial institution, consistent with existing approved traditional book entries that record changes to customer positions. In such circumstances, third parties cannot directly affect changes without the approval and vetting of such instructions by the regulated financial institution under its supervisory approved governance and controls;
- The Books and Records may also provide reporting and statements of account to the regulated financial institution's customers, as permissioned by the financial institution, without direct third-party access; and
- The Books and Records provide a mechanism for regulated financial institutions to reconcile and to unilaterally correct any mistakes in line with internal governance control protocols.

28 Ibid.
29 It is important for supervisors to differentiate a Books and Records system from an open or even a private, permissioned, but shared ledger. Specifically, no third party may directly access a bank's Books and Records system without express approval and permission from the bank.

The introduction of new technology alone, such as the use of DLT protocols by regulated financial institutions for Books and Records capabilities, akin to traditional banking activities, should not, in itself, give rise to additional regulation or capital charges that could impede the ability of well-regulated and supervised banking institutions to invest and to adopt innovative technologies. Regulated financial institutions have a history of demonstrating competency in evaluating and mitigating the risk of incorporating new technology, especially operationally-related solutions.

Tokenization

DLT Risk Assessment | Group 1a assets, as defined in the BCBS consultation for the prudential treatment of cryptoasset exposures, include the tokenized formats of regulated financial instruments (equities, fixed income including asset-backed securities, derivatives), with payment for such assets accomplished with DLT-based Payment Instruments (commercial bank money and deposits, and central bank money) that can be represented on a distributed ledger. As acknowledged by the BCBS standard, this does not alter the credit or market risk of the underlying assets and therefore carries the same risk profile.[30] This has also been demonstrated by the credit rating to the City of Lugano's recently issued unsecured municipal bond in January 2023. Assigning a Aa3 rating, Moody's commented:

> "The Aa3 debt rating mirrors the City's long-term issuer rating of Aa3 and is equal to debt ratings assigned by Moody's to Lugano's traditional bond issuances. The notes will have the same status of the issuer's senior unsecured rated bonds and, in Moody's view, the different technology will not add materially higher risks compared to a traditional issuance."[31]

DLT Risk Mitigation | Regulated financial instruments and commercial bank money are subject to comprehensive regulatory, prudential capital, and liquidity frameworks, as applicable. The tokenized forms of these assets can therefore be governed by existing policies and procedures. Similarly, DLT-based Payment Instruments used as payment for such assets comprise either commercial bank money subject to prudential regulation, or central bank money as a liability of the central bank, subject to central bank policy, and available only to regulated participants. Group 1a DLT-based Securities and DLT-based Payment Instruments can also be clearly identified based upon the classification conditions that are distinct and separate from Group 1b/2a/2b digital assets. The GFMA developed an approach to classification of digital-assets to support our response to the BCBS discussion paper on *Designing a Prudential Treatment for Crypto-Assets*[32] and Financial Stability Board's (**"FSB"**) consultation on the *Regulation, Supervision and Oversight of Crypto-Asset Activities and Markets.*[33]

The classification approach reflects the principle that the treatment of digital-assets should be underpinned by clear methodology for identifying different types of digital-assets' risk which will allow for tailored regulatory treatment, as appropriate, to mitigate reputational risks by conflating use cases of DLT, promoting legal clarity and confidence for asset managers, investors, and issuers (see Annex 1).

30 BCBS, "Prudential treatment of cryptoasset exposures", December 2022. We note that there are network specific considerations, and we have reviewed these risks separately to avoid overlap.
31 Moody's, "Moody's assigns Aa3 rating to City of Lugano's upcoming digital bond", 2023.
32 Joint Trades Comment Letter – Second Consultation on Prudential Treatment of Cryptoasset Exposures, 2022. Please reference page 4, 29-37 for additional detail on the proposed infrastructure risk add-on for Group 1 cryptoasset exposures.
33 FSB, Regulation, Supervision and Oversight of Crypto-Asset Activities and Markets, October, 2022.

(2) Lifecycle Activity

DLT-based Securities could lead to significant mitigation of operational, counterparty credit and systemic risks, but a limited number of additional risk considerations (generic across DLT network archetypes) will also require mitigations. Regulated financial institutions are well-placed to manage these through existing BCBS capital and liquidity supervisory frameworks and guidelines, which provide a proven basis to manage known financial and nonfinancial risk, as well as unforeseen risks through the imposition of buffers and other charges.[34] In addition, new risk mitigations are being developed and proven through live use case testing and market implementations. These risk considerations across the lifecycle are summarized below, along with mitigations:

Primary Market Issuance

DLT-Lifecycle Risk Assessment: Given the ongoing development of policymaking to support the growth of DLT-based Securities, the level of participation in DLT-based Primary Markets remains relatively low compared to traditional capital markets. As a result, DLT-based Primary Markets could face increased levels of liquidity risk, challenging or impairing the ability of Transaction Managers[35] to place initial offerings. This could be compounded by the potential for fragmentation across multiple DLT platforms and lack of interoperability between them. Non-financial risk impacts will also need to be accounted for, including operational risk (e.g., integrations between DLT and non-DLT platforms and interoperability between DLT platforms) and compliance with additional disclosure requirements (e.g., offering documents required for DLT-based issuance).

DLT-Lifecycle Risk Mitigation: Transaction Managers can launch dedicated efforts to source liquidity and generate interest, alongside broader industry initiatives to pool liquidity in high potential asset classes and in this way support the formation of DLT-based Primary Market liquidity and mitigate potential liquidity risk. Similarly, interoperability across DLT-based platforms will be crucial to prevent fragmentation and ensure sufficiently liquid markets. Existing operational risk and operational resilience frameworks can provide a basis for achieving sound integrations between DLT and non-DLT platforms for non-financial risk considerations. Regulatory clarity would be helpful to inform the necessary legal documentation for Primary Markets issuances.

Secondary Market Trading

DLT-Lifecycle Risk Assessment: The potential bifurcation of trading liquidity between traditional and DLT-based Secondary Markets, as well as across different DLT-based trading platforms, needs to be managed. This could primarily affect native Security Tokens that, as a new security format, are likely to require new liquidity pools. Secondary Markets for Security Tokens are likely to exhibit poorer liquidity conditions for some time, until critical mass is reached. Traditional and Tokenized Securities may also provide an imperfect hedge to support market-making; however, it is likely that a spread between traditional and DLT-based Securities may form, especially as Secondary Market Trading activity increases. The potential need to immediately pre-position securities and cash for Clearing and Settlement for DLT-based Securities could impact liquidity in DLT-based Secondary Markets, acting as a barrier to entry for investors by tying up assets in pre-funding requirements.

DLT-Lifecycle Risk Mitigation: The development of bridges across traditional and DLT-based trading venues, and interoperability between DLT-based platforms could resolve fragmentation and mitigate trading liquidity risk. Technical on/off ramp solutions with conversion mechanisms (e.g., Tokenization/deTokenization) will play a central role, with precedents in the approach taken today between Depositary Receipts and ordinary shares. Incentivization for liquidity provision in DLT-based Securities (e.g., fee discounts) could also serve as

34 Such as liquidity, capital, and funding requirements as set out in Basel III frameworks.
35 The term Transaction Manager is used in this report to generalize across asset classes and subfunctions; it covers a subset of roles including Coordinator, Bookrunner, Arranger, Underwriter, and Placement Agent.

an important mitigant. Security Tokens can be integrated into existing workflows to broaden participation, and automated market makers can provide liquidity in return for pricing cross-format risk.

As broader initiatives develop across the industry, it is likely that interoperability will be greatly enhanced, along with required operational changes to support the formation of secondary liquidity and adaptation of existing workflows. Existing trading systems have leveraged the Financial Information Exchange (**"FIX"**) protocol to standardize messaging and integration. There is a risk that competing protocols and standards could hinder the goal of interoperability, which could have a significant impact on the ability to integrate liquidity pools, automate trades, and simplify the trading ecosystem. This should be addressed through an early and broad alignment on technical standards. Liquidity risks around pre-positioning can be mitigated by ensuring pre-funding requirements are set at levels that avoid trapping capital for time periods equivalent to or exceeding traditional Clearing and Settlement cycles. Broker-dealers can also lend liquidity to pre-funding requirements and earn a return.

Clearing and Settlement

DLT-Lifecycle Risk Assessment: DLT-based settlement may result in (although does not necessitate) higher levels of gross settlement in specific asset classes and transaction types. All else being equal, this could require more liquidity on-hand and increase "aggregate liquidity requirements" when operating at scale, contributing to liquidity risk.[36] This is in addition to the liquidity impacts from the need for pre-positioning of securities and cash discussed above in Secondary Market Trading. Finally, there is uncertainty and limited alignment across jurisdictions regarding the legal basis of Security Tokens and determination of settlement finality[37]. This creates legal risk, particularly in the context of cross-border transactions.[38] Settlement finality, however, could also give rise to complex legal considerations in achieving DvP that vary by DLT network archetypes (further explored under "DLT Network Archetypes" below).

DLT-Lifecycle Risk Mitigation: In approaching these risks, it should be noted that DLT does not necessitate a gross settlement model and could be configured to support Deferred (or real-time atomic) Net Settlement where this could generate efficiencies or process advantages. However, regulatory guidance has begun to encourage real-time gross settlement in some jurisdictions outside the U.S..[39] Existing regulatory and risk frameworks can therefore provide applicable guidance for DLT-based Clearing and Settlement risk management. Legal clarity across jurisdictions will be required to clarify the status of Security Tokens. Regarding settlement finality, the use of private-permissioned or public-permissioned networks could help mitigate risk (refer to the discussion below under "DLT Network Archetypes").

Custody

DLT-Lifecycle Risk Assessment: Differentiated operational risks could stem from new lifecycle management workflows, including private key management (to the extent applicable to the relevant asset) and data integrity between distributed and traditional ledgers.

DLT-Lifecycle Risk Mitigation: Qualified custodians are already implementing processes and standards (e.g., compliance with jurisdiction-specific account segregation requirements) to mitigate these risks. Private key management mitigants could include split keys (with quotas for signatures), account abstraction smart contracts (e.g., timelocks and social recovery) as upgrades to externally owned accounts developed by self-custodial wallets

36 BIS, "On the Future of Securities Settlement", 2020.
37 The BCBS, in its paper entitled "Prudential Treatment of Cryptoasset Exposures", has specified that an essential element of classification of a digital asset as a Group 1 asset is that "the applicable legal framework(s) ensure(s) settlement finality" SCO 60.14. As the BCBS states further: "Banks are required to conduct a legal review of the cryptoasset arrangement to ensure this condition is met, and make the review available to their supervisors upon request". Id.
38 Ibid.
39 BIS-IOSCO, "Principles for Financial Market Infrastructure (Part 8, Annex D)", 2012.

like MetaMask, parachute recovery functions (that sends keys or tokens to a pre-programmed governance address), and location-based signing. We note that as technology evolves, so too will risk mitigants, and the above is not an exhaustive list of such mitigants. Data integrity between distributed and traditional ledgers can be enabled through new, automated reconciliations, with recourse processes where erroneous transactions are recorded. This is equivalent to existing data reconciliations processes between non-DLT systems.

Asset Servicing and Lifecycle Management

DLT-Lifecycle Risk Assessment: DLT introduces additional risk considerations centered on data residency and privacy, regulation, and smart contracts.

DLT-Lifecycle Risk Mitigation: On data residency and privacy, participants may need to align on technology and governance architecture to protect sensitive corporate action, tax, and regulatory data from other members of the distributed ledger while still maintaining core efficiencies. It should be noted that DLT platforms can also play a crucial role in enabling data consolidation and control. Market participants may need to establish clear accountability, governance, and recourse for errors in smart contract execution (refer to the discussion below under "DLT Network Archetypes" for more details).

(3) DLT Network Archetypes

DLT network archetypes present differing profiles of risk that require specific mitigation approaches. Regulated financial institutions bring a proven track record of responsible innovation, drawing on the high standards of proven institutional-grade technology and operational risk management, operational resilience, cybersecurity, data protection processes, client suitability frameworks, and established know-your-customer (**"KYC"**)/anti-money-laundering (**"AML"**)/combating the financing of terrorism (**"CFT"**) procedures. Together, these can help protect market participants and ensure safe innovation across global capital markets.

There are three archetypes of distributed ledgers:

Private-permissioned: Closed-loop, private networks, which restrict access to only predetermined users and are typically governed by rules agreed to by, and that apply to, all users. Authentication can be used to determine privileges. This is the most common archetype used in capital markets today, and is characterized by its security and central control, which has proven to be well-suited to certain capital markets use cases. They may be less suited to use cases requiring large-scale interoperability given the closed nature of these networks and limited user bases, but interoperability can be achieved if required.

Public-permissioned: By using permissioned network-level participants, effectively created closed access networks that can vary by design, given defined selective restriction of access through authentication for certain governance, administration, or other privileges. They can also include designs with more open or publicly-available access (i.e., access is open, but authentication is used to restrict privileges to pre-determined users only). In these instances, public access could introduce new considerations around security and risk mitigations for use in capital markets use cases, while balancing the benefits of offering access to a broader user base and stronger network effects as adoption scales. There can also be benefits around operational resilience given the potential for broader distribution across a greater number of nodes.

Public-permissionless: Open, public networks that do not restrict access for privileges. These include some of the largest distributed ledger networks adopted at scale today, and therefore offer proven potential for significant network effects. For example, the leading public-permissionless networks have demonstrated strong operational resilience given distribution across many nodes. However, the absence of defined restrictions of access gives rise to heightened levels of potential risks and therefore the need for market participants' to leverage and adopt appropriate governance and control frameworks.

DLT network archetypes therefore have differing defining characteristics and technical attributes which impacts their suitability for different use cases. For example, private-permissioned networks are particularly well-suited to use cases that prioritize a closed network of permissioned participants for confidentiality and defined finality of settlement, rather than requirements for broad interoperability and access. The largest public-permissionless networks, on the other hand, offer a proven channel to reach a mass market that may be advantageous in the development of Secondary Market liquidity for some asset classes.

Each network-type has advantages and trade-offs that should be optimized for the specific requirements of a given use case.

Exhibit ES.4

Comparison of Defining Characteristics Across Distributed Ledger Network Archetypes

		Private-permissioned	Public-permissioned	Public-permissionless
Defining characteristics	**Governance**	Centralized	Centralized (for the relevant application)	Decentralized
	Accessibility to users	Closed	Closed (for the relevant application)	Open
	Control over privileges	Can be defined as required	Users authenticated for specific roles	All users can perform all roles
	Identification requirements	All users known	All users known (for the relevant application)	Pseudonymous
	User base	Very Limited (by design)	Limited (for the relevant application)	Broad
	Interoperability	Can be developed as required but lower ease of implementation	Can be designed as required (for the relevant application)	Higher interoperability given existing DLT-based ecosystem

Source: BCG Analysis, GFMA Member Interviews

GFMA and its members have taken a principles-based approach to create a preliminary industry framework assessing the primary risk implications of each DLT network archetype being deployed against key risk categories. These were developed with the goal of substantiating that DLT-specific infrastructure risk is not unforeseeable, but instead can be mitigated and managed through an industry-agreed framework to promote the safe, coordinated development of DLT.

Operational Risk — Technology Robust cybersecurity including permissioning (network access, user privileges), operational resilience, smart contracts, data confidentiality, scalability, and delivery of secure interoperability across DLT-based and traditional capital markets systems.

Operational Risk – Technology: Cybersecurity

Ensuring security of the network as a whole and the integrity of specific nodes from cyberattacks from bad actors.

Existing cyber resilience, cryptography, and consensus mechanisms, correctly developed and deployed, have the potential to guard against bad actors. While cyberattacks (e.g., hacks, ransomware) are not unique to DLT, the industry has worked to develop and implement more robust regulatory frameworks exist and remain applicable for these generic, technological risk considerations.

Example of DLT-specific cyber security considerations to account for include:

- "Crypto bridge attacks": bad actor(s) exploit vulnerabilities in integrations between DLT networks known as "bridges".
- Sybil attacks: bad actor(s) gains influence over the network by controlling the consensus mechanism.[40]
- "51%" attacks: majority of the network's power is controlled by bad actor(s).

Private-permissioned networks: Closed and permissioned access, together with centralized governance over user privileges, significantly reduces exposure to cyberattacks. While risk of collusion-type cyberattacks are technically possible on private-permissioned networks, they remain highly unlikely given both (a) the robust permissioning required to access and participate on the network and (b) the high-degree of centralized network control. These considerations can be managed by existing cyber resilience risk frameworks.[41]

Public-permissioned network: Comparable to private networks (when permissioning occurs at the network layer), with closed and permissioned access and potential for centralized governance over user privileges, but potential for the network to be larger can increase exposure to cyberattacks. Like private-permissioned networks, effective permissioning can aid in preventing or mitigating the likelihood of a successful cyberattack. These considerations can be managed by existing cyber resilience risk frameworks.[42]

Public-permissionless networks: Open and permissionless access, decentralized governance over user privileges, as well as the potential for the largest-scale user bases, potentially increases the risk of malicious cyber events, attacks, or incidences. In practice, the interaction of cryptography and consensus mechanisms has been effective in mitigating these specific cyberattack risks in the largest public-permissionless networks. For example, there have never been any successful attacks on Bitcoin or Ethereum.[43] There have been a series of "crypto bridge hacks" on other such networks. Other cybersecurity threats include data privacy breaches and theft, operational breakdowns, counterparty risk management failures, and financial losses worth ~$21 billion USD in 2022.[44]

While network-based attacks like "Sybil" and "51%" described above are possible they are (a) rare, with a low probability of occurring due to the economic cost of securing the validators required to execute such an attack and (b) yet to be successful against established public-permissionless networks like Bitcoin or Ethereum with a diversified and large network of validators.

40 BIS, "Cryptocurrencies and Decentralized Finance", 2022.
41 Such as: FSB, "Recommendations to Achieve Greater Convergence in Cyber Incident Reporting", and Format for Incident Reporting Exchange (FIRE), April 2023.
42 Such as: FSB, "Recommendations to Achieve Greater Convergence in Cyber Incident Reporting", and Format for Incident Reporting Exchange (FIRE), April 2023.
43 BIS, "Cryptocurrencies and Decentralized Finance", 2022.
44 Chainalysis, "The 2023 Crypto Crime Report", 2023. Note: This figure may include a portion of financial losses from other DLT network archetypes.

Regulated entities could use governance controls as risk mitigants even on established public-permissionless networks such as those with a track record of proven cryptography and effective consensus mechanisms (e.g., Ethereum Mainnet). For example:

- Selecting public, permissionless DLT networks with a track record of proven cryptography and effective consensus mechanisms, and a wide network of validation nodes (e.g., Ethereum Mainnet);
- Defined criteria for permissioned applications on the network to identify users.[45] Société Générale – Forge built a permissioned application on Ethereum Mainnet for the first EIB bond issuance as part of Project Mercure that authenticated relevant parties; and
- Whitelisting of tokens to desired users through smart contracts (e.g., broker-dealers and investors).

Operational Risk – Technology: Common Mode Failure

Simultaneous failure of multiple nodes, validators, or components due to software bugs that lead to system-wide disruption.

Cross-industry coding standards and partnered development of infrastructure-level protocols, such as redundancy and failover mechanisms, should be used to enable transparent, auditable, and well-tested software and processes to prevent common mode failures.

Private-permissioned networks: Given the relatively smaller size of the network, failure resilience and fault tolerance are achieved through established technology resilience practices such as redundancy and failover approaches, rigorous testing and proven IT operational maintenance procedures (simulations, audits). Additionally, consensus mechanisms can be designed to prevent network outages in an event where multiple nodes are compromised.[46] This can be managed through adaption of existing FI cyber resilience frameworks.[47]

Public-permissioned network: Fault tolerance may be enhanced given the need for a greater number of nodes to be compromised to bring about network outages. Developer communities can also be larger, which can increase the resilience of code and reduce bugs. This can be managed through adaption of existing FI cyber resilience frameworks to public networks.[48]

Public-permissionless networks: The leading networks offer proven, historical resilience to failures and strong fault tolerance because the ledger is replicated by the largest number of nodes (e.g., Ethereum had more than 14,400 active nodes in March 2023)[49], reducing the likelihood of network outages even in the event nodes are compromised by failures and faults. These networks also have the largest developer communities. This can be managed through adaption of existing FI cyber resilience frameworks in tandem with the banks assessment of a public-permissionless networks own cyber resiliency standards.

45 This should not be conflated with a 'public-permissioned' network. Though counter-intuitive, it is possible to achieve permissioning on public-permissionless networks through permissioned applications. As an analogy, this is conceptually similar to a secure portal on the internet (which is also public-permissionless) but requires authentication to access the web application.

46 For example, the practical byzantine fault tolerance consensus mechanism (PBFT). PBFT is a fault-tolerant protocol used in DLT networks to ensure that a consensus can be reached even when a certain number of nodes in the network are compromised or fail. In PBFT, validators are randomly selected to propose new blocks, and other validators use a voting process to reach a consensus on whether the proposed block should be added to the DLT. If a certain number of validators agree on the proposed block, it is added to the DLT network. PBFT can prevent network outages when multiple nodes are compromised because it requires a two-thirds majority of validators to reach a consensus, which makes it difficult for malicious actors to disrupt the network by compromising a large number of nodes.

47 Such as: FSB, "Recommendations to Achieve Greater Convergence in Cyber Incident Reporting", and Format for Incident Reporting Exchange (FIRE), April 2023.

48 Such as: FSB, "Recommendations to Achieve Greater Convergence in Cyber Incident Reporting", and Format for Incident Reporting Exchange (FIRE), April 2023.

49 https://nodewatch.io/, node count figure taken in March 2023.

Operational Risk – Technology: Smart Contract Risk

Running a viable technical infrastructure to coordinate smart contract activity, and the prevention of undesired outcomes including self-execution of errors and violation of terms and conditions.

Smart contract infrastructure requires the extension and operation of a technical infrastructure which pose new considerations including, but not limited, to updates to data models, changes in calculation methods or other market conventions, and the resolution of valuation differences on the ledger. Clear governance and standards are required both within financial institutions and across industry to ensure common approaches.

Additionally, smart contracts pose a new form of 'automation' risk given their self-executing nature, and the design of some DLT network archetypes that use immutability that prevents editing post-execution (although conducting additional transactions may have the effect of 'reversing' erroneous transactions). Multifaceted approaches are required to mitigate these smart contract risks across all DLT network archetypes, which broadly do not fall under existing operational risk and cyber resilience frameworks.

These key risk mitigations are applicable on all three types of DLT networks defined above and are listed below:

- Cross-industry smart contract format standards (including but not limited to ERC-20[50] and others) and templates.
- Pre-deployment code review that includes user acceptance testing and scenario testing to identify issues or vulnerabilities prior to the go-live date to ensure smart contracts perform as intended, across business, legal, and technology stakeholders.
- Independent audit/verification before deployment conducted by reputable practitioners (such as professional service firms and technology providers) for smart contract code and oracles. This involves the use of mathematical models of the code logic applied against predetermined criteria to ensure execution is as intended and should be paired with industry-accepted standards for audit procedures and common pass/fail criteria.
- Ability to edit and redress erroneous code, and render a smart contract void (e.g., due to errors, breached terms).
- Multi-signature authentication to prevent pre-mature or inadvertent execution by requiring multiple parties to approve a transaction in advance.
- Timelocks, kill switches, failsafes, and monitoring to delay execution, enable manual interventions, and use APIs to enable real-time oversight (e.g., confirming correctness of wallet address, minimize operational "fat finger" errors) and ongoing transaction verification.
- Conduct due diligence on technology, operational, and legal considerations specific to a smart contract before its use (e.g., network upgrades, legal terms, jurisdictional applicability).
- Insurance and dispute management: Enable protection from unforeseen events and resolution of disputes between affected parties.

Private-permissioned networks: Closed and permissioned access, together with centralized governance over user privileges, significantly reduces the risk of bad actors accessing the network to potentially exploit vulnerable code. This also enables the central governance entity to verify the integrity of smart contracts and to provide for a rule-based approach to identify and remedy transaction-based errors. Most private-permissioned networks typically allow for editing and redress of erroneous code.

50 Ethereum Request for Comment 20 ("ERC-20") is a token standard that allows for the creation and issuance of smart contracts on the Ethereum DLT.

Public-permissioned network: Comparable to private networks, with closed and permissioned access and potential for centralized governance over user privileges, however the propensity for a larger network can increase exposure to bad actors exploiting vulnerabilities in smart contract code. Like private-permissioned networks, these networks typically allow for editing and redress of erroneous code.

Public-permissionless networks: Open and permissionless access, decentralized governance over user privileges, and large-scale user bases amplify the risks of bad actors exploiting vulnerabilities in smart contract code. Immutability also prevents editing and redress of erroneous code. To mitigate these risks, networks like Ethereum have code verification tools to ensure confidence in smart contracts executed.

Although existing cyber resilience frameworks provide a basis for approaching risk management, the differentiated nature of smart contract execution could require many of the mitigants listed above.

Operational Risk – Technology: Interoperability

Ensuring the security of connections and integrations between DLT systems and existing traditional systems.

Connections and integrations should be secured against bad actors and other cyberattack threats across the full range of solutions adopted including APIs, middleware, bridges, oracles and smart contracts. These solutions should mitigate against the risks of transferring security vulnerabilities between systems, instability from interference with consensus mechanisms, and maintaining KYC/AML/CFT regulatory compliance.

Private-permissioned networks: Closed and permissioned access significantly reduces the risk of exposure of transmitted data to bad actors. Interoperability can be achieved through adoption of common standards such as APIs, and single-common infrastructure, to bridge information flows, but distinguishing risks need to be mitigated to preserve the high standards of security and privacy. This includes unauthorized access, data leakage, and regulatory compliance (in the case of integrations with public, permissionless DLT networks). Depending on design, technical risks could also exist, stemming from incompatibility of data formats, consensus mechanisms, and scale requirements. To mitigate these risks, bespoke infrastructure and security protocols are being implemented by market participants to block unauthorized access, encrypt transmitted data and avoid interactions that could breach KYC/AML/CFT regulatory compliance (see KYC/AML/CFT risk for more details further below). Integrations with 'public, permissionless' networks are often also avoided altogether, to prevent the transfer of security vulnerabilities. Existing operational risk and cyber resilience frameworks provide a basis for risk management but require supplementation by these new infrastructure and security protocols to mitigate these risks.

Public-permissioned networks: Comparable to private networks, with closed and permissioned access, however these networks are typically designed for broader interoperability use cases 'out of the box'. The implication of a larger network also increases the risk of exposing transmitted data to bad actors. In addition to the mitigants described for private-permissioned networks, these networks should also consider mitigants set out for public-permissionless networks under Cybersecurity risk.

Public-permissionless networks: Open and permissionless access, decentralized governance over user privileges, and large-scale user bases increases the risk of exposing sensitive data (e.g., OTC security transactions) to bad actors during transmission. The distinguishing risks these networks present must be taken into account when implementing interoperability solutions to ensure safety and security.

Operational Risk – Technology: Scalability

Ensuring DLT-based capital markets can meet (a) processing throughput requirements and (b) digital storage requirements.

Sufficient processing throughput should be provided by the network to meet demand through a combination of techniques in the design of the DLT network including consensus mechanisms, data compression, and approaches to storage capacity requirements. Network operators should differentiate between different node types based on operational user requirements and storage capacity needs: from full-copy nodes, to lighter access-only nodes.

Private-permissioned networks: Scalability and processing speed is typically highest in these networks, given that there are far fewer nodes participating in the validation of transactions. These networks can also use more efficient consensus mechanisms such as Practical Byzantine Fault Tolerance (pBFT), Raft, Proof of Stake-derived models, and others. Custom node types can be defined to differentiate between requirements (e.g., from full-copy to access-only). This can be managed through existing cyber and IT resilience frameworks.

Public-permissioned network: Similar to private-permissioned networks, though the potential for more nodes could decrease scalability and processing capacity depending on the design of the network and use case. This can be managed through existing cyber and IT resilience frameworks.

Public-permissionless networks: Scalability and processing speed have presented ongoing challenges for these networks.[51] To mitigate these risks, workarounds on networks such as Ethereum spread storage workload (known as sharding) and bandwidth compression using layer 2s (like zero-knowledge rollups) have been successful in increasing capacity.[52] Proof of stake consensus mechanisms, such as that debuted by Ethereum in 2022, are increasingly common and significantly faster. These features could help provide the throughout required to meet scalability requirements. Can be managed through existing cyber and IT resilience framework.

Operational Risk – Technology: Settlement Finality

Ability to identify precise settlement and achieve designation as a securities settlement system.

The basis of settlement finality law is the identification of a precise moment after which the transaction (defined as discharge of an obligation by transfer of funds and transfer of securities) becomes irrevocable and unconditional.

Private-permissioned networks: Have the operational capability to identify the precise moment of settlement and can define the settlement finality moment in their rules (subject to availability of legal or regulatory frameworks that make such finality irrevocable).

Public-permissioned network: Can be designed to define the moment of settlement finality similar to private-permissioned networks set out above.

Public-permissionless networks: Use "probabilistic settlement" because any transaction must be validated through the consensus mechanism before it can be deemed completed. This makes the determination of the exact moment of operational finality relatively less precise to demonstrate settlement finality.[53]

51 For example, the Ethereum proof of work blockchain averages ~15 transactions per second (**"TPS"**) and Bitcoin ~7 TPS.
52 Zero-knowledge roll ups are protocols with of state updates off-DLT while storing transaction data on-DLT to improve scalability.
53 The use of permissioning to provide requisite settlement finality is discussed further in Chapter 4.

Compliance and Financial Crimes Risk | Permissioned and permissionless networks can comply with existing KYC / AML, data privacy regulations, settlement finality and reputational risk (avoiding Group 1b/2a/2b cryptoasset exposures).

Compliance and Financial Crimes Risk: KYC/AML/CFT Compliance

Ensuring the standards of KYC/AML/CFT implemented in regulated financial markets are upheld.

DLT networks can use authentication, verifiable credentials, and other relevant controls to ensure interaction with KYC'd accounts and ensure transactions are validated by KYCed nodes. Additionally, market solutions for real-time DLT transaction monitoring can be used to ensure KYC/AML/CFT standards are continuously being applied and upheld.

Private-permissioned networks: Enables a model with the closest equivalence to regulated capital markets infrastructure. Nodes are restricted to regulated financial institutions who would be responsible for ensuring counterparty compliance in each transaction (with anonymous counterparties but known institutional sponsors); governance is managed by a central entity, preventing rule-changes or "forks" of rules.[54] This can be managed through existing compliance frameworks.

Public-permissioned network: Can enable a model that operates similarly to private-permissioned networks. Although there is potential for unverified nodes on the network, central governance over user privileges and the use of authentication to deliver this can facilitate compliance with KYC/AML/CFT. This can be managed through existing compliance frameworks.

Public-permissionless networks: These networks present the most significant challenges to achieving KYC/AML/CFT compliance due to the absence of permissioning and central governance. To mitigate these risks, several practices are emerging. To achieve KYC/AML/CFT compliance on public-permissionless networks, applications can be built to use authentication so nodes and users can be identified. Users can also be equipped with verification markers, such as verifiable credentials, to support KYC/AML/CFT verification by decentralized applications. Furthermore, KYC/AML/CFT noncompliance only occurs if transactions are broadcast publicly for validation. However, on public networks, block-builder software can be used to hold transactions back from the public pool of unverified transactions and sent directly to validators subject to KYC/AML/CFT checks. It should be noted that this may result in slower processing times.[55] In respect of sanctions, smart contracts that screen transactions against sanctions lists such as Office of Foreign Asset Control (OFAC) and other due diligence requirements could be developed, though this is not currently in widespread usage. Additionally, qualified custodians have made investments in sophisticated DLT monitoring software to enable effective know-your-transaction (KYT) capabilities and ensure compliance with applicable rules and regulations.

As per the latest drafting of the Financial Action Task Force's (FATF's) *Updated Guidance for a Risk-Based Approach to Virtual Assets and Virtual Asset Service Providers,* transaction fees paid to validators as part of a virtual asset transfer on a public-permissionless network are not subject to the same personally-identifying-information requirements as the originator and recipient of the same transaction.[56]

54 A "fork" is a technical term to describe when a blockchain splits into two separate branches, sharing history up until the point of the "fork".
55 GFMA member input.
56 FATF, "Updated Guidance for a Risk-Based Approach to Virtual Assets and Virtual Asset Service Providers", Oct 2021. For specific detail see: Recommendation 16.180 and footnote 43.

Compliance and Financial Crimes Risk: Data Privacy

Replicating existing market confidentiality and data laws on DLT (e.g., General Data Protection Regulation (GDPR) right to be forgotten).

Data privacy and confidentiality of financial transactions can be protected to the same standards as traditional financial markets.

Private-permissioned networks: Privacy and confidentiality of financial transactions can be appropriately safeguarded across the network. Can be managed through existing Data Management frameworks.

Public-permissioned networks: Privacy and confidentiality of financial transactions can also be safeguarded to a similar standard as private-permissioned networks. Can be managed through existing Data Management frameworks.

Public-permissionless networks: The safeguarding of privacy and financial transactions pose challenges that require incremental risk mitigants, because transactions are publicly available on the ledger by default. Approaches like zero-knowledge proofs (**"ZKPs"**) can achieve data partitioning and keep transactions private (as seen on the Polygon distributed ledger). With ZKPs, the identities and value of the transaction would not be displayed on the ledger.[57] ZKPs could provide the nodes on the platform with RAG indicators (based on commonly agreed thresholds among participants) on the risks related to the beneficial owner, thereby reducing challenges relating to data protection. Zero-knowledge testing in the transition of on- and off-chain information can mitigate GDPR[58] risks.

Compliance and Financial Crimes Risk: Reputational Risk

Ensuring Group 1a DLT-based Securities and DLT-based Payment Instruments are clearly ringfenced from Group 1b/2a/2b digital assets, to protect market participants from unwanted exposures.

Regardless of network archetype, exposure to Group 1b/2a/2b digital assets as defined in the BCBS framework should be eliminated or minimized as appropriate to ensure regulatory compliance, create confidence for issuers and investors, and be appropriately ringfenced from Group 1a digital assets.

Private-permissioned networks: It is possible to limit digital asset classes and enable strict management of exposures to Group 1b/2a/2b digital assets in the context of the Basel Framework by expressly designing the network to prohibit use of any non-Group 1a digital assets.

Public-permissioned networks: Depending on the design and use case, these networks can similarly limit exposure to Group 1b/2a/2b digital assets.

Public-permissionless networks: The majority of public-permissionless DLT networks have a native cryptocurrency (Group 2b digital asset, in the context of the BCBS framework) token. On networks such as Ethereum and others that use EIP-1559, and similar, fee structure modifiers, a transaction validator is paid a transaction fee in the native network token (e.g., Ether for the Ethereum network) for posting its stake as collateral to validate the transaction (i.e., proof of stake). This creates significant risk of exposure to Group 1b/2/a/2b digital assets. To eliminate this exposure risk, GFMA members have highlighted several methods of participating on public-permissionless networks, *without* paying a transaction fee in the native network token, including:

57 Ibid.
58 Chainalysis, "The 2023 Crypto Crime Report", 2023. Note: This figure may include a portion of financial losses from other DLT network archetypes. BIS, "Cryptocurrencies and Decentralized Finance", 2022.

The EIP-2771 based Biconomy "gasless product" | A contract interface protocol that separates the signer and the payer of the transactions, thus allowing a third party to pay transaction fees. These are called meta transactions. In December 2022, J.P. Morgan executed its first-ever cross-border decentralized finance (DeFi) trade on Ethereum using Biconomy's gasless relayer.[59, 60]

Block builder software | Transactions do not have to be shared publicly for validation and can instead be directed to specific validators. Custom block builder software could pull transactions from a private group of transactions (which are not shared to the publicly accessible mempool) to which only financial institutions are allowed to contribute and direct them to validators that are being run by an organization that has been KYC'd in return for a premium or subscription payment (a KYC'd subset of the whole) that would be paid in DLT-based Payment Instrument or traditional cash offline.[61]

Our assessment shows that private-permissioned networks, which retain control over network access and user privileges, provide a model that is comparable to existing infrastructure used in capital markets. As highlighted above, these qualities enable robust management of cybersecurity risk as well as KYC/AML/CFT and data privacy compliance. These networks also offer arguably the strongest potential for scalability, and settlement finality in line with traditional payment systems. Some private-permissioned networks may have reduced resilience to common mode failure and ease of achieving interoperability compared with public networks. However, these remain in line with attributes of existing centrally administered systems, and can be managed by existing standards around operational and cyber resilience frameworks and supported by developing bespoke integrations with other distributed ledgers (e.g., through APIs). They can, therefore, be managed in line with established regulatory and risk management frameworks. As with all DLT networks, differentiated risk considerations exist around smart contract risk, for which mitigations have been substantiated and outlined above.

Though public networks raise questions on oversight, our assessment suggests that public-permissioned networks could potentially offer similar benefits around security and control to private-permissioned networks provided that appropriate risk mitigants are implemented. Public networks must contend with issues particularly around cybersecurity, KYC/AML/CFT and data privacy compliance, and settlement finality. However, public-permissioned networks can enable cybersecurity risk mitigation and KYC/AML/CFT compliance through permissioning , centrally-controlled governance, and through technology solutions that allow participants to share information and enter into agreements in ways similar to private-permissioned networks. Public-permissioned networks are also not exposed to the same level of cybersecurity as larger public-permissionless networks (e.g., 51% attacks, Sybil attacks) given they remain centrally controlled. These networks can also be designed to deliver settlement finality in line with traditional settlement systems. In addition to these mitigations, public-permissioned networks can offer potential for broader interoperability and market access to mitigate liquidity risks from fragmentation across bespoke DLT platforms in Primary and Secondary Markets. For example, leading DLT technology provider R3, which developed the private-permissioned Corda platform, has also developed 'Corda Network', a public-permissioned platform to meet use case requirements for interoperability.

Finally, the assessment suggests market participants and regulators should remain open to public-permissionless networks in the longer-term, as risk mitigants are further developed and proven. Key drivers include the potential for interoperability to access larger liquidity pools, the operational resilience of leading public networks, and reduced financial overhead of achieving economies of scale. However, differentiating risk considerations including cybersecurity concerns (cyberattacks on "crypto bridges" with other networks, 51% attacks, Sybil attacks, and

59 Biconomy, 2022: https://www.biconomy.io/post/jpmorgan-makes-history-with-first-ever-on-chain-defi-trade-using-biconomy-transaction-infrastructure.
60 "Gas" is a unit of measure referring to the computational resources required to complete a transaction, which manifests as a fee. A "gasless relayer" refers to a service where a third party (the 'relayer') pays the gas on the behalf of a user, thereby allowing the user to forego payment of the gas fee required to submit a transaction.
61 A "mempool" is an organized queue of pending, but not yet validated transactions that have yet to be added to a block-entry on a DLT.

other attempted network collusion), KYC/AML/CFT regulatory compliance (given unverified nodes are present), and exposure to Group 1b/2a/2b digital assets (native cryptocurrency tokens are used) could require technology workarounds, as described in the table of findings above.

An additional issue for public-permissionless networks arises in relation to settlement finality. Unlike private, permissioned DLT networks and traditional Clearing and Settlement infrastructure – which can define specific rules as to finality of payment and delivery, as well as backstops in relation to potentially failed transactions – these networks raise the issue of "probabilistic finality" in settlement due to the need to validate any transaction on the public network before it can be deemed completed. This makes the determination of the exact moment of operational finality relatively less precise. In practice, it is unlikely at present, to be possible for any fully permissionless DLT framework to obtain status as a securities or payment settlement system, which must demonstrate settlement finality.

To address these differentiated risks, market participants have been testing and developing mitigants as outlined in the risk mitigation framework and profiled in this report. Recent digital issuances (including those detailed in Chapter 3 | Use Cases) have experimented with these mitigants (e.g., whitelisting, privacy controls), finding success in their real-world application, paving a way forward for further adoption and exploration of new use cases.

3 | Legal And Regulatory Certainty: A Level Playing Field That Promotes Safe Innovation

Legal and regulatory certainty is a significant requirement for wholesale market development. The current position is that the laws and regulation applied to DLT-based Securities and DLT-based Payment Instruments are those developed for traditional assets. In some cases, this is effective, in others it can either operate as an inadvertent prohibition of certain types of business, or as a destabilizing influence undermining legal certainty as to the effectiveness of ownership and transfer of assets.

Both regulators and legislators are aware of this situation, and there are several initiatives around the world aimed at removing inadvertent barriers and improving legal certainty for investors and others. It is important to recognize that this updating of legal and regulatory functions involves engaging with difficult policy issues, and therefore requires significant resource input for the public sector.

This is an area where we would urge regulators and legislators to increase their focus and resourcing and to continue engaging in ongoing dialogue with the private sector to work towards solutions. This is not only because of the extreme undesirability of markets and practices developing outside the scope of the existing regimes, but also because the timely establishment of these structures will promote transparent, disciplined, and effective development of markets and infrastructures.

The legal challenges and barriers preventing or delaying the adoption and use of DLT and tokenized representations of securities in capital markets can be divided into three broad categories, which are discussed below.

It is important to note that both legislation and regulation or enacted on a national or, in the case of the E.U., supranational basis. Different jurisdictions are facing individual as well as global challenges and as such, legislation is evolving at different paces. It is unlikely that the development of different approaches in this area will benefit either individual jurisdictions or the market as a whole, and we believe that the development of coordinated policy positions across different jurisdictions would be a significant benefit both for the market and for governments and regulators.

(**1**) **Legislative Constraints:** In each jurisdiction, there may be specific legislation or regulatory requirements, almost always put in place for other reasons, which are incompatible with the use of DLT and the issuance or trading of DLT-based Securities by regulated entities. By way of example, in the E.U. and the U.K. it is a requirement that for a security to be traded on a trading venue (an exchange or a multilateral system) it must be recorded in book-entry form in a centralized securities depository (**"CSD"**). In practice, this does not prohibit the issuance of DLT-based Securities, but in the absence of a CSD that operates a DLT platform, such securities cannot be made fully available to investors. Where such outcomes are unintended consequences of existing legislation, they should be addressed as a matter of priority.

(**2**) **Legal Uncertainty:** While legal and regulatory requirements are often presented as being technology agnostic, in practice the decentralized nature of some DLT networks create legal uncertainty. For example, in many jurisdictions there is as yet no positive legislative instrument that permits the issuance and confirms the ownership status of holders of DLT-based Securities. This can lead to unacceptable levels of legal uncertainty as to what issuers are permitted to do, how issuances and transactions are to be treated for tax and settlement finality purposes, and the risk of invalidity for failure to comply with requirements established for report-based issuances. Some countries, notably Luxembourg and Germany, have passed laws establishing legal and regulatory clarity, and there is progress towards updating legal frameworks in many countries. Generally, we acknowledge that there is progress towards updating legal frameworks in many countries. However, there is a common thread as to the need for further development of an internationally-agreed approach to these issues, and to the development of the legal certainty that forms the foundation of trust necessary to support a capital markets framework and to meet the express expectations outlined in BCBS guidance regarding crypto assets. Regulators legitimately require regulated institutions to satisfy themselves as to the legal certainty and settlement finality in the transactions in which they engage, but this cannot happen unless regulators themselves co-operate with legislators and with the private sector to develop that legal certainty.

As usage of DLT increases, it will become increasingly necessary to (i) remove legislative constraints (such as rules requiring paper or mechanical processing of transactions); and (ii) create a legal and regulatory environment with clear guidelines that provide legal certainty to market participants. Some work is underway in certain jurisdictions, including the EU and the UK, to develop "sandbox" or pilot regimes that would create test environments in order to foster adoption of DLT. These measures are welcome. However, a sandbox is only useful where, once a concept has been proven within it, that concept is permitted within the relevant law – if necessary, by changing it. Sandboxes do not provide a long-term stable legal framework for market developments. It is particularly important in this context to note that the aim of such experiments is ultimately to provide legal and regulatory certainty to the entire securities value chain.

With regard to creating guidelines for legal certainty, an essential starting point is clarification of regulatory expectations as to the level of finality required to meet the BCBS requirement. As a first step, it should be clarified that the intended scope of the finality requirement should apply to the settlement process. Settlement finality is a legal technique used to cover delays in settlement systems – where a transaction involves an exchange of DLT-based Securities for payment in DLT-based Payment Instrument (or a fiat currency), this should be recognized as final is accomplished in a manner that is final. We note that payment in a form of DLT-based Payment Instrument may give rise to the sort of cross border payment issues identified in the BCBS paper "Enhancing cross-border payments: building blocks of a global roadmap" of July 2020. This clarification would be consistent with comparable settlement finality requirements in foreign exchange and regulated financial market infrastructures.

In this regard, we believe that the same approach should be adopted as for Foreign Exchange. In paragraph 3.6.5 of its *Supervisory guidance for managing risks associated with the settlement of foreign exchange,*[62] the BIS explains that the basis of this requirement is that "A bank should obtain legal advice that addresses settlement finality with respect to its settlement payments and deliveries. The legal advice should identify material legal uncertainties regarding settlement finality so that the bank may assess when key financial risks are transferred." This makes

62 BIS (BCBS), "Supervisory guidance for managing risks associated with the settlement of foreign exchange transactions", Feb 2013.

clear that the ultimate assessment of the legal protection available is a risk decision for the reporting institution and would avoid unintended extension to other lifecycle elements of capital markets (such as issuance or safekeeping). It would also be helpful to clarify that finality applies to settlement within the given network or platform that governs the relevant DLT-based Security and DLT-based Payment Instruments, which would also be consistent with the CPMI/IOSCO Principles. Such clarity would help promote ecosystems that are designed to result in free and clear ownership that is not impacted by events external to the relevant network or platform, including events on an unrelated network or platform.

It would also be helpful to underscore the importance of applying such guidance consistently, so that a global legal framework is developed in such a way as to promote the harmonization of rules and standards across jurisdictions. With clearer and consistent guidance, DLT's potential benefits outlined in this report can be effectively realized.

Market participants invite regulators to engage in a dialogue with the private sector and with legislators to develop legal infrastructure that meets expectations as to legal certainty and finality. Recent discussion of a "unified programmable ledger"[63] which could enable the creation of a DLT-based golden source for record-keeping, may be a potential starting point for this endeavor.

(**3**) **Avoidance of Legal Frictions:** As of today, there are significant frictions – referring to contradictory requirements or inconsistent obligations - which arise from divergent legislation and regulation regarding DLT-based Securities and DLT-based Payment Instruments. These frictions arise both within jurisdictions and between them. The process of updating legal and regulatory frameworks will take time, and whilst it is ongoing the occurrence of such frictions is likely inevitable. However, we believe that it is important that a process for identifying and addressing such frictions is established as part of the ongoing policy work in this area. We believe that the process of updating and enhancing wholesale market capabilities using new technologies will be an ongoing development which will have no clearly identifiable end point. This therefore needs to be a continuing process rather than a one-off project.

Recommendations: Legal and Regulatory Framework

Existing securities laws ideally should be refined and modified to apply optimally to DLT-based Securities. For example, existing disclosure requirements may not capture all the pertinent information or address all the risks that are most relevant to investors of DLT-based Securities. Examples of information that may benefit from more specific disclosure requirements include the processes by which new investments can be created or existing investments redeemed. Thus, the challenge is not as simple as just bringing these assets within the scope of existing laws – the detailed requirements of those regimes should be revisited to ensure that they capture information most relevant to an investment decision.

The existing rules of engagement for investors of DLT-based Securities with service providers and intermediaries (such as transfer agents, broker-dealers, and custodians) also pose an impediment to the development of the DLT-based Securities marketplace. Currently, investors may be effectively required to deal with one set of providers for traditional securities and another for DLT-based Securities, thereby increasing cost, adding complexity, while decreasing utility, and impeding interest. These rules should be revised to reflect the emerging structure of a DLT-based Securities ecosystem and reduce the number of providers DLT-based market participants must interact with. Additionally, it is critically important to ensure that DLT-based Securities are fully protected by qualified and well-regulated custodians. Here too, existing rules can be revised to ensure an equivalent standard of investor protection, while acknowledging the specific nuance of a DLT-based framework.

63 Carstens, "Innovation and the future of the monetary system"; speech at the Monetary Authority of Singapore, Feb 2023.

Settlement standards also should be revisited. The existing regime was put in place to further the goal of dematerialization of securities and the promotion of paperless settlement given problems experienced with a paper-based system. Today's regulated service providers work on systems that contemplate a robust, but intermediated, electronic settlement process and the migration to systems that contemplate a DLT-based environment requires analysis and modifications. Given the success and protections of the current settlement processes for traditional securities, regulators and legislators may be hesitant to seek changes. However, the question of how regulation should be reconfigured to facilitate the settlement of DLT-based Securities without losing legal and regulatory protections for users will require detailed policy analysis. This will include, in some jurisdictions, reviewing and revising mandates relating to clearing and related functions.

Where DLT-based Payment Instruments are intended to perform a money-like function, the regulatory issues are also complex. As a core principle, customers should benefit from the same protections when dealing with banks and "legacy" assets or payment instruments and when dealing with DLT-based Payment Instruments. Similarly, regulations and other standards should be rationalized to ensure that banks can provide the services that customers are accustomed to receiving from banks, with prime examples being Custody and transaction facilitation. Tokenized commercial bank money and deposits therefore should be subject to similar rules as traditional commercial bank money and not differentiated due to technology.

For a comprehensive exploration of the topics covered in this Executive Summary, we encourage you to refer to the full report.

The GFMA and its members acknowledge the increasing significance of DLT and the extensive research that underpins its implementation. We hope to encourage further study and exploration in the Closing Remarks, where we identify additional areas for examination.

We trust that the report will serve as a valuable resource for policymakers, regulators, and government officials, and we are confident that it will help foster a greater understanding of the impact DLT can have in global capital markets.

Chapter 01

Distributed Ledger Technology (DLT) and Tokenization

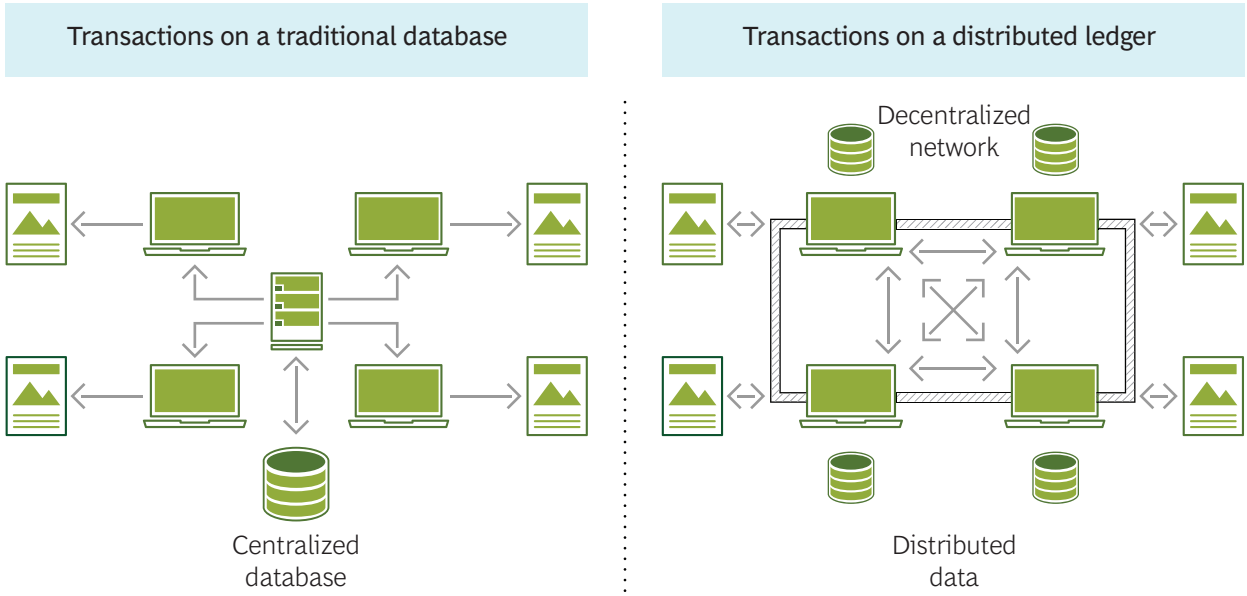
This chapter explores the two foundational concepts of this report: the database technology infrastructure known as distributed ledger technology (DLT)[64] and the digital representation of assets on this infrastructure, known as Tokenization.[65]

1.1 Definition of DLT

DLT is a database construct that brings together existing approaches around distributed computing networks and data encryption. It enables a new way to record state updates and transactions of assets between participants on a network.[66] A leading technology provider notes: "DLT enables everyone involved in a transaction to know with certainty what happened, when it happened, and confirm other parties are seeing the same thing without the need for an intermediary providing assurance, and without a need to reconcile data afterwards."[67] Separate participants in different locations, known as nodes,[68] each maintain a copy of a common ledger, proposing new transactions and verifying proposed transactions to be appended onto the ledger.[69] The verification of transactions requires the consensus of participating nodes. Verified transactions form a record that is protected by cryptography so historical transactions cannot be altered,[70] known as immutability.[71]

Exhibit 1.1

Comparison Between Traditional and Distributed Ledgers



Source: BCG analysis

If properly operated and maintained, the main advantages of a distributed ledger over traditional databases used by financial institutions are the potential for near-instant settlement, reduced operating costs, data integrity,

64 While often used interchangeably, a blockchain and a distributed ledger are distinct technologies. A blockchain is a way to implement distributed ledger technology, but not all distributed ledgers employ blockchains. In this report, we will reference distributed ledgers and DLT, rather than blockchain. Refer to "Blockchain Byte: R3 Research" by Emily Rutland for a discussion on the distinction between blockchains and distributed ledgers.
65 OECD, "The Tokenisation of Assets and Potential Implications for Financial Markets", 2020.
66 See, for example, the BIS discussion of distributed ledgers: "…as a collection of states and transactions that describe the transition from one state to another" – BIS, "Cryptocurrencies and Decentralized Finance", 2022. This report will refer to both state updates and transactions collectively as transactions for ease of reference.
67 R3, "Blockchain 101", 2023.
68 See Blockchain Council's overview: "Nodes are network stakeholders, and their devices are authorized to keep track of the distributed ledger and serve as communication hubs for various network tasks." Taken from "What Are Blockchain Nodes? Detailed Guide," 2022.
69 Bank of International Settlements, "What is distributed ledger technology?", 2017.
70 Blockchain Byte: R3 Research, Emily Rutland.
71 The term immutability refers to a state that cannot be changed or altered after it has been created. In capital markets, immutability can enable consensus and trust across the network but will also require mitigants to ensure errors and remediations can occur.

enhanced automation, and operational resilience.[72] DLT is enabled by an underlying computing network, protocols, services, and interfaces – which can have varying degrees of centralization or decentralization (explored in Chapter 1.2). A distributed ledger is accessible either through a private network (where access is permissioned to predefined users, similar to infrastructure used today in capital markets), or a public network (which includes either permissionless access or permissioned access). These concepts are explained in this chapter.

DLT consists of two foundational concepts that work together. First, a **distributed database architecture** across participants that provides a new infrastructure and method to capture and update data on a near real-time and shared basis. Second, this architecture enables the digital representation of assets (or other forms of value) as data on this infrastructure, which is referred to as **Tokenization**. Although Tokenization on DLT infrastructure was pioneered by public, permissionless distributed ledger networks with native cryptocurrency tokens (e.g., Ethereum), the same concepts can be applied to a broad range of asset classes on other public or private networks. This includes regulated financial instruments that are frequently traded (e.g., equities, fixed income including asset-backed securities, and derivatives), additional financial instruments (e.g., private debt and unlisted securities), and cash.

1.2 DLT Architectural Attributes and Networks

A distributed ledger uses a unique architecture for capturing, appending, and verifying transaction data, which typically has four key attributes:

1 | Distributed peer-to-peer (P2P) network: A single database architecture ("ledger") is replicated by multiple participants ("nodes") in a network of connected computers. The network is governed by predefined rules regarding the management of data on the ledger ("protocol"). This distribution across participants is the central feature of DLT, providing enhanced operational resilience compared with centralized databases as there is no single-point-of-failure.[73] While it is often conflated with the concept of decentralization, it is entirely distinct. Decentralization refers to the degree of central control and governance (or lack thereof) over the operation and administration of the infrastructure. Distributed ledgers can have varying degrees of decentralization (or none at all), which can be considered across the three sub-attributes shown in the sidebar.[74]

Sidebar: Decentralization

Computing network: Control over the computational infrastructure, called nodes, replicating the ledger to power the network. Decentralized computing networks provide operational resilience against technical faults and cyberattacks by reducing central points of failure.[75] This is a defining advantage of distributed ledgers when compared to centralized databases.[76]

Ledger architecture: Control over the overall interface and structure of the ledger database replicated by nodes. Counterintuitively, DLTs have a centralized ledger design that enables the provision of a uniform structure to be replicated by nodes (the distributed ledger itself). This ensures the ledger is the same for all nodes and resists change.

72 HSBC, "Distributed Ledger Technology in the Capital Markets – Game Changers – Future Trends in Securities Services", 2019.
73 Distribution is not unique to DLT–many databases and systems can be managed across locations, but typically they are connected to a central database or system with updates pushed out at a point in time. DLTs are differentiated because there is no central database–instead, copies of the ledger exist across the network.
74 Adapted from Vitalik Buterin, "The Meaning of Decentralization", 2017.
75 This is a generalized rule, though "common mode" failures can exist where, for example, all nodes are running the same software.
76 This concept already exists across mission-critical infrastructure and software systems, for example, in the use of backup systems in cloud computing provision, aircraft engines, and power generation.

Governance: Control over the decision-making authority (e.g., accessibility and permissioning) and operations across the network. With greater decentralization of governance, decision-making and operations can be increasingly shared by network participants. Governance can also be centralized in totality or with regard to specific functions — ultimately, this is a design option that can be defined and optimized for the activities being conducted. It is important to distinguish between decision-making and operations of the network. Though both can be combined, they can also be separated (e.g., when there is a central governance entity, but the operations are performed by specific actors), the consensus mechanism for a network is also fundamental to governance. The central governance entity can design how this consensus mechanism works for a given application. For example, in capital markets, permissioning (either for a private network or for one or more permissioned nodes on a public network) may define which market participants are entitled to have governance roles, which may vary as they are defined, for the network. These concepts are developed in the review of distributed ledger network archetypes.

2 | Validation of data integrity through consensus: New transactions are added to a distributed ledger only after they are verified through a predefined protocol known as a consensus mechanism. This is an important source of trust in the accuracy of the database and prevents double-spends.[77] Depending on the chosen approach and scale of adoption, both the network scalability (defined as the number of transactions processed per second) and energy consumption can vary drastically.[78] Many different consensus mechanisms are used in distributed ledgers, but the most common are Proof of Work and Proof of Stake.[79],[80] These are designed for public networks, where nodes are unverified and therefore not assumed to be trusted actors. Private networks can specify rules that guide how consensus is achieved, including consensus mechanisms can build on these approaches or take different forms based on the specific needs of the activities (for example the PBFT method).

3 | Immutability of data: Prevents data tampering on the ledger. Many distributed ledgers (but not all) choose to achieve this using the blockchain approach. Although this approach was pioneered by the Bitcoin ledger, it has no intrinsic link to cryptocurrencies or other digital assets defined as out of scope for this report.

A unique identifier known as a hash signature, or just "hash," is typically assigned to a bundle of transactions to be added to the ledger. This is known as a block. The next block added to the ledger is chained to the preceding block using the preceding block's hash signature, creating a mathematical linkage between the two. If an attempt is made to alter a previously agreed upon block, this mathematical relationship is broken as later blocks now refer to an incorrect hash signature. In such cases, the altered block is rejected and discarded by the network to restore the mathematical linkage through the consensus mechanism. Any block added to the ledger is therefore irreversibly recorded in this way and cannot practically be changed after it has reached consensus. This concept is called "immutability."

77 With fiat currencies, for example, there are structural safeguards against the double-spending of money (i.e., using the same money more than once): (1) double-entry bookkeeping to ensure the balance of debits and credits; (2) authentication, clearing, and verification processes that reconcile transactions and check for money laundering and fraud; and (3) the use of physical cash as a means of exchange to make sure it cannot be used by the same party again unless a theft is committed. Distributed ledgers provide alternative solutions to prevent double-spending, though they can also work in tandem with (1) and (2).

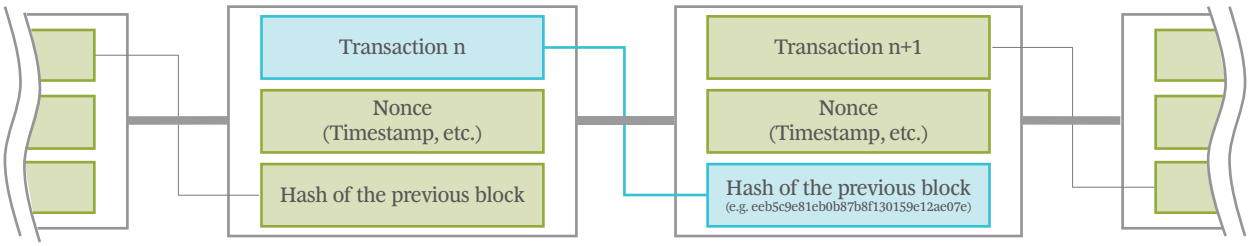
78 Boston Consulting Group, "Thinking Outside the Blocks: A Strategic Perspective on Blockchain and Digital Tokens", 2016.

79 Proof-of-Stake: Proof-of-stake (PoS) is a consensus mechanism used in DLT that relies on validators staking cryptoassets (the native token of the network) to validate transactions and create new blocks. Validators are chosen based on the amount of cryptoassets they hold and are willing to stake as collateral, with the higher the amount staked, the higher the chances of being selected as a validator. Validators earn rewards for their work, which typically come in the form of additional cryptoassets, but can also be penalized (e.g., lose their staked funds) for malicious behavior (e.g., double-signing transactions, which risks forking the DLT).

80 Proof-of-Work: Proof-of-work (PoW) is a consensus mechanism used in DLT networks that relies on computational power to validate transactions and create new blocks. In PoW, validators (also called "miners") compete to solve complex mathematical puzzles to create a new block, and the first validator to solve the puzzle gets to add the block to the DLT and earn rewards in the form of newly minted cryptoassets (the native token of the network). The difficulty of the puzzle is adjusted based on the total computational power of the network, and validators are incentivized to use more computational power to increase their chances of solving the puzzle and earning rewards.

Exhibit 1.2

DLT Prevents Tampering of Data by Using Encrypted Unique Identifiers (hash signatures) Between Transaction Data



Source: BCG analysis

4 | Composability: Ability to build an ecosystem of applications that are interoperable because they have back-end integrations with a common distributed ledger and a means of exchange to transact on the ledger. The back end delivers services by using software code known as smart contracts. Smart contracts are developed on a distributed ledger to self-execute "if…then"–style logic, based on predefined criteria, and applied to a user's assets on the ledger. This programming of smart contracts is known as programmability, resulting in asset-level automation. The front end can be accessed through web or mobile applications, providing functionality to end users, such as financial products and services (see exhibit).

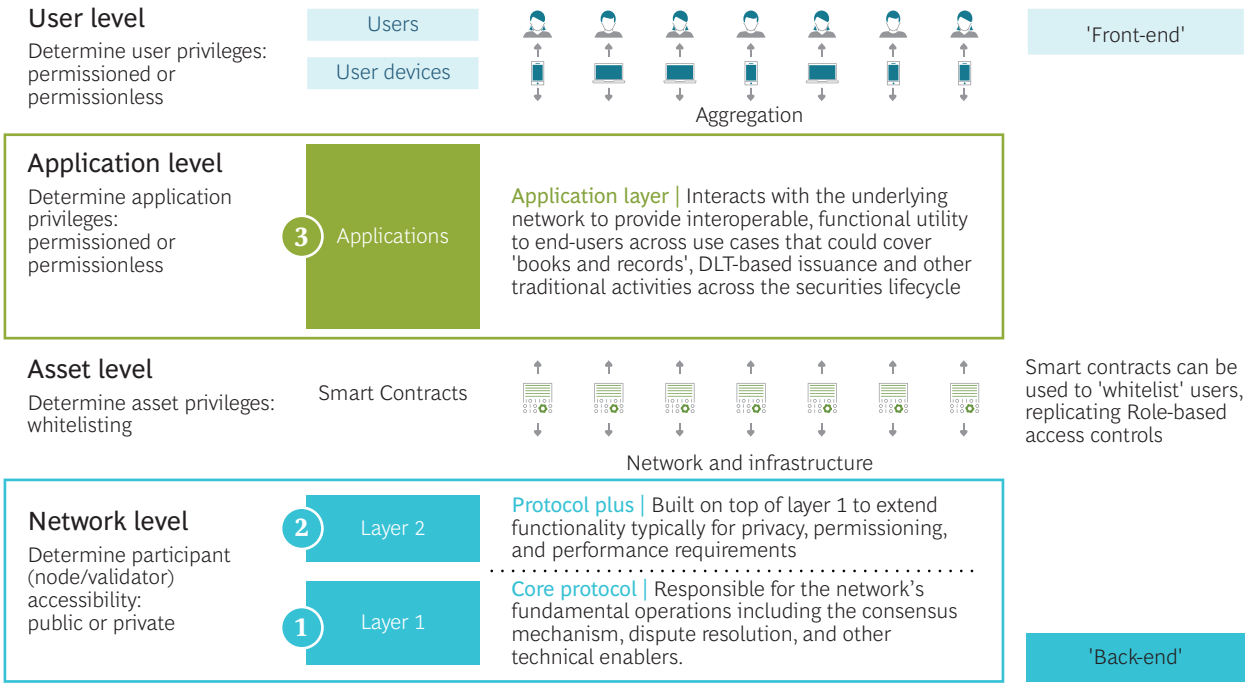
Composability through smart contracts is providing a conceptual basis that participants in capital markets are exploring to fulfill Books and Records back-office use cases, and experimentation with traditional services across the securities lifecycle provided to issuers and investors through distributed ledgers. This is driven by the potential to realize the benefits enabled by the four attributes highlighted above. **A series of choices exist around these attributes.** The distributed ledger network is one of the most critical, directly driving the ability to influence all other attributes. The level of central control over the distributed ledger network can also influence how data verification through consensus and immutability is achieved, and the extent of ecosystem interoperability enabled by composability.

Distributed Ledger Network Archetypes

Given its central importance to a DLT-based ecosystem, recent debate in the industry has focused on the different archetypes of distributed ledger networks. Distributed ledger archetypes are differentiated along two dimensions: (i) the **accessibility** of the network, which can be private (closed, invitation-only) or public (open to all); and (ii) the privileges set for users to perform specific actions, such as writing to the ledger, which can be permissionless (users are unauthenticated) or permissioned (users are authenticated). **Accessibility is determined at the network level (layer 1), while privileges can be set at the asset (through smart contracts), application and/or user levels.**

Exhibit 1.3

Accessibility and Privileges in a Composable, DLT-based Ecosystem



Source: Phemex; Blockchain Council, "A Beginner's Guide to Understanding the Layers of Blockchain Technology," 2022; BCG analysis

This has given rise to three archetypes of distributed ledgers – the Executive Summary has provided an overarching discussion on Distributed Ledger Networks, which is synthesized in the exhibit and supporting text below:

Exhibit 1.4

Comparison between distributed ledger archetypes

		Private-permissioned	Public-permissioned	Public-permissionless
Defining characteristics	**Governance**	Centralized	Centralized (for the relevant application)	Decentralized
	Accessibility to users	Closed	Closed (for the relevant application)	Open
	Control over privileges	Can be defined as required	Users authenticated for specific roles	All users can perform all roles
	Identification	All users known	All users known (for the relevant application)	Pseudonymous
	User base	Very Limited (by design)	Limited (for therelevant application)	Broad
Technology and infrastructure risk factors	**Default data confidentiality**	Can be defined as required	Can be defined as required (for the relevant application)	All users can view all transactions (without bespoke approaches)
	Overall operational resilience	Lower common fault tolerance but highest cyberattack resilience	Provides lower common fault tolerance and cyberattack resilience vs permissionless	Higher common fault tolerance; most exposed to cyberattacks but proven resilience in leading networks
	Scalability	Higher scale and performance in core network given fewer nodes	Higher scale and performance in core network given fewer nodes	Lower scale and performance in core network given many nodes; requires bespoke solutions
	Interoperability	Can be developed as required but lower ease of implementation	Can be designed as required (for the relevant application)	Higher interoperability given existing DLT-based ecosystem
Regulatory and Compliance Factors	**1 | Cyberattacks (application layer)**	Strongest mitigation as network closed and centrally controlled	Authentication reduces risks of cyberattacks and hacks	Unique risks of cyberattacks and hacks (e.g., bridges)
	2 | KYC/AML compliance	All participants are verified by default	Authentication enables KYC / AML, but some participants (e.g., node validators) unverified	Participants are unverified, so bespoke solutions are required (e.g., application whitelisting)
	3 | Group 1b & Group 2 asset exposure[1]	No Group 1b/2 assets are used	Can be designed to ensure no Group 1b/2 assets are used	Workarounds required to avoid Group 1b/2 assets
	4 | Settlement finality	Can demonstrate precise moment of settlement finality in network-wide rules (subject to rules/ regs)	Can be designed to define moment of settlement finality similar to private-permissioned networks	Probabilistic settlement due to validation by consensus; some networks defined "finality" step where reorg probability is very low
	Examples	HYPERLEDGER FABRIC, r3·corda, POLYMESH	c·rda NETWORK	bitcoin, ethereum

1: As defined in the Basel Framework, set out by BCBS in the "Prudential treatment of cryptoasset exposures", 2022.

Source: GFMA member input; BCG analysis.

Private-permissioned: Private networks enable a comparable model to existing infrastructure used by capital markets today, with control over all network layers, and their defining characteristics mean existing legal, regulatory, and institutional risk management frameworks (like operational and cyber resilience frameworks) can be applied. The primary limitation of these networks is interoperability, which is typically not a key design feature though can be achieved through API information flows or alternative solutions. Some industry participants have chosen private-permissioned networks as a starting infrastructure for use case development on distributed ledger technology.

Public-permissioned: Though public-permissioned distributed networks mark a step away from the tight central control of private networks, they also operate as closed networks with centralization retained over key network attributes. Therefore, like private networks, the same legal, regulatory, and institutional risk-management frameworks also provide a sufficient basis to govern these networks, including differentiated considerations around cybersecurity and impacts on operational resilience, and the emerging development of tools to better enable KYC/AML/CFT compliance. In these instances, the permissioning of the network can play an important role to mitigate these risks. As the DLT ecosystem matures, GFMA members identified the suitability of these networks for capital market use cases where interoperability and wider end-client access are key requirements (e.g., facilitating broker-dealer access), along with a degree of central control that can also be configured based on needs. Regulators interviewed for this publication have also expressed interest in public-permissioned networks for these reasons.

Public-permissionless: These publicly available distributed ledger networks have defining characteristics, such as decentralization, pseudonymity, and large-scale user bases, which are significantly different to private-permissioned and public-permissioned networks. GFMA members have identified advantages this could provide for use cases in a more developed DLT ecosystem. This includes interoperability and driving adoption, but also the proven operational resilience of leading public networks and reduced infrastructure costs they enable. The GFMA has worked with members using existing legal, regulatory, and risk-management frameworks as a valuable starting point to explore the execution of regulated activity on these networks. Several differentiated considerations exist around cybersecurity and KYC/AML/CFT compliance interaction with Group 1b/2 digital assets, market conduct controls, and settlement finality. Mitigations for these risks have been identified and are discussed in detail in the Executive Summary. These are intended as a starting point to build cross-industry alignment and inform regulators on appropriate evolutions to existing legal and regulatory frameworks.

In Annex 2: DLT-based Security Issuances, GFMA members have compiled a non-exhaustive list of DLT-based Security issuances, demonstrating the various use cases each network archetype is most suited for.[81]

As is the case with any new technology, financial institutions and regulators are evaluating these archetypes with a heavy focus on legal, regulatory, and risk management considerations for use cases in capital markets. The GFMA has worked with its members to better understand the defining attributes of these networks, the technical features, and the crucial implications on institutional-grade risk management frameworks. These were presented in the Executive Summary.

81 Recently Goldman Sachs, BNP Paribas, and other global institutions, announcted their participation in Digital Asset's Canton network, built on Daml 2.0. This is a privacy-enabled distributed ledger (Canton) and smart contract programming language (Daml) that allows business to build and deploy multi-party applications across complementary DLT networks in a decentralized manner. CoinDesk, "Digital Asset Will Start Global Blockchain Network With Deloitte, Goldman Sachs and Others", May 2023.

Sidebar: The Internet as an "analogy"

Financial institutions and regulatory bodies exploring DLT can examine parallels with decisions made around the adoption of the internet. Like a distributed ledger, the internet is a network of connected computers. It is accessible to any user with a service connection and there are generally no default limitations on privileges to interact with and develop webpages, email, and other applications (in line with publicly available rules, known as permissionless protocols).[82] The internet can therefore be described as a **public network** with **permissionless access.**

Applications developed on the internet deliver security through approaches including encryption and authentication to identify users and websites.[83] Mainstream web browsers search for certification from a website to confirm the website's identity and then encrypt all communication between the browser and the website.[84] The user can also be authenticated, such as for email access and online banking. Signing up for online banking or other financial services requires users to undergo KYC checks. This can be described as the use of a **permissioned application** on a **public network** with **permissionless access**. Most financial services are delivered through permissioned applications on the public internet to ensure end-user security while maximizing market accessibility.

There are also restricted, closed-loop networks of connected computers known as intranets. Intranets limit or block external connectivity to the public internet as a cybersecurity defense, typically chosen by corporations and governments. Users interacting with intranets are authenticated to gain access to the network. These can be described as **private networks** with **permissioned access**. They are not typically used to provide financial services to end users, but rather to store internal intellectual property, knowledge bases, and other internally focused content.

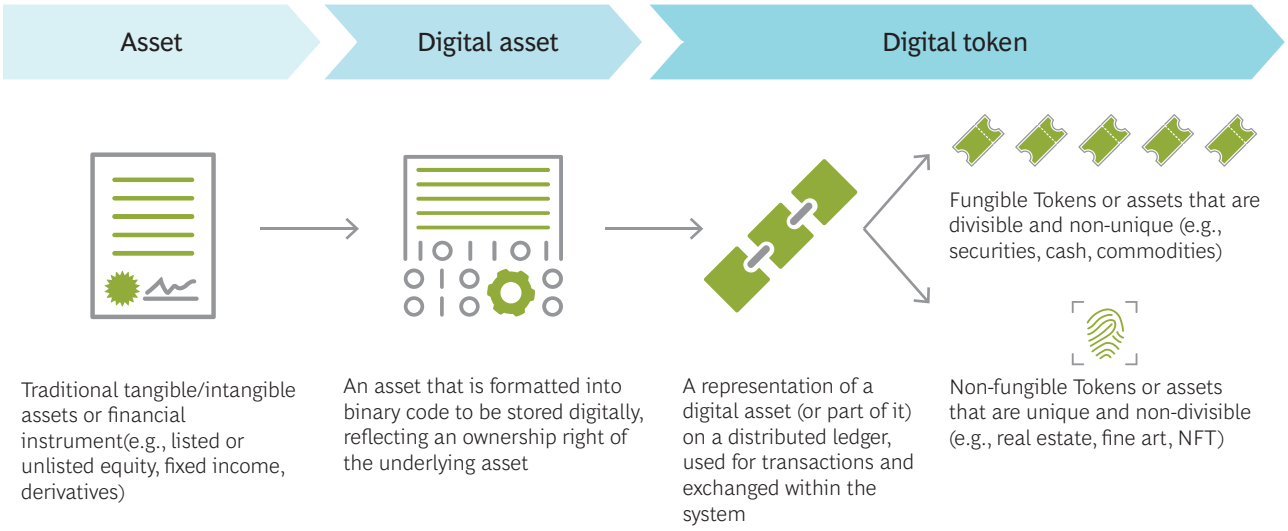
1.3 Digital Assets

Since the advent of paper certificates to represent real-world assets, such as banknotes, Tokenization has existed across various form factors in finance. This report defines Tokenization as the digital representation of regulated financial instruments and money on a distributed ledger, reflecting an ownership right of the underlying asset (e.g., securities, cash).[85] Assets tokenized on a distributed ledger are commonly referred to as digital assets.[86] For Tokenization to occur, units representing a digital asset, known as tokens, are added to the distributed ledger, and exchanged through transactions. This initial process is known as minting. Minted tokens can either be fungible (interchangeable and divisible – like securities, cash, or commodities) or non-fungible (unique and indivisible — like real estate, fine art, and other nonfinancial assets). The ledger can be used in primary issuance, secondary trading, Custody, and other back-office activities.[87]

82 For example, Transmission Control Protocol/Internet Protocol (TCP/IP), Hypertext Transfer Protocol (HTTP), and Simple Mail Transfer Protocol (SMTP).
83 For example, Secure Sockets Layer/Transport Layer Security (SSL/TLS) protocols.
84 Coin Center, "What does 'permissionless' mean?", 2017.
85 Tokenization includes the representation of other tangible assets (e.g., commodities) and intangible assets (e.g., copyrights and patents) on a distributed ledger, but these are out of scope for this report. Additional use cases for Tokenization also exist but are out of scope for this report.
86 European Union, "Article 3(2) of the 'E.U. Project Proposal for a Regulation on Markets in Crypto-assets (MiCA).", 2022.
87 The technical difference should be noted between native coins issued by a layer 1 distributed ledger (e.g., ETH) and tokens, which are composed on a layer 2 distributed ledger protocol through smart contracts. For simplicity, this report refers to any unit representing a digital asset on a distributed ledger as a token, in line with common usage by practitioners.

Exhibit 1.5

Tokenization of Assets on a Distributed Ledger



Source: BCG analysis

"Digital assets" is a broad umbrella term. For the purpose of this report, tokens that lack intrinsic value or are issued without backing by an asset with intrinsic value, like cryptocurrencies, are out of scope. Tokenized representations of regulated financial instruments, commercial bank and central bank money are however steadily emerging in the regulated financial services ecosystem today. Together, these assets meet the classification conditions set out under the Basel Framework for Group 1a cryptoassets.[88] Unlike Group 2a/b cryptoassets, they have precedents and proven utility in the financial ecosystem, governed by proven and globally harmonized regulatory and risk-management frameworks. A full discussion on the risk implications was provided in the Executive Summary.

With regard to digital taxonomy, the GFMA and its members remained concerned with the continued use of the term cryptoassets to refer to Group 1 assets by market stakeholders globally. The term fails to provide a meaningful differentiation between Group 1 and Group 2, despite the significantly different economic structures, regulatory status, and risk profiles outlined above. Consensus around terminology and classification is critical to prevent this conflation, enabling all industry stakeholders to work from a consistent baseline and globally harmonized definitions. The GFMA's proposed taxonomy, recently submitted to the FSB's cryptoasset consultation, is based on inputs from bodies including the IMF, WEF, and BCBS.[89] It also incorporates the views of the GFMA members, representing the perspectives of global capital markets. It is intended as a starting point for consensus-building across the financial services ecosystem. The relevant sections for this report have been highlighted and further refined below.

88 Ibid.
89 GFMA, "GFMA Response to FSB Crypto-Asset Consult", 2022.

DLT-based Securities

Type of assets	Traditional financial instruments including, but not limited to, equities, fixed income, derivatives, and asset-backed securities that satisfy existing legal definitions of securities and financial instruments.
Purpose	Issued as a means of generating additional capital and income through primary issuance and secondary trading on a distributed ledger.
Characteristics	Equivalent to the financial instruments they are representing outside of a distributed ledger or DLT ecosystem.
Examples	**Tokenized Security (e.g., USB AG's digital bond dual listed on Swiss SIX and SDX)**: Token that represents on DLT infrastructure underlying securities/financial instruments issued on a different platform (for example, a traditional central securities depository (CSD) or registrar) where such representation itself satisfies the definition of a security/financial instrument under local law. **Security Token (e.g., World Bank's "Blockchain Bond"):** Token issued solely on DLT infrastructure that satisfies the applicable regulatory definition of a security or financial instrument under local law.

DLT-based Payment Instruments:

Type of assets	Commercial bank money or, as may become applicable, central bank money.
Purpose	Issued as a means of exchange on a distributed ledger.
Characteristics	Holds a reliable value due to the nature of the issuance structure.
Examples	**Tokenized Commercial Bank Deposits:** A token reflecting a deposit ownership claim on a DLT for a fixed amount of fiat money denominated in a single currency by the token-holder against the token issuing bank.[90]
	DLT-based Deposits:[91] traditional deposits held at a bank, represented as an account balance on a DLT-based system, denominated in a single fiat currency.
	Wholesale Central Bank Digital Currencies (wCBDCs)[92] (none launched): Specialized, limited purpose form of money that represents a liability of a central bank for a fixed amount of fiat money denominated in a single currency, which may be designed for specific use by wholesale market participants who have central bank account access.

90 This may include registered liability networks (RLNs) depending on the specific technical implementation of commercial bank deposits on the DLT.
91 Onyx by J.P. Morgan, Oliver Wyman, "Deposit Tokens: A foundation for stable digital money", Feb 2023.
92 Though in rare instances (such as with China's e-CNY) CBDCs can rely on non-DLT-based infrastructure, this taxonomy is intending to capture only those leveraging DLT.

Sidebar: Dependency on DLT-based Payment Instruments

The settlement of securities transactions on a distributed ledger is dependent on integration with the payments infrastructure. Depending on the maturity of jurisdictions, central banks, and other public authorities could have to choose between existing real-time payment infrastructure or DLT-based payment infrastructure. DLT-based Payment Instruments have the clear advantage of enabling the full suite of benefits offered by DLT. DLT-based workflows can also be developed that link DLT-based Payment Instrument proxies with existing payments infrastructure, such as RTGS.

Existing payment infrastructure

Advanced payments infrastructure already exists across global markets, including RTGS for wholesale and other real-time retail payments systems like FedNow, FPS, SCT Inst, and others. Distributed ledgers used in capital markets could be integrated with these systems to enable the settlement of domestic securities transactions using existing forms of commercial bank and central bank money, building on investments already made in financial market infrastructures (**"FMI"**) across the U.S., U.K., E.U., Middle East, and Asia Pacific. For example, the Bank of England's proposed omnibus account structure enables its RTGS service to interface with DLT-based payment systems,[93] a structure being used by Fnality.[94]

However, longer-term adaptability could also be limited through existing forms of money and infrastructure, with trade-offs on payment automation (e.g., no smart contract–style programmability and higher transaction costs) and without the benefit of reducing settlement risk by means of full DvP settlement. Additionally, capital markets are globally interconnected, and real-time payment improvements have had a limited impact in cross-border transactions, which still rely on correspondent banking. To this end, Swift and others have been exploring the use of DLT-based infrastructure and interoperability solutions for cross-border payments.[95]

DLT payment infrastructure overview

DLT-based Payment Instruments enable a richer benefits case compared with existing real-time payments, given the compatibility with smart contract–based programmability, as well as the potential for pre-determined, precise atomic settlement optionality, and reduced transaction costs. Appropriate forms of DLT-based Payment Instruments remain in research and development across markets.

Tokenized Commercial Bank Money and deposits: GFMA members are exploring the use of DLT-based Commercial Bank Money and deposits for the settlement of securities transactions. This is in line with principle nine of the BIS-IOSCO Principles for Financial Market Infrastructure.[96] Deposits can be tokenized, account-based, with ownership reflected on a DLT, or otherwise linked to commercial bank accounts to allow for transfer of balances on DLT. This approach has been demonstrated with JPM Coin, used in the J.P. Morgan repo use case example described in Chapter 3 | Use Cases[97]. The Regulated Liability Network (RLN), initiated by Citi among other commercial banks and the Federal Reserve Bank of New York Innovation Center, is also exploring the interoperability of tokenized commercial bank money as a payment method with other Group 1a digital assets.[98] Tokenized Com-

93 Bank of England, "Bank of England publishes policy for omnibus accounts in RTGS", 2021.
94 Fnality is jointly funded by leading financial institutions across the U.K., E.U., Asia and US. See here for more details: "Fnality Global Payments & Multi-CBDC", 2021.
95 Swift, "New experiments pave way for international payments using CBDCs", 2022.
96 BIS-IOSCO, "Principles for Financial Market Infrastructure", 2012.
97 Further detail on JPM Coin can be found in: JP Morgan, Oliver Wyman, "Deposit Tokens: A Foundation for Stable Digital Money", Feb 2023.
98 Regulated Liability Network, "The Regulated Liability Network: Digital Sovereign Currency", 2022.

mercial Bank Money and deposits have typically been based on private-permissioned networks.

- **Wholesale CBDC (wCBDC):** wCBDC is the closest proxy to central bank reserves in a DLT-based ecosystem, representing a form of settlement free of credit and default risk, and limited to wholesale market participants who have central bank account access. As noted above, policymakers should seek to ensure opportunities for regulatory arbitrage are minimized and the role of banks in providing credit to the economy is not undermined. For example, the risk of deposit disintermediation – from a CBDC that could be made available to the general population (i.e., a retail CBDC) – could significantly impact bank funding costs and drive either higher borrowing costs for customers or reduce credit provision in the market should banks reduce lending activity.[99] Though many are under research and development, no fully launched wCBDCs exist today.

99 Bank of England, "Central Bank Digital Currency: opportunities, challenges and design", 2020.

Chapter 02

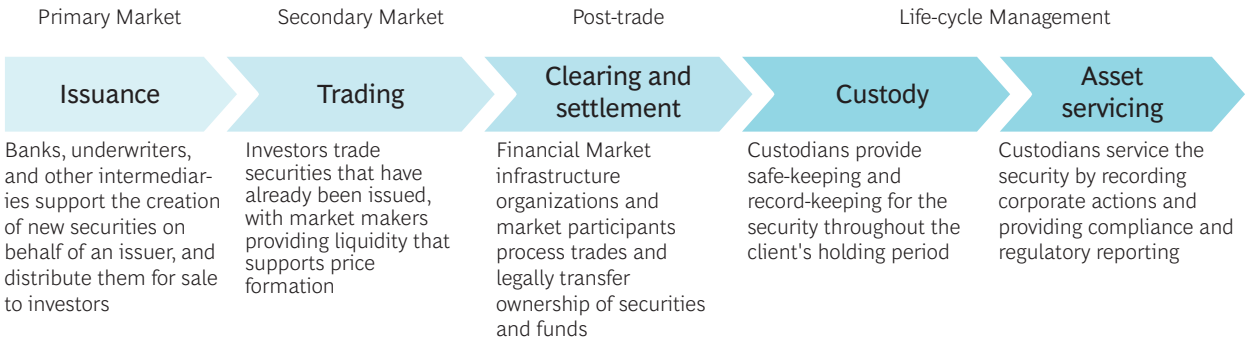
Opportunities and Risks: Impact of Tokenization Across the Securities Lifecycle

This chapter provides an overview of the current capital markets ecosystem and a detailed impact assessment of DLT and DLT-based Securities. Subsections are dedicated to Primary Markets and Issuance, Secondary Trading, Clearing and Settlement, Custody, and Asset Servicing to ensure that, this assessment is exhaustive across every stage of the securities lifecycle. The chapter concludes with a detailed analysis of the regulatory reporting and KYC/AML requirements across major jurisdictions globally with an assessment of the impact DLT could have.

2.1 Securities Lifecycle: Current State and Impact Assessment

Exhibit 2.1.1

Stages of the Securities Lifecycle



Source: BCG analysis

Each sub-chapter within Chapter 2.1 provides a description of the current state and key inefficiencies experienced by participants in each stage of the securities lifecycle—these can span across participants and processes or be found concentrated within a certain workflow. **The GFMA and its members seek to assess, through detailed assessment, whether DLT can address, mitigate, or eliminate these barriers.**

Each sub-chapter provides detailed impact assessment for each stage of the securities lifecycle – ranked HIGH, MEDIUM, or LOW based on the degree of positive impact DLT could have when considered across four key attributes of each lifecycle stage:

- Models of Implementation
- Activities
- Evolved Roles and Responsibilities
- Financial Impact and Opportunities
- Risk Impact

Important to note, the Risk Impact assessed here refers **specifically to existing risk in the traditional markets and does not address DLT-specific risk:** this is covered in detail in *Executive Summary: A Holistic Understanding of DLT-Specific Risk.*

Capital markets have specific nuance across asset classes that drive the level of impact. Where applicable within this chapter, asset-class sidebars, subsections, and other callouts provide these details.

KYC/AML and regulatory reporting are critical components of the securities lifecycle and span across many stages of the securities lifecycle – as a result they are treated completely and separately in Chapter 2.2 | Regulatory Reporting and KYC, with specific detail by the applicable global geographies.

2.1.1 Primary Market Issuance

This section provides an overview of participants, key activities, and critical inefficiencies that exist today. This provides a baseline for an impact assessment of DLT, considering **different models of implementation and impact on activities, roles and responsibilities, opportunities, and risk.**

Summary of Impact Assessment

Medium

The primary issuance phase (in isolation) is not deemed a major area of disruption by DLT, given existing processes are broadly expected to persist in a DLT ecosystem. Issuance would, however, act as a necessary on-ramp for the creation of Security Tokens, driving new workflows to support this activity.

Three possible implementation models of DLT-based issuance are considered: (1) Books and Records only; (2) Tokenized Securities; and (3) Security Tokens.

1. **Books and Records** (e.g., documents and administration etc.), which support pre-issuance workflows, could provide a starting point for getting institutions and regulators familiar with the technology.
2. **Tokenized Securities** allow greater utility of securities as collateral and enable some post-trade efficiency benefits, though these could be limited in primary issuance and are better suited to Secondary Markets.
3. **Security Tokens** enable the realization of the broadest benefits case, including significantly lower cost and time to issue and broader security innovation. However, legal and regulatory ambiguity and absence of liquidity are major hurdles.

Activities and roles: Existing activities performed by market participants **to originate, structure, and distribute securities will persist.**

- **Existing issuance workflows are generally highly bespoke and manual:** This adds time and cost to the issuance workflow but allows for effective formation of Primary Markets liquidity.
- **Structurally, there have been challenges in standardizing and electronifying issuance workflows.** This is driven by:
  - Bespoke processes perceived as necessary and value-adding;
  - Transaction Manager disincentives to support platform intermediation;
  - Behavioral changes that are challenging to implement. DLT is not required to achieve this evolution, but the technical requirement to have a DLT-based asset lifecycle management platform on-ramp could likely embed electronification.

Opportunities: DLT-lifecycle platforms and certain asset classes with the highest benefit case (e.g., corporate paper, medium-term-notes) will see the greatest impact. Other areas, where existing processes persist (e.g., those of Transaction Managers) will see less impact, respectively.

- **The rise of DLT-based asset lifecycle management platforms** could present the most significant market structure change. These platforms are a critical on-ramp to issue Security Tokens; adoption may drive standardization and interoperability, integrating with traditional systems and workflows, and achieving automation benefits.
- **Transaction managers have a low risk of disintermediation.** Their work could evolve to require less operational involvement, but their role in underwriting new issues and forming Primary Markets liquidity could remain. Intermediaries in the primary issuance value chain predominantly focused on operational execution are at a higher risk of disintermediation.
- **Asset classes have highly heterogenous issuance workflows** and thus have differing likelihoods of adopting Security Token issuance. This report presents a likelihood framework by asset class and recommends the market focus on specific use cases to prove meaningful adoption and validate viability. The

greatest opportunity exists in transitioning recurring, frequent issuance securities (corporate paper, medium-term-notes), Repo, and establishing new markets (DLT-based funds, private assets).

2.1.1.1 Current State and Inefficiencies

Existing workflows include the processes of issuers to tailoring securities to the needs of investors, involving specialist input from advisors, and supporting proven processes to form Primary Markets liquidity. Workflows generally follow the three stages below:

Exhibit 2.1.2

Primary Issuance – Key Workflows

Source: BCG analysis

(A) Origination

Issuers (or their representatives), Transaction Managers, and Advisors work together to set a capital strategy, drawing data from both Primary and Secondary Markets. Many issuance decisions are time-dependent, relying on disclosure windows or market conditions, and highly sensitive to the market environment, including interest rates and monetary policy, economic conditions, investor risk appetite, and market liquidity.

Inefficiencies exist in the cost and time to issue new securities. Issuance lead time is driven by cumbersome processes (e.g., issuing a bond takes six weeks, and requires around one hundred individuals working on nearly two hundred tasks) and extended settlement (e.g., up to T+5 for some asset classes and geographies).[100] To date, electronic primary issuance platforms have struggled to meaningfully impact workflows.[101]

(B) Structuring

Security issuance is documented (drafted, negotiated, and executed) through legal documents and regulatory filings that are specific to the asset class and issuance type. Production of legal and marketing documentation in particular are highly manual, bespoke to the issuance, and multi-party (including the Transaction Manager(s)[102], Advisor(s), Issuer, and Investors) allowing each issuance to be tailored to investors' needs.

Security document preparation is complex, adding considerable cost, time delay, and operational risk to the issuance process. Presence of numerous—often opposed—legal counsels introduce sequential document workflows, which must be reconciled across organizations, creating inefficiencies in document management. In some cases, inefficient document management could cause delays and lead to transactions being withdrawn from the market. However, some asset classes and issuers have developed solutions for these inefficiencies. For example, the Euro Medium-Term Note (EMTN) program allows issuers to access the market at short-notice (e.g., one or two days), and with very standardized documentation for vanilla senior unsecured transactions.

100 Complications such as security registration and cross-border payments lead to long settlement time which can be up to T+5 for some asset classes.
101 Dealogic Connect, Origin Markets, IPREO, Agora, and Nivaura are examples of platforms seeking to automate primary issuance workflows. DirectBooks is gaining traction on a significantly reduced functionality scope.
102 "Transaction Manager" is used in this report to generalize across asset classes and subfunctions: it covers a subset of roles including Coordinator, Bookrunner, Joint Lead Manager, Arranger, Underwriter, and Placement Agent.

(C) Distribution

Transaction Managers form Primary Markets liquidity through soft-sounding, formal roadshow, and/or broad notification of issuances. Heterogeneous workflows exist for various asset classes. For example, an issuer may request its commercial paper placement agent to distribute securities to investors at set terms (amount, rate, and maturity). Underwritten issuance processes have the benefit of pricing certainty, with underwriters taking pricing risks. The majority of deals are arranged on a best-effort basis, with pricing uncertainty mitigated by banks, and resulting in a very low number of failed trades (just a handful per year globally).[103]

Existing market structure allows for limited systematic buyside influence on the supply of securities. Instead, Transaction Managers gauge investor sentiment and structure issuances in response.

2.1.1.2 Impact Assessment: Medium

The overall impact of DLT and Tokenization on Primary Market Issuance is **Medium**

Exhibit 2.1.3

Primary Issuance Impact Assessment

Issuance	Issuer	Transaction Manager	Investor
(A) Origination	Low	Low	Low
(B) Structuring	Low	Medium	Low
(C) Distribution	Low	Medium	Low

Source: BCG analysis

Primary issuance workflows are unlikely to fundamentally change; however, adoption of Tokenization platforms would support standardization and electronification.

The main areas of impact from DLT on Primary Issuance are:

Lower cost and time to issue. Lower-cost DLT-based issuance can be used more frequently and faster. Securities can be minted at time of distribution (similar to any shelf-based issuance such as an MTN program). Impacts routine/repeated issuances.

Innovation in Primary Market Issuance offers new types of instruments (e.g., bespoke instruments with automation of income flows and ability to streamline Asset Servicing and Lifecycle Management events, ESG tracking); tailors these instruments to investor needs (recurring revenue-based financing, bespoke frequencies etc.); and takes advantage of market conditions more precisely and effectively.

Buyside collaboration can take a more active role, including more informed matching of supply/demand, tailoring to fit portfolio/fund strategies of buyers, and shared research.

Fractionalization potentially broadens distribution of illiquid private assets (unlisted equities, real estate, funds, commodities); may enable greater usability & liquidity; and lower ticket sizes offers potential for increased access

103 GFMA member input.

to investors and could aid more effective risk diversification.

Reduced settlement time. Settlement time is considerably longer in Primary Markets when compared with Secondary Markets, saving time for all parties, and limiting market risk (and the potential need for, and cost of, risk management transactions) during the settlement period.

Adoption will be heterogenous. Asset-class issuance workflows that are recurring, frequent, and offer benefits from improved operational efficiency and/or product innovations are likely to adopt issuance of Security Tokens first.

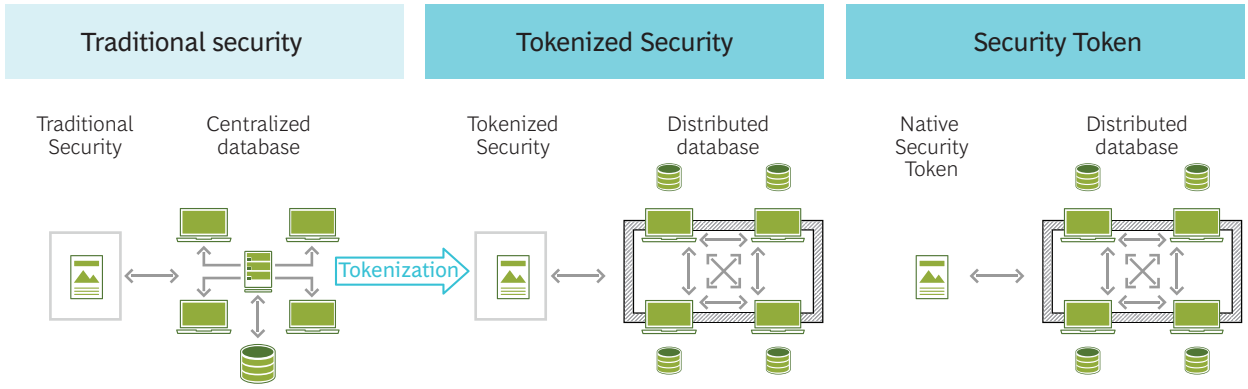
The main change in market structure may be the emergence of Tokenization platforms. There would be considerable short-to-medium-term cost to build required systems; establish legal comfort; and educate participants. Market participants may be likely to focus investment spend on specific use cases.

Models of Implementation

There are three formats of security issuance available to Issuers and Transaction Managers in a future state: (1) Books and Records; (2) Tokenized Securities; and (3) Security Tokens:

Exhibit 2.1.4

Format of Security Issuance Under DLT



Scale through Centralization

- Maintain the traditional issuance approach by issuing securities to the traditional markets and maintain those securities on existing centralized systems; only accessible in traditional markets

Books and Records

Extensions

- DLT may be used for books and records purposes in the issuance process to disseminate KYC/AML documents, due diligence materials, and legal documents

Resilience through Decentralization

- Issue securities in traditional format with record keeping partially or wholly held on distributed ledger
- Bridges provide liquidity between traditional and tokenized formats

Benefits

- Maintains familiar security form
- Enables faster settlement, greater utility as collateral, and fractionalization
- Streamlines post-trade workflow

Limitations

- More costly and time-consuming to issue than traditional security
- Hybrid ecosystem more costly to operate

Impact through Innovation

- Issue securities exclusively on DLT, creating a native security token
- New security types and full benefit of smart contracts available

Benefits

- Highly programmable through smart contracts – automation of manual processes possible to allow faster and less costly issuance
- New issuance parameters possible
- Supply chain simplification possible

Limitations

- New secondary market needs to form
- Unclear legal basis needs development

Source: BCG analysis

In the section below, the report focuses on impact from issuance of Security Tokens.

Evolved Roles and Responsibilities

The core workflow of Origination, Structuring, and Distribution could remain; however, there could be scope for faster iteration and response to market conditions through streamlined processes.

Issuers could have opportunity to self-issue securities (such as CP or MTN programs). Lower cost and faster time-to-issue could reduce issuance friction, increasing engagement with the capital markets, and reduce market risk.

Investors could have the opportunity to become systematically involved in the issuance process once the deal is public.

Transaction Managers have a low risk of full disintermediation; however, they could reduce their operational workload in the issuance process. Their role of security structuring, underwriting, and distribution is likely to remain critical.

Issuance Platforms are nascent and may likely be superseded by Tokenization platforms that could be used to create and register tokens. As market adoption increases, there is likely to be a sharp increase in the number of Tokenization platforms available on the market. It is unclear which party is best suited to operate these platforms (Transaction Managers vs. market operators vs. specialist data platforms); however, in the long-term, there could likely be consolidation of platforms and aggregation of deal flow.

It is unclear which platforms will succeed. In the near term, integration is critical between tokenized and traditional markets. In the longer term, interoperability between DLTs, issuance platforms, and other market systems (such as OEMS) may become a greater focus for market participants.

Sidebar: Tokenization Platforms

Tokenization platforms—with integration across existing infrastructure—are emerging to simplify and automate the issuance workflow. Transaction Managers could likely be the key decision-makers on which platform to use due to their role structuring and distributing the tokens. A lengthy procurement process will likely be required, covering auditing, selection, and testing.

These platforms may play a critical role in developing Security Token structuring capabilities with workflow automation tooling and broad systems integration.

Exhibit 2.1.5

Tokenization Platform Provider Archetypes

Provider type	Commentary	Examples
Transaction Manager (HSBC, Goldman Sachs)	Transaction Managers are developing proprietary tokenization platforms as a method of enhancing relationships and building competitive advantage.	HSBC Orion GS DAPTM DBS FIX
Security Lifecycle services provider (Nasdaq, LSEG)	Providers with involvement across the securities lifecycle (e.g., exchange groups). This is an area where securities service providers could play a key role in the future.	NASDAQ Primary LSEG DCM Flow
Specialist platform (S&P, Bloomberg)	Specialists are developing transaction manager and exchange neutral platforms.	S&P Issuer Services (IssueNet etc.) New entrants like PrimaryBid, Origin Markets, Nivaura (acquired by NowCM)

Source: BCG analysis

Financial Impact and Opportunities

Introduction of DLT into the Primary Market Issuance workflow may provide the following benefits:

Cost and time benefits

The technical design of Security Tokens would likely be digitized around industry-adopted standards (such as ERC-3643 and ERC-1400).[104] Decoupling from traditional convention and documentation—where existing workflow has evolved from manual processes toward digitized (e.g., syndicate desk collecting bids and issuing updates via email, and lengthy security documentation)—may support the step-change in issuance efficiency in relevant areas where issuance inefficiencies are particularly focused.

In these selected instances, reduced issuance cost may increase Primary Market Issuance volume by reducing issuance friction and enabling access to capital markets for (small-medium-enterprises) SMEs and other currently underrepresented Issuers. Bespoke securities may be issued directly to investors to meet individual needs.

Issuance innovation

Security Tokens may unlock new ways to deliver existing features or drive innovations, such as:

- **Smart contracts:** embedded governance over cash flow waterfall, covenants, types of security (assets as collateral and guarantees), and investor entitlements (liquidation preference, drag-along clauses)
- **Bespoke distinction by investor:** For example, IPO investors can earn bonus special dividends if they hold on to their allocation for a certain duration, promoting the interests of the Issuer. These could be programmed on a more customizable basis, with the execution of these income payments automated through smart contracts. Similarly, lock-up clauses may be programmed into the token to ensure adherence to issuance contract. For example, stock held by management and employees could offer additional benefits (e.g., use as collateral) while the Investor is affiliated with the Issuer.
- **New characteristics:** daily coupons, non-standard reference rates, revenue-based finance, and green-bond securities could be available and achievable to Issuers and Investors at a lower cost.

These innovations build on existing investor products and propositions and could additionally make it easier to trade different entitlements separately from the underlying security through DLT.

104 ERC-3643 is a token standard for the management and transfer of security tokens, while remaining compliant with rules and regulations. ERC-1400 is a proposed standard for security tokens that incorporates many of the features (e.g., error signaling, issuance semantics) in traditional securities).

Buyside collaboration

The introduction of Tokenization Platforms may allow Investors (once deals are publicly announced and in line with existing mandatory market pre-trade transparency requirements) greater a) systematic influence over security supply and design; b) the ability to participate in private placements or share risk through cornerstone investments; and c) the ability to collaborate with other investors through the issuance process.

Fractionalization

Fractionalization offers the potential to enable broader access to liquidity by allowing investors to purchase smaller tickets, diversifying the investor base, and supporting secondary liquidity. Investors may be able to further diversify idiosyncratic risk by holding a wider range of securities. It should be noted that the functionality described above can be preserved, even when the original Security Token has been subdivided multiple times.

Additional opportunities:

- **Cost to the ecosystem:** In the near term, participants in the issuance process would require significant capital and operational expenditure to build the underlying technological architecture, smart contract platforms, and test-nets central to DLT-based issuance processes. Participants would also need to consider the operational expenses of hiring the appropriate resources, additional workflows required to drive trust in the system, and general switching costs that underlie any technological transition.
- **Introduction of DLT-based asset lifecycle management platforms:** Many participants in capital markets would see strategic benefit in developing a DLT-based asset lifecycle management platform to service and attempt to influence the market structure of Primary Market Issuance workflows. These platforms are seen as attractive market positioning; however, fragmentation arising from differing platforms offered by multiple participants in this space may instead increase the cost to market participants and challenge goals of standardization.
- **Focused asset class use cases:** To drive significant market adoption, highly targeted use cases are recommended. Focusing on a very clearly defined target market could help product development, build secondary liquidity, and be seen as a credible primary issuance option.

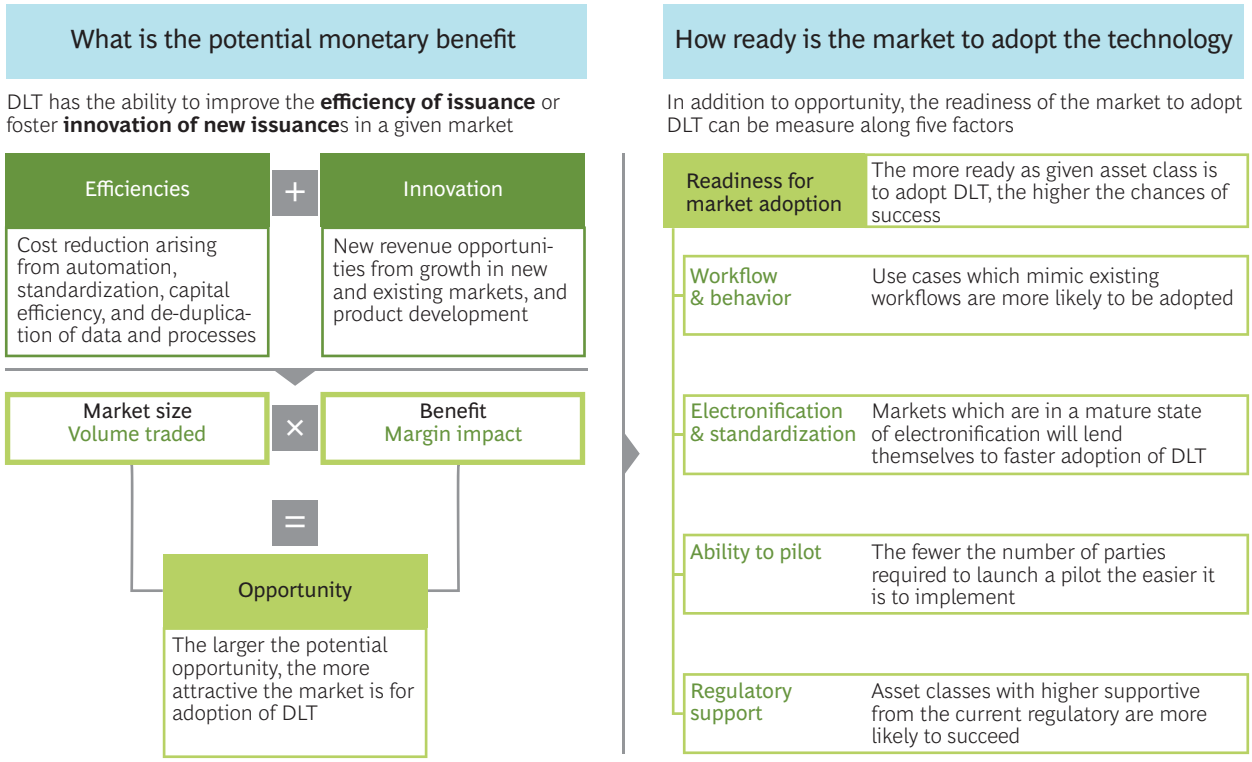
Sidebar: Transitioning existing markets to Security Token primary issuance by asset-class and workflow.

Issuance workflows by asset-class are highly heterogenous. The following framework is proposed to inform analysis of market adoption to consider both the a) opportunity, and b) readiness of a market to adopt Security Token issuance.

As presented in the Executive Summary, we find there is significant distribution on a global asset-class level in the opportunity and readiness for market adoption of Security Token issuance. Issuance workflows that are recurring, frequent, and offer benefits from improved operational efficiency and/or product innovations are likely to adopt issuance of Security Tokens first. Looking ahead, market participants could align on specific use cases to build meaningful adoption, pooling Secondary Market liquidity, and proving the viability of Security Tokens (i.e., D2D intraday repo or five-year unsecured fixed-rate investment-grade U.S. credit).

Exhibit 2.1.6

Framework to Inform Market Adoption of Security Token Issuance



Source: BCG analysis

Risk Impact

The implementation of DLT in Primary Markets introduces some limited risk mitigation considerations. Refer to the **"2 | Holistic Understanding of DLT-Specific Risk"** section for a discussion of these risks in detail, along with proposed mitigations. This commentary focuses on evaluating the potential of DLT to mitigate existing risks in the Primary Markets stage of the securities lifecycle.

Operational Risk: DLT can mitigate existing operational risk in Primary Market Issuance processes through the use smart contracts to (a) coordinate many-party issuance processes, (b) reduce the chance of errors by an individual party through independently coded checks and (c) use multi-party verification processes to ensure individual errors are not propagated throughout the system. However, these mitigations are likely to be marginal in the near-term, requiring widespread adoption of DLT across the many participants in the Primary Issuance workflow to be realized in full.

Legal and Compliance Risk: Representing the Primary Market Issuance process on a shared, transparent ledger (at minimum the non-competitive portions of the process) can aid Transaction Managers in ensuring compliance with legal and regulatory reporting requirements and/or improve transparency for would-be investors. The level of mitigation that can be realized is dependent on the degree to which applicable laws and regulations are updated to allow for DLT-based reporting.

DLT is not expected to have a significant role in mitigating existing risk, but could aid market participants in mitigating some forms of operational risk. Ultimately, the Primary Market Issuance stage of the lifecycle is a key enabler to realize the downstream risk mitigation benefits in the post-trade, and Asset Servicing and Lifecycle Management stages of the securities lifecycle.

2.1.2 Secondary Market Trading

This section provides an overview of participants, key activities, and critical inefficiencies that exist today. This provides a baseline for an impact assessment of DLT, considering **different models of implementation and impact on activities, roles and responsibilities, opportunities,** and **risk.**

Summary of Impact Assessment

Medium

Trading (i.e., order matching) is highly efficient across many asset classes and centralized execution venues (e.g., public equities). No immediate disruption to market structure impact is expected. As the DLT-based ecosystem develops, however, DLT may facilitate access to infrastructure for use across the securities lifecycle, including trading. Crucially, DLT-based investor platforms with features such as Tokenization and fractionalization, could help pool and deepen trading liquidity in Secondary Markets for traditionally illiquid asset classes, such as unlisted equities and unlisted investment funds, and broaden market access. Innovative propositions could also be developed, such as automated securities selection and portfolio balancing, and real-time carbon finance tracking. However, establishing these new markets may be a challenge.

Implementation models: DLT-based Securities are likely be traded on centralized execution venues, then settled on the distributed ledger. Broadly, two forms of execution venue may emerge:

1. **Execution venue for traditional securities:** Transacts at an ISIN level; modifications may be made to incorporate Tokenized Securities matching that ISIN.
2. **Execution venue for DLT-based Securities:** Primarily transacts at a token identifier level, built to natively incorporate DLT-based security features such as token programmability, atomic settlement optionality, and fractionalization.

Activities: Liquidity is likely to pool in select asset classes where there is clear opportunity and market readiness but may not be evenly distributed across asset classes nor Tokenization types.

- **Security Tokens have seen low Secondary Market liquidity** as experimentation has been focused on core DLT infrastructure, Primary Markets issuance and settlement, and repos.
- Due to a lack of to-date liquidity, **investors are not incentivized to hold Security Tokens for active trading,** which impede Secondary Market liquidity growth and should be addressed to encourage adoption.
- As DLT-based markets develop, it is likely **liquidity could become bifurcated by security format:**
  - Existing investors and automated market makers can bridge liquidity between traditional securities and Tokenized Securities through Tokenization/deTokenization workflow.
  - Liquidity cannot be perfectly bridged into Security Tokens, supporting formation of security format basis. Market makers could likely take a role trading this risk, using traditional securities as an imperfect hedge.
  - It should be noted that these risks already exist in today's market, e.g., Depository Receipts compared with ordinary shares, or multi-listed ETFs and equities
- Focusing efforts on **building secondary liquidity in smaller pools** of securities to achieve comparable liquidity conditions, will likely be more beneficial than attempting to build broad markets simultaneously.

Roles: Market structure is unlikely to be disrupted in the near term, but new DLT-based investor platforms could emerge and mature as the DLT ecosystem develops.

- The current trading ecosystem is a **highly complex array of liquidity pools** that vary based on asset class, investor, jurisdiction, and order characteristics (including transaction size, urgency of execution, and signaling of information).
- Existing market structure may be entrenched by the following factors:
  - Trading and settlement roles have value in independence as they have distinct market relationships (front

office vs. back office), expertise (human workflows vs. process optimization), and value in the supply chain (high fee rate vs. low fee rate).
  - Compatibility and integration with existing trading infrastructure and independent Clearing and Settlement providers.
  - Workflows and behaviors are difficult to change (as evidenced in the corporate bond market). New liquidity pools could likely integrate into existing trading workflows and infrastructure.
- That said, closed trading models and new Secondary Markets integrated with DLT investor platforms that are built outside of existing trading workflows and independent to net settlement may realize consolidation of these roles.

Opportunities: New markets, new protocol, and integration efforts offer attractive opportunities.

- The Tokenization of illiquid asset classes, such as unlisted equities – together with fractionalization, allowing smaller ticket sizes while retaining the programmability benefits of whole-unit DLT-based Securities – offer the most attractive Secondary Market growth opportunities.
- New features such as automated securities selection for portfolio balancing, interest payment frequency or swaps, ESG tracking, and use of event triggers to enable faster sourcing of securities for use in derivatives.
- There would be a significant additional cost to operate and transact on a duplicative new secondary trading ecosystem initially. To manage this, participants should focus on building secondary liquidity in targeted use cases with an innovative protocol:
  - To aid market adoption, aggregation of new liquidity pools and integration of workflows into existing systems is critical. Order and Execution Management Systems ("OEMS") would bear the responsibility of these platform developments. In return, they could strengthen their competitive position.

2.1.2.1 Current State and Inefficiencies

Exhibit 2.1.7

Detailed Pre-, At-, and Post-Trade Workflows

Source: BCG analysis

Pre-Trade

Pre-trade analysis:

Before a trade is executed, traders conduct pre-trade valuation and analytics to determine optimal order routing and trading tactics, utilizing information in a manner consistent with regulatory requirements. Implementation may be through rules-based trading strategies or on a trade-by-trade basis, in each case compliant with applicable laws and regulations. There are existing inefficiencies around market data accessibility such as, the cost to purchase, and the difficulty to integrate it into pre-trade workflows. In some asset classes, market data may be of poor quality or absent entirely. Proprietary data sets and valuation tools create an unlevel playing field.

Order routing:

Orders are routed through OEMSs from portfolio managers to execution desks, and eventually through to execution venues. Decisioning may be a combination of pre-set rules, algorithms (smart order routing), or manual direction (expert trading). As electronic order routing relies on connectivity to each liquidity pool, which is generally provided by OEMSs, inefficiencies exist for markets with low electronic penetration or barriers to integration, because these orders require significant manual trade direction. Constant evolution in liquidity conditions and market infrastructure requires continued investment.

At-Trade

Price discovery/formation and trade execution:

Price discovery varies based on venue protocol; order books consolidate bid and ask orders, with crossed orders matching a trade, whereas request-for-quote (**"RFQ"**) protocol generates quotes from counterparties that are confirmed to create a trade. Illiquid markets present difficulties matching buyers and sellers for instruments at the required volume and price. In these markets, the main inefficiencies are counterparty matching, information leakage, and price information asymmetry. Asset classes with a wide universe of security characteristics, such as corporate bonds, pose particular challenges.

Challenges are also faced in non-electronic markets that are traded telephonically or over email or chat. For example, fully electronic orders represent only 45% of transaction market share in corporate bonds.[105] In these markets, trade details must be captured and fed into post-trade workflows manually for settlement.

Post-Trade

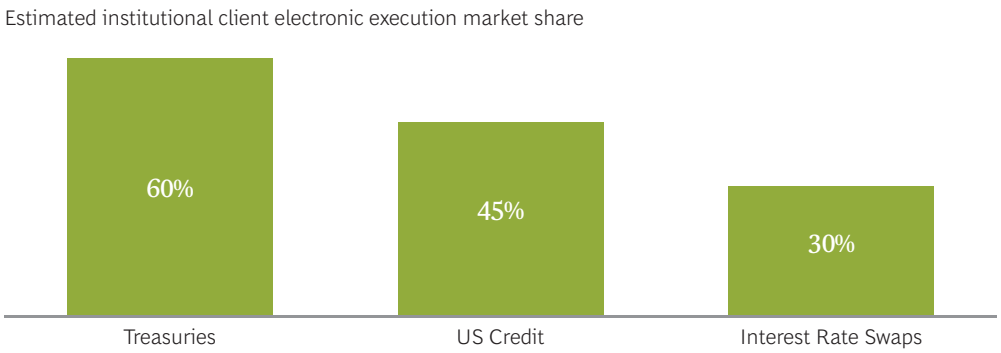
Execution venues and market participants record, monitor, and report trade data for risk management and regulatory purposes.

Sidebar: Electronification of Secondary Markets

Electronification first emerged in Equities and FX, then across Treasuries, Corporate Bonds, and Derivatives. Today, a significant proportion of the global securities pool has not undergone electronification, as shown in Exhibit 2.1.8. While electronic execution is more efficient, some asset classes and trade types rely on channels such as voice and chat. Non-electronic execution is especially prevalent for equities block trades, U.S. corporate bonds, and interest rate swaps. The impact of DLT on secondary trading may be limited in markets with a high degree of electronification today.

Exhibit 2.1.8

Major Markets Are Still Undergoing Electronification[106]



Source: Morgan Stanley, "Why we remain overweight", Nov 2022.; BCG Analysis.

105 Morgan Stanley, Tradeweb "Why we remain overweight" Research Report, 1 Nov 2022.
106 Morgan Stanley, "Why we remain overweight", Nov 2022.

2.1.2.2 Summary Impact Assessment: Medium

The overall impact of DLT and DLT-based Securities on Secondary Trading is expected to be Medium. DLT itself is not viewed as an impactful force; however, DLT-based investor platforms using new features such as Tokenization and fractionalization could drive impact over the long-term. Secondary trading liquidity must first be established to support a DLT-based ecosystem. This section analyzes direct impact and the steps necessary to build this.

Exhibit 2.1.9

Secondary Market Trading Impact Assessment

Trading	Investors	Broker-dealer	Execution venue	Platforms (OEMSs, Risk Management, and Data)
Pre-trade	Low	Low	Medium	Medium
At-trade	Low	Medium	Medium	Medium
Post-trade	Low	Low	Low	Medium

Source: BCG analysis

Models of Implementation

New liquidity pools could likely be required to support secondary trading of DLT-based Securities. Decentralized exchanges are broadly viewed as inappropriate for capital markets based on regulatory, technical, and commercial factors. For this reason, it is expected new liquidity pools could be formed by centralized execution venues to cover both Tokenized Securities and Security Tokens. While the use of DLT for Books and Records may support elements of the trade lifecycle for traditional securities, it is not relevant for trade execution, and therefore is not covered here.

Activities

Trading activities and workflows may broadly remain unchanged from traditional markets; however, adaptations are expected:

Trading Workflow Evolution

Existing workflows can also be adapted to incorporate Tokenized Securities into traditional liquidity pools. RFQ-based execution venues can include additional parameters to specify security format, settlement time, and settlement system. Users may have functionality to include the token identifier (rather than just ISIN) at the point of trade and may have the ability to lock the token on a distributed ledger until settlement.

Transformation Workflows

Workflows may be introduced to bridge liquidity between traditional securities and Tokenized Securities, thereby minimizing price disparity. There are two broad models for bridging liquidity between traditional and tokenized formats of securities:

- Owners of securities may request their custodian to initiate a Tokenization process which will move the record of ownership from a CSD to the distributed ledger through a Tokenization platform; and
- Participants in Secondary Markets may generate trading volume which allows automated market makers to provide cross-format liquidity in return for trading profits.

Assuming low transaction costs and trading risk, the combination of these modes will drive similar liquidity characteristics between the two security formats.

DLT-based Security trading may allow the following innovations:

- **Market data:** Recording transactions on interoperable and standardized distributed ledgers may improve accessibility and reduce cost of market data.
- **Certainty of settlement:** Optionality for atomic settlement and/or locking Security Tokens on the distributed ledger until settlement could reduce the rate of failed trades, the time delay for settlement and the need to manage risks during legacy settlement periods (as discussed in **Chapter 2.1.3 | Clearing and Settlement**) improving trader outcomes and potentially reducing risks and costs.
- **Order routing:** Enhanced use of data allowed by DLT may improve the ability to identify investors and improve the ability of buyers to identify potential sources of the security product in which they seek to invest.
  - Directed RFQs for corporate bonds to specific counterparties with inventory may reduce information leakage.
  - Liquidity signaling such as masked indications-of-interest and Axes may support smart order routing.
- **Increased electronic trading:** The design of digital security liquidity pools is likely to be exclusively accessible electronically, which could reduce the proportion of trades executed through voice channels.

Evolved Roles and Responsibilities

Few changes are expected to existing roles and responsibilities of actors in the Secondary Market Trading ecosystem.

Multilateral Trading Facilities ("MTFs") and CSDs

The most publicized potential evolution in market structure is collapsing the distinction between execution venues and Clearing and Settlement systems. This is supported in the E.U. Pilot Regime, through the creation of the role DLT TSS (trading and settlement system), which is an aggregation of DLT MTF (multilateral trading facility) and DLT SS (settlement system) roles.[107] While this implies MTFs can compete with CSDs to provide settlement services, and CSDs can move up the value chain by aggregating liquidity in competition with MTFs, the potential impact of market structure disruption is considered low for the following reasons:

- Traditional and native Security Token markets may need to operate in hybrid for the foreseeable future, supporting the persistence of existing roles.
- Central Counterparty Clearinghouse (**"CCP"**) enabled netting is most effective when trades are pooled from a variety of execution venues. This supports the ongoing role of an independent settlement system, likely to be operated by existing traditional market providers.
- Marketplace operation is a highly specialized business, requiring strong relationships with front-office traders and expertise in evolving market trading protocol. In contrast, CSDs predominantly interface with middle- and back-office stakeholders and focus on implementation of robust processes.

The TSS role is likely of higher utility in closed trading models and new Secondary Markets that are not reliant on existing settlement infrastructure or integration with existing CCP netting workflows.

107 European Securities and Markets Authority ("EMSA"), Report on the DLT Pilot Regime, September 2022.

OEMSs

The burden and responsibility of developing workflows, aggregating liquidity pools, integrating new data, and guiding investor behavioral change may ultimately fall on OEMSs. The prospect of OEMSs establishing their own DLT TSS capabilities or collecting access payments for strategic alignment is increasing.

Broker-dealers

Current broker-dealer services such as provision of liquidity, risk management, financing, analytics, and advisory may likely evolve to cover DLT-based Securities. Over time, broker-dealers are expected to remain relevant partners for institutional investors.

New entrants

Significant network effects, expertise in market development, and deep integration with existing systems position marketplace operators at a competitive advantage when it comes to developing Secondary Markets for Security Tokens. While innovation may be pioneered by new entrants, incumbents are expected to form partnerships with, acquire, and/or replicate successful functionality of new entrants to broaden their existing offering.

Bridges

A new role/responsibility could be created for a party to bridge liquidity across security formats. Automated market makers may likely perform the role of transforming traditional securities to Tokenized Securities, and vice versa. They may also provide liquidity across liquidity pools.

Financial Impact and Opportunities

The following factors are likely to present a challenge in Secondary Market Trading:

- **Liquidity provision** relies on network effects. New liquidity pools without participation from the full market are highly likely to exhibit poorer liquidity conditions. Execution venues and market participants should prioritize building pockets of liquidity in digital security markets, instead of creating large markets with low participation.
- **The financial cost** to the industry to develop, integrate, and operate duplicative systems may be significant. Business cases are difficult to write as there is limited understanding over market adoption and final technical designs.
- **Securities are often traded in cross-asset baskets** (or lists) to complete sophisticated risk-management processes. For example, lists of OTC derivatives may be traded to achieve margin compression[108] and credit and futures may be traded to manage interest-rate risk.[109] DLT-based trading may need to support multi-asset trade processes

Risk Impact

Utilizing DLT in Secondary Trading can give rise to a limited set of risk considerations and new mitigations. The **"2 | Holistic Understanding of DLT-Specific Risk"** section in the Executive Summary provides an in-depth examination of these risks, along with suggested mitigations. This discussion instead assesses the potential of DLT to mitigate existing risks in the Secondary Market Trading stage of the securities lifecycle.

Operational Risks: In the long-term DLT can enable a net decrease in the total number of systems, platforms, and integrations required to access trading markets. DLT can offer a single, common, interface to connect internal systems with, across many asset classes. This potential for risk mitigation could be especially impactful when combined with the existing protocols (e.g., FIX) that traditional trading systems have used to standardize

108 Osttra, Portfolio Compression, Feb 2023.
109 Tradeweb, Multi-Client Net Spotting, Feb 2023.

messaging and cross-participant interactions. However, in the near-to-medium term this benefit may be incremental as trading systems may need to be duplicated as traditional and DLT-based markets run in parallel.

Liquidity Risk: Fractionalization of DLT-based Securities has the potential to aid market participants in mitigating liquidity risk by allowing smaller ticket sizes and greater investor access. These effects could be particularly impactful in historically illiquid asset classes, such as types of asset-backed-securities. *Note: incremental liquidity risk considerations and associated mitigations are discussed in the Executive Summary: 2 | A Holistic Understanding of DLT-Specific Risk.*

Given the limited impacts to existing market structure, incremental risk mitigation may be limited. However, as Secondary Markets for DLT-based Securities mature, this could act as an enabler to the risk mitigations across the post-trade lifecycle, as outlined in Clearing and Settlement, Custody and Asset Servicing.

2.1.3 Clearing and Settlement

This section provides an overview of participants, key activities, and inefficiencies that exist today. This provides a baseline for an impact assessment of DLT, considering **different models of implementation** and i**mpact on activities, roles and responsibilities, opportunities,** and **risk.**

Summary of Impact Assessment

High

DLT-based Clearing and Settlement has the potential to act as an additional, complementary channel alongside existing Clearing and Settlement infrastructure. This is only expected to impact specific asset classes and transaction types that favor adoption and where Secondary Market liquidity could pool – not the broader traditional market.

Note: Clearing and Settlement is defined here to include netting, novation (e.g., CCP-related processes), affirmation, confirmation, and allocation (e.g., post-trade processes), and instruction, confirmation, and execution (e.g., settlement processes).

Implementation models: Four models of DLT-based Clearing and Settlement workflows are possible. This ranges from Books and Records (i.e., no use of DLT-based Securities and DLT-based Payment Instruments) to fully developed settlement systems for DLT-based Security transactions using DLT-based Payment Instruments. Benefits increase as implementation models broaden in scope.

Synchronization of Clearing and Settlement: For specific asset classes and transaction types, DLT could synchronize Clearing and Settlement into a continuous single workflow, with smart contracts enabling the front-loading of post-trade and pre-settlement processes into a single transaction. In a DLT-based ecosystem, this could reduce the likelihood of trade fails in specific markets and/or asset classes where this is a known problem and create the potential for back-office efficiencies more broadly. Smart contract execution would require pre-funding and pre-positioning of securities before trades are executed. There are also multiple enablers required including electronification, interoperability with existing systems, and common data standards.

Flexible settlement options: DLT-based settlement infrastructure could play a supporting role in the industry's long-term progression toward more efficient settlement cycles that have the potential to reduce relevant risks. This could give rise to a future capital markets ecosystem where decisions on settlement speed are made on a trade-by-trade basis, driven by needs around liquidity and financial resources. Transaction types such as collateral payments for repos and OTC derivatives could also be served by a DLT-based model with real-time DvP. Today, DLT-based settlement is already occurring in the intraday repos market.

Evolution of CCPs: CCPs play a critical role, including netting transactions and managing counterparty credit risk, which could eventually be supported through smart contracts with appropriate market conduct safeguards.

DLT-based settlement in specific asset classes and transaction types can also enable bilateral and multilateral trading that offers an alternative model to central clearing, with attractive capital efficiencies and risk mitigation.

Reduced costs: Building on the efficiency gains of recent years, Clearing and Settlement could have potential for further operational efficiency and cost savings. 2015 estimates within the industry range as high as ~$20 billion USD annually in operating cost savings across the global industry, enabled by the implementation of DLT – although some of these efficiencies may have been realized by market participants to date.[110]

Capital efficiency: DLT-based settlement cycles in specific asset classes and transaction types could unlock capital efficiencies in margin and clearing fund requirements for clearing member firms. The balance sheet capacity generated could create potential for returns on reinvested capital and collateral – estimated in 2016 to be as high as ~$500M USD in incremental annual revenue in the U.S. – this may be higher today, given the increase in global, trapped, collateral in clearing arrangements.[111] However, the extent of these benefits will depend on the degree to which the CCP remains prevalent in the post-trade and clearing lifecycle.

Financial, Operational, and Systemic Risk Mitigations: Where DLT-based settlement is operationally feasible and desirable in specific asset classes and transaction types, it could provide alternative approach to address operational inefficiencies and mitigation of replacement cost risk through automated settlement cycles – reduction of settlement risk by means of DLT-based settlement could have material benefits to both individual market participants and financial system. DLT could also mitigate operational risk through automated processing of post-trade activities (e.g., confirmation, affirmation). DLT could also provide an alternative risk mitigation model to CCPs, including the precise allocation of replacement cost and principal risk to transacting counterparties. Resilience could also be increased by distribution across the network, reducing single-points-of-failure.

2.1.3.1 Current State and Inefficiencies

Over the last two decades, significant advances have been made in Clearing and Settlement efficiency. This is marked by increased automation, industry-wide standardization (e.g., International Swaps and Derivatives Association (**"ISDA"**), International Securities Lending Association (**"ISLA"**), and International Capital Markets Association's (**"ICMA's"**) development of the Common Domain Model),[112] and the growth of central clearing to drive counterparty credit risk mitigation. In the ongoing search for further advancements, market participants highlighted specific opportunities that may be addressable by DLT in specific asset classes and transaction types, and may address operational inefficiencies, operating cost, financial resource inefficiencies, and risk within Clearing and Settlement workflows. These are summarized below:

Back-Office Operating costs: Batched processing, legacy systems, and other administrative expenses are significant cost drivers for the industry. The latest estimates found in institutional research, show that trade processing costs the industry between ~$17 billion and ~$24 billion USD annually, of which ~$6 billion to ~$9 billion USD is spent on highly-automated equity and fixed-income assets.[113] In payments, cross-border settlement can be almost twenty times more expensive than domestic transactions.[114] This is driven by transaction fees, account fees, compliance fees, and other drivers. Fees are amplified in countries with less established correspondent banking networks.[115] Given a material share of these costs are in highly-efficient products, they may not be immediate targets for transformation but could still drive material cost savings.

110 Santander, Innoventures, Oliver Wyman, Anthemis Group, "The Fintech 2.0 Paper: rebooting financial services", 2015.
111 Goldman Sachs, "Profiles in Innovation: Blockchain Putting Theory into Practice", 2016.
112 ISDA website, "What is the ISDA CDM", accessed 2023.
113 Broadridge, "Charting a Path to Post-Trade Utility", 2015.
114 BIS, "DLT-Based Enhancement of Cross-Border Payment Efficiency – a Legal and Regulatory Perspective", 2022.
115 BIS, "DLT-Based Enhancement of Cross-Border Payment Efficiency – a Legal and Regulatory Perspective", 2022.

Opportunity cost of trapped collateral: Market participants fund CCPs by posting collateral, usually in the form of cash or securities for use in a clearing default fund, as well as for margin requirements. The total value of global outstanding collateral exceeded $17 trillion USD in 2022.[116] Collateral trapped in clearing arrangements represents a significant opportunity cost, estimated in 2016 to exceed $500 million USD in foregone yield for the industry annually.[117] However, this opportunity cost may have increased, given the corresponding rise in trapped collateral from 2016 to 2022.

Manual processing of collateral payments for centrally cleared OTC derivatives: For centrally cleared contracts with margin requirements, periods of market volatility can suddenly and materially increase margin thresholds, with asset managers rapidly needing to meet margin calls. Asset managers faced spikes in initial margin calls during the high-volatility period of March 2020 after the outset of the COVID-19 pandemic, with increases in initial margin requirements as high as 125% in some equity index futures, when comparing January 1 and March 30, 2020.[118] Manual processing and delayed settlement can create systemic risk in such scenarios, also demonstrated more recently in the U.K. liability-driven-investing (**"LDI")** crisis in September 2022.[119]

Cost of risk management: Operational, credit, and systemic risk continue to be areas that participants in post-trade processing incur significant overhead to manage. Complex workflows with multiple steps (e.g., confirmation, affirmation, instruction generation) between many participants (e.g., CCPs, clearing members, global and local custodians, CSDs), within post-trade processes, drives reliance on expensive operational risk mitigants like reconciliations between parties and manual checks. This cost is reported to be rising year-on-year.[120] Deferrals between trade and settlement execution introduces counterparty credit risk, comprised of replacement cost risk and principal risk, that participants manage using a CCP. Since their introduction, CCPs have provided proven and effective risk mitigation. But the model, particularly given the increase in volumes cleared, also represents a single-point-of-failure. Although advances have been made in managing these risks, participants bear significant costs to effectively mitigate them.

2.1.3.2 Summary Impact Assessment: High

The impact of DLT on Clearing and Settlement is **high, across all participants and most activities**.

This assessment will consider four different models of DLT-based settlement and consider the potential of DLT-based settlement to drive participant choice in settlement cycles. In addition, it will assess the impact of DLT on key workflows in the post-trade value chain, including margin management. Finally, it will describe the financial impact and potential risk mitigations DLT-based settlement may enable.

116 Refer to the Collateral Management use case in Chapter 3.
117 Goldman Sachs, "Profiles in Innovation: Blockchain Putting Theory into Practice", 2016.
118 Blackrock, "CCP Margin Practices Under the Spotlight", 2022.
119 Refer to the Collateral Management use case in Chapter 3.
120 Value Exchange, Digital Asset, "Doing Tokenization Right", 2022.

Exhibit 2.1.10

Impact Assessment of DLT on Activities and Participants in Clearing and Settlement

Clearing	CCP	Clearing Members	Asset Managers
Confirmation and matching	High	High	N/A
Risk review	High	High	N/A
Netting	High	Medium	N/A
SSI Generation	High	High	High
Margin management	High	High	Medium

Settlement	CSD	Local Custodian	Global Custodian	Investor
Instruction	High	High	High	High
Positioning	High	Medum	N/A	N/A
Execution	High	High	N/A	N/A
Notification	High	High	N/A	N/A
Fails	High	High	High	High

Source: BCG analysis

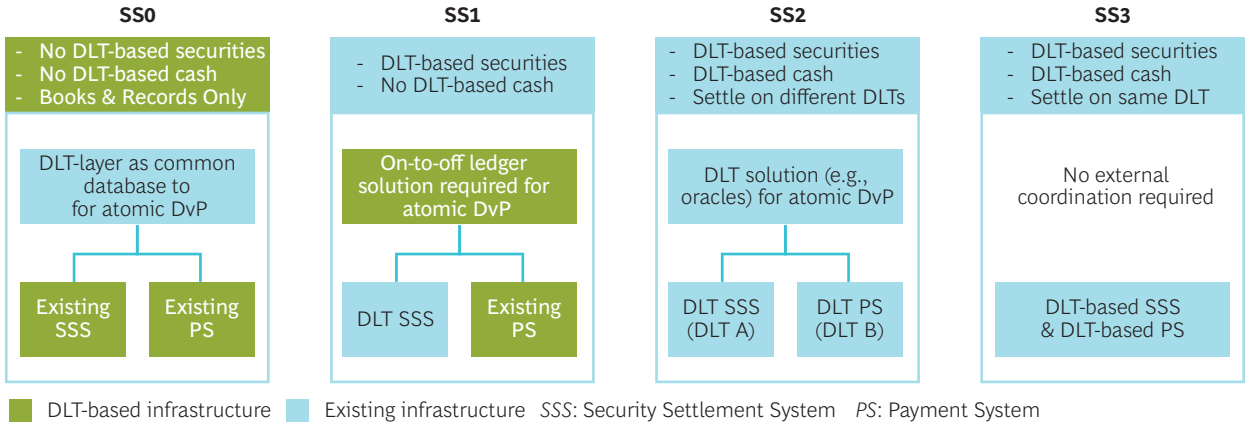
Models of Implementation

There are four models of DLT implementation within each of Clearing and Settlement to achieve the execution of DvP, the digital exchange of securities and cash that can enable atomic settlement. The models are derived from the varying role (or lack thereof) that DLT could play across both the securities leg and the payments leg of a transaction. A books and record implementation has neither DLT-based Securities nor DLT-based Payment Instruments. In models where DLT-based Securities exist, the payment "leg" can be enabled by traditional or DLT-based Payment Instruments.[121,122] Furthermore, DLT-based Securities systems can exist on a single distributed ledger or be synchronized with multiple distributed ledgers to integrate with a DLT-based payment system.[123] All four models are summarized in the diagram below and explained in further detail.

121 BIS, "On the Future of Securities Settlement", 2020.
122 Benos, Garratt, Gurrola-Perez, "The Economics of Distributed Ledger Technology for Securities Settlement", 2019.
123 Adapted from in BIS, "On the Future of Securities Settlement", 2020 & Benos, Garratt, Gurrola-Perez, "The Economics of Distributed Ledger Technology for Securities Settlement", 2019.

Exhibit 2.1.11

Comparison Models of DLT-based Settlement Implementation



Source: BCG analysis

Settlement System 0 (SS0): No DLT-based Securities or DLT-based Payment Instruments; DLT used as "Books and Records". In this model, there are no forms of DLT-based Securities nor forms of DLT-based Payment Instruments. Instead, DLT acts solely as a cross-participant database facilitating updates between participants, but settlement execution and finality remains with the CSD via Custodian accounts and must be reconciled on existing systems.

Settlement System 1 (SS1): DLT-based Securities but no DLT-based Payment Instruments; payment settled in traditional accounts. DLT-based Securities 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[124]). This model has already seen implementation in the market, with DLTs integrated with traditional payment systems. For example, a World Bank issuance, where Security Tokens called Bond-i were issued but payment was settled using cash in traditional accounts.[125] The European Investment Bank digital bond issuance also ultimately settled on Target2, the RTGS system operated by the Eurosystem.[126]

Settlement System 2 (SS2): DLT-based Securities and DLT-based Payment Instruments, settle on different ledgers. DDLT-based Securities would settle on one distributed ledger, and payment would be coordinated through interoperability with a separate distributed ledger. This model would facilitate a form of tokenized commercial bank money (including deposits), and DLT-based Payment Instruments issued by a central bank (e.g., a CBDC). Market examples of this include Project Stella (European Central Bank and Bank of Japan), Project Ubin III (Monetary Authority of Singapore),[127] and the Bank of England's synchronization payments layer concept.[128]

Settlement System 3 (SS3): DLT-based Securities and DLT-based Payment Instruments, settled on the same ledger. DLT-based Securities and DLT-based Payment Instruments both settle on the same distributed ledger—this model could simplify settlement and allow for more flexible use of smart contracts and other DLT-native technologies such as composability (outlined in Chapter 1).

124 Clearstream, Commercial Bank Money Settlement, 2023.
125 BIS, "On the Future of Securities Settlement", 2020.
126 Central bank interviews.
127 BIS, "On the Future of Securities Settlement", 2020.
128 Bank of England, "Background Guide to Proposed RTGS Functionality: Synchronization", 2019.

Activities

DLT-based settlement could emerge as an additional, complementary channel for security settlement alongside traditional settlement infrastructure. The impact of DLT-based settlement is likely to be very focused according to specific asset classes and transaction types that favor adoption. DLT is not intended to drive a market-wide move toward shorter settlement cycles. Instead, DLT-based settlement will be shaped by existing settlement cycles in the industry, along with the specific needs of products, markets, and regulatory constraints. For example, operational processes in securities lending, prime brokerage, mutual fund, and ETF fund management are not presently in a position to benefit from shorter settlement cycles, and existing constraints are not fully addressable by DLT either.[129] If it is not optimized for appropriate asset classes and transaction types, DLT-based settlement could instead introduce capital inefficiencies due to the need for pre-funding of cash and pre-positioning of securities before trade execution. At scale, pre-funding could significantly impact the liquidity of market-makers in Secondary Markets. As a result, the majority of asset classes and transaction types are expected to continue settling through existing Clearing and Settlement infrastructure.

The most significant opportunity for DLT-based settlement is for asset classes or transaction types where it is operationally feasible and desirable to settle with enhanced automation and precision. Key examples are repos and OTC derivatives, where collateral payments play a key role. Market participants have been actively exploring the role of DLT in repos, using DLT to perform settlement on an intraday basis. Benefits include the potential to reduce operating costs, free up collateral, and mitigate replacement cost risk. DLT-based settlement can help market participants address pain points in common processes, including posting collateral for repo transactions or variation margin for derivative contract credit exposures. Examples of this include J.P. Morgan Onyx and Broadridge DLR. They provide precise DLT-based settlement that can be stipulated in contracts, enabling repo transactions that span hours rather than days.[130] Market innovation with targeted initiatives such as these, are most likely to characterize the adoption of DLT-based settlement rather than a "big bang" wholesale change. This also helps manages concerns around the impacts of pre-positioning securities and cash prior to trade execution on market-maker liquidity — settling trades individually will require more liquidity on hand and could introduce more validations within the post-trade process.[131]

Net securities settlement, and the process of netting (which requires a high degree of legal certainty in settlement finality), is an important tool for the efficient functioning of financial markets. The National Securities Clearing Corporation (a U.S.-based CCP) reduces the value of payments that need to be exchanged daily by 98–99%.[132] This materially reduces required liquidity among market participants and the number of total trades that need to be processed, reducing the burden on post-trade processing and technological systems (thereby driving fewer failed trades). Net settlement enables capital benefits and risk mitigations that will remain relevant even as DLT-based settlement emerges. On a longer timeline, DLT could support netting processes using smart contracts.[133].

In this way, DLT-based settlement could play a supporting role in the industry's long-term progression toward more efficient settlement cycles. Flexible settlement could become a feature of the market.[134] This could give rise to a future capital markets ecosystem where decisions on settlement speed are made on a product-by-product, asset-by-asset, and trade-by-trade basis, driven by needs around liquidity and financial resource efficiency.

129 SIFMA, Letter to Vanessa Countryman, SEC, 2022.
130 Ledger Insights, "DBS Executes Intraday Repo Transaction on JP Morgan Blockchain", 2022.
131 BIS, "On the Future of Securities Settlement", 2020.
132 DTCC, "Advancing Together: Leading the Industry to Accelerated Settlement – A Whitepaper", 2021.
133 Swanson, "Decentralized Financial Market Infrastructure", 2020.
134 FINRA, "Distributed Ledger Technology: Implications of Blockchain on the Security Industry", 2017.

Sidebar: DTCC's Project Ion

The Depository Trust and Clearing Corporation's (**"DTCC"**) Project Ion, is a DLT-based settlement system that, as of August 2022, has gone live in a parallel production environment. Built on R3's Corda private-permissioned distributed ledger network, Project Ion is designed to meet rigorous regulatory standards, resiliency, volume expectations, and risk controls present in traditional settlement. Project Ion supports netted T+0 settlement cycles, T+1, T+2, and other settlement cycles.[135] This initiative, among others, could reflect a future model for flexible, DLT-based settlement.

The impacts of DLT for specific asset classes and transaction types, in a broader ecosystem characterized by optionality of settlement, is likely to be particularly beneficial in four specific areas : (1) DLT could enable automated clearing processes; (2) Enable new methods of settlement (Delivery-vs-Delivery); (3) Reduce costs in cross-border payment; and (4) Improved margin management, driving more transparent and precise requirements, and increasing the likelihood that asset managers can meet them. Each of these activity-level impacts is described below.

Automated Post-Trade Processing: 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 time-consuming reconciliations between legacy systems throughout the settlement chain. DLT can reduce information costs among participants if interoperability is achieved. Standardized data could significantly improve operational efficiency in post-trade processes.[136, 137]

New Settlement DvD: DvD settlement is a type of settlement mechanic gaining unique prominence with the rise of DLT, that consists of swapping one security (or basket of securities) directly for another security (or basket of securities), with no involvement of cash or the traditional Custody chain. SS0 (books and record use case) is a predominant model of implementation for this settlement mechanic. Participants can swap assets in collateral management/repo transactions on a DLT, settling instantly as the DLT provides constant updates to internal custodian Books and Records (and may not need a lengthy settlement process at the CSD). HQLA^x's platform is a market example of DvD settlement, based upon the permissioned R3 Corda network. They have created a DLT-based operating model that enables their clients to exchange ownership of securities, between collateral pools, while the underlying securities remains with the CSD and Custodian – such certainty in settlement is aided by the permissioned nature of the network on which this solution is based.[138]

Cross Border Payment vs. Payment (PvP): The use of a distributed ledger and DLT-based Payment Instruments could have a significant impact on the cross-border payment system and in PvP transactions. This includes faster processing speed, access, interoperability in global payment systems, transparency in counterparty liquidity pools, and ultimately lower costs per transaction.[139] Ease of cross-border transactions may potentially have a second-order impact on securities settlement, by encouraging a greater volume of transactions that have a cross-border payment component. However, implementing any effective cross-border payments solution may require programmability of the underlying DLT-based Payment Instruments to effectively meet compliance requirements in all applicable jurisdictions.

Clearing Capital Costs: DLT-based settlement could enable incremental improvements in margin and default fund management — driving transparency, reducing costs, and enabling efficiency.

135 DTCC, "DTCC's Project Ion Platform Now Live in Parallel Production Environment, Processing Over 100,000 Transactions Per Day On DLT", 2022.
136 Chiu, Koeppl, "Blockchain-based Settlement for Asset Trading", 2018.
137 Benos, Garratt, Gurrola-Perez, "The Economics of Distributed Ledger Technology for Securities Settlement", 2019.
138 HQLA^x Homepage, 2023.
139 Bank of International Settlements (BIS), "DLT-Based Enhancement of Cross-Border Payment Efficiency – a Legal and Regulatory Perspective", 2022.

- **Margin:** DLT could drive more automated, transparent, and efficient margin management enabled by more frequent margin calculation settlement of margin calls. Real-time positions available on a DLT-based settlement system can provide CCPs and participants the data needed to compute current exposure calculations more frequently and precisely. Similarly, the role of DLT to coordinate settlement can shrink the gap between exposure calculations and settlement of variation margin.[140] CCPs and participants can take advantage of DLT to drive transparency in their margin requirements and increase the likelihood of an asset manager's ability to meet them. As DLT supports more efficient settlement cycles, the reduced replacement cost risks could also enable a notional reduction in the total of margin required to mitigate risk of cleared but yet-to-be executed trades.[141]
- **Default Fund:** If DLT-based settlement grows in adoption, clearing fund requirements could potentially decrease as trade volume in specific asset classes and transaction types also accrue on DLT-based platforms. This could lead CCPs to revise the level of capital required for management of the margin period of risk.[142] The operational and systemic risk implications of distributed margin and default fund management are discussed later under "Risk."

Evolved Roles and Responsibilities

CCP: In the long-term, CCP processes, like netting, could potentially be encoded in smart contracts, supporting the operational role of a CCP. In DLT-based markets for specific asset classes and transaction types, where required, a CCP could fulfill standard setting and system governance functions. Participants could also develop distributed financial market infrastructure, where the responsibility of a CCP in managing default funds and setting margin requirements is spread among market participants and agreed through predefined smart contracts or encoded in market-wide infrastructure.[143]

CSD: The role of a CSD may persist if the impact of DLT is limited to DLT-based Securities for specific asset classes and transaction types. 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 on a distributed ledger, CSDs could evolve to be a governor of DLT-based settlement systems, but in almost all other models, they are likely to remain a central actor in DLT-based settlement.[144] A detailed analysis of the evolution of the CSD role is explored in Chapter 2.1.4: Custody.

Custodian (and role as Cash Settlement Bank): Custodians could remain central in coordinating DvP due to their role as owner and safekeeper of wallets and private keys and may stand to realize significant operational efficiencies in those asset classes and transaction types that transition to DLT-based settlement. Generation, notification, and validation of settlement instructions can be supported through smart contract automation, enabling a greater proportion of custodians to straight-through-process settlement instructions. A custodian's role in cash settlement is likely to continue in DLT-based settlement when the payment leg is coordinated through traditional systems of distributed ledger that is separate to the DLT-based Securities ledger (e.g., SS1 or SS2). Where DLT-based Securities and DLT-based Payment Instruments settle on the same ledger, a cash settlement function may no longer be explicitly required in DLT-based settlement but could evolve to manage the conversion between cash and DLT-based Payment Instruments for investors, provided finality can be achieved with requisite legal certainty. A detailed analysis of the evolution of the Custodian role is explored in Chapter 2.1.4: Custody.

Trading Member: The role of a trading member in Clearing and Settlement is likely to be unchanged. However, they can realize significant operational benefit from the automation of post-trade processing (e.g., confirmation/affirmation) and flexible settlement schemes (e.g., instant settlement of repo transactions) that could provide second-order business implications—for example, the ability to settle intraday repo transactions could lower the cost of funding for financial institutions, thereby allowing for greater lending activity.

140 Swanson, "Decentralized Financial Market Infrastructures", 2021.
141 GFMA Member Interviews.
142 BIS defines MPOR as: Margin period of risk is the time period from the last exchange of collateral covering a netting set of transactions with a defaulting counterparty until that counterparty is closed out and the resulting market risk is re-hedged.
143 Swanson, "Decentralized Financial Market Infrastructure", 2021.
144 For a complete legal discussion of settlement finality please reference Chapter 4 | Legal and Regulatory Landscape.

Financial Impact and Opportunity

DLT-based settlement could present material financial opportunities, both through operational cost savings and financial resource efficiencies. However, DLT-based settlement may, however introduce new capital constraints due to potential pre-funding requirements, and in the near-term it will require significant upfront investment to deliver new technology.

Capital Efficiency: Key drivers of capital efficiencies are (a) potential for more automated settlement cycles—reducing the amount of time capital is trapped as part of margin arrangements or within clearing funds held at the CCP; and (b) mitigated replacement cost risk for trade volumes in selected asset classes and transaction types that accrues to DLT-based settlement. These drivers considered together free previously trapped capital that can be used to generated productive returns, unlocking opportunity costs for primarily for clearing members. This economic opportunity is material.

Capital Cost: DLT-based settlement is likely to require prefunding for transactions and may shift some funding costs from broker-dealers and banks to investors.[145] Additionally, pre-funding ahead of DLT-based settlement cycles could introduce additional friction into the trading process and erode market liquidity, especially in less liquid instruments that rely on market-makers to provide continuous two-way pricing. Further, at times of attractive interest rate remuneration, interest paid on overnight central bank deposits may be more attractive than prefunding arrangements, thereby increasing the opportunity cost of prefunding transactions to be instantly settled.

At institutional scale, the GFMA and their members have indicated that there may be net benefit, when considering capital efficiencies and capital costs in aggregate.

Operational Cost Savings: Key drivers of operational cost savings are (a) reduced fees paid to CCPs for selected asset classes and transaction types, where transaction volumes accrue to settlement on DLT-systems or for DLT-based Securities without the need for a CCP, (b) reduced fixed costs per transaction of DLT-based vs traditional technology infrastructure; and (c) lower likelihood of errors requiring back-office remediation.[146] The most recent institutional estimates of savings have been material (*note: in some cases, current-day versions of these figures may be lower, given advances in post-trade processing and a shift away from T+3 settlement since their last publication*):

- In 2016, some estimated that the use of a distributed ledger in the Clearing and Settlement of cash securities, equities, repo, and leveraged loans could save $11–12 billion USD.[147]
- A different 2016 study estimated a $1.4 billion USD reduction in total IT and back-office operational costs due to the implementation of DLT in the Clearing and Settlement of the cash equities market alone.[148]
- Market participants, in 2015, estimated that distributed ledger technology could reduce banks' infrastructure costs attributable to cross-border payments, securities trading, and regulatory compliance by $15–$20 billion USD per annum.[149]
- By some estimates, standardizing trade processing functions, rendering them interoperable, and leveraging economies of scale and network effects could save participants between $2 and $4 billion USD per annum.[150,151]
- A Citi security services survey found 33% of market participants expect DLT to reduce post-trade costs.[152]

145 SEC, "Proposed Rule: Shortening the Securities Transaction Settlement Cycle", 2022.
146 GFMA Member Survey conducted as part of this report, n=25; Avg. Score of 2.0 out of 5.0, 1 is highest level of potential efficiency and 5 is lowest level of potential efficiency.
147 Capgemini, "Blockchain Disruption in Security Issuance", 2016.
148 Goldman Sachs, "Profiles in Innovation: Blockchain Putting Theory into Practice", 2016.
149 Santander, Innoventures, Oliver Wyman, Anthemis Group, "The Fintech 2.0 Paper: rebooting financial services", 2015.
150 Broadridge, "Charting a Path to Post-Trade Utility: White Paper", 2015.
151 Priem, "Distributed ledger technology for securities Clearing and Settlement: benefits, risks, and regulatory implications", 2020.
152 Citi, "Securities Services Evolution 2022", 2022.

It should be noted that operational efficiencies are not likely to transpire in the near-term given the overhead of additional resources to build, run, and maintain new technological platforms.

Risk Impact

For Clearing and Settlement, the introduction of DLT could introduce limited risk considerations and mitigations, discussed in **"2 | Holistic Understanding of DLT-Specific Risk"** section of the Executive Summary. This section focuses on the impact of DLT in mitigating existing risks in the Clearing and Settlement stages of the securities lifecycle.

Counterparty Credit Risk: DLT-based settlement can mitigate replacement cost risk due to the use of automation in settlement.[153] This is driven by the reduction in delay between trade and settlement execution. Principal risk can also be mitigated where DvP occurs atomically, which can be enabled by a distributed ledger if chosen, provided the applicable network enables finality as legally defined. If scale is achieved in selected asset classes and transaction types, the notional value of executed but not-yet-settled trades could be reduced, as well as the margin period for CCPs, currently mitigated through capital charges (e.g., collateral). DLT-based settlement could also support participants to post margin in real time. In the case of OTC derivatives, this could address variation margin gaps (between posted margin and calculated current exposure of contractual positions) — particularly valuable in times of market stress. Smart contracts could also support the management of margin and clearing funds, with the ledger record of transactions and open positions enabling the allocation of the default waterfall more precisely during times of market stress.

Operational Risks: DLT-based settlement could address operational risk for post-trade participants in selected asset classes and transaction types, with improved information sharing and automation in post-trade processes. This could lead to improved data quality between participant systems, and reduce the potential for trade fails (though this would only be material in markets like Europe, and for specific asset classes like equities). In the long-term, regulators could even directly access post-trade data, creating reports and monitor market health in real time. If predominant, the SS3 model (integrated DLT-based settlement platform), would avoid the risk of coordinating between securities settlement and payment settlement systems (that also exist in traditional markets, through the SS1, and SS2 models).

Liquidity Risk: DLT-based settlement could aid in mitigating liquidity risk. If scale is reached in selected asset classes and transaction types, DLT-based settlement enable allow asset managers to benefit from automated transactions and the potential for improved liquidity in the market (where liquidity is shallower in traditional markets today). For example, this could be particularly impactful in illiquid asset classes like certain forms of fixed income securities and unlisted equities.

Systemic Risk: CCPs provide a proven model to manage systemic risks and ensure financial stability. As volumes of centrally cleared securities have grown, however, this is now itself presenting a source of systemic risk. CCP failures are highly unlikely and effectively mitigated through capitalization. DLT could be used to support CCPs, or provide considerations for a future, alternative model for specific asset classes and transaction types that do not settle through a traditional CCP. For example, using smart contracts and multi-signature accounts, margin, default fund, and additional capital can be pooled at an account controlled by market participants. This could ensure, similar to a CCP today, that a qualified majority of non-defaulting parties have the ability to release funds according to a codified waterfall where risk participation is proportional to risk creation.[154] With the appropriate design of the distributed ledger, CCP-style data access could be replicated and protected by the cybersecurity protections of all market participants, thereby distributing operational resiliency among many participants.

153 Defined by BIS as settlement risk, and comprised of replacement cost risk and principal risk; see BIS, On the Future of Securities Settlement, 2020.
154 Swanson, "Decentralized Financial Market Infrastructure", 2020.

2.1.4 Custody

This section provides an overview of participants, key activities, and inefficiencies that exist today. This provides a baseline for an impact assessment of DLT, considering **different models of implementation** and i**mpact on activities, roles and responsibilities, opportunities,** and **risk.**

Summary of Impact Assessment

High

In this section, Custody is defined as record-keeping and account-management activities for investor securities and cash.[155]

Implementation models:

1. **Books and records only:** Managing internal records of securities, transactions, positions, and client information on a distributed ledger with other members of the Custody chain. Does not involve DLT-based Securities.
2. **Digital Custody:** Administering Books and Records as well as the safekeeping of DLT-based Securities on a distributed ledger across the participants involved in the Custody stage of the securities lifecycle. This implementation model could necessitate changes to official methods of record-keeping.

Digital Books and Records could address record-keeping inefficiencies:

- A distributed ledger used across the Custody chain could simplify post-trade reconciliations that currently occur between participants, leading to greater operational efficiency through less manual intervention, enhanced data transparency, and auditability. However, DLT may introduce new reconciliations with existing databases as distributed ledger records become a sub-ledger to be integrated into a financial institution's general ledger reporting.
- This solution would not offer the ability to Custody DLT-based Securities and broader efficiencies.

Digital Custody could present a further set of changes on top of the Books and Records impacts:

- **Digital Custody could introduce a new infrastructure for DLT-based asset safekeeping** via the wallet and key model. Custody could gain importance for DLT-based Securities given the dependence on the private key for transactions and the need to diligence new and emerging DLT-based platforms. To safekeep the private key and establish connectivity with existing accounts, custodians may require new sub-Custody or third-party services; the degree to which custodians outsource technology capabilities may depend on whether digital Custody services providers can scale as volumes increase.
- **Any new infrastructure is unlikely 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.
- Digital Custody could position traditional, qualified custodians to meet growing client demand for **an integrated, interoperable Custody platform across DLT-based and traditional securities,** with DLT-based alternative assets as a key growth area.

155 Other activities performed by a Custodian such as Settlement and Asset Servicing and Lifecycle Management are covered in their respective sections.

Considerations for digital Custody adoption:

- **Roles:** Impact on the CSD role and the Custody chain could depend on the type of DLT-based security. For Security Tokens, the CSD could evolve towards a governance role in enforcing standards and resolving disputes, while custodians and other intermediaries play a larger role in proposing and validating transactions, and safekeeping private keys on behalf of clients. In the case of Tokenized Securities, the CSD role and the Custody chain would remain similar to the status quo for the traditional asset portion.
- **Opportunities:** Large operational cost savings and considerable potential demand for Custody of DLT-based Securities (projected ~$16 trillion in assets under Custody by 2030) are two major sources of return on investment. Those benefits, however, are realizable only in the long term; costs may be significant in the near to medium term as firms must scale up new technology and operations while continuing to run processes outside of a distributed ledger.
- **Risk:** DLT could significantly mitigate operational risk through simplification of post-trade reconciliations and reduction of manual intervention. New cybersecurity, regulatory compliance and financial crime, business continuity planning, data privacy, asset onboarding, and vendor risk considerations would need to be managed. Financial institutions may also need to manage operational risk from running different systems in parallel, changing workflows and vendors to DLT-based solutions, and developing technological interoperability and integration between the distributed and traditional ledger.

2.1.4.1 Current State and Inefficiencies

For the purpose of this analysis, Custody is defined as the safekeeping and administration of securities and other assets on behalf of asset managers, asset owners, and trading firms. Additional activities undertaken by custodians, such as transaction initiation, settlement services, and liquidity provision are covered in the relevant lifecycle stages.

There are two core groups of activities:

1. **Record-keeping:** Maintain consistent records of positions and transactions by regularly conducting post-trade reconciliation among custodian, asset manager, sub-custodian, and CSD ledgers.[156]
2. **Account management:** Safekeeping of client securities and cash in accounts segregated from the custodian's own assets and liabilities.[157] This chapter will focus on asset safekeeping, with KYC/AML/CFT covered a later section.

Broker-dealers / prime brokers, investors, custodians (global and local), and CSDs form a Custody chain through an interdependent set of roles and responsibilities. The CSD or registrar provides the central source of truth on securities ownership (at an institutional-level) that is updated and referenced by the Custody chain.

Record-keeping

Financial institutions have continuously enhanced the post-trade reconciliation process with technology. Examples include the ability to do many-to-many matching instead of two-way matching, and the transition from close-of-business batch processing to real-time transactions.[158] Despite these improvements, lack of data standardization and continued manual intervention remain the two prominent inefficiencies of the process.[159]

Difficulty in securing standardized data inputs is a key driver of post-trade reconciliation complexity. While the industry has been moving toward the ISO 20022 standards from SWIFT, adoption is not yet universal for smaller

156 McGill and Patel, "Global Custody and Clearing Services", 2008.
157 McGill and Patel, "Global Custody and Clearing Services", 2008.
158 McGill and Patel, "Global Custody and Clearing Services", 2008.
159 Ibid.

investment managers, some of whom may rely on email or even fax to instruct.[160] Furthermore, the process of adopting new standards is operationally work-intensive; firms must become familiar with file formats, data tables, and a large list of message codes. They must ensure legacy systems can plug in and populate SWIFT messages reliably and seamlessly. For larger investment managers, a key driver of reconciliation complexity is the sheer number of inputs involved. They could interact with dozens of different custodians, which could multiply the number of reconciliations needed on a regular basis.[161]

Finally, financial institutions still rely on manual intervention for the reconciliation process. For example, a large asset manager may employ dozens of workers to examine and resolve breaks in processes.[162] When there is an inconsistency with position or balance data, teams may need to check every transaction within that time period. While this type of check can be trivial in isolation, daily error rates can amount to material operational cost and time on an annual basis.

2.1.4.2 Summary of Impact Assessment: High

This section examines the impact of DLT and DLT-based Securities on Custody. It will analyze the impact across the activities, associated Inefficiencies, and technologies established in the previous section. It will then consider the implications on roles and responsibilities, financial, and risk across the Custody ecosystem.

Exhibit 2.1.12

Custody Impact Assessment

Custody	Investor (client)	Global Custodian	Local Custodian (if applicable)	CSD
Record-keeping	High	High	High	Tokenized Securities: Medium
				Security Tokens: High
Account management/asset safekeeping	High	High	High	Tokenized Securities: Medium
				Security Tokens: High
Account management/KYC	High	High	High	Tokenized Securities: Medium
				Security Tokens: High

Source: BCG analysis

160 Ibid.
161 Ibid.
162 Ibid.

Models of Implementation

The impact of DLT on Custody may depend on whether financial institutions opt for (1) a books-and-records-only approach or (2) a fully digital Custody approach. This section examines the impact of each implementation in turn.

Books and Records Implementation (i.e., for traditional securities)

Under a digital Books and Records implementation, participants in the Custody chain could generate and maintain book entries and messages pertaining to securities, cash transactions, positions, and accounts on the distributed ledger. In this case, the distributed ledger is simply a useful reference that streamlines reconciliation and account management activity by breaking down data siloes and enforcing consistency of data values and standards across financial institutions. This solution covers records only, however. The securities and cash themselves do not enter the distributed ledger; they remain on traditional FMI and based at the CSD.

Because it does not require the creation and Custody of DLT-based Securities, the Books and Records implementation can be a first step in the journey toward digital Custody. Furthermore, if DLT-based Securities are introduced for Custody in the future, members of the Custody chain would directly utilize the record-keeping capabilities developed in the Books and Records implementation. This section will examine each capability in turn.

Notably, reconciliation processes would still be necessary, even with the introduction of DLT, since financial institutions will continue to employ traditional ledgers for internal and external reporting for at least the near and medium term. However, having a single distributed ledger could reduce the rate of data discrepancies and increase ledger transparency for those using it.

In a more developed DLT-based ecosystem, the distributed ledger could become the golden source of truth for all positions and transactions, ensured through consensus among participants. By reducing discrepancies among custodians, investors, asset managers, and CSDs, financial institutions could reduce back-office spend and resources allocated to normalize data into standard, comparable format. DLT could remove significant operational risk and reduce the resources (both FTE and financial cost) that custodians expend manually troubleshooting and resolving breaks and exceptions.

While DLT may substantially reduce discrepancies in data shared among Custody chain participants, it would not eliminate the potential for errors and may still necessitate the need for reconciliation between DLT-based and traditional Books and Records. Errors could still occur upstream for reasons including manual entry errors, client miscommunication, and data formatting. If errors are introduced into the distributed ledger and not identified immediately, they could still flow through the system. DLT may, however, simplify the identification of errors since parties do not need to reconcile records from one system to another to piece together the error. Additionally, DLT-based Securities would introduce another set of sub-ledgers corresponding to the wallet transaction history that would need to be synchronized with a banks formal, official, general ledger.

Digital Custody Implementation

In the digital Custody implementation, DLT is used to represent securities on a distributed ledger, and those securities are formally transacted and processed by the Custody chain. Traditional database technology could be used to manage client beneficial ownership of assets issued and recorded on external DLTs. Alternatively, DLT-based Books and Records could be used to convey information. Either solution is required so associated changes to record-keeping outlined above would apply to digital Custody as well. In addition, digital Custody will impact asset safekeeping, which is the focus of this subsection.

Under digital Custody, DLT could have three main impacts on asset safekeeping activities. First, it requires the **safeguarding of both forms of DLT-based Securities,** with a custom set of technology and operations in

addition to, rather than in place of, the current account-based Custody model. Second, it allows custodians to build a platform that meets expected growth in client demand for **integrated Custody of traditional and DLT-based Securities.** Third, DLT-based Securities under Custody (here: **"AuC"**) could feature a **higher share of alternative assets** compared with the existing Custody asset mix.

Safeguarding DLT-based Securities

In contrast to the account model for traditional securities, the Custody of DLT-based Securities is typically based on a wallet and key model originally designed for use in public-permissionless DLT networks. Holdings exist as a record of transactions on a distributed ledger. The wallet is a front-end application that integrates with the ledger and typically interacts or stores an asset owner's cryptographic keys. There are two types of cryptographic keys. First, is the public key, which is used to derive a public address which acts like a bank account number, and every transaction is linked to the public addresses of both the sender and receiver. A wallet application queries transactions on the ledger to provide a user with details on holdings associated with their public address. Second, is the private key, which is a randomly generated alphanumeric string that is cryptographically linked to the public key at creation. The private key therefore provides the security holder with the control of the DLT-based security associated to the derived public address. A private key must never be divulged to others or lost, since it is the sole component used to unlock access to and transfer of the DLT-based security recorded against the associated public address.[163] Therefore, a custodian's role evolves into safeguarding the private and public keys, which confer the ability to access and transact the DLT-based security. It should be noted that private keys are not a wholly new tool; for instance, custodians manage private keys without DLT to communicate securely over the SWIFT network.

Custody could play a different role in DLT-based Securities relative to traditional securities because secure storage of the private key is paramount. To be executed, all transactions require a digital signature with the private key that controls the asset that is recorded against the public address. If the private key is lost, the investor can lose access to the corresponding securities; there is currently no recourse available on public permissionless networks. The secure Custody of the private key is fundamental to any activity in DLT-based Securities. Given their technological expertise, scale, and established regulatory standing, traditional, qualified custodians are favorably positioned to provide institutional-grade services relative to self-Custody and exchange-provisioned options.[164]

A custodian may use three primary forms of wallets:

- **Hot Wallet:** A wallet with private keys always connected to the internet; it prioritizes accessibility at the expense of security.
- **Cold Wallet:** A wallet that stores private keys fully offline, not connected to the internet, and could require human intervention for transactions or signing; it prioritizes security at the expense of accessibility.
- **Warm Wallet:** A mix between a hot and cold wallet. The keys are held online, as with a hot wallet, but human interaction or additional security policies (e.g., requiring human interaction to sign a transaction) are required to authorize transactions, as with a cold wallet; a blend between the security and accessibility of the previous two wallet types.

There are additional security features used in DLT wallets to enhance the security of private keys:

- **Multi-sig Wallet:** A smart contract–based wallet that requires multiple private keys to authorize a transaction, which can be spread across multiple systems. These private keys can be a combination of hot, cold, and warm wallets per criteria encoded into the contract when it is first created.
- **Multi Party Computation (MPC) Wallet:** A wallet utilizing a solution where a single private key is sharded and distributed between multiple parties. This method ensures that the private key never exists in its entirety in one place at any given time and enables signatures in a similar way to a multi-sig wallet. The MPC wallet

163 Fireblocks, "Digital Asset Custody 101: Guide to Self-Custody, Wallet Options, and More", 2023.
164 Deloitte, "A Market Overview of Custody for Digital Assets: Digital Custodian Whitepaper", Jun 2020.

contrasts with multi-sig wallets in that multi-sig wallets require multiple different private keys, whereas an MPC wallet uses a single private key separated into parts. The key shards could also be held in a combination of hot and/or cold key storage systems.

In addition to securely storing private keys, the custodian must also be able to securely generate those keys. There are detailed key-generation procedures that custodians may need to consider. For wallets, account abstraction may be a useful tool if realized in the future. Account abstraction allows an account to be fully programmable. This could potentially allow the signing private key for an account to be changed via social recovery mechanisms to avoid loss of funds, for the creation of wallets without an initial seed (e.g., via email), for transaction fees to be paid with a different token (e.g. ERC-20 instead of ETH), or even allow no gas transactions via sponsored transactions.

In a steady state, custodians could likely use several wallet types (e.g., hot and cold storage) and hardware solutions (e.g., hardware security modules) to meet security, anonymity, flexibility, and transaction throughput demands from clients. In addition, key and wallet generation procedures may simplify substantially as technology providers package these capabilities into software solutions that custodians can readily deploy.

Limitations to the wallet-based model

The wallet-based Custody model for DLT-based Securities is unlikely to displace the current account-based model at the CSD for three reasons. First, most outstanding securities is likely to remain outside the distributed ledger for the foreseeable future. Second, regulatory requirements aiming at managing systemic risks could require a CSD operating an account-based system to store the underlying security as a mitigant. Custodians that are safekeeping Security Tokens must ensure that it is always "backed" by the traditional asset at the correct ratio (1:1 or 1:n in the case of fractionalization) to maintain the integrity of the tokenized security.[165] Third, some jurisdictions require transactions to be booked through securities accounts to transfer ownership. Thus, all members of the Custody chain need to develop technological interoperability and integration between wallets and legacy account-based systems.

Importantly, while the wallet and key model is the dominant Custody model for public networks, it does not need to be the design for private-permissioned networks. Given the higher level of built-in security, especially for small private networks where data is not viewable by the public, Custody participants can use accounts with the traditional credentialing technology. Thus, for private networks, participants may have more freedom to design the Custody model according to use case and the relevant security and regulatory considerations.

Integrated Custody of traditional and DLT-based Securities

The adoption of DLT could mean that an integrated Custody model across traditional and DLT-based Securities could emerge as the dominant future packaging of Custody services. In BNY Mellon and Celent's 2022 Survey of Global Institutional Clients, 72% of investors indicated they prefer an integrated, one-stop shop for digital asset Custody, as opposed to best of breed providers for individual needs.[166] Despite the enthusiasm for the potential offerings, the survey found that only 35% of respondents are currently investing in digital asset exposures through a traditional finance platform, and most firms report having to use more than one vendor. Moreover, respondents named product feature set, legal framework, and lack of integration among traditional and digital assets as the top three Inefficiencies affecting current digital asset custodians.[167] This is evidence of a need among institutional investors for a complete, integrated Custody platform across traditional and distributed ledgers provided by a traditional player.

Traditional, qualified custodians appear to be well-positioned to deliver integrated Custody services for DLT-based Securities. BNY Mellon/Celent survey respondents indicated that they would increase portfolio allocations to

165 OECD, "The Tokenisation of Asset and Potential Implications for Financial Markets", 2020.
166 BNY Mellon & Celent, "2022 Survey of Global Institutional Clients", n=271. Respondent panel included asset managers, asset owners, and hedge funds with core activities covering North America, Europe and Asia. Respondents were surveyed from May to June 2022.
167 Ibid.

assets, including DLT-based Securities, by an average of seven percentage points in the next two-to-five years if conditions are favorable.[168] Most respondents (63%) indicated they would only be comfortable trading DLT-based Securities or DLT-based Payment Instruments with traditional financial institutions. This is driven primarily by concerns over the regulatory standing of non-bank providers, the reassurance of well-capitalized firms, and the outsized burden of conducting due diligence on new providers.[169]

Higher share of alterative assets

Among the different categories of DLT-based AuC, custodians are likely to see more growth in private market assets. As of 2021, alternative assets represented only 17% of global assets under management (**"AUM"**).[170] Broad trends in traditional assets indicate that expected growth in alternative asset AUM (9% CAGR) could outpace that of traditional assets (5% CAGR) from 2021 to 2026.[171] Furthermore, market participants identify increased access to alternative assets as a major benefit of DLT-based Securities. In the BNY Mellon/Celent survey, respondents ranked access to private equity, real estate, and other alternative asset classes as the top benefit from Tokenization.[172] This preference was corroborated by a survey of GFMA members for this publication, where respondents ranked private placements, illiquid assets, investment funds, and real estate as the asset classes with the most potential for DLT.[173]

Evolved Roles and Responsibilities

The roles and responsibilities in the Custody chain could evolve through the introduction of a distributed ledger. This could create one Custody model for Tokenized Securities (Model 1) and another for Security Tokens (Model 2), reversing the general trend toward consolidation that has characterized CSDs over the past few decades.[174]

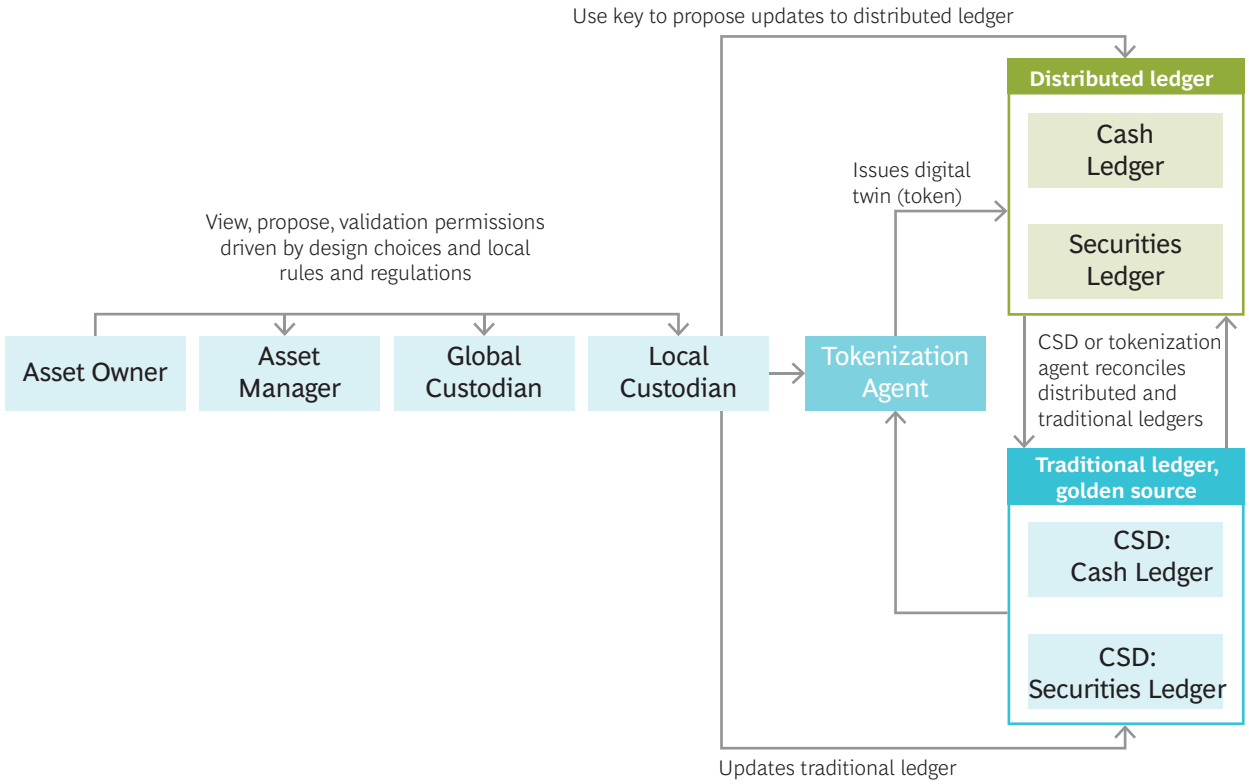
Tokenized Securities (Model 1): The CSD's traditional ledger remains the source of truth for the underlying traditional securities holdings. As Tokenized Securities have both an underlying instrument trading and settling on traditional markets in parallel with a digital twin token trading and settling on DLT-based markets, the CSD may likely continue to play its current dual role as official record of ownership and overseer of governance issues for traditional securities holdings (Exhibit 2.2.12).

Under Model 1, a Tokenization agent could issue the digital twin Tokenized Security on the distributed ledger on behalf of the local custodian that is storing the traditional asset. For the digital twin, the local custodian or participant with the correct wallet and private key could propose transaction and ownership changes to the distributed ledger. If the DLT-based system executes internalized settlement, it is possible that tokens can be transferred on the distributed ledger without having to update the traditional ledger on the CSD. However, either the CSD or custodian could need to regularly verify that the record of ownership for the traditional asset exactly matches the record of ownership for the digital twin. For these reconciliations, the traditional CSD ledger could likely remain the golden source of truth, given its legally established nature today (note: for omnibus accounts, there would be no change at the CSD level). Furthermore, the CSD may also play the validator role for updates to the distributed ledger.

168 Ibid.
169 Ibid.
170 BCG, "Global Asset Management 2022: From Tailwinds to Turbulence", May 2022. AUM is used as a proxy for AuC. Alternative assets include hedge funds, private equity, real estate, infrastructure, commodities, private debt, and liquid alternative mutual funds.
171 Ibid.
172 BNY Mellon & Celent, 2022.
173 GFMA member surveys, Nov-Dec 2022.
174 European Central Bank, "The Securities Custody Industry".

Exhibit 2.1.13

Model 1 (for Tokenized Securities): The Golden Source Record of Ownership for a Security Remains in a Traditional CSD



Source: BCG analysis

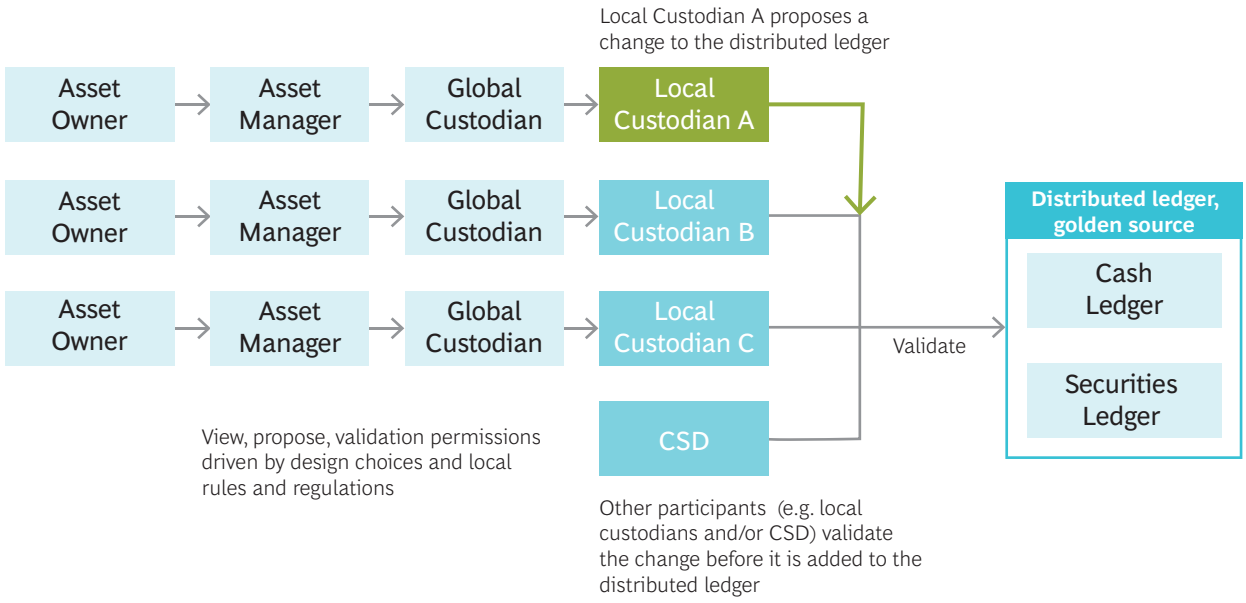
The chain of Custody could remain as it is today for the underlying traditional assets, thereby maintaining the same Custody risk profile. The digital twin would exist in parallel on the distributed ledger, with changes requiring validation by the CSD or according to an alternative mechanism agreed to locally. The CSD or Tokenization agent would need to reconcile between traditional asset and digital twin to ensure consistent records.

Security Tokens (Model 2): The distributed ledger becomes the golden source of truth. The CSD role may shift toward governance while custodians and other financial intermediaries play a larger role in validating transactions on the distributed ledger (refer exhibit). It should be noted that this model assumes regulation that requires the role of a CSD. Depending on the progression of regulation in different jurisdictions, alternative models may also be possible where a CSD may not be required.

Since a Security Token is digitally native, it does not get recorded on a traditional ledger. In this design, assuming a CSD is required, the distributed ledger records ownership of securities and is administered and managed jointly by the CSD and the custodians. The CSD would continue to be a central, trusted authority, but its role **could evolve towards predominantly a governance role with increasing automation, allowing more decentralized methods for updating the distributed ledger.** Governance activities could include enforcing data standards, determining validation mechanics, and arbitrating disputes. In terms of making 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 securities ownership. Financial institutions dealing with Security Tokens could likely need to continue abiding by local fiduciary, AML, and other financial regulations, suggesting that local custodians could continue playing an important role updating the distributed ledger, as they do today with traditional assets at the CSD. A more centralized design could feature the CSD serving as the sole validator or one of a few.

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

For Model 2, the level of decentralization is a design decision dependent on several governance and regulatory considerations. First, a consensus mechanism in which custodians or brokers mutually validate their clients' trades could raise competition and disclosure concerns.[175] Custody chain members can potentially mitigate these concerns by implementing zero-knowledge proofs and other privacy-enhancing cryptographic techniques. Second, members need to ensure that the consensus mechanism and associated recourse processes could comply with both legal and governance standards. For example, the CSD role is legally mandated by several jurisdictions (e.g., the U.S.), so any changes to the CSD role resulting from the consensus mechanism would require regulatory blessing.

Financial Impact and Opportunities

The financial impact of DLT on Custody could be considerable. On the cost side, simplification of reconciliations could lower the total cost to serve. Custody of DLT-based Securities could open new ways to serve client demand.

Capital Expenditure

Upfront operational and capital expenditure may be necessary to build out Custody platforms and (at least in the short/medium term) link legacy and DLT-based platforms. Custodians and CSDs alike may need to invest in new technology and resources, with many interviewees indicating the investment phase is at least 5 to 10 years.

Additional technological requirements like the hardware and software required to run and manage a node, connectivity tools (e.g., external data inputs or oracles, APIs, linked ledger systems), and wallet management controls (e.g., cold storage facilities, key generation algorithms, and computing) are capital expenditures that must be borne in the near term to meet the requirements of clients. Similarly, custodians and CSDs could need additional capital expenditure to bolster and enhance existing cybersecurity controls and adapt them to the specifics of a distributed ledger.

175 Randy Priem, "Distributed ledger technology for securities Clearing and Settlement: benefits, risks, and regulatory implications", 2020.

Operating Expenses

DLT also presents opportunity for significant operating expense savings in a mature state, especially as end-to-end efficiencies are realized. However, in the short-to-medium term, those operating expense savings are unlikely to transpire. This is due to the need to run traditional systems in parallel to DLT systems to build regulatory and client trust. As described in previous sections, the true operational efficiencies and cost-saving impact is realized through the impact of DLT-based Securities at scale, reducing the complexity of reconciliation efforts. As of 2015, the annual cost base for post-trade processing was $6–9 billion USD; simplifying these processes could lead to $2–4 billion USD in annual cost savings, of which reconciliations costs are a major portion.[176] When realized, these savings could be passed up the Custody chain.

Demand Factors

The market growth opportunity represents a promising avenue for custodian growth and monetization. As of 2022, the stock of DLT-based Securities is $310 billion.[177] While best-case scenarios estimate total market value of $68 trillion USD, conservative projections indicate that stock is expected to grow to $16 trillion USD by 2030, representing a 63% CAGR.[178] By comparison, AuC for the top 11 custodians grew 5.7% CAGR from 2010 to 2018.[179] Even assuming most of the DLT-based market cannibalizes current non-DLT market value, it represents a shift in growth by market segment. Custodians would be well-placed to invest in Tokenization so they can defend existing AuC outside of a distributed ledger and capitalize on areas of tokenized AuC growth.

Risk Impact

DLT could introduce limited risk considerations and mitigations when implemented for use in Custody. These risks, together with proposed mitigations are discussed in the **"2 | Holistic Understanding of DLT-Specific Risk section of the Executive Summary."** This section focuses on the impact of DLT on mitigating existing risks in the Custody stage of the securities lifecycle.

Operational Risk: The shared ledger can simplify reconciliation effort, reduce positional deviations between organizations and create a standardized data format for post-trade data. A combination of different nodes allows each participant bespoke, programmable access to the shared ledger of ownership. This drives transparency and trust throughout the Custody chain.

Risk-Adjacent Impact, Operational Resiliency: The distributed nature of the ledger in Model 2 means greater resilience against operational or system outages, as there is no central operator. Existing resiliency and continuity plans have been tested and validated with regulators and can be easily adapted for DLT tech (e.g., ensuring back-up power/generator and the four-eyes principle). The solid regulatory foundation of traditional, qualified custodians could provide a lower-risk means for institutional clients to access DLT-based Securities, compared with self-Custody or other industry options. On the KYC/AML/CFT side, custodians can access client data more efficiently, at lower cost.

176 Broadridge, "Charting a Path to a Post-Trade Utility", 2015.
177 BCG and ADDX, "Relevance of on-chain asset Tokenization in crypto winter", 2022.
178 Ibid.
179 BCG, "Asset Servicing Primer", 2020.

2.1.5 Asset Servicing and Lifecycle Management

This section provides an overview of participants, key activities, and inefficiencies that exist today. This provides a baseline for an impact assessment of DLT, considering different models of implementation and impact on activities, roles and responsibilities, opportunities, and risk.

Summary of Impact Assessment

High

Asset Servicing and lifecycle management covers corporate actions, tax withholding for dividend and interest payments, and regulatory reporting processes.

Models of implementation

- **Books and records only**: Entails posting and managing records on the distributed ledger while the securities themselves stay on a traditional ledger. The level of impact would be a subset of the DLT-based implementation.
- **DLT-based Securities:** This implementation involves the full set of Asset Servicing and Lifecycle Management processes for DLT-based Securities, which necessitates that records to be posted and maintained on a distributed ledger.

DLT impact is expected to be high for mandatory corporate actions and proxy voting and lower for more complex voluntary corporation actions.

- DLT impact could be realized in two ways. (1) The distributed ledger significantly reduces the need to reconcile among multiple siloed data sources. (2) Smart contracts can automate execution by codifying legal rights and obligations from corporate actions into standard, unambiguous, consensus-driven execution parameters tied to the security itself and ensuring quality of execution through verification infrastructure.
- The custodian role could be de-risked, as the likelihood of data discrepancies on the distributed ledger could be greatly reduced. Issuer agents who mostly transmit data currently could see their roles shift to helping issuers engage with smart contract templates and announce corporate actions via DLT. The system could require a governing body to align on corporate action smart contract template standards.
- Except for proxy voting, DLT impact is not expected to be high for voluntary corporate actions due to the operational complexity and the likelihood of substantial activity outside the distributed ledger.
- A Books and Records implementation could benefit from the distributed ledger's golden source of corporate action data, but likely would not deliver smart contract–based corporate action execution.

DLT-based tax withholding could automate the appropriate application of tax relief for each investor at the source (or during the taxable event), reducing the need for a tax-reclaim process.

- If the distributed ledger becomes the source of truth, the withholding process could reduce its dependency on physical documents and wet ink signatures; the risk of tax fraud could also be reduced.
- The extent of impact may depend on whether a DLT-based solution can (1) protect confidential data while automating tax treaty eligibility determinations; (2) require changes to a jurisdiction's tax code; and (3) accurately withhold for more complex corporate entity structures; each factor could limit the feasibility of DLT-based tax withholding.
- While the main responsibilities of withholding agents, investors, and tax authorities may not change, the system could require a governing body to align on implementation and promote scalability.
- A Books and Records implementation could fully realize DLT-based tax withholding impact.

DLT-based regulatory reporting, a key component of security lifecycle management, could enable embedded supervision, where supervisors automatically monitor compliance of DLT-based positions and

transactions in real time via a node on the distributed ledger.

- The single source of truth and accompanying data transparency of DLT could reduce the currently heavy manual and operational processes required to record and report regulatory data.
- Embedded supervision's impact on broader regulatory reporting could be limited until industry and regulators align on approach to realizing three enabling conditions: (1) interoperability among distributed ledgers and with the broader market data, (2) legal guarantee of the integrity of DLT-based Securities, and (3) an established definition of settlement finality, so that the data presented to supervisors is not subject to change
- While this solution is meant to address DLT-based Securities, a Books and Records implementation involving traditional securities could be a useful pilot.

Opportunities: Long-term cost savings from adopting DLT could be meaningful. Corporate action errors can cost custodians over $1 billion USD per year. Unsuccessful tax reclaims cost the industry at least €8 billion EUR per year. Embedded supervision regimes could bring down the cost of compliance, which currently sits at 3–9% of non-interest expense for banks. However, the initial investment may be significant; all required parties must be on the distributed ledger for each of the systems to achieve network effects that justify both set-up cost and the cost of integration. Lack of regulatory clarity regarding smart contract standards, permissibility of tax relief at the source, and legal status of DLT-based settlement finality could constrain the growth and adoption of each solution. DLT may also need to prove its value proposition against non-DLT solutions in development.

Risks: New risks could be introduced around privacy, security, and smart contract execution, given the confidential nature of corporation action, tax, and regulatory data. Permissioning, privacy-enhancing cryptography, and cybersecurity could be paramount to system design. Creating a well-controlled smart contract layer may be crucial to automation in all cases.

2.1.5.1 Current State and Inefficiencies

Asset Servicing is the administration of legal rights and obligations associated with a security post-trade. This section covers three types of Asset Servicing and Lifecycle Management activities: corporate actions, tax withholding, and regulatory reporting.

Corporate actions are events triggered by the issuer that affect the position of the security. There are two types:

- **Mandatory:** These do not provide the security holder a choice on whether to participate.[180] Examples include dividends, coupon payments, and mandatory stock splits.
- **Voluntary:** These require a decision on the part of the security owner and additional process involving prompting, receiving, and communicating decisions.[181] Examples include proxy voting, M&A, spin-offs, rights issues, and voluntary conversions.

Tax Withholding: Dividends and interest payments are the two most common income streams that are subject to taxes, and most jurisdictions tax those forms of income via a withholding system.[182] Tax withholding is carried out by the withholding agent (usually the local custodian), with involvement from financial intermediaries.

Regulatory reporting: Periodic reporting of transactions, positions, capital, and measures of financial health to regulators.

180 Chartered Institute for Securities & Investment, Global Securities Operations, Ed. 18, Apr 2022.
181 Ibid.
182 Ernst & Young, "Withholding tax distributed ledger report", July 2021.

Corporate Actions

Inefficiencies in the corporate action process concern operational risk. The linear data flow from one stakeholder to another means that inaccuracies can easily pass down the chain. The transfer agent, CSD, and custodian are each responsible for their own data integrity. For downstream stakeholders like the custodian, this dynamic can create distrust in any one source. Given the large costs and contractual liability that custodians can incur from corporate action administration errors, they spend considerable resources on multiple, often duplicative sources of information to confirm the accuracy of data. Firms can use up to seven different data feeds to source and validate information, which itself drives incremental reconciliation costs.[183] Despite these efforts, 56% of corporate action errors still originate from data issues.[184] In 2020, corporate action errors cost 70% of market participants more than $2 million per year.[185]

Tax Withholding

In most jurisdictions, by default, the local tax rate is withheld even for cross-border investments.[186] However, for cross-border income payments, investors can potentially receive tax relief due to tax treaties.

The process to prove eligibility for tax treaty relief is documentation-heavy and time-consuming. A substantial portion of tax treaty documentation is still paper-based and requires wet signatures. Applicants must navigate each intermediary's specific commercial confidentiality and investor privacy obligations.[187] During COVID-19, office closures exacerbated delays in completing paperwork, leading to more missed opportunities for tax relief at the source and a likely future influx of tax reclaim requests.

If investors cannot claim the tax benefit "at the source" or during the taxable event, a reclaim process must be initiated to remove the excess tax withheld. The reclaim process is also typically described as cumbersome.[188] Investors and their agents must file a separate series of documents to the tax authority, and then face a lengthy processing time. As a result, many investors do not complete the reclaim process once started or do not file a reclaim at all, thus paying more tax than necessary.[189]

Slow processing time and complex documentation requests weaken the resiliency of the oversight system. For instance, the European "cum-ex" tax fraud case in 2012 featured a technique employed by investors to complete quick transactions on the dividend pay-out date, then file fraudulent claims for tax relief on those transactions. Given the speed of the transactions and inability of the tax documentation system to keep pace, authorities granted tax relief to many investors who filed fraudulent claims. Overall, E.U. country treasuries lost €55 billion.[190]

The total costs resulting from these tax withholding Inefficiencies is substantial and persistent. The losses amounted to ~€8.4 billion EUR in the E.U. alone as of 2016, including ~€6 billion EUR foregone tax benefits, ~€1.2 billion EUR in operating costs to attain relief, and ~€1 billion EUR in opportunity costs (cash trapped in the relief process).[191]

Regulatory Reporting

Today's regulatory reporting regime for capital markets participants covers millions of transactions and positions spread over a patchwork of different databases.[192] Given the siloed nature of internal and external financial data at

183 The Value Exchange, "From issuer-ready to investor-ready: Removing the manual data burden."
184 The Value Exchange, "Asset Servicing innovation: Are we in the perfect storm?"
185 Kelly Mathieson, "Reimagining the high-stakes, expensive problem of Asset Servicing and Lifecycle Management", Digital Asset,
186 Ernst & Young, 2021.
187 Ibid.
188 Ibid.
189 Ibid.
190 Ibid.
191 Ibid.
192 European Central Bank, "The potential impact of DLTs on securities post-trading harmonisation and on the wider E.U. financial market integration", September 2017.

many banks, data quality issues are common and some require manual reconciliation to resolve.[193] For instance, European Market Infrastructure Regulations (**"EMIR"**) require that both parties in a derivative trade report it to a repository with the appropriate Unique Transaction Identifier (**"UTI"**). The UTI is then used to match each counterparty's report. However, this process tends to break down if UTIs are not properly shared; in 2014, DTCC was only able to match ~40% of trade reports.[194] Compounding the data quality issues, banks must convert raw data into a high form of readiness for regulator consumption. For example, the Federal Deposit Insurance Corporation (**"FDIC"**) rules and regulations stipulate that large depository institutions must have all insured accounts readily identifiable.[195]

Both data quality issues and rigorous requirements ensure that regulatory reporting and compliance are resource-intensive activities. Survey data indicate that compliance costs account for more than 1% of revenue for most institutions. High operating costs are not limited to regulated entities; the Federal Reserve System spent ~$2 billion on supervision in 2017.[196] The increased cost of regulatory compliance tends to weigh most heavily on smaller financial institutions, where compliance costs account for a higher share of non-interest expense.[197]

2.1.5.2 Summary Impact Assessment: High

The overall impact on Asset Servicing and Lifecycle Management is **high**, driven by the considerable changes across workflows, roles and responsibilities, technology, risk, and financials.

Exhibit 2.1.15

Impact Assessment of DLT on Activities and Participants in Asset Servicing and Lifecycle Management

	Issuers	Transfer Agent/ Registrar	CSD	Data aggregator	Custodian	Asset Manager/ Investor
Mandatory	High	High	High	High	High	Medium
Voluntary	Medium	Medium	Medium	Medium	Medium	Medium
Proxy voting	High	High	High	High	High	Medium

Government/ tax authority	Local custodian/ With-holding agent	Global Custodian, fund manager, distributor	End Investor
High	High	High	High

Government/supervisor	Regulated entities
Medium	Medium

Source: BCG analysis

193 Raphael Auer, "Embedded supervision: how to build regulation into decentralized finance", BIS Working Papers, September 2019.
194 R3, "Applications of Distributed Ledger Technology to Regulatory & Compliance Processes", Decemeber 2017.
195 Auer, 2019.
196 Ibid.
197 Ibid.

Models of Implementation

Corporate Actions

DLT could affect corporate action processes in two ways. First, the distributed ledger creates a shared source of truth, reducing the need for custodians to cross-check multiple data sources for accuracy. Second, assuming requisite integrations are made to Clearing and Settlement systems, smart contracts can automate execution of corporate actions, thereby shortening processing timelines. The mechanics of smart contracts in corporate actions is further elaborated below.

Corporate actions are legal arrangements that confer certain rights on investors and corresponding obligations on issuers, CSDs, and custodians. Smart contracts are therefore well-suited to operationalize corporate actions on the distributed ledger by providing a mechanism to automate and execute based on predefined conditions ("if…then" coding).

A smart contract template can serve as an electronic representation of a legal document.[198] A smart contact template consists of legal prose and a series of parameters derived from the prose expressed in a smart contract language that can be used to run processes on the DLT.[199] Each parameter contains at least an identifier, type, and value that can be used as inputs into the smart contract code.[200] An "agreement" is a fully developed template with its bespoke legal agreements and corresponding parameters, usually arrived at as a result of negotiation between the parties to the corporate action.[201]

Smart contract templates and agreements could have two major effects on corporate actions. First, they embed corporate action reference data as intrinsic parameters of the Tokenized Security itself.[202] Corporate actions that are already set out in the prospectus at security issuance (such as scheduled future coupon payments for bonds) can be coded and tokenized immediately. More discretionary corporate actions, such as stock splits and dividend issuances, can then be tokenized and appended as additional smart contract agreements. In this way, the smart contract template system ensures that corporate action reference data are always up to date, creating a clear, immutable audit trail for each Tokenized Security throughout its lifecycle.[203]

Second, the template system forces alignment and clarity on corporate action data.[204] Assuming the template and parameterization process is based on the legal documentation of the corporate action, the process compels issuer and all other members to explicitly agree to the parameters ex ante; there is no room for disparities in interpretation.

Specific impact of Books and Records implementation: If financial institutions implement DLT for corporate action Books and Records, they can expect impact to be limited to potential processing efficiencies, data visibility and consistency provided by the distributed ledger. As stated earlier, custodians may no longer need to consult multiple sources to validate corporate action data. The ongoing collaboration between SWIFT and Symbiont is an example of a Books and Records implementation that aims to harmonize data from multiple sources into a single source of truth via DLT and smart contract automation.[205]

However, it would be difficult to realize corporate action execution automation without the use of DLT-based Securities. Automated execution envisions that corporate action rights and obligations are embedded with the

198 Christopher D. Clark, Vikram A. Bakshi, and Lee Braine, "Smart Contract Templates: foundations, design landscape and research directions", March 2017.
199 Ibid.
200 Ibid.
201 Ibid.
202 Digital Asset, "Reimagining the high-stakes, expensive problem of Asset Servicing and Lifecycle Management", Digital Asset blog, 2022.
203 Ibid.
204 HSG Task Force, "Follow-up analysis for the HSG Task Force on Distributed Ledger Technologies (DLT-TF) on Issuer Corporate Actions Golden Copy", November 2017.
205 SWIFT, "SWIFT innovates to remove friction in corporate actions", September 2022.

security itself via smart contracts, usually starting at the point of issuance.[206] DLT-based Securities enable embedded data because composability is a key feature of DLT. On a traditional ledger, the process of designing smart contract–based automation for each security would likely be substantially more difficult.

This section now examines how the effects outlined above apply to dividends, bond coupons, and proxy voting.

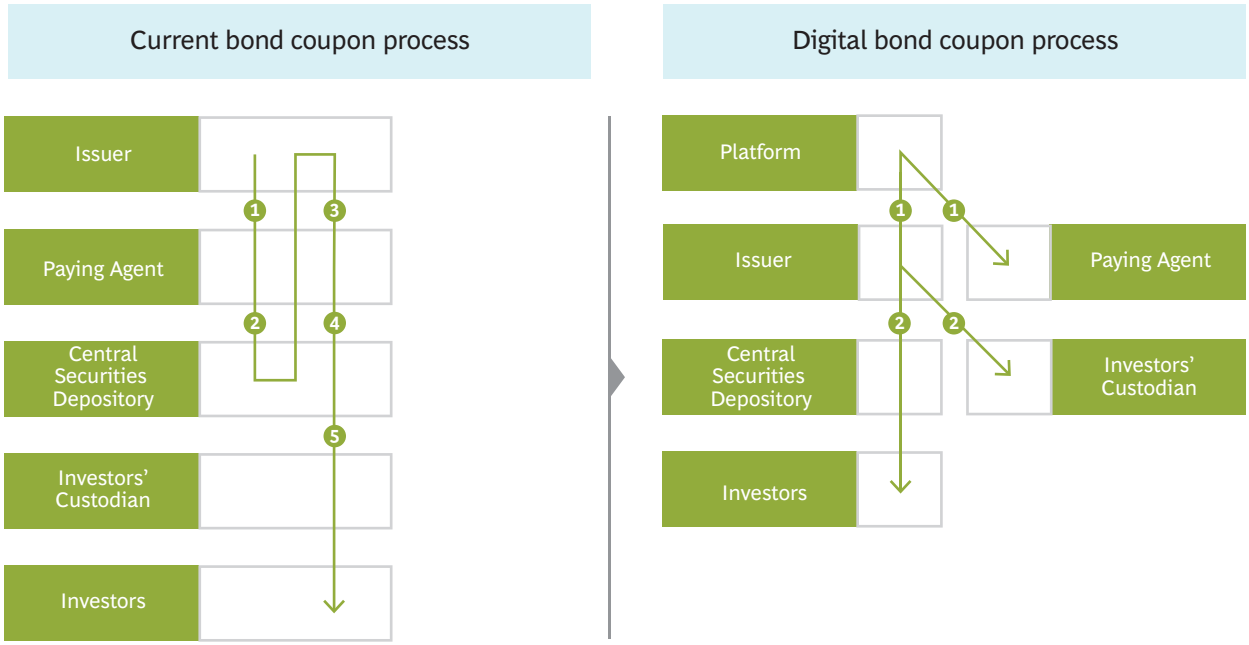
Dividends: The impact of DLT on dividend processes can touch two different categories of activities: record date activity and payment processing. On record date under the current process, the issuer or transfer agent consults the register to determine who is eligible for the dividend. However, each member of the Custody chain has only one level of visibility, so each successive intermediary must repeat the eligibility and entitlement determinations until the beneficial owners are determined. In a DLT-based system, the shared source of truth could render the eligibility and entitlement calculations straightforward; a smart contract could identify the end investors automatically.

The impact of Tokenization on payment processing depends on the Clearing and Settlement system in place. If the corporate action ecosystem adopts a distributed ledger but must be integrated with traditional payment rails, the efficiency gains are likely limited.

Bond Coupons: The bond coupon process is streamlined by DLT in a similar way as dividends. The current process involves considerable iteration among multiple stakeholders, as depicted in Exhibit 2.2.16.

Exhibit 2.1.16

Bond Coupon Payment Process with and without DLT



Source: Singapore Exchange

In the status quo (left side of Exhibit 2.1.16), the process entails: (1) the paying agent notifies the issuer and CSD about the upcoming coupon payment, usually using email or other free text format.[207] (2) The CSD responds with

206 Digital Asset, 2022.
207 Singapore Exchange, "Fixed Income Digital Assets" (White Paper).

a coupon payment report and reconciles any discrepancies on terms with the paying agent.[208] (3) When payment is due, the issuer transmits the funds to the paying agent.[209] (4) The paying agent then passes the payment on to the CSD.[210] (5) The CSD remits payment to the investor's custodian, who then checks the amounts and credits the investor's account.[211] The flow of information and funds is chiefly linear, with information like coupon reports passed back and forth and reconciled between issuer, paying agent, and CSD.

A DLT-based system could feature automated coupon payments based on a common, transparent ledger of ownership. Given coupons are usually agreed at issuance and generally require little to no customization, these payments are especially well-suited for smart contract automation. In this scenario, all stakeholders could be connected to a DLT-based platform where they jointly codify the terms and schedules of the bond coupon payment in smart contracts at the time of bond issuance. (1) As the coupon payment nears, smart contracts could alert issuer and paying agent of an upcoming coupon via a standardized platform message, complete with terms and calculated payment amount.[212] (2) After receiving notification with all relevant details, the issuer can pay the appropriate amount directly to the CSD, who then passes on the correct payments to investors.[213] In this scenario, the DLT-based platform has eliminated the need for iteration and reconciliation among issuer, CSD, and paying agent by codifying mutually agreed-upon terms into smart contract code in advance.[214]

Proxy Voting

Today's proxy voting system creates two inefficiencies:

(1) Information risks being lost or distorted through the communication chain. To enable quality control, intermediaries set conservative notification deadlines to allow time for processing and reconciliation.[215]

(2) Reconciliation processes happen at every stage of the chain, thus multiplying the processing cost. There is a real possibility of over-voting or under-voting, in which the total number of votes cast do not match the total number permitted by the shares outstanding. The troubleshooting and remedy process tends to be onerous, including back-and-forth communication (via email, SWIFT messages, API, or bespoke messaging), canceling previously cast votes, and issuing new voting instructions for custodians and investors.[216]

In a DLT-based solution, the underlying distributed ledger and smart contracts could address these inefficiencies, reducing operational overhead in the proxy voting process. The distributed ledger would enable issuers and the CSD to rapidly identify which investors have voting rights and what proportion of the vote they control. Issuers could be able to communicate directly with shareholders, with detailed company meeting information in line with SRD II.[217] With the use of a smart contract platform, custodians can register client votes or delegate those votes to match another asset manager or owner automatically and transparently for everyone involved. Due to the automation and digitization provided by smart contracts, custodians can extend voting cut-off times, disclosed in a manner consistent with applicable regulatory requirements. Smart contracts can also reduce operational risk in the voting process. By checking that tokens correspond to the number of votes authorized, smart contracts can ensure there is no over- or under-voting.[218] With the proxy voting process streamlined, the system may see increased participation from retail investors. As of 2021, retail investors voted on just 28% of shares owned, compared with 92% for institutional investors.[219]

208 Ibid.
209 Ibid.
210 Ibid.
211 Ibid.
212 Ibid.
213 Ibid.
214 Ibid.
215 Luis Marado, "Streamline proxy voting and regulatory reporting using DLT", Digital Asset blog, September 2020.
216 Ibid.
217 Ibid..
218 Ibid
219 Digital Asset, 2022.

Apart from proxy voting, other voluntary corporate actions, such as M&A, conversions, and warrants, tend to be more complicated transactions that rely on external data and often bespoke arrangements among specific classes of investors. Smart contracts would either need to use non-DLT to DLT data integrations (defined here as oracles) more heavily for these use cases, which introduces operational risk, or one would have to code a one-time smart contract at the time of the event, which may not be cost-effective. For these reasons, voluntary corporate actions (except proxy voting) are less suited for DLT adoption.

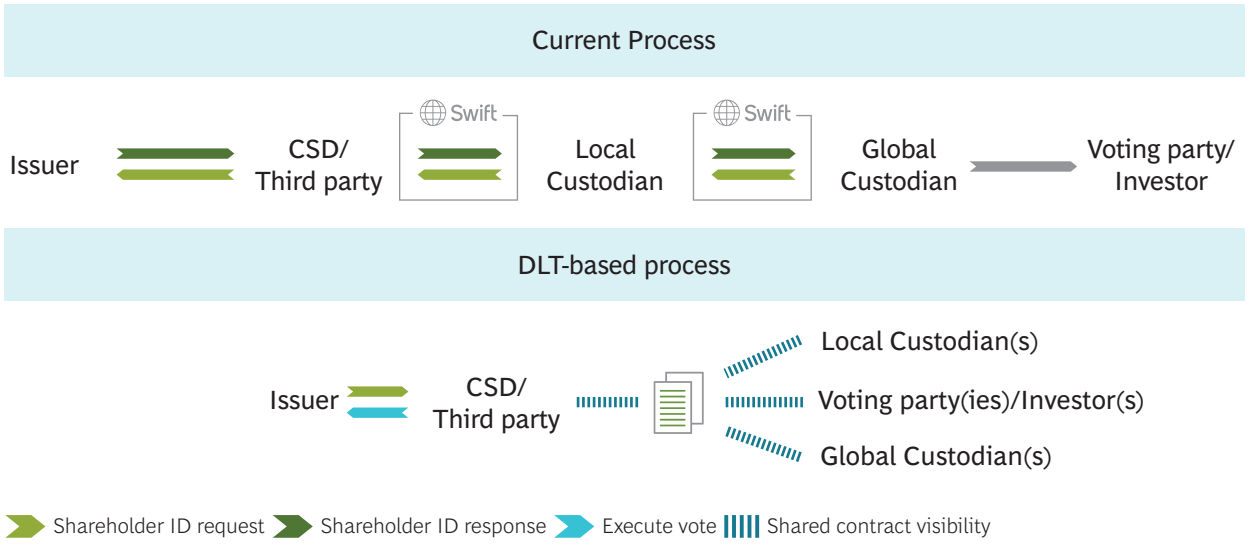
It should be noted that there are other non-DLT-based solutions that can also provide services to simplify proxy voting by taking different approaches to overcome these inefficiencies.

Tax Withholding

The main impact of DLT is that tax withholding can take account of tax treaty benefits and withhold the correct amount of tax at the source of the taxable event, thereby reducing the need for a later reclaim process.

Exhibit 2.1.17

Proxy Voting Activities, with and without DLT



Source: Digital Asset (2020)

A Permissioned Distributed Ledger Enables Secure Data Sharing in Near Real Time. The distributed ledger at the heart of the new withholding system could facilitate transparency into individual investor countries of residence and allow easy determination of beneficial ownership—the two key parameters to determine eligibility for tax treaty relief. In addition, a distributed ledger–based system replaces the linear, sequential Custody chain with a common source of truth. Investors and withholding agents would be able to view the same documents and transfer them expeditiously.[220] Accessibility and transparency also mean that tax authorities would be able to initiate near-real-time audits.[221] The occurrence of tax fraud scandal could be diminished given the ledger would be updated at a much faster cadence, with constant visibility from the regulator.

Smart Contracts Enable Correct Withholding at the Source, Reducing the Need for the Tax Reclaim Process. Withholding agents can withhold tax accurately during the taxable event itself by replacing the document-based manual workflows with a series of tokens assigned by smart contracts.[222] The tokens could model the dividend entitlements and determine the tax treatment, accounting for relevant tax treaties.

220 EY, "Withholding tax distributed ledger report", July 2021.
221 Ibid.
222 A non-fungible token (NFT) is a token that is unique, non-divisible, and non-interchangeable for other tokens.

Participants Could Need to Manage Robust Integrations on a Distributed Ledger and off a Distributed Ledger to Enable Each Tax Withholding.

While the distributed ledger reduces manual processing costs from handling documentation and reconciling across data sources, it may increase workload for custodians and investors in managing integrations and permissions to protect investor confidentiality and personally identifiable information.

For tax withholding, investor names, addresses, and taxpayer identification numbers are highly sensitive and protected under GDPR.[223] As such, the system would likely need to keep that data off the DLT.[224] If the need arises to access documents with sensitive information, participants may need to maintain a parallel system off the distributed ledger system that is tightly integrated with transactions on the distributed ledger. ZKP technology would likely be necessary to represent a token's private data on the distributed ledger.[225] ZKP provides transacting parties access to the information; third parties could know a transaction occurred and be assured of its validity but would not be able to read the private data involved.[226]

Crucially, the degree of change in tax withholding depends on the jurisdiction's tax laws. A distributed ledger, if implemented and integrated fully, would enable automatic withholding at the source, taking into account tax treaty eligibility. Some jurisdictions do not allow this type of tax relief at the source without preapproval from tax authorities.[227] Assuming no corresponding reforms in the country's tax laws, DLT-based solutions may need to be less ambitious at best or could be stymied at worst. In a less ambitious implementation, the DLT-based withholding solution could simply inform existing tax withholding processes. Smart contracts would not automate tax collection, and the distributed ledger may not be the golden source of truth.

Moreover, the breadth of applicability for DLT-based tax withholding is still unclear. While cross-border dividends and interest payments to individuals are simple, the tax entitlements are notably more complicated for large corporations, which often have a large constellation of legal entities. In those cases, the smart contracts could likely need to account for not only domicile and income source, but also special provisions within the tax code.

Specific impact of Books and Records implementation: DLT-based tax withholding is, by definition, a Books and Records use case. It would require that dividend and interest entitlements be represented on the distributed ledger, with personal tax parameters accessible either on or off the distributed ledger. These records can be entered onto DLT while the securities themselves stay on traditional ledgers.

Regulatory Reporting

A DLT-based ecosystem can enable an embedded supervision approach. Embedded supervision is a regulatory conceptual framework in which the supervisor monitors compliance automatically by reading the market's distributed ledger in real time rather than periodically through large data requests and reports.

This system could save banks and regulators considerable resources currently absorbed in gathering, cleaning, and reconciling data from multiple databases and formats. For example, DLT could streamline or mostly eliminate UTI matching for derivative trades since it would impose a single trade record between the counterparties.[228] With less time focused on data-quality issues, regulators and regulated entities could more quickly identify sources of risk and focus on areas of non-compliance. In periods of financial stress, both regulators and financial institutions could potentially react more nimbly with the benefit of enhanced transparency and real-time data. For instance, a macro-prudential supervisor could calculate real-time stability and risk metrics for specific institutions.[229] Embedded supervision could also reduce the disproportionate burden of compliance cost currently borne by smaller banks.[230]

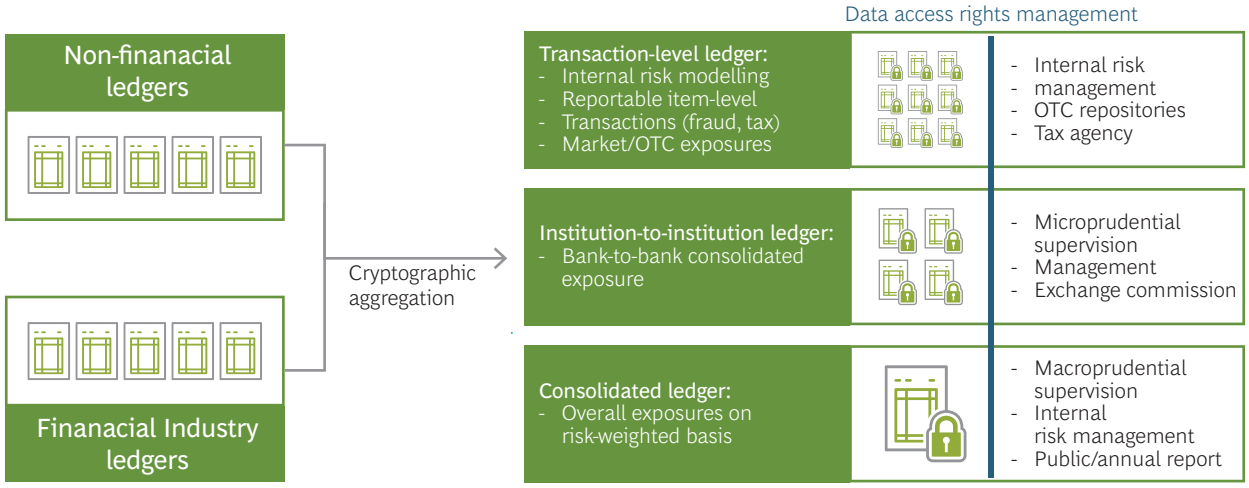
223 Ibid.
224 Ibid.
225 Ibid..
226 Ibid
227 Auer, 2022.
228 R3, "Applications of Distributed Ledger Technology to Regulatory & Compliance Processes", December 2017.
229 Auer, 2022.
230 Ibid.

It is crucial to note, however, that DLT does not eliminate the need to aggregate data; data localization and privacy laws and resolution planning for systemically important institutions may require data to be dispersed.[231] To the extent that data enters the distributed ledger, the aggregation process can be simplified through greater ledger transparency. In addition, DLT does not absolve financial institutions from monitoring compliance traditionally in non-DLT markets. Ultimately, regulated entities may need to develop an integrated compliance apparatus across traditional and distributed ledger to track their cumulative capital adequacy and prudential positions.

The new operational challenge for an embedded supervision paradigm lies in permissioning, privacy, and data standards.[232] The system must determine which institutions have access to which ledgers and data stores. An OTC repository, for instance, could access just the transaction-level ledger without being able to see intTransactionsolidated exposures. A macroprudential authority could access a wider array of data, such as the consolidated ledger showing all transactions and positions (shown in Exhibit 2.1.18). For personally identifiable information and other sensitive data, participants may need to consider using private distributed ledgers accessible only by regulators with no presence from other financial institutions. These are major data structure and process changes which could require a long period of study and alignment across industry and regulatory community.

Exhibit 2.1.18

Detail of DLT-enabled Regulatory Reporting



Source: Auer (2022)

Given the current periodic cadence of regulatory reporting, transitioning to a real-time data-sharing paradigm would likely require a new set of analytical frameworks around data interpretation. Regulators would need to clearly articulate how current metrics (such as common equity tier 1 requirements and liquidity coverage ratio (**"LCR"**)) apply to DLT-based markets and whether any new metrics would be introduced.

Thus far, embedded supervision is mostly conceptual. To become viable, this solution would require large-scale adoption and guarantee that the distributed ledger embodies final, accurate, and relevant data. There are two key features to note: (1) robust interoperability; and (2) in the case of Tokenized Securities, legal guarantee of the connection between an underlying security and its digital twin.

1. Tools enabling interoperability could be crucial given the numerous reference data fields regulators require for each transaction may lie on different distributed ledgers or on traditional ledgers as well. Oracles could enable the consolidation of data from financial and non-financial ledgers onto the distributed ledger. In addition, they route necessary off-distributed ledger inputs, such as interest rates, to calculate consolidated regulatory metrics.

231 R3, 2017.
232 Ibid.

2. Embedded supervision requires that the distributed ledger be structurally sound. This means that any Tokenized Security (which contains both the security off the DLT and its digital twin on the DLT) must always maintain its integrity at all times, and that integrity must be guaranteed by the legal system.[233] Any discrepancies would distort and compromise the integrity of the system as a whole.

Both features are large challenges that may likely require considerable time and investment to resolve across firms and regulators. Additionally, efficiencies from embedded supervision are limited to DLT-based markets only. Thus, although the impact within DLT-based markets is profound, total impact on consolidated bank regulatory reporting is likely to be muted as long as DLT-based Securities continue to be a small portion of total banking sector assets.

Specific impact in Books and Records implementation: The concept of embedded supervision was designed to regulate and monitor DLT-based Securities. Having the securities themselves legally owned on the traditional ledger while the reporting data is on the distributed ledger could lead to more operational complexity than having all data on the distributed ledger. Complications can arise, given data would need to traverse between two fundamentally different systems. That said, a Books and Records use case without DLT-based Securities could be a useful initial proof of concept to test the cost efficiencies argument.

Evolved Roles and Responsibilities

This section will explore the roles that could see material impacts from the introduction of DLT.

Corporate Actions

Issuers of securities would remain responsible for initiating corporate actions, as in traditional markets today and in line with corporate governance, but their method of engagement with the markets could change. In addition to the current modes of press release and regulatory filing, issuers could announce corporate actions on the DLT-based platform. Given the upfront technological costs required to build and maintain a node and the risk framework and controls required to run a node responsibly, issuers may rely more heavily on ***issuer agents*** to transmit the announcement via DLT. This could be a useful role for ***issuer agents,*** since some of their traditional role of maintaining the register and calculating routine payments (in the case of a ***calculation agent***) on behalf of the issuer could be replaced via smart contract automation.

Custodians may expect their operational risk associated with corporate action discrepancies and errors to decrease in a DLT-based system. Custodians currently play the dual role of detecting corporate actions and administering them on behalf of investors. These tasks could be simplified by DLT. Custodians may no longer need to invest heavily in multiple data sources to obtain reliable corporate action data. Moreover, the source of data discrepancies could be more easily traceable to the source or the DLT itself.[234]

The distributed ledger, however, does not eliminate all work for custodians in terms of corporate action communications. The consensus algorithm could require that custodians help validate new corporate actions that have been submitted by issuers or issuer agents. Custodians may play a role in monitoring the smart contracts that automate corporate action processing. Finally, local custodians may continue to play an important role in ensuring compliance with local regulations.

A governing body for DLT-based corporate actions would likely be necessary in the set-up phase of the DLT-based corporate actions system. This consortium of industry stakeholders and public authorities could formulate standards governing the codification of corporate action rights and obligations in smart contracts. This should incorporate existing market standards wherever possible, such as those from the Corporate Actions Joint Working Group (**"CAJWG"**), or instruction formats established in ISO 15022 and more recently in 20022.

233 Ibid.
234 Digital Asset, 2022.

Tax Withholding

Withholding agents' core responsibility should not change in a DLT-based system. The technology, however, should make withholding much simpler. Withholding agents would deploy and oversee smart contracts that determine the appropriate withholding rate, inclusive of applicable tax treaties.

Global custodians, fund distributors, and other financial intermediaries could continue their roles supporting investors with documentation needs and requests. They could play a large part in creating and maintaining integrations between secure messaging off the distributed ledger for documents and calculations of tax liability on the distributed ledger.

Tax authorities' core responsibilities are not likely to change. In a DLT-based system, they could likely have more potent and granular oversight capabilities. Audit checks in a DLT-based ecosystem would be conducted in near real-time. Processing of tax reclaims, if necessary, may be significantly simplified and expedited due to the transparent and immutable data stores on the distributed ledger.

A neutral governing body for DLT-based tax withholding could facilitate the development of the DLT-based tax withholding system. This could be a consortium consisting of financial institutions and tax authorities, which could come to consensus on applicability of the system (in the context of the jurisdiction's tax laws), solicit stakeholder feedback, design risk management protocols, and promote the realization of network effects.

Regulatory Reporting

Regulators and regulated entities likely would not see their roles change in regulatory reporting and could benefit from better data quality and lower operational cost. It remains unclear, however, what impact that constant and automatic vigilance may have on regulated entities. This dynamic underscores the importance of the system clearly defining which types of data regulators could be able to access through embedded supervision. For that data, both regulators and regulated entities could agree on guidance around interpretation of financial stability metrics in real time.

Financial Impact and Opportunities

The long-term potential cost savings for DLT in Asset Servicing and Lifecycle Management are considerable. Corporate action errors cost the custodian industry over $1 billion USD per year.[235] Though technology is one driver of broader operational inefficiencies, implementing a DLT-based solution could play a role in addressing a portion of that cost. The combined savings for a DLT-based tax withholding system, assuming it reduces most use cases for tax reclaims, could save the E.U. up to €8 billion.[236] Embedded supervision regimes could bring down the cost of compliance, which currently sits at 3–9% of non-interest expense for most banks[237] and more than $1 billion per year for the Federal Reserve.[238]

The profound degree of change to technology and operations required by DLT-based solutions introduces uncertainty into the investment case. In the short-to-medium term, those operating expense savings could likely be incremental, if at all. This is due to the need to run traditional systems in parallel with DLT systems to build regulatory and client trust. At the same time, DLT-based solutions may need to compete against more incremental but lower-cost non-DLT solutions in regulation technology and process optimization. Moreover, these DLT-based systems are dependent on concerted investments by all public and private sector stakeholders to realize network effects. The support and engagement of tax authorities and financial supervisors will be instrumental to the success of DLT-based tax withholding and embedded supervision, respectively.

235 S&P Global Market Intelligence, "De-risking corporate actions processing: getting the right mix of expertise and technology", January 2022.
236 EY, 2021.
237 Federal Reserve Bank of St. Louis, "Scale Matters: Community Banks and Compliance Costs", July 2016.
238 Auer 2022.

Risk Impact

Integrating DLT in Asset Servicing can give rise to differentiated risk considerations that require a comprehensive analysis. The Executive Summary's "**2 | Holistic Understanding of DLT-Specific Risk"** section examines these risks and proposes mitigations. Furthermore, this section evaluates the potential impact of DLT in reducing existing risks in the Asset Servicing stage of the securities lifecycle.

Operational Risks: The data uniformity of the DLT and smart contract automation could drive significant operational efficiency. With a DLT independently validating and maintaining a golden source of data, with shared visibility, all participants could drastically reduce the chances of data discrepancies or disagreements, leading to faster, more efficient corporate actions, tax withholding, and regulatory reporting. Smart contracts can reduce execution risks in processing by reducing opportunities for manual data manipulation, reconciliation, or data entry. These benefits are likely contingent on updated legal and regulatory frameworks that allow automated tax, corporate action, or regulatory reporting, with use of DLT. In the interim, the effect of DLT in mitigating risk may be diminished.

2.2 Regulatory Reporting and KYC

As of 2017, the average annual KYC cost was $150 million for financial institutions with more than $10 billion in revenue.[239] It took between 26 and 32 days to fully vet a customer through KYC procedures; both financial institutions and their clients expected that process to lengthen going forward.[240] Key drivers of KYC cost and processing time are the manual and repetitive nature of the work. A customer must go through a full KYC process with every bank it works with, even if some or most requirements are the same.[241] As a result, clients must process duplicative requests between banks and even among different divisions of the same bank, leading to a heavy documentation workload.[242] Moreover, the many stakeholders also introduce multiple pass-backs and iterations that lengthen the process timeframe. This cost compounds as a client's business scales.

Clients recognize the KYC process as a growing operational Inefficiency. In a 2019 survey of corporate treasurers conducted by EuroFinance and SWIFT, 93% of respondents indicated that KYC requests were more challenging than five years ago.[243] Clients reported that responding to KYC requests is a daily activity that occupies up to three FTEs throughout the year.[244] More than half of respondents stated they had limited the number of banks they work with for KYC purposes, while 28% said they had abandoned an account opening process one or more times.[245] Thus, the KYC process could continue to be a challenge if no action is taken to streamline its operations.

2.2.1 Challenges—U.S.

As discussed above, KYC/AML/CFT requirements may pose challenges in permissionless environment given that participants are pseudonymous, yet these regimes require identification as part of a strong CDD program and for reporting purposes. Regulators such as the U.S. Securities and Exchange Commission (the **"SEC"**) have highlighted these challenges, specifically pointing to AML and sanctions concerns related to DLT environments.[246] However, as detailed further below, under a controlled-DLT environment, compliance is not only feasible, but could be largely automated. In order to effectively implement such controls and address potential concerns as

239 Thomson Reuters, "Thomson Reuters 2017 Global KYC Surveys Attest to Even Greater Compliance Pain Points", 2017.
240 Ibid.
241 Jose Moyano & Omri Ross, "KYC Optimization using Distributed Ledger Technology," 2017.
242 Ibid.
243 EuroFinance & SWIFT, "Solving the KYC Conundrum," 2019.
244 Ibid.
245 Ibid.
246 https://www.sec.gov/files/digital-assets-risk-alert.pdf ("Certain pseudonymous aspects of distributed ledger technology present unique challenges to the robust implementation of an AML program. The staff has observed broker-dealer AML programs that have not consistently addressed or implemented routine searches or, to the extent they implemented routine searches, have not updated those searches to check against the Specially Designated Nationals list maintained by [OFAC]. The staff also has observed inadequate AML procedures, controls, and documentation regarding Digital Asset Securities. The staff will continue to examine broker-dealer compliance with AML obligations (e.g., filing suspicious activity reports and performing customer due diligence).").

to fragmentation, the industry needs sufficiently detailed guidance from regulators. Among other things, such guidance should be tailored to the applicable network archetype for which such controls need to be implemented.

2.2.2 Challenges—U.K./E.U.

(i) Wallets. The obligation to satisfy CDD (as discussed above) must be satisfied in respect of customers' wallets. However, in practice, due to the anonymity of customers' crypto wallets in certain DLT systems, additional operational measures need to be put in place to allow firms to carry out the required CDD.[247] The identity of a customer or beneficial owner must be verified 'on the basis of documents or information obtained from a reliable source which is independent of the customer'. As discussed under Chapter 1.2, it is highly unlikely that, in the context of a permissionless system, it would be possible to obtain the required information from all relevant wallet providers / beneficial owners in order to satisfy relevant CDD. Even if it is possible to obtain the required information, this is likely to require manual reconciliation and processes that may have commercial implications that mitigate potential operational cost-savings associated with DLT-based systems, ultimately acting as a barrier to widespread adoption. Additionally, a key draw of the movement towards DLT-based systems is an increase in accessibility to financial markets, and such rigorous identity verification would sit contrary to this aim.

(ii) Nodes/Participants in DLT-based systems are typically rewarded with tokens or some other form of value, in return for calculating and recording transactions on a distributed ledger. While the FATF 2021 Guidelines generally exclude transaction fees from the scope of certain requirements, this is not legally binding. As such it is necessary to consider the legal position in each individual jurisdiction, some of which may take a more stringent approach. It is currently unclear the extent to which nodes/participants would fall within the CDD obligation placed on a bank or other in-scope firm. However, it would be reasonable to assume that the obligation would apply. The identity of a customer or beneficial owner must be verified 'on the basis of documents or information obtained from a reliable source which is independent of the customer'. As discussed under Chapter 1.2, in the context of permissionless systems, it would be effectively impossible to comply with CDD obligations as it would require (i) identifying all nodes that are calculating transactions and (ii) to extent that the nodes/participants can be identified, they would not provide the relevant information to carry out the CDD.

Additionally, there are no geographical or jurisdictional restrictions on the location of nodes/participants in permissionless systems. Given the anonymity afforded to nodes/participants in permissionless systems, it is likely to be difficult or impossible for firms to establish any applicable obligations under sanctions regulations for a given node/participant based on the jurisdiction in which the node is located.

2.2.3 Challenges—Hong Kong

Intermediaries engaged in digital asset activities currently may not be caught within the scope of the Anti-Money Laundering and Counter-Terrorist Financing Ordinance ("AMLO"). The AMLO amendment bill intends to rectify this by capturing Virtual Asset Service Providers ("VASPs") engaging in different virtual asset operations. However, from a practical implementation perspective, considering that virtual assets could fall under different regulatory categories and involve a wide range of possible operations / services, it poses great challenges to regulators from a surveillance and enforcement perspective. It is difficult to strike the right balance between ensuring investor protection and encouraging technology / financial innovation to promote the virtual asset ecosystem. In this respect the amendment bill will first seek to cover centralized virtual asset exchanges (that do not involve instruments regulated under the Securities and Futures Ordinance and therefore do not involve virtual assets that are securities which would be regulated under Securities and Futures Ordinance), and will not yet capture other virtual asset operations at the beginning (e.g. OTC trading, decentralized trading platforms or Custody operations). It is also important for regulators to avoid regulatory overlap in regulating similar virtual asset operations

247 For example, the identity and ownership of an address can be verified, and this verification process can even be timestamped at the point an organistaion completes CDD on the specific account by airdropping an NFT.

– for example, the Hong Kong Monetary Authority (HKMA) are facing similar issues in their proposal to regulate stablecoins in Hong Kong, which was announced via a discussion paper on cryptoassets and stablecoins issued in January 2022.[248] As also discussed in Chapter 4.2.3.1, there are many existing regimes which regulate "securities" that could potentially capture stablecoin operations. The HKMA, and other regulators, should carefully consider the scope of any new regulatory regimes in order to avoid any overlap between various regulatory regimes, ensure consistency in regulatory standards (with respect to AML, conduct of business requirements, capital requirements, etc.), and promote harmonization across regulatory regimes (such as introducing any cross-regime exemptions).The HKMA have now proposed the introduction of a stablecoin licensing regime in their consultation conclusion, published on January 31, 2023.[249] The proposal sets out the regulatory perimeter for stablecoins, including the activities that will be regulated and the entities that will require licensing.

2.2.4 Challenges—Japan

Crypto-Asset Exchange Service Providers qualify as Specified Business Operators and are obliged to meet the requirements to take AML measures. However, it may be difficult for Crypto-Asset Exchange Service Providers to meet such requirements due to the anonymity afforded to nodes or participants in DLTs, especially in permissionless-type DLTs. For example, Crypto-Asset Exchange Service Providers are required to build a monitoring scheme of Suspicious Transactions and, if a tool to patrol DLTs to check for any Suspicious Transactions is implemented, it will be required to check the details of the transactions conducted via DLTs through the customer's address in order to enhance the effectiveness of patrolling Suspicious Transactions. When permissionless-type DLTs are used, it is likely to be difficult or even impossible for Crypto-Asset Exchange Service Providers to check the details of the transactions or the identity of a node or participant therein. This would be the case for Type I Financial Instrument Business Operator ("FIBOs") and/or Type II FIBOs regarding their transactions involving Security Tokens.

2.2.5 Challenges—Singapore

The challenges described in the U.K./E.U. Chapter 4.1.2 would be similar in Singapore. The verification of customers and beneficial owners should be made using reliable, independent source data, documents, or information.

It should be noted that Singapore has implemented the FATF travel rule for digital payment token service providers. Providers that facilitate the sending of digital payment tokens are required to obtain and record accurate originator information and beneficiary information on digital payment token transfers, immediately and securely submit such information to the beneficiary institution, and make the information available on request to relevant authorities.

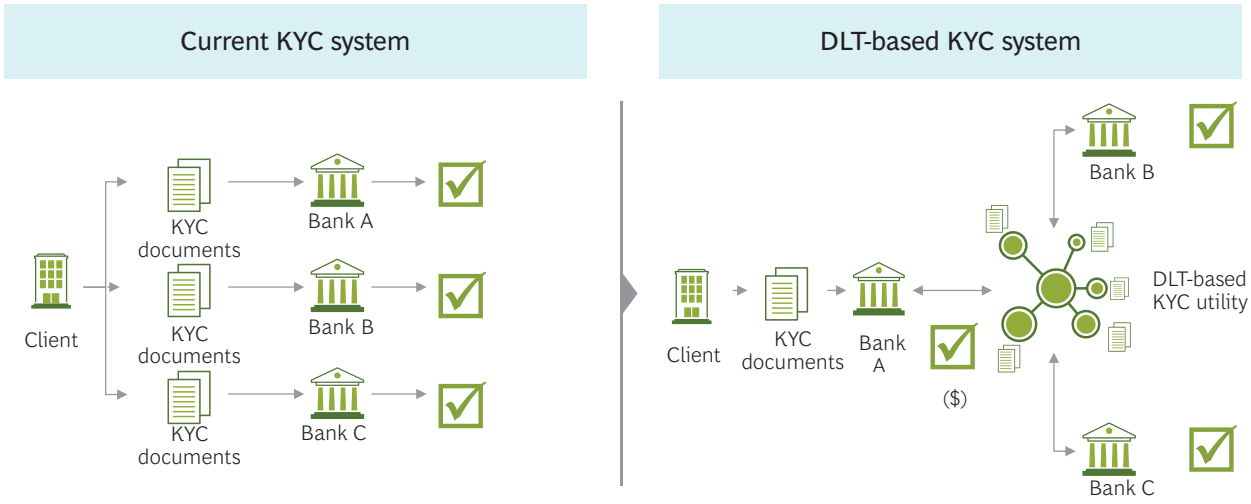
2.2.6 Solutions

The use of DLT in advancing KYC prosses is often cited as a promising use-case for this technology. There are two potential DLT utilities identified here: (1) DLT as a data collection utility, standardizing the collection of KYC data, and (2) DLT as a KYC verification utility, expediting the KYC verification process by validating previously completed verifications through cryptographic tools. However, the impact from these two use cases is likely to be limited. When considering DLT as a data collection utility, existing, purpose-built, non-DLT solutions can address inefficiencies in KYC data collection with far greater efficacy than a DLT-based tool. Further, DLT is unlikely to be used as a KYC verification utility due to the unresolved issue of the substantial legal liability that could arise if financial institutions rely on an erroneous verification without examining the client's underlying credentials. In aim of being comprehensive, these two use cases are examined in greater detail below, with a similar discussion of the challenges that would need to be overcome in order for them to be integrated into a DLT-based capital markets ecosystem.

248 HKMA, "Discussion Paper on Crypto-assets and Stablecoins", January 2022: https://www.hkma.gov.hk/media/eng/doc/key-information/press-release/2022/20220112e3a1.pdf.
249 "Conclusion of Discussion Paper on Crypto-assets and Stablecoin": https://www.hkma.gov.hk/media/eng/doc/key-information/press-release/2023/20230131e9a1.pdf, Hong Kong Monetary Authority, January 2023.

Exhibit 2.2.1

A DLT-based KYC Model Can Standardize and Expedite KYC Processes



Source: Moyano & Ross (2017)

(1) DLT in KYC data collection

The extent to which DLT can support the collection of KYC data varies by network archetype. In a private-permissioned or public-permissioned model, access to the network will remain permissioned by a regulated financial institution who is responsible and capable of upholding institutional-grade KYC data collection standards. Use of DLT for KYC data collection on a public-permissionless network would be considerably more challenging due to increased challenges around the verifiability of third-party credentials and is unlikely to be realized in the near-to-medium term. Described below are considerations and challenges for instituting KYC data collection on a permissioned network.

Under a DLT-based KYC data collection process, clients only need to upload data once to a KYC utility. The KYC utility could then serve as a repository on the distributed ledger housing the authoritative KYC document file for each client.[250] Financial institutions could refer to the KYC document file for clients as a starting point, which should reduce the number of direct data requests that clients receive. For clients that work with multiple financial institutions, the distributed ledger's consensus mechanism can ensure that discrepancies are highlighted and resolved.[251] The KYC utility can provide this level of data sharing and access while also protecting confidential data. For example, highly sensitive information can be stored outside the distributed ledger and encrypted with a cryptographic hash function if it needs to be shared.[252] In this way, the utility would employ a tiered permissions system that shares information on a "need to know" basis.

The key enablers of DLT-based KYC data collection concern data governance and scalability. The value of DLT is premised on standardized entity data that is sharable both conveniently and compliantly. To enable this, financial institutions and regulators would likely need to agree on data formats, privacy safeguards, and sharing processes spanning multiple regulatory regimes.[253] This is likely to be a lengthy journey. Additionally, questions exist around any DLT-based KYC solution's ability to scale. On the technical side, there are concerns regarding whether DLT can consistently handle enterprise-level throughput.[254] The substantial infrastructure investment and operational set-up cost may represent a significant barrier to entry for smaller financial institutions.[255]

250 Refinitiv, "A Blockchain Enabled KYC Solution: New Horizon or False Dawn?", 2018.
251 Ibid.
252 Ibid.
253 Ibid.
254 Ibid.
255 Ibid.

Even if regulators and financial institutions were able to overcome the set-up challenges, it is not evident DLT is required to deliver the benefits of a KYC data utility. For instance, a KYC utility can employ encryption and cryptography to enable secure data sharing and protect privacy without adopting the distributed database architecture that DLT would feature. Additionally, numerous non-DLT solutions seek to streamline the data collection process without requiring a KYC utility. These include workflow tools that automatically fill KYC documents and manage task checklists to data management platforms that can consolidate multiple data systems into unified views for financial institutions.

(2) DLT in KYC verification process

DLT could theoretically reduce lengthy verification processes by introducing confirmation of KYC approval, and the supporting evidence, to the client's authoritative data file. This verification is added by the first institution that screens and validates the client's KYC profile. The first verifier may be a bank (which would be compensated by the other parties for the effort)[256] or a trusted, objective third party that maintains the KYC utility.[257] In either case, the confirmation and evidence allow other institutions to expedite their verification processes, leveraging the work done by the first verifier. A more advanced DLT-based system could adopt a self-verification scheme where institutions can use zero-knowledge proofs and other cryptographic techniques to execute the KYC check in near real-time without referencing the underlying data. The client profile can become a "KYC ID" managed by local authorities and used to check AML sanctions lists as part of cross-border payment processing.[258]

DLT-based KYC verification is not feasible at scale due to liability and governance concerns. Financial institutions may be hesitant to be the first verifier in a DLT-based system for fear of consequences if they commit an error, while other institutions may be hesitant to rely on the first verifier's work. The current margin of error for KYC is low and penalties high for institutions conducting their own KYC checks. The liability is likely to multiply if a verifier supplies an erroneous decision that then propagates through the system. The alternative, which is to entrust a third party to review and verify, may de-risk the system. These challenges must be resolved before DLT-based verification can attain widespread trust and acceptance.

Additionally, using permissioned systems (for example, a fully permissioned DLT, or alternatively a permissioned environment built on top of a public, permissionless DLT) on which participants and nodes are fully identified and have been vetted could help in meeting applicable AML regulations. The use of private transactions and agreements in which access is restricted to participants and node operators on which CDD has been completed could also help to resolve this concern in the context of permissionless systems.

From a legal/regulatory perspective, clarity is required as to whether the technical solutions set out above are an acceptable way for firms to satisfy the applicable obligations under the applicable AML/KYC standards. By way of illustration, it is technically possible to create a protected layer that sits on top of a permissionless framework, producing a permissioned environment that could ensure, among other things, that incentives are not paid to parties that are not compliant with the applicable AML/KYC regulations (i.e., CDD can be conducted in respect of the permissioned participants), or alternatively are in sanctioned jurisdictions. To encourage industry adoption of DLT-based systems and DLT-based Securities, regulators must be clear that firms can utilize such technology without breaching AML/KYC or sanctions requirements.

256 Moyano and Ross, 2017.
257 Refinitiv, 2018.
258 David Ballashk & Marcus Hartel, "The 'amplus' initiative – a modular approach to improving cross-border payments."

Chapter 03

Use Cases

This chapter provides an overview of capital markets use case activity since 2015, noting key trends across asset class, geography, and capability type. This is followed by deep dives on use cases across three specific areas: (1) Collateral Management, (2) Sovereign and Quasi-sovereign Bonds; and (3) Tokenization of assets. These use cases showcase real-world decisions that financial institutions have made around technology, risk, and governance. It also provides practical evidence of benefits enabled by DLT.[259]

Financial institutions have been actively applying DLT in a broad range of capital markets use cases, from proof-of-concept initiatives to fully launched market solutions. In the GFMA member survey, 85% of respondents reported that their organizations had a use case either at pilot stage or live in the market.[260] Multiple interviewees emphasized that their organizations were following a deliberate, iterative approach of experimentation and piloting to build capabilities and experience for launch. GFMA members have been cautious to align with existing legal structures and regulatory guidance across jurisdictions. For example, private-permissioned networks have been preferred in most use cases highlighted in this chapter. In the instances where public networks have been used, risk mitigants have been implemented to ensure cybersecurity safeguards, KYC/AML/CFT compliance, and avoidance of group 2 assets as classified under the Basel framework.

3.1 Emerging DLT-Based Capital Markets Use Case Overview

There are three categories of use cases present in the market today. First, **underlying DLT infrastructure (e.g., DLT networks, DLT-based FMIs)** use cases provide the foundation for DLT-based operations, applications, and securities. Second, use cases advancing **platform capabilities (e.g. Tokenization, digital Custody)** provide key services across the value chain to support a broader DLT-based ecosystem. Third, **DLT-based transactions** are designed and conducted on the underlying DLT networks and platform capabilities. The exhibit traces the major events in each of these domains since 2015.

259 GFMA, "Why Basel Should Not Apply A Blanket Infrastructure Risk Add-On For Group 1 Cryptoassets", 2022.
260 GFMA member surveys, November-December 2022.

Exhibit 3.1.1

Major DLT-based Market Activity Since 2015

	Underlying DLT infrastructure	Platform capabilities	DLT-based transactions
2015	Linux launches Hyperledger		Nasdaq Linq issues first private equities
2016	R3 establishes Corda MAS tests tokenized SGD with R3	ASX starts to develop replacement for CHESS post-trade platform	
2017	MAS tests DLT-based RTGS HQLAx builds prototype for collateral mobility		Broadridge pilots intraday repo with Natixis and Societe Generale
2018	MAS tests DLT-based DvP, cross-border PvP settlement Bank of Canada tests DLT-based settlement DvP	SIX announces SDX, a DLT-based exchange to service full security lifecycle	World Bank issues first blockchain bond JP Morgan arranges floating rate note issued by National Bank of Canada, mirrored on Quorum
2019	Digital Asset establishes Daml Fnality founded by consortium of banks to build DLT-based FMI	SIX prototypes SDX (2019)	SG FORGE issues covered bonds on Ethereum Santander issues bonds on Ethereum BBVA issues first DLT-based structured green bond
2020	MAS completes research on multi-currency DLT-based payments	JP Morgan forms Onyx HKEX starts Project Synapse for post-trade SDX/Temasek pilot Market-node for digital bonds DTCC publishes Project Whitney for infrastructure in private markets	HSBC and Temasek complete digital bond pilot on SDX
2021		Broadridge launches DLT repo platform	HSBC arranges first bond issuance on Marketnode EIB issues digital bond on Ethereum Partners Group tokenizes a global PE fund with ADDX JPMorgan executes intraday repo with GS and BNY Mellon
2022	MAS launches Project Guardian pilot Announcement of the RLN 12-week pilot with the Federal Reserve Bank of New York and US Financial Institutions, including Citi, HSBC, Mastercard	Deutsche Boerse launches D7 to support full lifecycle JPM Onyx launches TCN for collateral mobility HSBC launches Orion for bonds DTCC Project Ion launches for equities settlement BNY Mellon launches digital custody platform GS launches DAP™ to support full lifecycle JPM Onyx conducts DeFi experiment via MAS Project Guardian	UBS launches first dual-listed digital bond on SDX & SIX HSBC arranges first bond issuance on Marketnode EIB issues digital bond on GS DAP ™ Partners Group tokenizes a global PE fund with ADDX JPMorgan executes intraday repo with GS and BNY Mellon Credit Suisse, Pictete and Vontobel issue tokenized securities on BX Swiss BNP Paribas issued tokenized bond on public Ethereum GS and BNY Mellon settle securities lending transaction on HQLAx Fnality and HQLAx, with Santander, GS, UBS demo first cross-chain repo swap (Corda and Enterprise Ethereum) Hamilton Lane tokenizes a PE fund through ADDX KKR partners with Securitize to tokenize a health care PE fund
2023			EIB issues GBP digital 'Mars' bond on HSBC Orion'. City of Lugano (Switzerland) issues first municipal digital bond, dual-listed on SDX & SIX Siemens issues digital corporate bond on public Polygon DLT Government of Hong Kong issued digital sovereign green bond on the GS DAP™ supported by Bank of China, Goldman Sachs, HSBC and Credit Agricole.

Source: WEF (2021), GFMA Members, BCG Analysis

Underlying DLT infrastructure

The use cases for the underlying technology can be split into the DLT and FMI initiatives. The DLT network provides the underlying distributed ledger as well as fundamental tools and protocols concerning access, ledger updates, integrations with existing systems, cybersecurity, risk, and compliance. FMI initiatives use the tools and protocols from the DLT to facilitate payment, clearing, and settlement activities.

DLT Networks: The introduction of private-permissioned DLT networks since 2015 has driven DLT-based activity in capital markets. These networks embed privacy, consensus, regulatory compliance, and security features on the DLT to give companies more of a closed system. This contrasts with the public networks approach, where companies must add security layers on top of an open foundational layer. Two private-permissioned networks, Hyperledger and Corda, were established in 2015 and 2016, respectively. Since then, Corda has powered the majority of platform use cases, though financial institutions have also developed in-house platforms. Public networks also had notable developments over this period. In 2022, Ethereum converted its consensus algorithm from Proof-of-Work to Proof-of-Stake, creating a more scalable technological ecosystem for enterprise application. Smart contract languages have also seen development during this time with the introduction of DAML in 2019 and Solidity in 2014.

DLT FMIs: Prominent FMI use cases have been driven by central banks partnering with consortia of financial institutions. For example, between 2017 to 2020, the Monetary Authority of Singapore (**"MAS"**) (as well as certain initiatives by the Bank of Canada) have developed a better understanding of how Clearing and Settlement, and payments could function in a DLT-based world. MAS found potential for DLT to shorten the settlement cycle below T+2 with on-DLT cash.[261] Bank of Canada found in its wholesale payments testing that proof-of-work algorithms do not provide sufficient settlement finality and operational risk improvements.[262] These insights may be key toward designing an optimal DLT-based Clearing and Settlement system. Financial market consortia launched HQLA^x in 2017 and Fnality in 2019 to test and build DLT-based FMI. HQLA^x focuses on DLT-based solutions for collateral management, while Fnality seeks to create a system of interoperable FMI on DLT to allow for immediate settlement. Each of these FMI initiatives is built on a permissioned network.

Platform capabilities

DLT-based platforms enable key activities across the securities lifecycle, including issuance, Tokenization, and digital Custody. One of the earliest trials of DLT-based platforms was Nasdaq Linq in 2015, which demonstrated the listing of stock in a private company.[263] Since 2018, development of platforms has intensified, with three key trends:

- **Among traditional exchanges, CCP and CSD, Asian and European institutions are leading the industry.** In Asia, ASX has been experimenting since 2016 while SDX/Temasek piloted Marketnode (to focus on a range of digital assets) and HKEX launched Project Synapse to revamp post-trade matching workflows in 2020. In Europe, SDX has built a platform already in operation covering the entirety of the securities lifecycle.
- **Platform solutions have focused mostly on parts of post-trade services and full security lifecycle solutions.** The focus on post-trade (e.g., ASX Chess, HKEX Synapse, DTCC) accords with the general sense that post-trade features demonstrable value of DLT, especially when primary and Secondary Markets in DLT-based Securities are still nascent. However, to have a secure, flexible platform for DLT-based Securities, platforms can benefit from having securities locked into their ledger technology and accompanying standards; full lifecycle platform, such as SDX and JPM Onyx, can maximize the realization of network effects.
- **Platform solutions are progressing beyond pilot use cases to supporting full launches.** SDX and JPM Onyx are examples of platforms that have launched and are fully operational in bonds and intraday repo, respectively. Platforms must make pivotal decisions are they seek to transition from proof of concept

261 Monetary Authority of Singapore, "Project Ubin: Central Bank Digital Money using Distributed Ledger Technology", July 2020.
262 Bank of Canada (Chapman, Garratt, Hendry, McCormack, McMahon), "Project Jasper: Are Distributed Wholesale Payment Systems Feasible Yet?", February 2017.
263 Financial Times, "Nasdaq to step up blockchain trials", 2015.

to real-world implementation. Not all projects have successfully bridged that gap. For instance, after delaying the launch of its CHESS replacement multiple times, ASX decided to pause development and comprehensively reassess project design in November 2022.[264]

DLT-based transactions

Issuances require platforms for Tokenization, settlement, and digital Custody; thus, activities in both platform and asset class capabilities have grown together. Among the earliest asset class use cases were Broadridge's intraday repo pilot in 2017 and the World Bank's issuance of the first global DLT-based bond in 2018. Since then, there have been two trends of note:

- **Use cases have been concentrated in fixed income, including for use in repo and other securities financing.** Corporate bond issuances have been the most frequent use case since 2015, accounting for 10 of the 13 major use cases listed in the exhibit. Issuance, trading, settlement of repo, securities lending, and money market fund collateral use cases have been a recent trend over 2021-22, with most major financial institutions as notable participants in the space.
- **Almost all launched use cases have focused on digitally native issuances.** Of the 11 major use cases listed in the exhibit, 10 were digitally native. One explanation may be simplicity; Security Tokens do not require interoperability and reconciliation between distributed ledger and traditional ledger to monitor the integrity of the security. The one exception was UBS' digital bond launch on SIX and SDX; the dual listing meant that investors could trade and settle fully on DLT or via traditional avenues.
  - This chapter will deep dive on three categories drawn from the use cases identified above. The first category will examine **collateral management** across repos and OTC derivatives. For repos, it will examine J.P. Morgan's Onyx intraday repo platform; for OTC derivatives, it will explore the HQLA^x platform. The second category, **sovereign and quasi-sovereign bonds,** will highlight the two digital bond issuances completed by the European Investment Bank. And the final category will describe macro trends in **Tokenization of assets,** with a brief case study on Tokenization of funds.

3.2 Deep Dive #1: Collateral Management

The objective of collateral management is to optimize collateral obligations such that only the required collateral is posted, avoiding over-collateralization.[265] This is a significant activity at financial institutions, with the total value of collateral outstanding in the global financial system reaching over $19 trillion USD in 2022 (refer to exhibit). Prudent collateral management releases securities which can be deployed more productively elsewhere. Key areas of collateral management include CCP default funds (discussed in Chapter 2.2.3 *Clearing and Settlement*)[266] and securities transactions (e.g., securities lending, repurchase agreements (repos), and OTC derivatives)

264 ASX, "ASX will reassess all aspects of the CHESS replacement project and derecognise capitalised software of $245-255 million pre-tax in 1H23," November 2022.
265 ISDA, "Demystifying Collateral Optimization: A Collection of Essays Focused on Collateral Optimization in the OTC Derivatives Market", 2021.
266 ISDA, "The Economics of Central Clearing: Theory and Practice", 2011.

Exhibit 3.2.1

Global Value of Collateral Outstanding Reached ~$19 Trillion USD in 2022

Source: SIFMA, ICMA, ISLA , ISDA, BCG analysis

The 2008 Great Financial Crisis marked a watershed in collateral management following regulatory changes and developments in risk management. For example, Basel III reforms require banks to hold higher levels of high-quality liquid assets (**"HQLA"**) on balance sheets to meet LCR requirements. [267] High margin requirements for non-cleared derivatives have also been implemented to encourage central clearing of OTC derivatives and reduce systemic risks in the market.[268] However, collateral management has typically been fragmented across multiple dimensions. Internally, some trading desks may manage siloed pools of collateral usually organized by asset class, without visibility across the full organization. Externally, financial institutions manage a patchwork of custodian and counterparty relationships that currently makes collateral mobility costly and complex. This fragmentation leads to inefficient allocations of collateral across the activity centers of a firm, excessive over-collateralization in certain positions, as well as higher cost of collateral over suboptimal tenors.[269] In addition, today's deferred net settlement cycle means that access to collateral follows actual transactions with a further delay of up to two business days after settlement.

The increased demand and stock of collateral held by financial institutions today becuse of post-crisis reforms underscores the utility of prudent collateral management, as well as the opportunity costs of inefficient collateral

267 BIS "Developments in collateral management services", September 2014.
268 BIS 'Central clearing: trends and current issues', December 2015.
269 Accenture & Clearstream, "Collateral Management: Unlocking the Potential in Collateral, 2011.

use. Financial institutions have been addressing this challenge by coordinating and centralizing collateral activities within the enterprise. For example, global custodians offer software solutions that provide holistic views of assets across jurisdictions held with multiple custodians to facilitate collateral selection. This activity is typically concentrated in the Treasury function of a financial institution.[270] The introduction of DLT-based Books and Records or securities, combined with smart contract-driven automation, can introduce further efficiencies into collateral management activities. Most financial institutions interviewed highlighted three key benefits from DLT:

1. **Freed collateral:** Shortened settlement cycles reduce length of time collateral is held, enabling tighter, more optimal intra-day liquidity and HQLA balances. A Books and Records implementation of DLT can obviate the need to settle via physical collateral movement through the Custody chain.
2. **Operational efficiency:** Use of smart contacts can automate processes like daily variation margin payments, onboarding multiple custodians and CCPs, and other manually intensive processes.
3. **Improved visibility:** Shared ledger acts as a golden source, offering real-time visibility of trade and collateral status across counterparties and clearing houses. This enables central coordination across clearing houses, reducing risk overestimation and over-collateralization.

The GFMA and its members have highlighted DLT-based use cases gaining traction in the market for Repos and OTC derivative transactions today.[271]

3.2.1 Repurchase Agreements

Repos are commonly used by financial institutions seeking to raise funding or to earn a return on surplus capital.[272] A significant portion of repos enable short-term access to funding, which adds liquidity and efficiency to the market. The European Central Bank estimates that 75% of Euro denominated repos are overnight.[273] However, even overnight repos are not optimized for intraday liquidity needs at banks because access to actual repo funds and securities is governed by the traditional deferred (T+2) settlement structure. There are two forms of repos: a 'bilateral repo' administered directly between the lender and borrower, and a 'triparty repo' coordinated by a third-party agent.

Existing areas of inefficiency

- **Delayed settlement cycle traps collateral:** Deferred settlement causes collateral to be kept from other productive uses and creates counterparty credit risk, which requires higher collateral value to mitigate.
- **Operational inefficiency:** Current processes involve fragmented, manual processes between multiple parties: collateral needs to be transferred multiple times between borrower and lender custodians.[274] Delays in collateral release may further have knock-on effects for the next trade, resulting in trade failure.
- **Lack of transparency:** Financial institutions have limited visibility on the repo status across lifecycle and other market participants' willingness/ability to engage in a repo/reverse repo.[275]

Impact of DLT and Tokenized Securities

DLT-based operations for Repos transactions can accelerate settlement, freeing trapped collateral and improving operational efficiencies. Intra-day repo transactions allow market participants to access liquidity for the exact period needed instead of overnight. This reduces unnecessary funding costs and improves market efficiency.

270 BIS "Developments in collateral management services", September 2014.
271 Securities lending refers to the temporary transfer of securities ownership to a borrower, in return for a fee. The borrower posts cash and/or other securities as collateral. This is another way of securities financing. Although repos and securities lending are mechanistically different, they share inefficiencies that can be addressed by DLT. This section focuses on DLT application in Repos because financial institutions have been more engaged with this type of transactions.
272 Bank for International Settlements Glossary, October 2022.
273 IMCA, Frequently Asked Questions on Repo.
274 World Economic Forum & Boston Consulting Group, "Digital Asset, Distributed Ledger Technology and the Future of Capital Markets", May 2021.
275 Ibid.

DLT-based Securities are a key focus for the intra-day repo market expanding because of the potential speed of settlement. DLT-based repos could also improve the degree of visibility regulators have into the sources and uses of securities in collateral agreements, thereby improving their ability to mitigate potential risks.

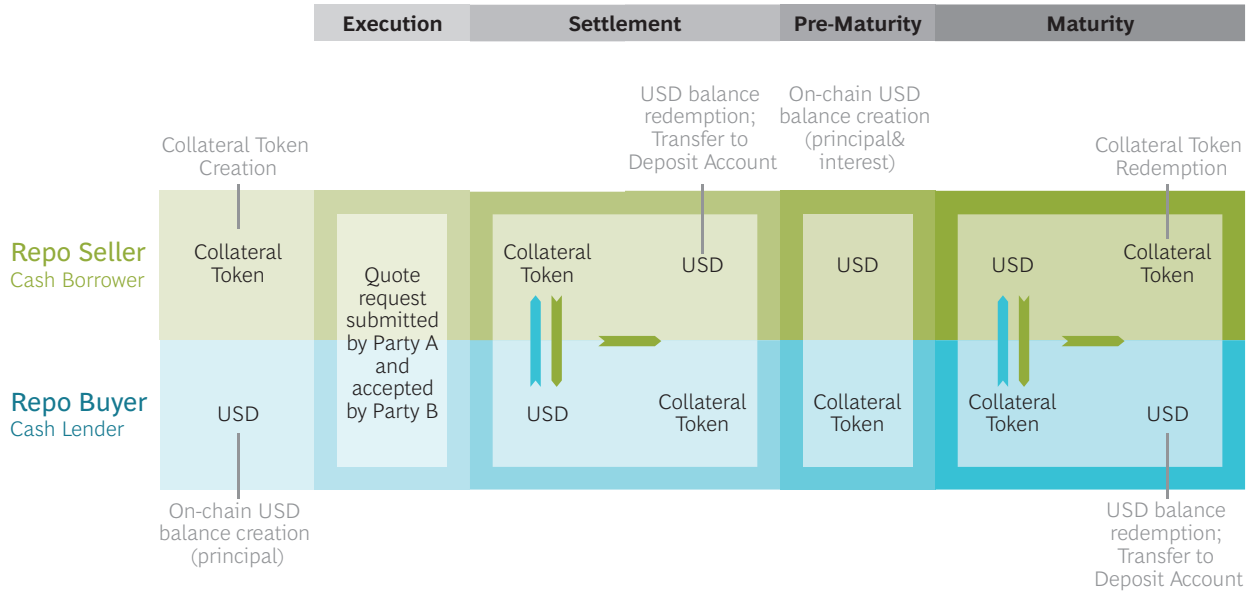
DLT-enabled repos are growing across global capital markets. Key providers include J.P. Morgan's multi-asset DLT network Onyx Digital Assets (case study below) and Broadridge's Distributed Ledger Repo (**"DLR"**) offering, which recently report $1 trillion USD in average monthly volume.[276] HQLAˣ's intraday liquidity management tool supports the collateral swaps market. This section focuses on J.P. Morgan's Onyx intra-day repo platform as an example.

Use Case: J.P. Morgan Onyx Digital Assets

In 2020, the Onyx by J.P. Morgan business unit within J.P. Morgan's Corporate and Investment Bank launched Onyx Digital Assets, a private permissioned DLT platform. The Digital Financing Application is a web-based application on the Onyx Digital Assets platform that enables J.P. Morgan and clients of their Markets business to settle repos. Unlike other repo platforms, the Digital Financing Application settles repos delivery-versus-payment (DvP) through the simultaneous exchange of cash and collateral on the Onyx Digital Assets ledger. Operating mainly in the U.S., Onyx had processed repo transactions worth over $500 billion USD by end of 2022.[277]

Exhibit 3.2.2

Illustrative Workflow of DLT-enabled Exchange of Collateral and Cash during a Repo



Source: Adapted from The Future of Distributed Ledger Technology in Capital Markets, J.P. Morgan & BCG, Nov 2022, https://media-publications.bcg.com/The-Future-of-Distributed-Ledger-Technology-in-Capital-Markets.pdf

How It Works (refer to Exhibit 3.2.2):

1. The borrower (the "Repo Seller") escrows assets to be used as collateral with traditional triparty agents.
2. The lender (the "Repo Buyer") transfers cash from their traditional demand deposit account ("DDA") at JPMorgan Chase Bank, NA ("JPMCB") into a deposit account at JPMCB maintained on the Onyx Digital Assets ledger (a "Blockchain Deposit Account," or "BDA").
3. Once both participants have their assets in place, the trade details, which include both a "Settlement Time" and a "Maturity Time," are entered into the application.

276 Broadridge, "DLR Transacts $1 Trillion a Month," 2023.
277 "Blockchain Brings collateral mobility to traditional assets", JP organ Insights, 2022, https://www.jpmorgan.com/solutions/treasury-payments/insights/blockchain-onyx-asset-Tokenization.

4. When the Settlement Time arrives, assets are exchanged, leaving the Repo Seller with cash in their BDA and the Repo Buyer with an entitlement to the underlying securities, which are still sitting at the triparty agent. The Repo Buyer can transfer the cash outside of the Onyx Digital Assets ecosystem to fund settlements, make margin payments or otherwise make use of the proceeds.
5. Prior to the Maturity Time, the cash is transferred back from the Repo Seller's DDA into their BDA. At Maturity, the assets are swapped, and the collateral is left unencumbered.

This new settlement technology has allowed Repo Sellers and Repo Buyers on the Onyx Digital Asset Platform to achieve significant improvement in repo settlement efficiency and take advantage of new transaction types while staying within the structural framework that has governed the repo markets for years.

Settlement Efficiency

Requiring assets to be positioned before a trade can be entered into the application eliminates virtually all settlement fails. Onyx Digital Assets adds precision and certainty by including settlement and maturity times as part of the trade agreement.

New Transaction Types

By minimizing the settlement fail rate, introducing settlement and maturity times to the trade contract, and instituting per-minute interest accruals, it is possible for Repo Sellers to use the Digital Financing Service to meet their intraday cash management needs through intraday repos. Intraday borrowing has been viewed as an alternative to unsecured credit facilities, ensuring high priority payments are made on time and smoothing cash flows throughout the day. Onyx Digital Assets supports DvP settlement nearly 24 hours a day, 7 days a week. The extended settlement window allows both borrowers and lenders who have previously been saddled with uninvested cash or unfunded securities positions at the end of the traditional settlement window to improve operational efficiency.

Structural Framework

Digital Financing offers a new technology to settle repos utilizing traditional triparty documentation, with trades governed by existing master repurchase agreements. Trading via Digital Financing fits into the same general risk and controls framework across J.P. Morgan's Markets business. This includes transaction reporting, risk monitoring, electronic trading controls, and cyber security.

3.2.2 OTC Derivatives

OTC derivatives transactions require collateral in the form of initial margin (IM) and variation margin (VM). Since most OTC derivative volumes are now centrally cleared, the CCP manages the collection and management of margin requirements. However, IM and VM are required for non-centrally cleared (bilateral) OTC derivatives as well. Regulators introduced requirements for two-way posting of IM and use of VM for non-cleared OTC derivatives as part of post-crisis reforms.[278]

Initial margin (IM), typically determined as a percentage of contract notional value, is the collateral that both counterparties post at the start of the derivatives contract to reduce exposure to counterparty credit risk.[279] Through the contract term, the value of both the underlying assets and the collateral posted fluctuate over time. Brokers or CCPs move margin funds between the counterparties to reflect movements in the underlying assets. If the margin balance in one account falls below a set minimum threshold (called the maintenance margin), the broker will initiate a margin call, requesting for the counterparty to contribute additional margin. The variation margin (VM) is the amount of cash or securities the counterparty must contribute to restore the margin balance

278 ISDA, "Margin Requirements for Non-cleared Derivatives," April 2018.
279 HSBC, "Initial Margin," 2023.

to the initial margin.[280] This ensures the collateral pool reflects the latest credit risk exposure on a daily or intra-day basis.[281]

Existing areas of inefficiency

While margining occurs at a large scale today, the process suffers from long and manual Clearing and Settlement, and Custody timelines.

- **Extended processing time trapping collateral:** Slow processing time of margin calls and payments requires counterparties to prefund margin accounts, tying up collateral (a requirement that is amplified when such collateral must be held by an independent custodian).[282]
- **Operational inefficiency:** Complex manual processes across long Custody chains are involved to coordinate VM calls and payment, particularly when securities are used as collateral.[283] In times of volatility, custodians may not be able to move collateral across accounts fast enough, resulting in missed VM calls, leading to further market turmoil and margin calls.[284]
- **Lack of transparency:** Local CCPs lack an overall view of counterparties' collateral obligations and positions across clearing houses, leading to risk overestimation. Asynchrony in market data leads to discrepancies in margin calculation, resulting in the need to reconcile.[285]

Some of these inefficiencies were highlighted during the recent U.K. LDI crisis in September of 2022. A brief recap of the crisis and the relevance of the inefficiencies identified above to some of the market participants is set out in the following section.

U.K. Liability-Driven Investing (LDI) Crisis, September 2022

Recap: what happened during the crisis?

LDI is an investment product popular with defined benefit pension funds, where pensioners are paid guaranteed monthly payouts. This is achieved by using derivatives like interest rate swaps and repos,[286] to hedge inflation and interest rate risks.[287], [288] Sovereign U.K. bonds (**"Gilts"**) and cash are commonly posted forms of collateral for these types of derivative products . The sharp rise in the yields of U.K. gilts in September 2022 resulted in a fall in the value of collateral that had been posted against these derivative products, triggering emergency margin calls. Most pension funds were required to exclusively post cash to meet these margin calls, as most margin agreements stipulated cash as the only acceptable form of LDI VM.[289] As cash buffers were exhausted, pension funds liquidated their gilt holdings to raise further cash to post as margin for their derivative products. These sales exerted further downward pressure on gilt prices, further devaluing the gilt collateral balances the funds had posted and triggering further margin calls.[290] Eventually, the Bank of England intervened to stabilize gilt prices.[291]

280 Corporate Finance Institute (CFI), "Variation Margin," January 2023.
281 Bank for International Settlements, "Glossary", October 2016..
282 World Economic Forum and Boston Consulting Group, 2021
283 ISDA, "Demystifying Collateral Optimization: A Collection of Essays Focused on Collateral Optimization in the OTC Derivatives Market", 2021.
284 FIA, "Commentary - How technology can free up capital in clearing systems", May 2020.
285 World Economic Forum and Boston Consulting Group, "Digital Asset, Distributed Ledger Technology and the Future of Capital Markets", 2021.
286 Financial Times, "Lessons from the gilts crisis", https://www.ft.com/content/2a2e7a9b-d984-45c1-8ada-0d0a6e57911b, October 2022.
287 Reuters, "Explainer: What is LDI? Liability-Driven Investment strategy explained", October 2022.
288 Financial Times, "LDI strategy has left DB pensions in better shape", https://www.ft.com/content/095132a6-73d5-4a3b-b969-5f2ffcdd19e3, October 2022.
289 HQLA^{x}, "Could HQLA^{x}'s solution has helped ease market and operational disruptions during the recent U.K. Gilt volatility?" December 2022
290 Reuters, "Explainer: What is LDI? Liability-Driven Investment strategy explained", October 2022.
291 Ibid.

Operational inefficiency as a contributing factor

While LDI funds faced a liquidity crisis that limited their ability to meet their margin requirements, back office operational inefficiency was also an important contributor to the crisis.[292] Assets held by pension funds usually require days to settle, whereas collateral is typically required on an intraday or EoD basis. A liquidity buffer bridges the window between margin calls and liquidizing assets.[293] The speed and scale at which gilt yields rose in September consumed unforeseen levels of liquidity in emergency margin requirements and required the liquidity buffer to be topped up at an unprecedented speed.[294] Custodians, overwhelmed by the volume of processing requirements, became a bottleneck. One custodian serving large LDI fund managers could not process the margin calls in time even with extra staff from the U.S., given the high volumes and heavy manual processing involved.[295] U.K. regulators subsequently requested that the bank to improve its operations.[296]

Potential for DLT to help improve collateral mobility: HQLA^x

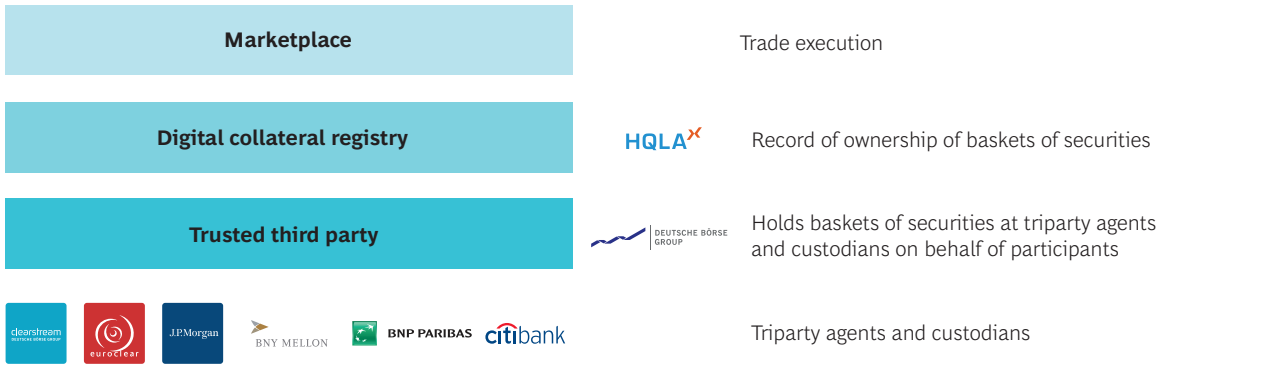
DLT can improve the operational processes of margin management in two ways: (1) DLT can provide solutions to improve collateral mobility and (2) the use of a shared ledger and common data standards can improve the transparency and visibility of margin calculations. HQLA^x is one solution in the market today than is helping market participants improve the efficiency with which they move collateral (improvement (1) identified above).

Solutions to Improve Collateral Mobility: HQLA^x

HQLA^x is a technology provider that seeks to improve collateral mobility across market makers, triparty agents, and custodians by recording collateral ownership on DLT and using it to enable atomic DvD settlement. HQLA^x does not issue tokens, instead it uses a DLT-based Digital Collateral Registry that records legal ownership of securities and all transfers of ownership. This "Books and Records" implementation of a DLT can integrate more easily with exchanges and existing post-trade infrastructure than solutions that require Tokenization of securities. Securities no longer move in the Custody chain and the associated traditional ledger. The Digital Collateral Registry becomes the golden source record for securities ownership, tracks securities at the ISIN level, and enables instantaneous, atomic gross settlement.[297]

Exhibit 3.2.3

HQLA^x Technology Integrates onto Existing Market Infrastructure



Source: HQLA^x

292 Financial Times, "LDI strategy has left DB pensions in better shape", https://www.ft.com/content/095132a6-73d5-4a3b-b969-5f2ffcdd19e3, October 2022.
293 Ibid.
294 Ibid.
295 Financial Times, "Northern Trust told by U.K. regulators to improve following pension turmoil", Nov, 2022, https://on.ft.com/3GdE8wC
296 Ibid.
297 HQLA^x, 2022.

Potential Benefits of HQLA^x in VM

- **Accelerated collateral deployment reducing trapped collateral:** Increased throughput allows more frequent VM calls to be made intraday, enabling VM to return to the marketplace instantaneously.[298] This enables participants to carry tighter, more optimized intraday liquidity balances.
- **Improved operational efficiency:** Automating VM calls and avoiding physical settlement through the traditional Custody chain reduces settlement fails, the possibility of human error, and associated labor cost.
- **Transparency of information:** Real-time visibility of trade status across CCPs allows better monitoring and more accurate margin obligation computation, reducing overcollateralization and increasing liquidity in the market. Shared ledger reduces discrepancy in margin computation.[299]

Apart from potential VM transactions, one of the most prominent current HQLA^x use cases is collateral upgrades and downgrades (or collateral transformations), which involve the exchange of collateral securities between counterparties. In traditional markets, collateral transformations are executed via two DvP transactions (using cash as the common leg) or two Free of Payment (**"FoP"**) deliveries.[300] These settlement mechanisms consume intraday liquidity or credit. HQLA^x provides those savings by avoiding cash or credit entirely and settling instantaneously through DvD. DvD is a DLT-based settlement mechanism that swaps one security (or basket of securities) directly for another security (or basket of securities) with no cash transactions.

It is important to note that the HQLA^x platform is limited to **use cases involving exclusively non-cash collateral that can be settled DvD.**[301] One reason HQLA^x does not currently offer atomic settlement of traditional repo transactions or any derivative collateral transactions that involve a cash leg is because it does not integrate into DLT-based Payment Instruments settlement systems. DLT-based Payment Instruments becoming more widespread could facilitate atomic DvP settlement could becoming an HQLA^x use case.

Common Data Standards

Industry-wide initiatives around data standards are already underway for the incorporation of DLT. For example, the ISDA has published a CDM[302] introducing a data processing framework to link real world events to margin calculations, that can be integrated with various digital systems, but especially DLT.[303] A pilot has already been launched with interest rate derivatives.[304]

3.2.3 Legal and Regulatory Analysis

The repo market is a central pillar to the efficient working of a number of financial markets. Perhaps the key function of the market in relation to Intra-day repos, is the provision of short-term funding in an efficient manner, thus allowing many other markets to operate more efficiently. The size and importance of this market can be seen by the fact that the 56 institutions that responded to the International Capital Markets Association (**"ICMA"**)'s European Market survey in June 2022[305] had an aggregate total outstanding value of repo contracts of EUR 9,680 billion.

DLT-based Securities and DLT-based Payment Instruments (if used to enable settlement) are a key focus for the Intra-day repo market expanding because the potential speed of settlement makes it possible to have repo transactions with terms of only a few hours.

298 BIS, "Review of margining practices", Oct 2021, https://www.iosco.org/library/pubdocs/pdf/IOSCOPD686.pdf .
299 World Economic Forum & Boston Consulting Group, "Digital Asset, Distributed Ledger Technology and the Future of Capital Markets", May 2021, https://www3.weforum.org/docs/WEF_Digital_Assets_Distributed_Ledger_Technology_2021.pdf.
300 HQLA^x, 2022.
301 Ibid.
302 ISDA, Common Domain Model, October, 2019, https://www.isda.org/2019/10/14/isda-common-domain-model/
303 Ledger Insights, "How the Common Domain Model and blockchain should interact in derivatives post-trade" , April, 2022, https://www.ledgerinsights.com/how-the-common-domain-model-and-blockchain-should-interact-in-derivatives-post-trade/
304 Withersworldwide, "ISDA and Digital Asset launch a CDM clearing pilot using DAML with distributed ledger technology", October, 2020, https://www.withersworldwide.com/en-gb/insight/read/isda-and-digital-asset-launch-a-cdm-clearing-pilot-using-daml-with-distributed-ledger-technology
305 https://www.icmagroup.org/assets/9789-ICMA-Repo-Survey-June-2022.pdf .

Intra-day Repos

For the purposes of this report, the discussion is limited to the Global Master Repurchase Agreement 2011 (the **"GMRA"**),[306] which is the most recently published version of ICMA's master agreement non-U.S. repo transactions and the 1996 Master Repurchase Agreement (the **"MRA"**), which is the primary standardized form for U.S. repurchase transactions. Additionally, the discussion is limited to repurchase transactions where the Purchased Securities are DLT-based Securities, although similar considerations would arise if any Margin Securities were DLT-based Securities. Other Digital Assets are not considered, save as a point of contrast.

The GMRA anticipates that the Purchased Securities will be "securities or other financial instruments", and the MRA anticipates that the Purchased Securities will be "securities or other assets", each of which are broad definitions. Industry may find a consensus as to how DLT-based Securities will, in and of themselves, be capable of satisfying this definition in the various legal systems but if they do not meet the definition then this would be a contractual point that could be addressed in any future market documentation (and in the interim, resolved by the parties agreeing an appropriate amendment to the GMRA or MRA between them). There is no further consideration of any points which could likely be satisfactorily resolved by parties through a contractual solution.

There are, however, several areas that might benefit from additional clarification to aid parties with the legal bases for market practices adopted by the parties. These are considered in turn below.

(1) **Financial Collateral Arrangements.** The treatment for repurchase transactions conducted under a GMRA is dependent on receiving positive netting or set-off opinions. In some non-U.S. jurisdictions, the positive analysis is dependent on the arrangement qualifying as a title transfer financial collateral arrangement under the relevant implementation of the financial collateral arrangement directive (the **"FCA Directive"**).[307] In this regard, particular focus will be given to whether specific DLT-based Securities qualify as financial collateral (i.e. financial instruments, cash or credit claims). Of these, it is financial instruments (as defined in the FCA directive) that are most likely to be relevant. The definition from the FCA Directive is copied below, although it is worth noting that different jurisdictions may have implemented the FCA Directive differently.

> "Financial instruments" means shares in companies and other securities equivalent to shares in companies and bonds and other forms of debt instruments if these are negotiable on the capital market, and any other securities which are normally dealt in and which give the right to acquire any such shares, bonds or other securities by subscription, purchase or exchange or which give rise to a cash settlement (excluding instruments of payment), including units in collective investment undertakings, money market instruments and claims relating to or rights in or in respect of any of the foregoing;"

This definition was not drafted with DLT-based Securities in mind. Further development of legal principles as to how DLT-based Securities fall within this definition, i.e., whether a given digital security is "negotiable on the capital market" in its own rights and/or otherwise qualify as a financial instrument, for example by virtue of conferring a right to acquire such shares, bonds or other securities by an exchange, can help parties by providing a legal foundation with stability, clarity and predictability for transactions.

In the United States, parties also seek positive netting opinions in connection with repo transactions. Positive netting opinions depend on whether the contract meets certain specified standards for the safe harbor exemptions from the automatic stay that otherwise applies under insolvency laws. Accordingly, it may be beneficial for U.S. repo transactions if these standards were clarified to confirm that they are inclusive of DLT-based Securities, given that DLT-based Securities did not exist at the time of drafting.

306 https://www.icmagroup.org/assets/documents/Legal/GMRA-2011/GMRA-2011/GMRA%202011_2011.04.20_formular.pdf.
307 Directive 2002/47/EC of the European Parliament and of the Council of 6 June 2002 on financial collateral arrangements, as amended.

Without further development on these points, growth in the market might be expected to occur more slowly while a market consensus develops.

(2) **Property Rights and conflicts of laws.** For transactions under the GMRA, the economics of repurchase transactions are derived from the analysis that the Purchase Securities are property that has been transferred outright to the Buyer on the Purchase Date. In the MRA, the parties both express an intent that the transactions under the MRA are sales and purchases and not loans and also provide for a backstop provision that grants the buyer a security interest in the Purchased Securities. Further development of relevant legal principles related to the creation and perfection of a security interest in DLT-based Securities and DLT-based Payment Instruments and conflicts of laws analysis for DLT[308] would aid parties with the legal bases for repo transactions and associated rights.

Unresolved legal questions can lead to an additional level of uncertainty that is likely to slow or fragment any market development in relation to DLT-based Securities. Various initiatives are seeking to resolve these points currently and provide the legal foundation for parties to rely on (for example, the UNIDROIT Digital Assets and Private Law Working Group[309] and the Law Commission's consultation in relation to Digital Assets[310] in Europe and the American Law Institute and the Uniform Law Commission,[311] the two sponsors of the UCC, in the United States). Therefore this issue is not considered further here other than to note that the repo market is an international market and would therefore benefit significantly from a consistent approach across all relevant jurisdictions.

(3) **Agency relationships.** Many participants in the repo market enter into transactions through an entity acting as an agent to Custody and help with the management of the collateral. For repo transactions that use DLT-based Securities and DLT-based Payment Instruments as collateral, this may lead to additional questions related to how DLT-based Securities and DLT-based Payment Instruments should be held for such market participants (either on a segregated or omnibus basis) to ensure legal certainty in the event of close-out. As legal precedents and market practices in this area continue to develop, clarity on the permissibility of such activities from regulators and supervisors could encourage more agents that are regulated institutions to act in these capacities.

(4) **Regulatory capital treatment.** As discussed below in Chapter 4.2.2, in December 2022, the BCBS endorsed a prudential standard on banks' cryptoasset exposures.[312] This delineated cryptoasset exposures into separate categories. For the purposes of this analysis, it is anticipated that parties will focus on their attention on DLT-based Securities that fit into the category of Group 1 cryptoassets. It is likely that the market will take great comfort from the decision to update earlier proposals so that the 2.5% risk-weighted-asset (**"RWA"**) infrastructure add-on will not be applied automatically. Authorities would be empowered to activate this add-on if they observed any weaknesses in the infrastructure on which particular cryptoassets are based. As such, the activation of such infrastructure add-on would constitute a potential impediment to market development, for example if firms were concerned that an add-on might be applied in the future, causing assets to depreciate as firms become incentivized to divest themselves of their holding. This should act as a persuasive factor against authorities' application of the infrastructure add-on.

(5) **Regulatory classification and tax treatment.** Further development of principles in these areas would help ensure that market participants will be comfortable that the treatment of repurchase transactions in respect of DLT-based Securities and DLT-based Payment Instruments reflects that of repurchase transactions in respect of traditional securities and traditional cash.

308 The decentralised nature of DLT means that the traditional conflicts of laws analysis might not be applicable.
309 https://www.unidroit.org/work-in-progress/digital-assets-and-private-law/#1622753957479-e442fd67-036d
310 https://www.lawcom.gov.uk/project/digital-assets/
311 https://www.uniformlaws.org/committees/community-home?communitykey=1457c422-ddb7-40b0-8c76-39a1991651ac
312 https://www.bis.org/bcbs/publ/d545.pdf

Variation Margin

Where the OTC derivatives are uncleared and the parties are in scope of applicable uncleared margin rules, the parties will be required to post VM. As can be seen, the efficient posting and collection of VM is of critical importance to the reduction of credit risk in the market, just as OTC derivatives are a critical tool for the controlling of market risk.

EMIR,[313] and the corresponding legislation in the UK following Brexit (**"UK EMIR"**) not only regulates how much VM must be exchanged (and when) but also what assets can be posted as collateral ("Eligible Collateral"). Similar restrictions are found in other sets of uncleared margin rules. The purpose of these legal requirements is to ensure that parties to OTC derivatives contracts mitigate their trading risks such that counterparty credit and operational risk are reduced when trading in OTC derivatives that are not cleared by a CCP.

For the purposes of this report, this discussion is confined to VM posted under the terms of a 2016 Credit Support Annex for VM governed by English law (the **"VM CSA"**) and a 2016 Credit Support Annex for VM governed by New York law (the **"NY VM CSA")** and assuming the VM consists of DLT-based Securities. Other Digital Assets are not considered, save as a point of contrast.

As for intra-day repos above, the following discussion does not include consideration of points which could be satisfactorily resolved by parties through a contractual solution, for example, by defining the "Eligible Credit Support (VM)" in a way that includes the relevant Digital Assets. There are several areas in the existing legal framework which might benefit from additional clarification. These are considered in turn below and cross-reference to the repo transaction considerations above where the points are of a similar nature.

(**1**) **Financial Collateral Arrangements.** The treatment for collateral posted under a VM CSA or NY VM CSA is dependent on receiving positive netting or set-off opinions. In some jurisdictions, the positive analysis is dependent on arrangement qualifying as a title transfer financial collateral arrangement under the relevant implementation of the FCA Directive, as noted above in relation to repo transactions, and similar considerations apply in relation to the posting of VM. In the United States, similar to the analysis noted above, a positive opinion depends on whether the contract meets certain specified standards for the safe harbor exemptions under insolvency laws.

(**2**) **Property Rights and conflicts of laws.** The economics of VM posted by way of title transfer are derived from the analysis that the VM is property that has been transferred outright to the collateral receiver on the date of transfer. In the United States, a security interest in the collateral is typically granted. Further development of legal principles related to the creation, perfection and enforcement of security interests in DLT-based collateral would aid parties with the legal bases for their transactions and associated rights. As noted above in relation to repo transactions, the differentiated and decentralised nature of DLT gives rise to several issues and similar considerations apply in relation to the posting of VM.

(**3**) **Uncleared Margin Rules.** As stated above, UK EMIR and EU EMIR, amongst other sets of uncleared margin rules (including U.S. rules and regulations), regulate how much VM must be exchanged, when this VM must be exchanged, and what assets constitute Eligible Collateral.

The definitions related to Eligible Collateral were not drafted with DLT-based Securities in mind. Further development of legal principles in this area might include considering whether the definitions across the different uncleared margin rules would benefit from clarification, rather than necessitate firms take a view on whether any individual Digital Security is within the scope of the applicable uncleared margin rule sets.

313 Regulation (EU) No 648/2012 of the European Parliament and of the council of 4 July 2012 on OTC derivatives, central counterparties and trade repositories, as amended.

Development in the market might be expected to occur more slowly while a market consensus develops in relation to any problematic rule sets or Digital Securities.

(4) **Regulatory capital treatment.** As noted above in relation to repo transactions, the prudential standard on banks' cryptoasset exposures endorsed by the BCBS could act as an impediment to market development, for example if firms were concerned that the 2.5% RWA infrastructure add-on might be applied in the future and assets depreciate as firms become incentivized to divest themselves of their holdings.

Hong Kong

Since documentation of repurchase transactions in Hong Kong largely adopt the GMRA and are commonly governed by English law, the U.K./E.U. analysis on the regulatory landscape and points above are generally applicable to Hong Kong.

The key differences under Hong Kong law are highlighted below:

1. Currently there is no Hong Kong equivalent of the FCA Directive.
2. Regarding VM requirements, financial institutions are subject to the HKMA Supervisory Policy Manual CR-G-14 on Non-centrally Cleared OTC Derivatives Transactions – Margin and Other Risk Mitigation Standards (**"CR-G-14"**), which sets out the minimum standards that the HKMA expects authorized institutions, such as banks, to adopt in relation to margin and other risk mitigation techniques for non-centrally cleared OTC derivatives transactions[314]. Schedule 10 of the Securities Future Commission of Hong Kong's (**"SFC's"**) Code of Conduct for Persons Licensed by or Registered with the Securities and Futures Commission also elaborates on the risk mitigation requirements and margin requirements in relation to non-centrally cleared OTC derivative transactions.[315]

   Separately, with respect to collateralized transactions by way of security, uncertainty remains over what type of security can be granted and enforced (and how to grant and enforce such security) over digitized securities, for example, whether it is possible to create/register a fixed or floating charge over certain types of digitized security which affects priority and enforceability of such charges. Further, there could also be uncertainties over legal recognition of security document if they are "digitized" (e.g., in the form of smart contract or executed through electronic signatures). For example, where the security is required to be registered with the Companies Registry of Hong Kong, such registration procedures include the delivery of the certified copy of the security instrument. This would create difficulties where there may not be such an instrument in the context of digitized securities, and the current definition of a "certified copy" in the Companies Ordinance is unclear as to how an instrument created/stored on the DLT may be certified as a true copy.

Singapore

Much of the discussion covered above under the U.K. and E.U. legal and regulatory analysis are jurisdictionally agnostic. However, there are certain differences. Singapore do not have an equivalent of the FCA Directive. Accordingly, in Singapore, it would typically be required to satisfy 'true sale' transfers and positive close-out netting analysis.

In relation to uncleared margin rules, MAS has issued the Guidelines on Margin Requirements for Non-Centrally Cleared OTC Derivatives Contracts. Paragraph 7.1 of the Guidelines provides a list of eligible collateral to meet IM and VM requirements. As for the U.K./E.U., the list of Eligible Collateral was not drafted with DLT-based Securities in mind, and it might be helpful to consider whether the list would benefit from clarification in this regard.

314 https://www.hkma.gov.hk/media/eng/doc/key-functions/banking-stability/supervisory-policy-manual/CR-G-14.pdf .
315 https://www.sfc.hk/-/media/EN/assets/components/codes/files-current/web/codes/code-of-conduct-for-persons-licensed-by-or-registered-with-the-securities-and-futures-commission/Code_of_conduct_05082022_Eng.pdf?rev=0fd396c657bc46feb94f3367d7f97a05

Japan

Intra-Day Repos

In Japan, the Financial Instruments and Exchange Act (**"FIEA"**) was amended in 2019 to regulate transactions of tokens representing securities in an attempt to facilitate capital formation in this manner while protecting investors. The amendment came into force in May 2020. As such, a regulatory framework for transactions in respect of DLT-based Securities has already been implemented in Japan (this framework is examined in further detail in Chapter 4.2.4 below). Under this framework, tokens representing (i) a conventional class of financial assets listed as Type I Securities under the FIEA (such as shares and bonds) or (ii) an interest in a collective investment scheme, would be deemed to be "securities". In case of Intra-Day Repos of traditional "securities", such Intra-Day Repos are subject to the regulations under the FIEA for the sale and purchase of "securities". Accordingly, Intra-Day Repos of tokens representing such "securities" would also be subject to the regulations under the FIEA for the sale and purchase of such "securities". In terms of financial collateral arrangements, the netting of tokens representing "securities" is not distinguished from the netting of "securities" themselves. Therefore, there does not seem to be specific discussion on the netting of tokens representing such "securities". On the other points, the analysis discussed in the U.K./E.U. legal and regulatory analysis above would generally be applicable to Japan.

Variation Margin

With regards to financial collateral arrangements, there has not been discussion to carve out tokens representing "securities" from applicable financial collateral in Japan. In terms of property rights and conflicts of laws, the analysis discussed in paragraph 2 of 4.2 would generally be applicable to Japan. In terms of uncleared margin rules, requirements for securities to be qualified as VM (**"Qualified Securities"**) are stipulated in a public notification issued by the Japanese Financial Services Agency. However, the current public notification has not been drafted with DLT-based Securities in mind, therefore it would be expected to specify whether tokens representing Qualified Securities are also qualified as VM. In addition, regarding regulatory capital treatment, the current capital adequacy regulation is not made with DLT-based Securities in mind either and it would need to be seen how tokens provided as VM may be treated in the future.

3.3 Deep Dive #2: Sovereign and Quasi-Sovereign Bonds

3.3.1 Current state overview

Sovereign bonds[316] are debt securities issued by national governments to raise capital. A quasi-sovereign entity is defined as an organization that is legally separate from, but owned and controlled by, a sovereign.[317] The sovereign bond market is tightly linked to repos and futures market as sovereign bonds are frequently used as collateral.

3.3.1.2 Inefficiencies of the current process

Unlike corporate bonds covered in Chapter 3, issuance processes for OECD sovereign debt follow well-established formats (mostly auction or tap). They feature a defined set of primary dealers and often have high liquidity and thus lower cost of issuance. That said, there are a few nuanced inefficiencies in the sovereign debt markets:

316 Hereinafter, for the goals of this report terms "sovereign bonds" and "quasi-sovereign" bonds are used as interchangeable.
317 Clearly Gottlieb, "Emerging Market Sovereigns' Frequent Indulgence for their Quasi-Sovereigns," 2016.

- **Risk of low issuance demand:** Sovereign bond issuances sometimes experience weak demand, leading to postponed or even cancelled auctions.[318] This was the case immediately following the Global Financial Crisis as governments ramped up debt finance, leading to greater issuance competition.[319]
- **Large ticket size:** While sovereign bonds enjoy broader and deeper Secondary Market liquidity than corporate bonds, the markets are still dominated by institutional investors dealing large ticket sizes. For example, average trade size for E.U. sovereign bonds in 2019 was ~€8 million.[320] Direct access to sovereign debt markets by retail investors is still uncommon.
- **Expensive to acquire as collateral:** The use of sovereign debt as a HQLA for collateral has increased given post-crisis regulatory reforms. However, interviewees mentioned that sovereign bonds are expensive. Although developed market government debt markets are generally highly liquid, the increase in use for collateral has led to a decline in liquidity and turnover across U.S. Treasuries, U.K. Gilts, and other markets.[321]
- **Delayed market transparency:** Although rare, developed sovereign debt markets sometimes experience moments of atypical volatility. In those cases, the complexity of today's market infrastructure means that authorities do not have deep visibility into causes until sometime after the fact but must take countermeasures immediately. An example of this dynamic occurred during the Treasury "flash crash" in October 2014.[322]
- **Large and growing debt service burdens:** Government debt management offices often do not have the most current operational risk practices.[323] This may pose a bigger burden as the financial burden of debt service grows.

Impact of DLT:

The benefits of DLT lie mostly in operational and market-based efficiencies that could arise from the added transparency of the distributed ledger, automation introduced by smart contracts, and investor demand for DLT-based sovereign bonds.

Data transparency could enable more efficient issuance and supervision:

- Assuming DLT-based Securities or records attain critical mass, sovereign issuers could gain enhanced visibility into the ownership and demand dynamics for sovereign debt. This information could inform more optimal issuances moving forward.
- Enhanced visibility into market dynamics conferred by the distributed ledger would allow regulators real-time knowledge of secondary activity and enable more informed decisions regarding systemic risk and financial stability.

Additional secondary liquidity granted by DLT-based sovereign bonds:

- DLT-based sovereign bonds would provide another channel of liquidity for sovereign debt markets. For collateral use cases, this could lead to higher turnover and start to make sovereign debt a less expensive source of collateral.
- To the extent that these tokenized versions enable lower ticket sizes and become widely accessible, this could attract a greater degree of demand from the retail sector.

Automation of debt servicing via smart contracts:

- Smart contracts can be used to improve automation and streamline processes in bond issuance, coupon and principal payments, and Custody.[324]

318 OECD, "New Challenges in the Use of Government Debt Issuance Procedures, Techniques, and Policies in OECD Markets," 2009.
319 Ibid.
320 ESMA, "E.U. securities Markets Annual Statistical Report", 2020.
321 FSB, "Liquidity in Core Government Bond Markets", 2016.
322 PwC, "Global financial markets liquidity study", 2015.
323 OECD, "Government Debt Management and Operational Risk: A Risk Management Framework and its Application in Turkey," 2013.
324 World Economic Forum & Boston Consulting Group, "Digital Asset, Distributed Ledger Technology and the Future of Capital Markets", May 2021, https://www3.weforum.org/docs/WEF_Digital_Assets_Distributed_Ledger_Technology_2021.pdf.

Some of these benefits are currently yet to be demonstrated in Secondary Markets and post-trade processes (debt servicing) given the lack of real-world initiatives in those two stages. Issuance has been explored, but only by a small set of governments, including Thailand, the Philippines, Poland, South Korea, and Colombia.[325] These issuances are also examples of emerging market bonds, which typically do not hold auctions at issuance. Among quasi-sovereign entities, there have been three DLT-based issuances led by the European Investment Bank (EIB) and its partners. This section will examine these use cases in further depth.

Exhibit 3.3.1

Timeline of EIB Issuances 2021-2023

Source: EIB (2021)

3.3.2 Project Mercure: EIB digital bond on public DLT, April 2021

In April 2021, EIB issued a DLT-based bond on Ethereum, the first multi-dealer led digitally native issuance using a public network.[326] Apart from its innovation, this issuance was notable because it was settled through CBDC from the Banque de France.[327] It also marked the first time the bond was sold to third parties, as opposed to pre-identified counterparties.[328] Key terms of the issue are summarized in the exhibit.

Exhibit 3.3.2

Summary of Key Terms, EIB Issuance (April 2021)

Issue Amount	€100M
Pricing Date	27 April 2021
Settlement Date	28 April 2021
Maturity Date	28 April 2023
Coupon	0.000%, annual

325 Ledger Insights, "U.K. to explore blockchain-based government bond," July 2022.
326 European Investment Bank, "EIB issues its first ever digital bond on a public blockchain," April 2021.
327 Ibid.
328 Ledger Insights, "Goldman, Santander, SocGen help European Investment Bank issue €100m public blockchain bond," April 2021.

Re-offer Yield	-0.601%
Re-offer Price	101.213%
Governing Law	French law
Joint Lead Managers	Goldman Sachs, Santander, Société Générale
Registrar, Fiscal Agent, Settlement Agent and Platform Manager	Société Générale – FORGE
Legal advisers	Linklaters LLP (to EIB) and Allen & Overy LLP (to the joint lead managers)
DLT network	Ethereum (public DLT network)

Source: EIB

Issuance details

The EIB bond was a €100 million EUR issuance of 2-year AAA-rated bonds on the SG Forge platform, which runs on public Ethereum DLT network. The selection of a public DLT network was notable given that previous experiments from sovereign issuers had used permissioned DLT network.[329] While the network was permissionless, the application provided by SG Forge for the issuance was tightly permissioned.[330] This meant that all tokens had whitelisting in place to restrict holders to only the eligible counterparties and investors.[331] Furthermore, SG Forge had smart contracts in place that conducted KYC/AML/CFT and sanctions checks to verify counterparty identities before the relevant transaction could take place.[332] Finally, in accordance with French law, SG Forge maintained a monitoring system outside of a distributed ledger for the bondholders' positions to track any potential operational risk issues.[333]

The issuance was arranged under the Société Générale's Compliant Architecture for (DLT-native) Security Tokens (CAST) standard, which is design to fit clearly within the tools and frameworks of French law and regulation.[334] The bond tokens were designated under French law as MiFID2 financial instruments.[335] Though the bonds were fully digitally native, the issue legally qualified as equivalent to traditional bonds in terms of rights and obligations.[336] Fitch Ratings, which provided the credit rating for the bond, noted that the DLT underlying the issue did not create any additional credit risk compared with a traditional bond issuance.[337] In accordance with French law, the issue proceeded without a traditional CSD or CCP, opting for a DLT-based registry instead; this arrangement, however, is likely not transferrable to other jurisdictions.

The bond settled on a T+1 timeframe using a CBDC proxy provided by the Banque de France, meaning that the bond completed issuance, trade, and settlement entirely on the distributed ledger. Banque de France used smart contracts to issue and control CBDC tokens and ensure simultaneous CBDC transfer in accordance with DvP.[338]

329 Ibid.
330 SIFMA, "Why Basel Should Not Apply A Blanket Infrastructure Risk Add-On For Group 1 Cryptoassets," November 2022.
331 Ledger Insights, 2021.
332 SIFMA, 2022.
333 Ibid.
334 Ibid.
335 Ibid.
336 Fitch Ratings, "Fitch Assigns European Investment Bank's Proposed Digital Bond Issuance 'AAA' Rating," April 2021.
337 Ibid.
338 Banque de France, "Experiment on the use of Central Bank Digital Currency (CBDC)," April 2021.

Key Benefits

- EIB benefited from the lower cost of issuing on public DLT network.
- At the same time, the programmability of the SG Forge ecosystem allowed for robust layers of permissioning, security, and control on top of the public DLT.
- The issue demonstrated that a digitally native issuance can fit clearly within the regulatory framework as fully equivalent to a traditional bond.

3.3.4 Project Venus: EIB digital bond on private DLT network, Nov 2022

EIB issued its second digitally native bond token in November 2022, this time on a private, permissioned DLT network via the DAP™ platform run by Goldman Sachs. A notable aspect of this issuance was the same-day T+0 settlement across two distributed ledgers in partnership with the Banque de France and Banque Centrale de Luxembourg. In addition, the bond was admitted to the Luxembourg Stock Exchange and used the Common Domain Model for associated interest rate swaps (refer exhibit).[339]

Exhibit 3.3.3

Summary of Key Terms, Project Venus

Issue amount	€100M
Pricing date	29 November 2022
Settlement date	29 November 2022
Maturity date	29 November 2024
Coupon	2.507%, annual
Re-offer yield	2.507%
Re-offer price	100%
Governing law	Luxembourg law
Admission	Luxembourg Stock Exchange SOL (Securities Official List)
Joint lead managers	Goldman Sachs Bank Europe SE, Santander, Société Générale
Legal advisors	Clifford Chance (to EIB) Allen & Overy LLP (to the joint lead managers) Ashurst (to GS DAP™)
DLT network	Private DLT-network via Tokenization platform by Goldman Sachs (Hyperledger BESU / DAML)
Central Account Keeper	Goldman Sachs Bank Europe SE
Account Keeper	Société Générale Securities Services Luxembourg (SGSS Luxembourg)

Source: EIB

Issuance Details

The issuance was issued, recorded, and settled as the first transaction on the Goldman Sachs DAP™ platform. The DAP™ platform runs a private-permissioned distributed ledger using Digital Asset's DAML smart contract

339 EIB, "EIB innovates further with Project Venus, the first euro-denominated digital bond on a private blockchain," November 2022.

language and its Canton private DLT network.[340] Given the private-permissioned nature of the system, all participants were controlled and screened by default.

The settlement mechanism this time was atomic, completing the process in less than one minute.[341] In this implementation, clients purchased Security Tokens with cash. Goldman Sachs and the other lead managers (Santander and Société Générale) then settled the purchases on DLT using euro-based CBDC. The cash leg relied on a separate permissioned distributed ledger jointly operated by Banque de France and Banque Centrale du Luxembourg.[342] Settlement was therefore "cross-chain" between the central bank and Goldman Sachs' distributed ledger; it required a trusted message exchange protocol (Hashed Time lock Contract Protocol, or HTLC) to coordinate the simultaneous exchange of experimental CBDC tokens for bond tokens in accordance with DvP.[343]

The bond was issued under Luxembourg law and subsequently the first syndicated digital bond to be admitted to the Luxembourg Stock Exchange.[344] Moody's, which gave the issue an Aaa rating, based its adjudication on EIB's strong credit position and robust risk management practices.[345] It noted the potential cyber risk posed by issuing the bond using DLT. However, it emphasized that the credit risk of the issue is ultimately dependent on EIB itself, not on the technology underpinning the issue.[346] Furthermore, it noted that the technology risk posed by DLT was "limited" by the private-permissioned nature of the platform, and the separation between EIB's internal technology systems and the DLT platform.[347]

Finally, the DAP™ platform supported an associated interest rate swap as a hedging instrument using the ISDA CDM, intended as a first trial of future on-DLT interest rate solutions.[348]

Key Benefits

- EIB benefited from the low issuance cost and successfully demonstrated atomic settlement.
- Permissioning, security, and control were built into the DAP™ platform and cash settlement distributed ledgers themselves.
- The issue successfully demonstrated a cross-distributed ledger settlement involving communication between the securities ledger and cash ledger.
- The interest rate swap could lead to further innovation with CDM-based derivatives on the GS DAP™ platform.

3.3.5 Project Mars: EIB GBP digital bond on private and public DLT networks, Jan 2023

On January 31, 2023, EIB issued its latest digitally native bond, and its first in pound sterling. This bond—a £50 million GBP 3-year floating rate note—was issued on both private and public distributed ledgers. Firstly, the bond was issued on a private-permissioned DLT network on HSBC's Orion platform. At the same time, HSBC Orion also mirrored key anonymized details of the issuance on a public DLT network. The bond is "digital native", represented in securities tokens. Payment for bonds is processed on the platform using tokenized DLT GBP. BNP Paribas and RBC Capital Markets were the other joint lead managers.

340 Digital Asset, "Goldman Sachs' Tokenization Platform GS DAP™, Leveraging Daml, Goes Live," Januray 2023.
341 Ibid.
342 Banque de France, "The Banque de France and the Banque centrale du Luxembourg jointly conducted a successful wholesale central bank digital currency initiative," November 2022.
343 Ibid.
344 Ibid.
345 Moody's, "Moody's assigns Aaa rating to EIB's second digital bond," November 2022.
346 Ibid.
347 Ibid.
348 EIB, 2022.

Exhibit 3.3.4

Summary of Key Terms, Project Mars

Issue amount	£50M
Pricing date	31 January 2023
Settlement date	02 February 2023
Maturity date	03 February 2025
Coupon	SONIA + 12bps
Re-offer yield	SONIA + 12bps
Re-offer price	100%
Governing law	Luxembourg law
Admission	Luxembourg Stock Exchange SOL (Securities Official List)
Joint lead managers	BNP Paribas, HSBC, RBC Capital Markets
Legal advisors	Clifford Chance (to EIB) Allen & Overy LLP (to the joint lead managers)
DLT network	Private DLT-underpinned platform, via Tokenization platform by HSBC
Central Account Keeper	HSBC Continental Europe, Luxembourg Branch
Account Keeper	HSBC Bank, U.K. BNP Paribas Securities Services Royal Bank of Canada

Source: EIB (2022)

Issuance details

This inaugural issuance on the HSBC Orion platform is the first ever GBP tokenized bond. The platform is the first to use the Central Account Keeper (**"CAK"**) status in Luxembourg digital assets regulation. The bond was issued under Luxembourg Law and is listed on the Luxembourg Stock Exchange. Money movement was handled by the creation of a settlement tokens backed by cash held at HSBC and deposited by Secondary Account Keepers. This approach allows later adoption of CBDCs or other money options, as they arise.

Issuing on both private and public networks was a previously unexplored innovation. The private DLT network is built using technologies including Hyperledger Fabric, and DAML smart contracts running on Canton. The public DLT network is Ethereum Mainnet. For future issuances on the platform the decision to use both private and public DLT networks, or just private, will be as per issuer decision.

Key Benefits

- EIB benefited from low issuance cost and demonstrated atomic settlement with a floating rate coupon.
- The three banks gained significant insight into the operational and legal complexities of the market, and the platform is the first to use the CAK in Luxembourg law.
- The platform provides a simple low impact adoption pathway for existing market participants that enables transition to shorter settlement cycles.

3.3.6 Legal Considerations

The legal and regulatory considerations for sovereign bonds are largely covered in Chapter 4.1 and Chapter 4.2 for U.S., U.K., E.U. and other jurisdictions.

U.K./E.U.

In principle, there is nothing that would expressly prevent the use of DLT in relation to the native issuance and trading of sovereign bonds. Generally, however, one of the main considerations when analyzing sovereign bond issuance in the context of DLT-based systems is whether the sovereign has adequate powers under the relevant legislation to pursue a digital issuance of sovereign bonds. Such legislation would have to be considered on a case-by-case basis and may contain requirements that are incompatible with a digital issuance, for example by mandating that the issuance takes place in certificated form or that the bonds are made available to certain persons. Provided the relevant legislation is compatible with digital issuance, then the digital sovereign bond issuance would still face the legal and regulatory challenges and hurdles that apply to debt instruments generally, as are set out in detail in Chapter 4.1.2. These challenges include: (i) whether the digital security issued constitutes a valid debt instrument in accordance with the laws of the local jurisdiction; (ii) whether, upon creation, the structure is such that it grants a legally enforceable obligation to the token holder; and (iii) whether the debt instrument (issued on a DLT-based system) can be traded in accordance applicable pieces of E.U.-level legislation[349] (for example, in accordance with book-entry requirements Article 3(2) of the Common Securities Depository Regulation (CSDR)).[350]

For a full legal and regulatory analysis of the current framework for debt instruments generally, and the challenges surrounding the application of DLT-based systems, please see Chapter 4.1 below.

Practically, there may be other factors that present challenges in the context of a sovereign bond issuance. Due to their public status, sovereigns may have a particular sensitivity to legal risk, and in practice sovereign issuers often rely on established value chains (and the checks and balances applied therein) to ensure legal certainty. Arguably, a key component of this reliance is the knowledge that adequate legal checks are being completed across the intermediaries by virtue of applicable regulation. By way of example, in the U.K., gilts are issued onto CREST which qualifies as an "Operator" for the purposes of the Uncertificated Securities Regulations 2001[351] (the **"USRs"**). As an Operator, CREST must comply with certain requirements, for example compliance with sanctions and the relevant AML/KYC legislation (for a discussion of such requirements, please see Chapter 2.2 above). Accordingly, CREST's participants are authorized for the purposes of the relevant legislation, reducing the legal risk to which the sovereign issuer is exposed. Operating in an established value chain mitigates the risks of an open market.

The barriers to adoption of DLT are generally the same as for commercial bond issuances except that, due to the special position of sovereign entities, it is arguably more important to ensure that the chain of intermediaries and participants in the process are being regulated and monitored. Similar to the discussion in Chapter 2.2, this is likely to be achieved via the use of permissioned environments, either on private or public DLT networks.

Sovereigns are often keen to ensure that there is an unrestricted ability to tap existing bond issuances, which is usually achieved by issuing new bond tranches that are fungible with previous a previous tranche of bonds that have been issued by them. Therefore, a vital further consideration when implementing DLT-based systems in the context of sovereign bond issuances is to ensure that fungibility can be assured, such that holders are not able to distinguish between the relevant tranches of the same series of bonds.

349 Throughout this report, "E.U.-level" typically refers to E.U. regulations and E.U. directives (as implemented via the applicable regulations in each Member State), and includes the U.K. "onshored" E.U. legislation in respect of the U.K.
350 Regulation (E.U.) No 909/2014.
351 The Uncertificated Securities Regulations 2001 (SI 2001/37755).

On a national level, it should be considered whether applicable statute or regulation may have to be clarified or amended. For example, in the U.K., gilts are one of the few debt securities issued under the USRs. It is unclear whether a DLT-based system utilizing a multi-jurisdictional spread of nodes could satisfy the requirement for a U.K. registrar under the USRs. Legislators and regulators could provide certainty to issuers (sovereign or otherwise) by clarifying that this requirement is either satisfied, or disapplied in respect of financial instruments issued under the USRs. Practically speaking to issue debt instruments using a DLT-based system under the USRs would require an Operator (e.g., CREST) to operate a suitable DLT platform. No Operators do so at present, and as such the USRs are not currently a practical option for the issuance of Digital Sovereign Bonds.

Secondary Market (Tokenized Securities):

While the discussion above contemplates the sovereign entity completing a native issuance of bonds, this is not the only relevant application of DLT in this context. Even if the sovereign entity issues traditional debt instruments, market participants may be able to create Tokenized Securities, in accordance with the "True Tokenization" process, as set out in Chapter 4.1.2.1. In this case, the same legal and regulatory challenges and hurdles that apply to the issuance of DLT-based Securities generally would be relevant for consideration (see Chapter 4.1).

Hong Kong

The Government Bond Programme and Government Green Bond Programme are initiatives of the Hong Kong Government to develop the local bond market in Hong Kong. The bonds issued under these Programmes are a form of securities which are subject to the existing securities regulatory framework in Hong Kong including the Securities and Futures Ordinance (SFO).

Where sovereign bonds are to be tokenized, below are several key legal and regulatory points which may benefit from additional clarification:

1. **Token creation and documentary formalities.** The documents required to support a sovereign bond's legal structure is multifold, including constitutive documents, subscription agreements and registry filings. The Tokenization process will need to clearly define which part of the bond issuance process and the relevant documents are "tokenized", what "Tokenization" of a certain process or document really means (e.g., whether the information is stored on a distributed ledger, or an agreement is executed using smart contract, and what rights and obligations a Security Token issued in this process confers), including whether a copy/version of the same exists outside of a distributed ledger and what its legal effect is in case of discrepancy.

   Further, the issuer may need to have Tokenization-specific documents in place, including token purchase agreement that outlines the rights of investors and the tokenized bond offering details, tokenized bond creation deed/terms of the token, smart contract code, Custody deed, disclosure documents including technical papers, underwriting agreement and third-party agreements with service providers including technology auditors and software/platform developers.

   As discussed in further detail in Chapter 4.1.3.1, there is legal uncertainty as to how current electronic transaction rules (e.g., the Electronic Transaction Ordinance) apply to DLT-based transactions and smart contracts, in particular potential non-recognition of electronic execution of certain instruments that are required to be stamped under the Stamp Duty Ordinance, transactions involving government entities where only limited certification authorities are recognized under the Electronic Transactions Ordinance, and deeds. This means the valid execution of such documents could be incompatible with migration to DLT absent legal clarification or update.

2. **Ownership and transferability.** Formal recognition of the legal nature, including what constitutes evidence of ownership, of tokenized bonds is required. Technical aspects of evidence of title should also be clarified, such as whether such evidence should be on a public or private network and the number of confirmations that will be required for a tokenized bond's transfer to be final.

   Clarification is required as to the content of a transfer of a tokenized bond – whether the transfer includes with it the legal rights and obligations of the bond or any rights on a distributed ledger or outside of a distributed ledger, or is merely a representation of a beneficial interest in the token or any underlying asset. The documentation on a distributed ledger/on an issuance platform should clearly delineate the consequences of a transfer, as well as potentially automating the corresponding notice procedures, assignments, or any other transfer mechanics.

3. **Suitability and investor protection.** Existing investor protection provisions including suitability and disclosure requirements may need to be updated in view of Tokenization, such as whether a tokenized bond would be a "complex product" due to its specific structure on the DLT or depending on exactly which part of the bond issuance is "tokenized". More regulatory guidance would be welcome on how various risks regarding the suitability of a tokenized bond vis-a-vis a client can be ascertained (e.g., the measurement and standards for product risk and concentration risk etc.), and guidance should be given to outline distributors' obligations and factors to be considered when evaluating the suitability of the tokenized bonds to clients.

Singapore

In Singapore, the issuance of Government securities and Treasury Bills are governed by the Government Securities (Debt Market and Investment) Act 1992. The MAS is appointed to act on the Government's behalf as an agent for issuing of Government securities or Treasury Bills for moneys borrowed under the Act.

There is also the Significant Infrastructure Government Loan Act 2021, which authorizes loans to be raised by the Government in relation to nationally significant infrastructure. Similarly, the MAS is appointed to act on the Government's behalf as an agent for issuing of securities for moneys borrowed under the Act. An inaugural sovereign green bond was issued in August 2022 under the Act.

Similar how the issuance of digital tokens which constitute regulated products such as securities are subject to the same regulatory regime under Securities and Futures Act 2001 (the SFA) as offers of such regulated products made through traditional means, given how MAS takes a technology-neutral stance, the issuance of sovereign bonds whether digital or made through traditional means is likely to be subject to the same regulatory regime.

3.4 Deep Dive #3: Tokenization of assets

This section will examine the opportunity and risks in tokenizing assets, with a focus on the use case for DLT in illiquid asset classes, such as private equity and other alternative assets. It will first explore the role of market participants in a long-term tokenized end state, evaluate the growth and benefits that Tokenization of assets brings, and deep dive the particular case of tokenizing an investment fund.

3.4.1 Growing Client Demand and Market Growth

The market growth prospects for DLT-based Securities are considerable. As of 2022, the stock of DLT-based Securities is $310 billion (a combination of listed and unlisted equity, bonds, and other financial assets).[352] While best case scenarios estimate total market value of $68 trillion, conservative projections indicate that stock is expected

352 BCG and ADDX, "Relevance of on-chain asset Tokenization in crypto winter", 2022.

to grow to $16 trillion USD by 2030, representing a 63% CAGR.[353] By comparison, AuC for the top 11 custodians grew 5.7% CAGR from 2010-2018.[354] Even if one assumes some of the DLT-based Securities market growth would cannibalize existing security market value outside of a distributed ledger, it represents a marked shift in growth by market segment.

Demand for DLT-based Securities is emerging. In BNY Mellon and Celent's 2022 Survey of Global Institutional Clients, 97% of respondents agreed that Tokenization would "revolutionize asset management" and 84% believed that it would benefit the industry by removing frictions around transfer of value.[355] Respondents are also planning to invest in the space, indicating that they would increase portfolio allocations to digital assets by an average of 7pp in the next 2-5 years if conditions are favorable.[356] In the BNY/Celent survey, a a most respondents (63%) indicated they would be comfortable trading DLT-based Securities or DLT-based Payment Instruments only with traditional financial institutions. This is driven by concerns with regulatory standing of DeFi providers, desire for well-capitalized firms, and outsized burden of performing due diligence on new providers were the top three reasons provided.[357]

3.4.2 General Benefits of DLT-based Securities and DLT-based Payment Instruments

Growth in DLT-based Securities will necessitate that custodians to build a platform that meets the client need for **integration between assets on and outside of a distributed ledger.** This could lead to two main benefits. First, Tokenization could **expand access and liquidity to private or alternative assets.** Second, Tokenization could increase liquidity within these and other assets through **fractionalization.**

Integrated Custody

An integrated Custody model across traditional and DLT-based Securities could emerge as the packaging of Custody services, given market indications. In BNY Mellon and Celent's 2022 Survey of Global Institutional Clients, 72% of investors indicated they prefer an integrated, one-stop shop for digital asset Custody, as opposed to best of breed providers for individual needs.[358] Despite the enthusiasm for the potential offerings, the survey found that only 35% of respondents are currently investing in digital asset exposures through a traditional finance platform, and most firms report having to use more than one vendor. Moreover, respondents named product feature set, legal framework, and lack of integration among traditional and digital assets as the top three Inefficiencies affecting current digital asset custodians.[359] This is evidence of a need among institutional investors for a complete, integrated Custody platform across traditional and distributed ledger provided by a traditional player.

As noted in Chapter 2.1.4, traditional custodians appear to be well-positioned to deliver integrated Custody services for DLT-based Securities. BNY Mellon/Celent survey respondents indicated that they would increase portfolio allocations to assets, including DLT-based Securities, by an average of 7 percentage points in the next 2-5 years if conditions are favorable.[360]

353 Ibid.
354 BCG, "Asset Servicing Primer," 2020.
355 BNY Mellon & Celent, "2022 Survey of Global Institutional Clients," 2022.
356 Ibid.
357 Ibid.
358 BNY Mellon & Celent, "2022 Survey of Global Institutional Clients," n=271. Respondent panel included asset managers, asset owners, and hedge funds with core activities covering North America, Europe and Asia. Respondents were surveyed from May to June 2022. Note: the scope of the survey also included Group 1b/2 assets, which are out of scope for this paper. However, the survey results remain broadly applicable to state of interest and development of Integrated Custody within the market today.
359 Ibid.
360 Ibid.

Expanded access to alternative assets

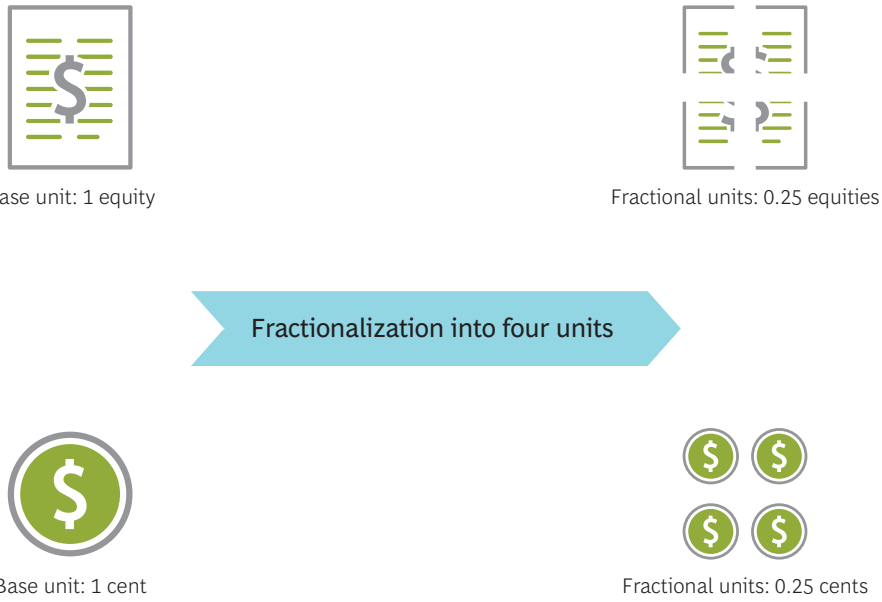
Among the different categories of DLT-based AuC, custodians are likely to see more growth in private market assets. As of 2021, alternative assets represented only 17% of global assets under management (AUM).[361] Broad trends indicate that expected growth in alternative asset AUM (9% CAGR) could outpace that of traditional assets (5% CAGR) from 2021-2026.[362] Furthermore, market participants identify increased access to alternative assets as a major benefit of DLT-based Securities. In the BNY Mellon/Celent survey, respondents ranked access to private equity, real estate, and other alternative asset classes as the top benefit from Tokenization.[363] This preference was corroborated by a survey of GFMA members for this publication, where respondents ranked private placements, illiquid assets, investment funds, and real estate as the asset classes with the most potential for DLT.[364]

Fractionalization of existing asset classes

A core benefit from the Tokenization of assets is the ability to vary the ratio between an underlying asset and the fungible tokens minted to represent it. For example, a public equity can be represented by a single digital token, in a one-to-one ratio. However, the same public equity token can also be subdivided into multiple tokens to create a one-to-many relationship, allowing investors to own a fraction that is less than the base unit of a security or cash (i.e., less than one equity or less than one cent). This concept is known as fractionalization.[365]

Exhibit 3.4.1

Fractionalization Divides Base Units into Sub-units



Source: BCG analysis

Fractionalization of DLT-based Securities is attractive for issuers and investors, particularly in the case of higher-value securities, because it reduces the unit-cost of a security while retaining the benefits of automation and programmability of its non-fractionalized counterpart. These factors can increase potentially available liquidity in Primary and Secondary Markets as it potentially widens the total addressable investor base.[366] At scale, this can also drive positive macroeconomic and societal impacts by improving small-medium-enterprises' (**"SMEs"**) access to capital markets and allowing greater participation of retail investors in previously out-of-reach asset classes, thereby improving liquidity for all market participants.[367]

361 BCG, "Global Asset Management 2022: From Tailwinds to Turbulence," May 2022. AUM is used as a proxy for AuC.
362 Ibid.
363 BNY Mellon & Celent, 2022.
364 GFMA member surveys, November-December 2022.
365 ASIFMA, "Tokenised Securities: A Roadmap for Market Participants and Regulators," 2019.
366 Ibid.
367 OECD, "The Tokenisation of Assets and Potential Implications for Financial Markets," 2020.

Fractional ownership of securities already exists in capital markets. Fractional equities, for example, typically result from corporate actions like stock splits or after a merger or acquisition. More recently, broker-dealers like Fidelity and Robinhood have started offering fractional shares to retail investors.[368] However, some trade-offs and inefficiencies are addressed by fractionalization on a distributed ledger, as explained below.

While stock splits reduce an equity price without impacting market capitalization, they are not an effective way of fractionalizing securities. In the case of a stock split, fractional equities result from a pre-determined corporate action rather than any decision taken by the investor on their behalf. As a result, these fractional equities can have liquidity constraints and may not be transferable across broker-dealers. This is due to technical limitations of the CSD and other intermediaries in the post-trade process whose legacy systems may not be able to handle fractional equities.

With the use of a distributed ledger adopted at scale, fractional securities may become more prominent in capital markets. Use of DLT could allow fractionalization across asset classes rather than just in equities (as demonstrated by DLT pilots today) and ensure broad cross-platform compatibility in Secondary Market and post-trade processing as all DLT-compatible systems would necessitate support of fractional securities. However, corporate governance would similarly have to be updated to meet the needs of fractional securities. For example, voting rights of fractional securities would need to be adequately reflected in company law and communicated to investors during Primary Market Issuance.

Finally, units of cash have limitations on subdivision. Although these can be represented on an electronic database, exchanges of cash are limited to a set number of decimal places. This necessitates the need for rounding. On a distributed ledger, these could be far more precise as the technology can extend to more decimal places for DLT-based settlement assets like tokenized commercial bank money and central bank digital currencies. Though this impact is limited on a transaction basis, at scale and over time, it could become meaningful.

3.4.3 Use Cases: Tokenization of Investment Funds

The funds space has seen increased Tokenization activity in recent years as both investors and fund managers have been exploring the two main sources of value that DLT would bring: (1) greater efficiency to fund operations, and (2) increased access and liquidity of more illiquid investment funds.

Greater efficiency for fund operations

In the status quo, fund operations are a complex process involving a constellation of stakeholders. For instance, the subscription process for a mutual fund, which is one of the most straightforward in the funds space, actual involves around ten key steps.

Given that investment funds pool groups of securities together, the Inefficiencies are consistent with some of the operational Inefficiencies for individual securities. Post-trade reconciliation and KYC/AML/CFT processes are labor intensive as fund managers and transfer agents must issue duplicative requests for siloed data. Onboarding processes for alternative investment funds require extensive paper-based documentation, given the increased regulatory requirements on those investments relative to publicly traded mutual funds.

Introducing the distributed ledger would confer the data consistency and accessibility needed to rationalize and reduce post-trade reconciliation processes. Similarly, DLT can power a KYC utility that collates and shares each client's KYC documentation to streamline data requests. Assuming the distributed ledger becomes the source of truth, DLT can also store information currently gathered via paperwork, expediting, and reducing the cost of the onboarding process for alternative investment funds. FundsDLT, a Luxembourg-based startup

368 See Fidelity's "Stock by the Slice" concept here, for example: https://www.fidelity.com/trading/fractional-shares

funded by Clearstream, Credit Suisse, LSE, and Natixis, seeks to improve fund transaction processing using the Quorum DLT technology.

Increased Access

DLT can also broaden investor access to illiquid alternative investment funds such as private equity and venture capital. Today, access to private equity is mostly limited to institutional investors, pension funds, and high-net-worth individuals given the high minimum investment and long holding periods involved. However, there exists a group of accredited investors who can qualify to invest but do not have easy access to the return profile and diversification benefits of private equity. They represent an $80 trillion USD pool of investable capital, a market that managers have not yet served.[369]

DLT allows private equity fund managers to reduce investment minimums because (1) the fund token is easily divisible and (2) the reduced cost of fund operations and onboarding makes it economically feasible to accept smaller investments. Private equity managers have already begun to offer tokenized fund products. In 2021, Partners Group partnered with ADDX to tokenize one of its funds. In April 2022, Hamilton Lane worked with tokenized a private equity fund with ADDX as well, followed by a similar move by KKR's Health Care Strategic Growth vehicle later that year. Current law continues to require private equity investors meet high income and wealth thresholds; as an example, Hamilton Lane set its minimum buy-in at $10,000 USD, substantially lower than the minimum investment for its traditional funds ($125,000 USD). However, while a lower price threshold can facilitate access, a more important enabler is ensuring that the terms and conditions of tokenized funds are the same, or functionally similar, to the terms and conditions of the underlying liquid fund.[370]

With increased access comes the prospect of more robust Secondary Market activity in an asset class traditionally known for illiquidity and long holding periods. For example, investors who purchase tokenized interests in KKR Health Care Strategic Growth must abide by a 1-year lockup period before dealing on the Secondary Market. The exact consequences of Secondary Market activity are still to be seen as managers and investors continue to test DLT.[371]

3.4.4 Legal Considerations

There are various legal structures via which an asset can be tokenized. The types of methods available, and the requirements to achieve each, will depend on local legal and regulatory framework for the jurisdiction in which the asset is being tokenized.

Typical legal structures that can be used to tokenize assets include (but are not limited to):

1. the creation of a contractual framework under which economic exposure to the asset is created with no associated proprietary interest in the asset, effectively constituting a contract for differences, which would attract the applicable derivatives regulation in a given jurisdiction;
2. the creation of fractional entitlement to a pool of assets (either by contract or otherwise), which may be considered in certain jurisdictions to be a collective investment scheme, which would typically subject to applicable rules for investment funds (for example, in the E.U., AIFMD); or

369 S&P Global Market Intelligence, "Private equity's blockchain adoption may clear path to retail investors," October 2022.
370 Ibid.
371 Ibid.

3. the creation of asset-backed tokens, whereby the reference asset it not cash/fiat currency, and the token holder has a right of redemption either to the asset or a representative monetary value. For example, in the E.U., MiCA will provide a framework allowing for the issuance of Asset Reference Tokens.[372] [373] While the use of this legal structure may have been intended for the creation of stablecoins, it is also a means by which assets can be tokenized. As such, it is relevant in this context.

Once the regulatory treatment of the digital asset has been established, the activities that a regulated financial institution or service provider is able to carry out in respect of these will depend on this regulatory treatment, as well as the legal and regulatory framework of the jurisdiction in which the asset is being tokenized. In some jurisdictions, there may be nothing preventing financial institutions from carrying out certain activities, for example providing custodial services, in respect of some or all types of digital asset, However, other jurisdictions may actively prohibit the holding of certain other kinds of digital assets, or impose stringent capital requirements when holding these assets, making it impractical or impossible for financial institutions to do so. Similar considerations apply to other activities carried out by financial institutions or service providers, for example trading in or issuing of digital assets. Each activity will be subject to different rules and it will be necessary for the financial institution or service provider to see whether each activity will be permitted in the relevant legal and regulatory framework.

Ultimately, clarity is required from legislators and regulators as to the delineation between the different categories of tokenized assets (created using the methods discussed above), so that participants do not inadvertently create the wrong type of asset. Additionally, clarity is required from regulators in relation to the ability of financial institutions to Custody each form of tokenized asset for clients, subject as always to the condition that the financial institution in question has put in place the relevant risk-mitigation measures. The same consideration applies for other types of activity including (but not limited to) trading in or issuing of digital assets.

372 It should be noted that, in certain jurisdictions there are currently restrictions on the assets that can back a stable coin, for example in Hong Kong, stablecoins can only be backed by fiat currency, and in Singapore this is restricted further to a single type of fiat currency for a given stablecoin.

373 It should be noted that, these regimes are not available in all jurisdictions.

Chapter 04

Legal and Regulatory Landscape

4.1 Legal and Regulatory Challenges

This chapter focuses on the challenges for the valid creation and trading of traditional securities using DLT, such as shares or bonds. Depending on the jurisdiction, these challenges could be categorized as issues surrounding the valid creation and recognition of the security and issues relating to compliance with secondary trading requirements that may arise. Once securities have been validly created and can be validly traded, they should be able to be deployed in the applicable use cases discussed in Chapter 3.

Existing securities laws ideally should be refined and modified to optimally apply to DLT-based Securities. For example, existing disclosure requirements may not capture all of the pertinent information or address all of the risks that are most relevant to investors of DLT-based Securities, to the extent that they differ from traditional securities.

The existing rules relating to dealings with DLT-based Securities by securities services providers and intermediaries (such as transfer agents, broker-dealers and custodians) also pose a challenge to the development of the DLT-based Securities marketplace. These rules should be refined and revisions should be considered to reflect the nature and structure of the DLT-based Securities ecosystem and permit investors and the markets to seamlessly deal in, hold, or otherwise use DLT-based Securities and traditional securities. This includes achieving the same legal protections for DLT-based Securities that are in place for traditional securities. While non-exhaustive, of particular importance would be to achieve insolvency remoteness, settlement finality and recognition of netting arrangements.

These changes will involve reviewing the settlement standards. The existing regime was put in place to further the goal of dematerializing securities and the promoting paperless settlement given problems experienced with a paper-based system. Today's regulated service providers work on systems that contemplate a heavily intermediated electronic settlement process. The migration to newer, more efficient systems that contemplate a DLT-based environment requires analysis and modifications. Given the success and protections of the current settlement processes for traditional securities, regulators and legislators may be hesitant to seek changes despite the potential for DLT to enable shortened and improved settlement cycles. Detailed policy analysis is required to determine how regulation should be reconfigured in order to facilitate the settlement of DLT-based Securities without losing legal and regulatory protections for users. This will include, in some jurisdictions, reviewing and revising mandates relating to clearing and related functions.

Because DLT-based Payment Instruments are intended to perform a function equivalent to underlying legacy products, the legal and regulatory issues are also complex. In these cases, it is important to ask whether the same standards that provide assurances and trust in traditional commercial bank money and fiat currency should be applied and, if so, how they might need to be adopted or clarified to fit DLT-based Payment Instruments. In addition, existing laws should be reviewed to ensure that the legal principles establishing payment finality continue to provide the legal bases for supporting DLT-based Payment Instruments that are based upon the digitization of legacy products such as bank deposits. For example, financial market infrastructures (**"FMIs"**) must establish rules that determine settlement finality between the FMI and system participants and between or among participants, and prudentially regulated participants, such as banks are required to mitigate risks to safety and soundness and financial stability when engaging in such payments activities.[374] These requirements include conducting a legal review of arrangements to ensure that there is a high degree of certainty of settlement finality

374 See e.g., CPMI/IOSCO "Principles for financial market infrastructures" paragraph 3.8.4.

with respect to transactions.[375] Further development of legal principles with respect to settlement finality and collateral in different jurisdictions could help parties more easily demonstrate the legal bases to meet this standard. Similarly, policymakers in relevant jurisdictions should consider whether amendments to the insolvency laws could help parties demonstrate that they have the legal bases to ensure that contractual provisions governing tokenized forms of financial instruments (such as repos) will have the same insolvency treatment as traditional cash in their jurisdiction.[376]

As a core principle, regulation should not prevent or create inappropriate barriers for the development of DLT-based Payment Instruments. Regulations and other standards for DLT-based Payment Instruments should be rationalized to ensure that banks can continue provide the types of services to customers that customers are accustomed to receiving from banks, with prime examples being Custody and transaction facilitation. Other digital assets that serve payment functions, which have been developed by non-banks, remain largely unregulated in the current environment and are outside of the legal framework that could provide the legal bases for meeting a high level of legal certainty as to finality of payment or insolvency treatment under applicable law. Customers that use these instruments are not likely, therefore, in the near term, to benefit from the same protections as when dealing with banks and assets or payment instruments based upon commercial bank money.

4.1.1 U.S.

4.1.1.1 Application to Digitized Securities and Certain Trading and Markets Issues

Application of U.S. Framework to DLT-based Securities

The following section sets out the application of the U.S. regulatory framework to issuers and intermediaries of a DLT-based Security framed in reference to a digital equity security across its trade lifecycle. Under section 2(1) of the Securities Act of 1933[377] (the **"Securities Act"**), a "security means any note, stock, . . . investment contract . . . or, in general, any interest or instrument commonly known as a 'security[.]'" The Securities Act's expansive definition of "security" has raised notable legal questions for the SEC with regard to certain digital assets, namely how the characteristics of certain digital assets reconcile with the SEC's and U.S. case law's historical interpretation of a security. The Howey test, developed by the U.S. Supreme Court in 1946, is the primary legal test for determining whether something is an "investment contract" security under the Securities Act.[378] While the SEC's increased regulatory involvement in recent years[379]may suggest a momentum toward the design of a comprehensive regulatory framework for digital assets, no such federal framework yet exists, and there is a lack of consensus and clarity as to which digital assets may fall in and out of the scope of the federal securities laws. We limit our application of the U.S. framework to digital assets qualifying as securities under Howey, namely DLT-based Securities and securities tokens, consistent with the report scope set out above.

375 Although the BCBS guidance with regard to prudential treatment of cryptoassets introduces the condition of "settlement finality" in SCO 60.14, and states that "banks are required to conduct a legal review of the cryptoasset arrangement to ensure this condition is met, and make the review available to their supervisors upon request", it does not provide express guidance as to what standard such legal review is required to meet. In prior guidance on the subject of settlement finality for foreign exchanges, the BCBS has provided the following guidance: " A bank should obtain legal advice that addresses settlement finality with respect to its settlement payments and deliveries. The legal advice should identify material legal uncertainties regarding settlement finality so that the bank may assess when key financial risks are transferred" and that "[a] bank needs to know with a high degree of certainty when settlement finality occurs as a matter of law." BCBS "Supervisory guidance for managing risks associated with the settlement of foreign exchange", paragraph 3.6.5. This is similar (but not identical) to the guidance in respect of FMIs contained in paragraph 3.8.4 of the CPMI/IOSCO "Principles for financial market infrastructures".

376 The amendments involved may be minor - current insolvency law does provide a basis for recognizing these assets see: ISDA, "Navigating Bankruptcy in Digital Asset Markets: Netting and Collateral Enforceability", January 2023; and ISDA, "Navigating Bankruptcy in Digital Asset Markets: Digital Asset Intermediaries and Customer Asset Protection", May 2023.

377 15 U.S.C. § 77a et seq.

378 See SEC v. W.J. Howey Co., 328 U.S. 293 (1946) (holding that an instrument is an "investment contract" security if: (i) there is an investment of money, (ii) in a common enterprise, (iii) with the expectation of profits (iv) to be derived from the efforts of others). See also Reves v. Ernst & Young, 494 U.S. 56 (1990) (resulting in the so-called "Reves family-resemblance test" for "stock" securities, infrequently applied to digital assets in comparison with Howey).

379 See, e.g., SEC Press Release, SEC Nearly Doubles Size of Enforcement's Crypto Assets and Cyber Unit (May 3, 2022), available at https://www.sec.gov/news/press-release/2022-78.

1. Registration and Issuance

The existing registration and disclosure requirements under the Securities Act and Securities Exchange Act of 1934[380] (the **"Exchange Act"**) for issuers of traditional securities can be largely compatible with issuers of a traditional corporate form offering DLT-based Securities. While the expansive definition of "issuer" under the Securities Act may create unaddressed issues for securities offered and sold by nontraditional, decentralized entities, such issues are outside of the scope of this report.[381] Despite this, exceedingly few digital asset issuers have registered a digital asset as a security (e.g., INX Limited[382] and Overstock's "digitally enhanced security"[383]).

The main challenge that registration and disclosure requirements may pose for DLT-based Securities is not technical in nature. Rather, from an analytical perspective, the current line-item disclosure requirements may fail to account for key aspects of the security and a DLT environment that a purchaser may consider material.[384] For example, DLT-based Securities are generally issued through a smart contract. The deployer of the smart contract can define in code the controls of what the DLT-based Security can and cannot do on the DLT. These controls include transfer restrictions and the ability for an administrator to issue further tokens or burn tokens from supply. While broad principles of risk disclosure could pick up these issues, there is no DLT-specific line-item disclosure requirement related to a code review associated with a DLT-based Security that describes a given token's functionality to an average investor.[385]

While potentially underinclusive, the disclosure requirements may prove to be simultaneously overinclusive. For example, a central purpose of the current disclosure requirements is to address information asymmetry between issuers, management and promoters on the one hand, and investors on the other hand. However, DLT-based Securities might aid in the absolute or partial mitigation of certain disclosure risks, potentially creating fundamental inefficiencies for some DLT-based-Security issuers and purchasers under existing disclosure requirements. For example, the Exchange Act requires SEC -reporting companies' directors and officers, as well as shareholders who own more than 10% of a given class of equity securities, to report most of their transactions involving the company's equity securities to the SEC within two business days.[386] The burden is placed on the issuer or large shareholder to report because it is not feasible for the SEC or investor to obtain access to each issuer's Books and Records (or their transfer agent's) where ownership of the security is recorded. The same may not be said for a DLT used by issuers. The SEC and investors could have access to the DLT to instantly see the current state of ownership, and event logs could be used to notify when a party surpasses the 10% threshold.

380 15 U.S.C. § 78a et seq.

381 We note, however, that the broad definition of issuer may pose issues for decentralized entities given that their structures often lack traditional corporate decision-making or controlling bodies. The SEC has suggested that a group of individuals may be held liable for failing to register a security if those grouped individuals were "responsible for the success or failure of the enterprise." See SEC, The DAO at 16 (citing SEC v. Murphy, 626 F.2d 633, 644 (9th Cir. 1980) at 643). Decentralized entities typically have flat structures with sometimes hundreds of persons, even thousands, implementing code changes to a protocol in a way that may be directly tied to the success or failure of an enterprise, raising concerns that the broad issuer definition may potentially capture unintended persons in decentralized entities.

382 In April 2021, INX Ltd. (INX), a Gibraltar-based cryptocurrency trading platform, listed the first blockchain token to be registered with the SEC under Form S-1, in an offering that ultimately raised $83.6 million. INX worked with SEC regulators for two and a half years and through sixteen registration amendments to realize the offering. INX used the proceeds to launch its digital trading platforms—initially two separate platforms, one for cryptocurrencies and one for security tokens. In September 2022, INX merged its two trading platforms—cryptocurrencies and securities—into one platform called "INX One." INX claims that its platform constitutes the first fully regulated trading platform for both security tokens and cryptocurrencies.

383 In May 2020, Overstock, the Nasdaq-listed online retailer and technology company, registered and offered a digital dividend (an 'airdrop') to its 40 million shareholders, where one digital voting Series A-1 preferred share of the stock was offered for every 10 shares owned of Overstock. The stock paid a 16 cent annual dividend, sharing liquidation rights of common shares, and would be available for trade only through broker-dealer subscribers to tZero (a blockchain-based ATS marketplace owned by Overstock's subsidiary). See Exhibit (sec.gov). But see SEC.gov | SEC Charges Alternative Trading System for Failing to Comply with Certain Requirements of Regulation ATS (describing the SEC's settled charges against tZero in January 2022 for its violation of Rule 301(b)(5) of Regulation ATS under the Exchange Act, among others, given that that tZero failed to meet certain requirements applying to ATS's where the trading of any security has exceeded 5% of the total volume in at least four of the previous six months, including a requirement to establish written standards for granting access to the ATS. In tZero's case, trading of the Series A-1 security increased 100% on the platform by the end of 2021).

384 See Hester M. Peirce, SEC.gov | Outdated: Remarks before the Digital Assets at Duke Conference (January 20, 2023) ("Disclosure under current regulations, however, is not well-suited to elicit the most useful and appropriate information for token purchasers because it does "not cover a number of features unique to digital assets that would undoubtedly be considered important when making an investment decision[.]" . . . Instead, traditional disclosures are "designed for traditional corporate entities that typically issue and register equity and debt securities" and "focus on disclosure about companies, their management and their financial results—topics that poorly fit the decentralized and open-source nature of DLT-based digital asset securities").

385 Ibid. ("[A] more tailored crypto disclosure regime would be good for investors and crypto companies").

386 See § 16 of the Exchange Act; see also id. §§ 13(d), 13(g) and Regulation 13D-G of the Exchange Act (requiring issuers who beneficially own more than 10% of a given class of publicly-traded equity securities to report their beneficial ownership to the SEC).

2. Listing Requirements and Secondary Trading

DLT-based Securities of a traditional corporate form, the focus of this report, can be largely compatible with the existing listing requirements, such as those mandated by national security exchanges ("**NSEs"**).

The main challenges arise in applying the secondary trading laws, which only contemplate intermediation, to a system where disintermediation is possible. Specifically, the existing legal framework contemplates the use of a broker-dealer to facilitate secondary trading. The SEC and FINRA have provided guidance regarding registration requirements for broker-dealers that trade DLT-based Securities, but further clarity and tailoring to gain widespread adoption is needed. Furthermore, the current regulatory structure requiring intermediation via broker-dealers creates a clash between the promise of the technology and the law. To date, secondary trading of DLT-based Securities has been limited and largely confined to ATSs, which are themselves broker-dealers. While inserting intermediaries is certainly possible (and perhaps, in some cases, preferable) in DLT environments, the requirement to use a broker-dealer to facilitate secondary trading could be seen to conflict with the direct access to value generally promised by DLT. Additionally, the SEC recently proposed, and reopened the comment period, for a rule that would amend the definition of an "exchange." A final rule may capture and impose additional requirements for exchanges that facilitate the trading of DLT-based Securities and further impede the trading of DLT-based Securities.[387]

3. Transfer Agents

The SEC has provided limited approvals for transfer agents that use DLT,[388] but more needs to be done to enable a registered transfer agent to use DLT as the issuer's master securityholder file—the official ledger for record ownership of a security. Currently, in our survey of applicable SEC filings, the transfer agent must use its own private database and have administrative rights (whether on the token's smart contract or permissioned DLT network) to update the DLT to reflect its own private database.[389] For example, in the ArCoin prospectus, the transfer agent Securitize "maintains the Fund's shareholder records in a book-entry system" with the "Ethereum blockchain contain[ing] a viewable 'courtesy copy' of such records, but the Transfer Agent's records constitute the official shareholder records of the Fund and govern the record ownership for the Fund's shares in all circumstances."[390] Furthermore, "[i]n the event of a conflict between the transaction history on the Ethereum DLT network and the records maintained by the Transfer Agent, the Transfer Agent shall update the distributed ledger record as necessary and such update will be recorded and viewable on the Ethereum network as a subsequent transaction."[391]

In our survey of applicable SEC filings, we are unaware of the SEC approving a transfer agent's sole use of the DLT as the "issuer's master securityholder file" (transfer agents that use DLT must also use a traditional book entry that serves as the "issuer's master securityholder file"). Under this structure, the benefits that DLT could provide are largely unrealized. Requiring the use of a private database in some ways undermines a purpose of using DLT to store data—the DLT is supposed to serve as a decentralized source of truth, yet the private, centralized database is instead what has final say. When record ownership is managed on a private database, there is not direct auditability—a major benefit of many DLTs—because the transfer agent can unilaterally update the DLT based on opaque off-chain information. Additional areas of potential clarity from the SEC to help facilitate the benefits

387 See Supplemental Information and Reopening of Comment Period for Amendments to Exchange Act Rule 3b-16 Regarding the Definition of "Exchange", Proposed Rule: Rule 3b-16 Reopening of Comment Period (sec.gov).
388 See Securitize, About Us, Securitize | Tokenize your assets with Securitize Transfer; See Securrency, What We Do, A compliant, interoperable platform for financial transactions (securrency.com).
389 See e.g., SEC Filing | Overstock.com Inc. ("[W]hile the records of Computershare (as our transfer agent) govern record ownership of the Series A-1 Preferred, for all record holders on the transfer agent's official and controlling records there is a "courtesy carbon copy" of certain Computershare ownership records on the blockchain. Following Computershare's approval of any change in record ownership, the security position information relevant to a record holder's digital wallet address on the blockchain is updated consistent with changes to Computershare's official Books and Records"); See also https://www.sec.gov/Archives/edgar/data/1758583/000121465920001068/f26205n2.htm ("[T]he ownership and transfer of [the DLT-based Securities] will be authenticated and recorded as ERC-1404 compatible tokens on Ethereum, an electronic distributed ledger that is secured using cryptography[,] . . . [t]he ERC-1404 standard allows shareholders to interoperate with the entire Ethereum ecosystem with added functionality that allows the Fund to enforce transfer restrictions within the ArCoin smart-contract" such as control over „the conditions under which ArCoins may be transferred, to whom they may be transferred and the number of ArCoins that may be transferred").
390 https://sec.report/Document/0001580642-22-004983/.
391 https://sec.report/Document/0001580642-22-004983/.

of DLT could include a determination of whether a transfer agent is necessary for DLT-based Securities, where ownership records are publicly available (pseudonymously) and a determination about when a transfer agent could rely solely on the distributed ledger as its official record.

4. Custody

The SEC staff has provided staff guidance on Custodying digital assets[392] and considerations for broker -dealers in order to satisfy the SEC rules regarding Custody, such as the Customer Protection Rule.[393] Most recently, the SEC proposed rule changes that would broaden the application of the current investment adviser Custody rule beyond client funds and securities to include any client assets in an investment adviser's possession, including digital assets.[394]

However, there are several differences in the mechanisms and risks associated with Custodying traditional securities and DLT-based Securities. Many solutions for how broker-dealers can Custody DLT-based Securities limit their usability. For example, the SEC and FINRA have provided three "buckets" for how a broker-dealer can comply with the Customer Protection Rule, and thus receive approval to develop a business model based on DLT-based Securities.[395] Namely, a broker-dealer can act as (1) a placement agent,[396] (2) an ATS, or (3) establish themselves as a "special purpose broker-dealer" (**SPBD**) that can Custody DLT-based Securities. All three paths leave much of a DLT's benefits on the table. In effect, (1) and (2) provide a solution greatly limiting broker-dealers' business models surrounding this technology. Broker-dealers that fall into these buckets but still would like to use DLT are constrained to do so by ensuring "non-controlling elements of blockchain technology" and instead using the DLT as a "courtesy copy" of Books and Records maintained under traditional systems.[397]

The option of becoming a SPBD permits Custody, but many in the industry have found it impractical.[398] The requirement of SPBDs to only deal in DLT-based Securities,[399] not digital assets nor traditional securities, adds significant costs and creates significant inconvenience for customers who need a separate broker-dealer for each type of asset the customer would like to transact. The structure also does not permit broker-dealers and their customers to take advantage of the benefits of DLT. For example, because SPBDs must limit their activities exclusively to DLT-based Securities, and cannot engage in activities involving non-security digital assets, the broker-dealer will be unable to effectuate transactions crucial to the clearance and settlement—the payment side of the trade, removing the operational efficiency DLT affords.[400]

An SEC staff interpretation, Staff Accounting Bulletin 121 (**"SAB 121"**) affecting the accounting treatment of "crypto-assets" held in Custody by reporting entities, including regulated banks, raises significant process, policy, and related concerns, and as written would present major obstacles to the involvement of regulated financial institutions in these markets.[401] Specifically, SAB 121 provides that an SEC reporting entity, including a financial

392 See SEC.gov | SEC Issues Statement and Requests Comment Regarding the Custody of Digital Asset Securities by Special Purpose Broker-Dealers (December 23, 2020); See SEC.gov | Joint Staff Statement on Broker-Dealer Custody of Digital Asset Securities (July 9, 2019).
393 https://www.sec.gov/news/public-statement/joint-staff-statement-broker-dealer-Custody-digital-asset-securities.
394 https://www.sec.gov/news/press-release/2023-30.
395 https://www.finra.org/media-center/finra-unscripted/membership-application-program-digital-assets-firms.
396 Under this approach, the "broker-dealer sends the trade-matching details (e.g., identity of the parties, price, and quantity) to the buyer and issuer of a digital asset security . . . and the issuer settles the transaction bilaterally between the buyer and issuer, away from the broker-dealer. In this case, the broker-dealer instructs the customer to pay the issuer directly and instructs the issuer to issue the digital asset security to the customer directly." The broker-dealer never takes Custody of the tokenized security under this bucket.
397 https://www.sec.gov/comments/s7-25-20/s72520-8648975-231028.pdf ("tZERO Markets is an SEC-registered broker-dealer, member of FINRA and one of the subscribers to the tZERO ATS. It operates an online platform that permits investors to trade securities that are quoted on the tZERO ATS. These securities utilize blockchain technology elements that are intended to enhance the investor experience through added transparency. The blockchain allows for a courtesy carbon copy of certain ownership records to be viewable, as a convenience and with no controlling effect, on a publicly available distributed ledger. While the courtesy carbon copy of certain ownership records is publicly viewable on the blockchain, it is also is pseudonymized, meaning that such copies do not contain personally identifiable information. In all cases, Books and Records of regulated market participants continue to be the sole controlling authority on ownership and other matters. These securities are not digital asset securities within the meaning of the Statement given the non-controlling elements of blockchain technology.").
398 https://www.sec.gov/rules/policy/2020/34-90788.pdf.
399 Note that the SEC uses the term "digital asset securities" in this guidance, which we refer to as "DLT-based Securities" in this report.
400 https://www.sec.gov/comments/s7-25-20/s72520-8819436-238123.pdf.
401 See https://www.sec.gov/oca/staff-accounting-bulletin-121. SAB 121 states that "[f]or the purposes of this SAB, the term 'crypto-asset' refers to a digital asset that is issued and/or transferred using distributed ledger or blockchain technology using cryptographic techniques." This appears to mean that SAB 121 applies to all DLT-based Securities, cryptocurrencies, and any other digital assets, regardless of whether the assets are held on a public, permissionless or private, permissioned blockchain.

institution, should present a liability on its balance sheet to reflect its obligation to safeguard the digital assets held for its platform users at the fair value of the cryptoassets. The entity should also recognize a corresponding asset on its balance sheet measured at the fair value of the digital assets held for its platform users. In a break from the treatment of traditional assets, SAB 121 applies even if the safeguarded digital asset is held in a Custody capacity on behalf of a client. This is entirely different from how institutions account for traditional securities and other assets they hold in a Custody capacity. An institution that determines that it is appropriate for it to apply SAB 121 for SEC reporting purposes must complete its regulatory reporting consistent with the classification determination made for SEC or other financial reporting purposes. For example, an institution that has concluded that a SAB 121 safeguarding asset should be recorded on its balance sheet as "other assets" would need include the asset in the relevant regulatory reporting schedules as "other assets". Because other assets figure into the calculation of total assets, holding cryptoassets on behalf of a client would impact banking organizations' regulatory capital ratios. This treatment effectively deters banks from safeguarding digital assets due to the significant regulatory capital costs of such activities.

5. Settlement and Clearing

In 1975, Congress passed amendments to the Securities Act which facilitated the current clearing agency regime. DLT can solve many of the issues clearing agencies were established to fix through more efficient and advanced technology. Unlike the clearing agency model spurred by the 1975 amendments, execution, clearing, and settlement may now occur in a singular transaction given that many popular DLTs are atomic—where either all transfers occur at the same time or none occur at all. Therefore, on atomic DLTs, the risk that assets will not be provided when parties execute a trade is no longer present. In other words, the need for a central role of clearing agencies—to act as a CCP addressing counterparty risk—can be mitigated.

Clearing agencies play an integral role in today's markets. While DLT can address many of the issues that clearing agencies were put in place for, including counterparty risk, the current regulatory system may have the unintended consequence of regulating every validator node on a DLT. Such a regulatory system may not only be impractical (some DLTs have hundreds of thousands of validator nodes), but it would arguably apply a legal framework to entities that do not serve the functions we typically associate with a clearing agency.[402] The attendant regulatory requirements and potential liability may deter many participants from acting as validation nodes, thus canceling out some of the key benefits of DLT-based systems.

4.2.1.2 Application to Digitized Payment Instruments and Issues Related to Assets Held or Intermediated by Banks

1. DLT-based Payment Instruments

In the United States, the federal government has only begun work to evaluate the feasibility and desirability of a U.S. CBDC. In a factsheet released by the White House on September 16, 2022, the Biden Administration stated that "the reports [issued by the Treasury and DOJ on CBDCs] encourage the Federal Reserve to continue its ongoing CBDC research, experimentation, and evaluation and call for the creation of a Treasury-led interagency working group to support the Federal Reserve's efforts."[403] There is currently no consensus as to whether the United States should proceed with a CBDC or what characteristics a U.S. CBDC should have.

The federal banking regulators recently confirmed that it would be legally permissible for a state or national banks in the United States to issue certain DLT-based Payment Instruments, subject to receiving a supervisory

402 Section 3(a)(23) of the Exchange Act finds that a party that is an "intermediary in making payments or deliveries or both in connection with transactions in securities" or that "otherwise permits or facilitates the settlement of securities transactions . . . without physical delivery of securities certificates" is performing the functions of a clearing agency. It is unclear whether participants on the infrastructure layer of DLT would be classified as a "clearing agency" and would thus have to register. For example, validator nodes could be perceived as "facilitat[ing] the settlement of securities transactions" by ensuring that each party holds the assets or funds that it commits to buy or sell. Not only is it unclear how such a validator node would register with the SEC on a practical level (when such registration envisions a centralized entity), but the stringent requirements placed on clearing agencies would also arguably be mismatched when applied to a validator node that neither custodies securities nor serves in the role of reducing counterparty risk.

403 The White House, FACT SHEET: White House Releases First-Ever Comprehensive Framework for Responsible Development of Digital Assets (Sep. 16, 2022).

nonobjection and demonstrating to its supervisors that it has controls in place to conduct the activity in a safe and sound manner.[404] Notably, the FRB highlighted that it generally believes that issuing tokens on open, public, or decentralized networks, or similar systems is highly likely to be inconsistent with safe and sound banking practices because it raises concerns related to operational, cybersecurity, and run risks, and may also present significant illicit finance risks. Such risks also are "pronounced" where the issuing bank does not have the capability to obtain and verify the identity of all transacting parties, including for those using un-hosted wallets.[405]

2. Settlement

In the United States, federal regulators have the authority to supervise and oversee certain payment, Clearing and Settlement activities, and certain FMIs. For example, Title VIII of the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 (**"Dodd-Frank Act"**) authorizes the Financial Stability Oversight Council (**"FSOC"**) to designate systemically important payment, clearing, and settlement activities and financial market utilities (**"FMUs"**).[406] It remains to be seen what the effect of the adoption of DLT platforms will be. Legal principles for settlement finality for payment instruments is set forth in commercial law, which can incorporate certain private-sector system rules and contractual agreements.[407] Existing laws may provide the mechanisms for parties to demonstrate sound legal bases to support a high degree of certainty with respect to settlement finality of DLT-based Payment Instruments. We note that last year, the CPMI and IOSCO identified "probabilistic settlement" as an issue that certain DLT platforms may face when seeking to achieve settlement finality.[408] However, because DLT-based Payment Instruments do not use public-permissionless blockchains, probabilistic settlement may not be an issue for these types of payment instruments.

4.1.2 U.K./E.U.

From a U.K./E.U. perspective, the legal architecture utilized in creating the digital security must be considered at the outset, as each form (set out below) has specific and varying legal and regulatory outcomes.

4.1.2.1 Legal Architecture for Tokenization

The paragraphs below set out an overview of the three primary methods of Tokenization.

1. **True Tokenization.** This method involves immobilizing an underlying financial instrument and placing it with a nominee, who holds the instrument on trust for a custodian. The custodian then creates the token that represents the underlying financial instrument, granting rights in accordance with the legal structuring of the token (e.g., as set out in the terms and conditions). Under English law, the tokens produced are likely to qualify as specified investments, specifically as "certificates representing certain securities" or as "rights or interests in investments".[409] These are well-recognized structures in the U.K. In the E.U., they are likely to qualify as a financial instrument for the purposes of the Markets in Financial Instruments Directive II (**MiFID II**),[410] subject to any local law requirements around formalities for issuance (as discussed in Chapter 4.1.2.2 below).

2. **Native digital issuance.** The security is created and exists natively, directly on the distributed ledger as a financial instrument. There is no Tokenization of an underlying asset. Currently, only certain jurisdictions have built a framework allowing native digital issuance of securities for private markets (e.g., France, Germany and Luxembourg), while others (e.g. the U.K.) are considering the legal framework needed to enable it.

404 88 Fed. Reg.7848, 7850 February 7, 2023.
405 Ibid.
406 P.L. 111-203, the Dodd-Frank Wall Street Reform and Consumer Protection Act.
407 See e.g., UCC § 4A-501.
408 Application of the Principles for Financial Market Infrastructures to stablecoin arrangements (July 2022), paragraph 3.4.2.
409 Under Articles 80 and 88 (respectively) of the Financial Services and Markets Act 2000 (Regulated Activities) Order 2001 (SI 2001/544).
410 Directive 2015/65/E.U.

3. **Contractual Tokenization.** This method involves creating an economic exposure to an underlying financial instrument without creating any proprietary rights in that instrument. This effectively constitutes a derivative contract, and accordingly, tokens created via this method are likely to trigger certain regulatory requirements that apply to derivative contracts. DLT is used simply as a record of these contractual rights, with the potential for automation of payment flows under the contract via the implementation of smart contracts. For completeness, it is noted that, to the extent that there are any contractual arrangements between an issuer and a holder of the token that enables the holder of the token to subscribe for an investment, then this may qualify as a warrant. Under English law, warrants qualify as specified investments, specifically as *"instruments giving entitlements to investments"*.[411]

Assets that fall within category 3 do not create the same legal and regulatory issues in respect of their valid creation and trading as those in categories 1 and 2. This is because the rights that attach to category 3 assets are contractual in nature, and so are treated in the same way as any other contractual right. As a result, throughout this report, the U.K./E.U. legal analysis is focused on categories 1 and 2, referred to as "Tokenized Securities" and Security Tokens' respectively, and as 'DLT-based Securities' together.

4.1.2.2 Application to DLT-based Securities and Certain Trading and Markets issues [412]

Issuance

As set out in Chapter 4.1.2.2, when issuing debt and equity instruments specific requirements and formalities must be considered and complied with. The formalities that apply to the issuance of DLT-based Securities are specific to E.U. country (and not harmonized at E.U.-level). These requirements can present certain challenges when considered in the context of DLT-based systems.

1. **Equity instruments (shares).** The extent to which issuances of Security Tokens on DLT-based systems could satisfy the requisite formalities for the valid issuance of equity securities is currently unclear. For example, in the U.K., a Security Token issued on a DLT-based system may not comply with the formalities for issuance set out under the Companies Act 2006. Additionally, for equity securities issued under USRs, a U.K. registrar is required to monitor ownership. It is not clear whether a DLT-based system with a multi-jurisdictional spread of nodes would qualify as a U.K. registrar for the purposes of the USRs.
2. **Debt instruments (bonds).** To issue bonds natively on a DLT-based system, the issuer must create a token which (a) acknowledges the debt, and (b) creates a validly enforceable obligation on the issuer to pay the debt acknowledged under the token. Both elements are achievable electronically via a DLT-based system. In the U.K., for example, limb (b) is typically achieved via a deed poll which must be validly executed as a deed. It is well established that deeds can be created in electronic form, however, how this is achieved in practice depends on the parties to the deed. E.U. jurisdictions may require jurisdiction-specific formalities when validly issuing bonds. The validity of the issue of native digital bonds in the context of DLT-based systems should be considered on a case-by-case basis, per jurisdiction.
3. **Tokenized Securities.** Tokenized Securities created via true Tokenization (as set out under Chapter 4.1.2.1), may be recognized as specified investments under English law, potentially as "certificates representing certain securities" or as "rights or interests in investments".[413] These financial instruments may have their own specific issuance formalities, however listing requirements, and the issues surrounding settlement and payment, will still be relevant for Tokenized Securities. The specific classification of such tokens depends upon the characteristics of the token and the underlying financial instrument, as well as the local law in the relevant Member State. As set out in Chapter 4.1.2.1, to the extent that there is an intention to trade these securities on trading venues and enable a liquid Secondary Market it will be necessary to comply with all relevant regulatory requirements that are triggered.

411 Under Article 79 of the Financial Services and Markets Act 2000 (Regulated Activities) Order 2001 (SI 2001/544).
412 E.U. law deals with commonalities in E.U. jurisdiction markets but is not jurisdiction specific. As such, securities are issued in accordance with local law requirements.
413 Under Articles 80 and 88 (respectively) of the Financial Services and Markets Act 2000 (Regulated Activities) Order 2001 (SI 2001/544).

4. **Enforcement of Rights.** When examining the post-issuance lifecycle of Security Tokens, it must be considered how rights and interests (whether legal or equitable) in respect of the digital security can be stapled to an entry in a DLT-based system, so that the holder of the legally enforceable rights is identifiable and able to enforce these rights against a third party. These rights must be created upon issuance in such a way that they effectively transfer between subsequent holders of the digital security.

Generally, the creation of a Security Token must be done in a manner that ensures it embodies a claim to money, as opposed to just evidencing a claim. In most jurisdictions, the act of creating a token does not, by itself, create an enforceable legal obligation. As such, existing mechanisms must be used to create the applicable obligations (as discussed above, this can happen in the U.K. for debt instruments via use of a deed poll) in order to ensure the thing that is created is actually the issuer's legal obligation. Additionally, when issuing a Security Token, it must be ensured that the obligation is legally owed to the token holder, i.e., that the token is not simply a record of a claim to an underlying physical instrument.

The question of stapling and enforcement of rights will typically be jurisdiction-specific, and as such, it would have to be considered separately in each E.U. Member State. Additionally, certain jurisdictions have restricted the issuance of DLT-based Securities to registered form (as discussed below in Chapter 5.1.2.1). To encourage wide-scale adoption of DLT and DLT-based Securities in capital markets, market participants ultimately need clarity, as applicable, that DLT can be utilized in the context of the legal/regulatory framework in question.

CSD Requirements

The CSDR designates the functions that a CSD must exercise and sets out various mandatory requirements for CSDs.[414] In order to achieve adoption, perhaps in place of traditional CSDs, DLT-based systems must be able to achieve each of these functions from both a legal and technical perspective.

Provided that the issuance requirements for debt and equity instruments (as set out in Chapter 5.1.2.1) are satisfied by the native digital security, it is technically possible to issue these instruments on a DLT-based system. Generally, one of the key issues with listing, as set out in Chapter 5.1.2.1, is that transferable securities may only be admitted to trading on a trading venue (including regulated markets) or used as collateral if they are recorded in book-entry form on a CSD. For this to be possible in a DLT-based format, an existing CSD must obtain the relevant regulatory approvals to operate a DLT platform. No CSDs have obtained this form of approval to date. Accordingly, the most prominent native DLT-based Securities issued in Europe have not been listed. It should also be noted that it is not currently clear which form of DLT platform would be able to obtain such approval. Please see Chapter 2.1 for a discussion of the distributed ledger archetypes and their comparative attributes.

Legal clarity is required as to the validity of using DLT-based systems in this context. It should be noted, however, that if market participants wish to undertake private issuances that will not require listing or admission to a trading venue, the CSD requirements will not be applicable.

414 For example, under Section A of the Annex to the CSDR, CSDs effectively perform three core services: (i) the initial recording securities in a book-entry system ('notary service'); (ii) providing and maintaining securities at the top tier level ('central maintenance system'); and (iii) operating a securities settlement ('settlement service').

Secondary Trading

1. **Trading Venues.** The access and licensing requirements set out in the CSDR and MiFID II limit trading venue participants to authorized trading firms. This arguably presents a barrier to widespread adoption of DLT-based systems in capital market. Proponents of DLT-based systems and DLT-based Securities highlight the potential for greater accessibility and a deeper investor base when trading DLT-based Securities, which includes retail investors who are currently excluded from such participation. As noted above in respect of CSD requirements, this challenge is not relevant if market participants wish to undertake private issuances that will not require admission to a trading venue.
2. **Transfer.** When transferring DLT-based Securities, market participants need legal certainty that the relevant transfer has in fact occurred. A legally valid transfer of DLT-based Securities and their associated rights are contingent upon formalities and/or requirements that must be satisfied. Generally speaking, to facilitate secondary trading of DLT-based Securities, the DLT-based system in question must either be: (i) capable of satisfying the applicable formalities and/or requirements or (ii) exempt from the applicable formalities and/or requirements. These requirements are not harmonized across the E.U., and are determined by local laws in each E.U. member state (and the U.K.).

   To encourage adoption, regulators and/or legislators need to provide market participants with clarity as to the capacity for DLT-based systems to satisfy or be exempt from these requirements. Importantly, it will be relevant to provide certainty as to typical legal protections to transactions such as netting and settlement finality, particularly to satisfy commonly accepted principles of prudential regulation.

   One consideration under U.K. law when transferring DLT-based Securities is whether they are treated as securities or as mere contractual claims on the entity that created them. Generally, a contractual right can only be transferred under the law by which the contract is governed, via assignment. A contractual claim will be determined by the laws governing the contract. For example, a legal assignment is only made validly if it is made "in writing" under s.136 Law of Property Act 1925. "In writing" could be interpreted broadly in a DLT-based system that envisions full automation via smart contracts, for example. However, market adoption will require certainty on this front

   Conversely, a bearer security is generally regarded as an item of property in itself. Under U.K. law, it is therefore transferred under the relevant property law, which is dependent upon its situs. For example, the situs of bonds that are represented by a global note is deemed to be the place where the global note is physically present. For registered securities, the situs of the security is deemed to be the place where the register is maintained. In a DLT-based system with a multi-jurisdictional spread of nodes, the register could be seen to be maintained in some or all of the jurisdictions in which a node is located. Therefore, where the governing law is unclear, the requirements for a valid transfer are also not certain.

   Additionally, there are certain formalities under corporate law in relation to the registration and transfer of shares. In the U.K., while DLT-based systems could theoretically handle the various registration requirements upon transfer, the U.K. company would have to ensure that its systems are fully integrated with DLT and that the terms of its constitution are correctly encoded in the smart contracts effecting the changes to registers. Additionally, there may be challenges as to whether certain legal requirements (such as the directors' rights to refusal when registering ownership of the share transfer) could practically be satisfied by DLT-based systems, especially where the intention is to achieve automation of such processes. It should be noted, however, that many "transfers" of financial instruments in capital markets are in fact transfers of beneficial, and not legal title, which generally have less rigorous formalities/requirements.

   There are additional challenges posed in relation to corporate-adjacent rights afforded to holders of equity securities under the applicable corporate law, for example voting rights. It is not yet clear how these rights would be effected on a legal or operational level for Tokenized Securities or Security Tokens.

Whilst the preceding paragraphs focus on equity instruments (shares), there may be similar requirements for bonds depending on how the bonds in question are structured. Such requirements will be jurisdiction specific.

Similar considerations are applicable in the E.U. under jurisdiction-specific corporate law in each Member State.

Clearing

There is no mandatory clearing requirement for debt and equity instruments in the U.K. and E.U. under the applicable regulatory legislation. However, there may be clearing requirements for listed debt and equity instruments within the rules of trading venues. It is currently unclear how, or whether, clearing requirements may be updated for DLT-based systems and DLT-based Securities.

Compliance with E.U.-level Legislation

MiFID II and the CSDR, amongst other E.U.-level legislation, place multiple obligations on FMI. In the context of DLT-based systems, a number of these requirements appear onerous or unnecessary. For example, in such a system the relevant competent authority could hypothetically access the platform as a participant observer, arguably rendering the daily reporting requirements for MTFs under MiFID II unnecessary. Moreover, a DLT-based system could be capable of providing real-time transaction reporting. It could appear that the cost-saving incentives for adoption of DLT-based systems are offset by the cost to market participants of compliance with these requirements, among others. Further consideration is required in respect of compliance in the context of DLT-based systems, particularly as to whether it is possible or necessary to satisfy a given requirement where DLT-based systems are used.

The U.K. and the E.U. have created separate legislative proposals aimed at addressing, amongst other things, issues of legal and regulatory compliance for DLT-based systems. These proposals are discussed below in Chapter 4.4.2..

Adoption of DLT-based systems could be encouraged by addressing legal definitions, improving legal certainty, and removing certain barriers as discussed throughout this section.

Capital Treatment

Capital requirements are generally determined through a risk-based assessment of the asset in question. The approach to the risk assessment and consequential capital treatment of DLT-based Securities remains unclear. If capital requirements associated with DLT-based Securities are greater than the capital requirements associated with the corresponding traditional securities (i.e. a digital bond versus a traditional bond) as would be true if a jurisdiction would adopt the 2.5% infrastructure risk add-on or if digitally custodied securities were required to be recorded on the balance sheet of the Custody bank, then this presents a clear barrier to the adoption. Generally speaking, the application of any additional charges for the use of DLT are contrary to the principle of same risk, same activity, same regulatory outcome because in essence a legally recognized security is being treated differently depending on the system in which it is held. As discussed above, the ability of competent authorities to apply an infrastructure risk add-on is not well-founded and ignores the available risk mitigants in real world use cases for the use of this technology.

4.1.2.3 Application to DLT-based Payment Instruments and issues related to assets held or intermediated by banks

DLT-based Payment Instruments and Settlement

As outlined in Chapter 2, DLT-based Payment Instruments can be used to facilitate faster, or even simultaneous settlement of a digital security transaction. Therefore, legal and regulatory consideration of DLT-based Payment Instruments from a settlement perspective is essential.

The potential application of the FMI Principles as implemented in the relevant jurisdictions (across the E.U. and U.K.) should be considered in this context. In terms of securities and payment settlement, this will include the application of certain statutory protections such as settlement finality protection, netting and enforceability of collateral arrangements. DLT platforms are not risk-free, however, it is not clear to what extent they might replicate the same risks that exist under traditional FMIs. Further regulatory consideration in this respect is required, particularly as industry begins adopting this technology, as permitted under the E.U. Pilot Regime and U.K. FMI Sandbox (discussed below in Chapter 4.2.2.3).

In the existing U.K. framework, there is nothing generally precluding a provider using a DLT-based system from qualifying as: (i) a designated payment system (regulated by the Payment Systems Regulator); (ii) a recognized payment system (regulated by the Bank of England pursuant to the Banking Act 2009); or (iii) a designated system under the Settlement Finality Regulations. Indeed, a U.K. provider using a DLT-based platform has already obtained the applicable authorizations to achieve status as a designated and recognized payment system. Obtaining such status now allows operators of payments systems to gain access to the Bank of England RTGS system. In this case, the payment system would benefit from the legal protections of settlement finality, netting (where relevant) and enforceability of any collateral arrangements in respect of this system. Whilst the applicable licensing requirements can be onerous for a provider to obtain, it is certainly possible under existing U.K. law. Further, in April 2019 the Bank of England announced the creation of a new model allowing operators of payments systems to hold funds in an omnibus account to fund their participants' balances with central bank money[415]. Nonetheless, an entity providing such services risks triggering licensing requirements as an e-money issuer, a payment service provider, and/or a bank. Despite this, it is possible, if onerous for an entity to obtain the requisite authorizations.

The operational features of any permissionless DLT framework may in practice include different settlement mechanisms. In order to achieve legal settlement finality, it is therefore necessary to determine a precise moment of settlement after which the transaction becomes irrevocable. This makes the determination of the exact moment of operational finality nearly impossible. However, the intended scope of any settlement finality requirement must be assessed at the level of the settlement process as a whole and not simply the operational elements. Settlement finality is a legal technique used to cover delays in settlement systems. As such, where a transaction involves an exchange on a DLT system, this should be recognized as final on the basis of the legal consensus between the parties, subject to confirmation through appropriate legal opinions. While such consensus maybe easier to achieve on a DLT-based permissioned environment – either because the environment can be engineered to provide a clear moment of settlement finality, or because it is possible for parties to contractually agree to settlement finality – market participants and regulators should remain open to the possibility of achieving settlement finality in public permissioned networks with appropriate controls in the long term, on the basis of legal consensus.

415 Other central bank authorities may take different approaches, see for example the position of the European Central Bank ("ECB"): https://www.ecb.europa.eu/paym/target/target2/shared/pdf/Policy_prefunding_ancillary_systems.pdf .

There is an existing E.U.-level framework for issuing electronic money (including, the E-money directive,[416] as implemented in each E.U. Member State, and associated pieces of legislation). However, it is unclear how the specific obligations under this framework, for example in relation to the holding and reconciliation of reserves held in DLT-based Payment Instruments, may be satisfied by an e-money issuer using a DLT-based system. Legal and regulatory clarity will be required as to how these requirements may be satisfied, noting that MiCA does not address this point.

Issues beyond Financial Services

The legal analysis contained in this report is not exhaustive, and several of relevant legal/regulatory challenges lie beyond the scope of financial services, each of which is more broadly relevant to the use of DLT. For completeness, a brief discussion of some of these key areas is set out below. These would require additional consideration.

Qualification of DLT-based Securities of DLT-based Payment Instruments as property. There is authority in the U.K. for the proposition that tokens are property,[417] and there is ongoing discussion as to the treatment of digital assets as property under U.K. law.[418] If treated as property under U.K. law, then transfers of, and rights associated with, DLT-based Securities will, in certain circumstances, be determined by property law as opposed to contract, affording the holder of the token enforceable rights against the issuer and third parties (i.e. rights to the token itself as property).

Data Privacy. In the U.K. and E.U., specific legislation places restrictions on owners and processors of data, relating to data protection and privacy, as well as the usage, storing and sharing of data.[419] Certain aspects of these regulations may be incongruent with DLT-based systems, for example, the GDPR provides clients with the right to 'erasure' or the 'right to be forgotten', which may not be compatible with the inherent immutability of DLT-based systems.

Tax. There is no harmonized proposal in the U.K./E.U. as to the tax treatment of DLT-based Securities or DLT-based Payment Instruments. Tax treatment could have significant impacts on profitability for investors and issuers alike and will vary between jurisdictions.

Legal validity/certainty of Smart Contracts. Smart contracts relate to programmability, which is one of the main potential benefits of DLT. One of the key pre-conditions for programmability is clear legal contracts, which can then be translated into code. Several issues surround the validity of smart contracts under English law, which could thereby mitigate the potential benefits of smart contracts. Issues with smart contracts that may give rise to disputes include:

Validity/certainty. The analysis concerning whether a smart contract constitutes a legal contract is unclear. There are issues with some of the fundamental principles of contract formation. A contract generally requires an offer and acceptance, consideration and an intention to create legal relations. The parties to that contract must be sufficiently certain, and either a natural or a legal person with the legal capacity to enter into such an agreement. It will not always be possible in the context of smart contracts and DLT-based systems generally, to reliably identify the parties, their capacity, or their intention to create legal relations. This could prevent smart contracts from constituting legal contracts.

Insufficiency of code. There are complexities translating the real-world agreement into code. Discrepancies can give rise to disputes.

416 Directive 2009/110/EC.
417 See the Lawtech Delivery Panel "Legal Statement on Cryptoassets and Smart Contracts" of November 2019.
418 Reference is made here to the ongoing Law Commission Consultation on Digital Assets: https://www.lawcom.gov.uk/project/digital-assets/
419 For example, in the U.K., the Data Protection Act 2018, and in the E.U., General Data Protection Regulation (E.U.) 2016/679 ("GDPR").

Mistakes. Any errors mean that the contract may not be performed as intended. Contract law doctrines developed over centuries are not applied in code simply, especially where intention is necessary for automation

4.1.3 Hong Kong

4.1.3.1. Application to DLT-based Securities and certain trading and markets issues

1. **Issuance:** Current rules set out formalities to document the ownership of shares (e.g. share registers), which are incompatible with securities issued on DLT-based systems that utilize automated ownership records. Issuers of DLT-based Securities would be required to reproduce such records in a format compliant with current rules.
2. **Listing requirements:** Securities issued on DLT-based systems would technically be compatible with the current legal regime.
3. **Secondary Trading:**

   These requirements assume an intermediary that generally must be licensed by the SFC and be an approved exchange participant; certain DLT arrangements may need to be restructured to accommodate an intermediary, especially when using a DLT-based system that does not require an intermediary by default.

   There is legal uncertainty as to whether current electronic transaction rules (such as the Electronic Transaction Ordinance) apply to DLT-based transactions and smart contracts. This creates operational difficulties in ensuring the validity and enforceability of transfers of DLT-based Securities under Hong Kong law. In particular, the Electronic Transaction Ordinance carves out the recognition of the validity and enforceability of certain instruments which are executed electronically, such as instruments that are required to be stamped under the Stamp Duty Ordinance (e.g. share transfer documents) and deeds in relation to interests in land. This means that such documents must be executed in wet-ink and are fundamentally incompatible with DLT structures.

   Where Tokenized Securities represent ownership in listed securities, there is legal uncertainty as to whether holders of Tokenized Securities would be subject to the existing market integrity framework, such as disclosure of substantial shareholder rules, investor identification rules and insider trading rules. Similar concerns exist regarding Tokenized Securities which may be classified as OTC derivatives and uncertainty exists over whether they would be subject to the OTC derivatives regime.
4. **Clearing:** Given that there are mandatory clearing obligations for listed securities and OTC derivatives, this may be incompatible with DLT structures.

Additionally, the legal challenges, hurdles and considerations set out under the Hong Kong legal and regulatory analysis in Chapter 3.3 in relation to Sovereign bonds, apply to bonds generally.

4.1.4 Japan

A regulatory framework for transactions in respect of DLT-based Securities has already been implemented in Japan. The regulatory framework is discussed in detail in Chapter 4.2.4.

4.1.5 Singapore

4.1.5.1 Legal Architecture for Tokenization

In Singapore, MAS takes a technology-neutral stance and would examine the characteristics of the token to determine the appropriate regulatory treatment. For instance, if the digital asset has the characteristics of a security such as a share or a bond, it would be regulated under the Securities and Futures Act 2001, similar to other capital markets products. If the digital asset is not such a regulated product but used as a medium of exchange for payment, then it is regulated as a digital payment token under the Payment Services Act 2019.

4.1.5.2 Application to DLT-based Securities and Certain Trading and Markets Issues

In Singapore, the MAS has published "A Guide to Digital Token Offerings", which provides general guidance on the application of the relevant laws administered by MAS in relation to offers or issues of digital tokens in Singapore. Offers of digital tokens that constitute regulated products such as securities are subject to the same regulatory regime under the SFA as offers of such regulated products made through traditional means. Such regulatory requirements would include prospectus requirements unless the offer can be made in reliance on prospectus exemptions.

Similarly, in relation to the secondary trading of digital tokens which constitute regulated products such as securities or derivatives contracts, a person who establishes or operates such a trading platform in Singapore may be establishing or operating an organized market. A person who establishes or operates an organized market, or holds himself out as operating an organized market, must be approved by MAS as an approved exchange or recognized by MAS as a recognized market operator under the SFA, unless otherwise exempt.

4.1.5.3 Issues Beyond Financial Services

Data Privacy. The Personal Data Protection Commission (**"PDPC"**) has published a Guide on Personal Data Protection Considerations for Blockchain Design.[420] When personal data is written on a DLT network, the decentralised and tamper-resistant attributes of DLT give rise to challenges in complying with the obligations under the Personal Data Protection Act 2012 (**"PDPA"**).[421] For instance, the PDPA prohibits organizations from collecting, using or disclosing an individual's personal data unless the individual gives consent for the collection, use or disclosure of his or her personal data for a specific purpose.[422] This presents a challenge in a permissionless DLT network, where data written on a distributed ledger is publicly accessible by all participants (e.g. node operators), making it impossible for organizations to effectively establish control over the collection, use and disclosure of the data by another participant. In addition, if an organization has fulfilled the purpose of collecting a piece of data, and there is no further business or legal requirement for data retention, the organization should dispose of the data. It can do so either by securely erasing it or stripping personal identifiers from the data. However, as the data committed on a distributed ledger is immutable, it cannot be erased or modified. In view of these challenges, the PDPC has provided some recommendations to ensure personal data on DLT networks still comply with obligations under the PDPA. Such recommendations include not storing personal data on a permissionless DLT network whether in-clear, encrypted or anonymized, unless consent has been obtained from the individual for public disclosure. Even in a permissioned network, given that any personal data written on a distributed ledger in cleartext will be accessible by all other participants that host or operate nodes, access to personal data should be provided only to authorized network participants that have a business purpose to use the data.

420 PDPC, Guide on Personal Data Protection Considerations for Blockchain Design, 2022.
421 Singapore Parliament, Personal Data Protection Act, 2012 (2020 Revised Edition).
422 Ibid.

Qualification of DLT-based Securities or DLT-based Payment Instruments as property. In the recent Singapore case of *Janesh s/o Rajkumar v Unknown Person ("CHEFPIERRE")* [2022] SGHC 264, the Singapore High Court held that non-fungible tokens could be considered as property as they satisfied certain legal requirements, where such non-fungible tokens (i) are capable of being isolated from other assets whether of the same type or of other types and thereby identified; (ii) have an owner being capable of being recognized as such by third parties; (iii) where third parties must respect the rights of the owner in that asset and that the asset must be potentially desirable; and (iv) have some degree of permanence or stability.

4.2 Current State of Tokenization Legislation and Regulation

4.2.1 – U.S.

4.2.1.1 DLT-based Securities

There is no legislative framework explicitly pertaining to DLT-based Securities that exists at a federal level in the U.S. However, several individual lawmakers have pushed for U.S. Congressional action.[423] The prospect of greater clarity brought through U.S. federal legislation remains uncertain in the short term, though some U.S. states have made limited strides forward. On a national level, regulatory clarity will likely continue to develop gradually as courts grapple with the outer limits of regulation as they adjudicate both regulatory enforcement actions and private actions. On the regulatory side, the SEC has issued no-action letters,[424] Commission and staff statements, and requests for comments.[425] This has led to limited SEC approvals in the digital asset space, despite the continued and rapid growth of digital asset marketplaces. There have been limited steps to modify the current regulatory framework for nontraditional digital assets and none through rulemaking.

4.2.1.2 DLT-based Payment Instruments

Although the Federal Reserve has initiated public discussion with stakeholders about CBDCs, for all practical purposes, the issuance of a U.S. CBDC may not happen for many years, if at all. As noted above, the federal banking regulators recently confirmed that U.S. banks may issue tokenized commercial bank money and deposits if they are able to demonstrate that they are able to conduct such activities in a safe and sound manner receive supervisory nonobjection prior to engaging in the activity.

4.2.2 U.K./E.U.[426]

As discussed, the jurisdiction in which issuances of Security Tokens takes place is critically important when attempting to construct an understanding of the applicable legal position. Each jurisdiction can present separate and independent issues relating to legal certainty when using DLT-based systems. Legal certainty is one of the key factors for market participants considering the issuance of DLT-based Securities in each jurisdiction.

423 E.g., Digital Asset Market Structure and Investor Protection Act, H.R.4741, 117th Cong. (July 28, 2021), (introduced in the House of Representatives by representative Donald S. Beyer, Jr. (D-VA)). The bill proposed to create statutory definitions for digital assets and digital asset securities and provide the CFTC and SEC with respective authority over them, providing greater legal certainty. See Lummis-Gillibrand Responsible Financial Innovation Act, S.4356, 117th Cong. (June 7, 2022) (introduced by senators Cynthia M. Lummis (R-WY) and Kirsten Gillibrand (D-NY)). The bill similarly divides authority between the SEC and the CFTC whereby the SEC would have jurisdiction over the regulation of securities offerings of digital assets and the CFTC would have jurisdiction over ancillary assets falling within the digital asset definition. This bill represents the first significant bipartisan effort to apply comprehensive regulation to DLT-based Securities.

424 See e.g., TurnKey Jet, Inc.: No Action, Interpretive and/or Exemptive Letter of April 3, 2019 (sec.gov).

425 See e.g., SEC's Hester Peirce: U.S. dropped the ball on crypto regulation (cnbc.com) (SEC Commissioner Hester M. Peirce calling for greater regulatory clarity from the SEC, implying that the SEC's current method of regulation-by-enforcement has stymied technological innovation).

426 This section focuses on legislation implemented in the U.K. and E.U. jurisdictions specifically focusing on tokenisation and the use of DLT. Section 5.1 discusses a number of existing pieces of legislation that may apply in the context of DLT-based Securities.

At an E.U. and U.K. level, the E.U. Pilot Regime and FMI sandbox provide a useful opportunity to test DLT-based platforms within more flexible iterations of the existing legal landscape. This is expected to support the development of legal certainty in this area by affording market participants and regulators the opportunity to proactively assess and confront market access barriers.

As such, this section deals with the current position of Tokenization legislation and regulation by jurisdiction and examines the E.U. Pilot Regime and FMI sandbox in more detail (Chapter 4.2.2.3. below).

4.2.2.1 E.U.

Luxembourg, France and Germany, among others, have distinguished themselves in this field by developing and/or adopting legislation that allows companies to issue securities directly on DLT-based systems.

The law in Luxembourg permits issuance of dematerialized securities by foreign and local companies using DLT. Further, it allows other forms of securities to be converted into Tokenized Securities. This is achieved in Luxembourg by enabling certain firms to act as central account keepers (or similar roles) that perform functions akin to that of a CSD, although it should be noted that this does not circumvent the CSDR requirement discussed under Chapter 4.1.2.2) above and as such the securities cannot be listed.

French law allows for the issuance, transfer and delivery of Security Tokens on a digital ledger. It has also been developed incrementally by adapting the existing regime for registered bonds and adding protective features for token holders.

Germany has created a new legislative framework for digital assets, permitting the issuance of dematerialized bearer securities. Germany has provided legal certainty by deeming electronic securities to be tangibles and, as such, subject to the existing statutory framework. This treatment supplements the existing regime for bearer securities. Issuers in Germany can now issue native electronic securities instead of issuing physical (global or definitive) notes. This is achieved by formally depositing the applicable terms and conditions and establishing and maintaining a register of the applicable securities holders.

There are limitations in each jurisdiction. For example, in France, the securities cannot be listed on a regulated market or an organized trading facility under MiFID II nor admitted to the operations of a CSD.[427] Additionally, French law does not currently allow Security Tokens to be issued in bearer form, whereas German law does. Lastly, in Luxembourg, Security Tokens are treated under standard book-entry transfer rules, which do not provide a departure from the process for traditional securities.

The development and implementation of such legislation in E.U. member states provide some legal certainty and means that in these jurisdictions it is possible to create such natively-issued Security Tokens. However, once created, many of the same post-issuance challenges and hurdles discussed in Chapter 4.1 above remain relevant. Ultimately, Security Token issuances in E.U. member states remain subject to requirement to record securities in book-entry form on a CSD (as discussed in Chapter 4.1). As such, only private placements are possible for Security Tokens at this stage. Private placements do not create the desired liquidity for DLT-based Securities, in contrast to the liquidity that can be achieved by issuing traditional securities that are admitted to trading-on-trading venues. However, for completeness, it should be noted that the issuers of such non-listed Security Tokens are afforded some Secondary Market liquidity of their non-listed digitally native securities for example, via an admission to listing on the Securities Official List of the Luxembourg Stock Exchange and the use of bulletin boards.

427 These restrictions generally limit the securities that can be registered on a distributed ledger to: (i) negotiable debt securities; (ii) units or shares of collective investment undertakings; and (iii) unlisted equity securities issued by joint stock companies.

From a practical perspective, the potential cost savings and efficiencies granted by DLT may not be sufficient to compensate issuers for the costs and administrative burdens of complying with the more complex legal and regulatory regimes that are being established in various E.U. member states.

4.2.2.2 U.K.

In the U.K., the USRs permit a company to issue both equity and debt instruments in dematerialized form, which is generally accepted to include digital-only form. As such, the USRs might allow for the issuance of DLT-based Securities using DLT. However, to benefit from the USRs, securities must be issued on an electronic or digital registry that is operated by a licensed operator. Currently, there is no licensed operator that operates a DLT-based system. The USRs also require securities to be recorded on a register maintained in the U.K., and as such their ownership must be determined in accordance with English law. It is not clear whether a DLT-based system with a multi-jurisdictional spread of nodes would qualify as a U.K. registrar for the purposes of the USRs. Additionally, the obligations prescribed by these regulations are onerous and U.K. firms will need to consider carefully whether to issue debt instruments under them.[428] Accordingly, the USRs are not currently a viable way of issuing a digital security.

Participants are required to issue DLT-based Securities outside of the USRs. The problem is that, while in principle, it should be possible to rely on pure common law to issue these instruments, i.e., in the context of debt instruments, by creating tokens which (a) acknowledge the debt, and (b) creates validly enforceable obligation on the issuer to pay the debt acknowledged under the token to the token holder (as discussed above in Chapter 4.1.2), there remains legal uncertainty as to whether or not valid legal obligations have been validly created when issuing financial instruments in the context of a DLT-based system.

The U.K.'s approach to native digital issuances continues to progress. For example, the U.K. Jurisdiction Taskforce has consulted on the position under U.K. law in respect of native digital issuances and recently published a Legal Statement on its findings. T**his concludes that the existing legal framework in the U.K. supports the transfer and issuance of digital securities and reiterates the benefits of English law as a basis to position the U.K. as a global standard in digital securities markets.**[429]

4.2.2.3 E.U. Pilot Regime and U.K. FMI Sandbox

In the U.K./E.U., legislative proposals are under way that may facilitate the issuance and trading of DLT-based Securities using DLT-based systems, as set out below.

E.U. Pilot Regime

Certain key activities in relation to the lifecycle of financial instruments are regulated by E.U.-level legislation that was drafted before DLT-based systems were poised to enter into widespread use in financial markets. These activities include: (i) the sale and purchase of financial instruments; (ii) transfer of payments; (iii) providing settlement services, recording securities in book-entry form (e.g. see Article 3(2) of the CSDR, as discussed in Chapter 4.1.2) and maintaining securities accounts. The E.U. Pilot Regime recognizes that certain requirements under existing E.U. financial services legislation could be restrictive and prevent operators from innovating with DLT in capital markets, which would in turn prevent the development of solutions for trading and settling financial instruments that are issued, recorded, transferred and stored using DLT-based systems. As such, the E.U. Pilot Regime will allow applicants to obtain exemptions from certain provisions of CSDR and MiFID II, allowing them to (a) carry out activities for which they would not otherwise be authorized and (b) refrain from carrying out activities that are imposed by legislation but are ultimately burdensome or irrelevant for DLT-based systems.

428 U.K. public companies almost always issue equity securities, but not debt securities, under these regulations.
429 https://lawtechuk.io/insights/ukjt-digital-securities

The E.U. Pilot Regime focuses on the development of certain FMI actors. Specifically, it envisages the development of DLT-based multilateral trading venues (**"DLT MTFs"**) and DLT-based financial settlement systems (**"DLT SSs"**).[430] Additionally, a third FMI is envisaged that combines each of these roles into a DLT-based trading and settlement system (**"DLT TSS"**).[431] The E.U. Pilot Regime places its own, standalone requirements on participants, and does not restrict participation. However, in addition to the Pilot Regime requirements, participants must satisfy existing requirements, for example under MiFID II and CSDR. DLT MTFs may be operated by investment firms[432] or market operators[433] (i.e., the participant must satisfy the applicable requirements under MiFID II), and DLT SSs may be operated by CSDs[434] authorized under CSDR to run settlement systems. DLT TSSs must be authorized as a CSD and a market operator or investment firm. As such, while the Pilot Regime is theoretically open to new participants, it would be onerous for a firm to obtain the requisite levels of authorization.

a) Participant exemptions

Under the E.U. Pilot Regime, DLT MTF and DLT SSs will be able to apply for exemption from the listing requirement under Article 3 CSDR, that transferable securities may only be admitted to trading on a trading venue (including regulated markets) if they are recorded in book-entry form on a CSD. As discussed in Chapter 4.1.2, this requirement is one of the hurdles currently preventing the listing of DLT-based Securities in the E.U. If such an exemption is obtained, the security will be traded directly on a DLT SS. This will be a marked step forward in the E.U., where, to the extent that there has been any trading of financial instruments issued, recorded, transferred and stored using DLT, it has been limited to private placements and OTC trading. This will appeal to multiple market participants including (i) investors looking to diversify their portfolios with DLT-based Securities and (ii) issuers seeking the liquidity offered by established E.U. trading venues.

Another significant exemption under the E.U. Pilot Regime is the exemption from MiFID intermediation requirements for DLT MTFs. This exemption will theoretically allow retail investors to gain direct access to the DLT MTF's platform, and to deal on their own account. This exemption is appealing as it reduces intermediation fees and the number of actors required in the trade and post-trade processes, and expands the potential investor base, providing greater liquidity, and allowing issuers to access different investor profiles. The E.U. Pilot Regime will, however, place requirements on these retail investors, as set out in Article 4(2) of the E.U. Pilot Regime, including, for example, that they (i) must have sufficient trading ability, competence and experience, (ii) cannot be market makers on the DLT MTF, and (iii) must not use a high-frequency algorithmic trading technique on the DLT MTF. These requirements maintain financial stability and integrity on the trading venues, but (i) in particular precludes a significant proportion of retail investors from participating. It remains unclear how such experience could be demonstrated, and what level would be considered sufficient.

DLT MTFs will also be able to apply for exemption from transaction reporting requirements under MiFID[435]. Such requirements may be unnecessary in the context of a DLT-based system, given that it will be possible for the applicable competent authority to be granted direct access the platform as an observer participant.

Under the CSDR, CSDs perform three core services: (i) the initial recording securities in a book-entry system (**"notary service"**); (ii) providing and maintaining securities at the top tier level (**"central maintenance system"**); and (iii) operating a securities settlement (**"settlement service"**).[436] Performing (i) or (ii) of these functions while operating a Security Settlement System will trigger a licensing requirement under CSDR, a feature that is retained under the Pilot Regime for entities establishing a DLT SS or TSS. The Pilot Regime takes a step toward recognizing that, if DLT-based systems are used, there is arguably a reduced need for the CSD as a means of providing the notary service. In respect of the other essential services provided by CSDs in current trade and

430 EMSA, Report on the DLT Pilot Regime, September 2022.
431 Ibid.
432 As defined in Article 4(1), point (1) of Directive 2016/65/E.U. ("MiFID II").
433 As defined in Article 4(1), point (18) of MiFID II.
434 As defined in Article 2(1), point (1) of Regulation (E.U.) 909/2014.
435 Regulation (E.U.) 600/2014.
436 Section A of the Annex to the CSDR.

post-trade processes (i.e., by effecting the settlement of transactions as a Security Settlement System, acting as a depositary and offering investor CSD services similar to those offered by a custodian), the E.U. Pilot Regime will provide an opportunity for FMI to test the efficacy of DLT-based systems to carry out these processes while maintaining safe, integral financial markets.

The E.U. Pilot Regime allows DLT Security Settlement Systems and TSSs to apply for exemptions from certain requirements. It is designed to create the possibility of instantaneous settlement.

b) Conditions to participation

The E.U. Pilot Regime is limited to certain financial instruments, including: (i) shares issued by issuers with a market capitalization of less than EUR €500 million; and (ii) bonds or securitized debt (including depositary receipts or money market instruments but excluding those that embed a derivative or complicated structure) with an issue size less then EUR €1 billion. Additionally, financial instruments issued on DLT under the Pilot Regime can only be recorded or admitted to trading on an authorized DLT market infrastructure if the aggregate of all such financial instruments recorded or admitted to trading on the DLT market infrastructure does not exceed EUR €6 billion. These limits have received widespread criticism as being too low. Although the short-term aim is to provide a sandbox environment for DLT-based systems to be tested in the context of capital markets (as opposed to the long-term aim of facilitating access to capital), the application of DLT-based systems in capital markets should arguably be tested at scale. It remains to be seen whether the limits imposed will be sufficient for these purposes.

Investor protection, transparency, market integrity and financial stability are protected under the Pilot Regime via further requirements placed on participants, including the need to provide (i) a detailed business plan that details how the DLT would be used and the applicable legal terms, (ii) specific and robust IT and cyber arrangements relating to the use of DLT, (iii) appropriate measures for the safeguarding of clients' funds and even (iv) an exit plan in the event that the E.U. Pilot Regime is discontinued.[437]

c) Issues with the E.U. Pilot Regime

1. **Secondary trading.** Whilst the E.U. Pilot Regime allows greater investor participation in theory by giving national regulators some discretion, there are issues with the approach taken which mean that issues surrounding secondary trading remain. The E.U. Pilot Regime sets out essentially the same requirements as in Article 53(3) MiFID II, i.e. there is little improvement on the participation from the current legal and regulatory framework.[438] The Pilot Regime makes an express reference to operators permitting natural persons to deal on their own account; however, it is unclear how a natural person could demonstrate that they have "a sufficient level of trading ability, competence and experience". The requirement is in fact more onerous than that under Article 53(3)(b) MiFID II, as it also requires the participant has a "knowledge of the functioning of distributed ledger technology".[439]

   Additionally, there is a licensing issue. The activity of "dealing on own account" in respect of financial instruments that are admitted to trading on a trading venue is an investment service/activity under MiFID II[440] and as such would require the participant to be licensed to deal on their own account. Article 2 MiFID includes a carve-out for dealing on one's own account from the licensing requirement (other than in respect of commodity derivatives or emission allowances or derivatives thereof)[441]. However, this exemption does not apply where the person in question is a member or participant of an MTF. There is no exclusion or modification of Article 2 under the E.U. Pilot Regime, and so the only option for members, participants or the MTFs themselves would be to argue that this activity is not undertaken on a professional basis. Regardless, this leaves

437 Article 7 of the E.U. Pilot Regime.
438 This applies to both regulated markets and MTFs as a result of Article 19(2) MiFID II.
439 See, for example, Article 4(2)(b) of the E.U. Pilot Regime.
440 Annex 1, Section A, Point (3) MiFID II.
441 Article 2(1)(d) MiFID II.

uncertainty in relation to the requirement for licensing. This lack of clarity presents practical issues for DLT market infrastructure, issuers and participants alike.

2. **Cash leg.** As discussed above, the E.U. Pilot Regime allows participants to apply for an exemption to the requirement that CSD transactions must be settled in traditional cash and allows transactions to be settled with DLT-based Payment Instruments, including CBDCs, tokenized commercial bank money and e-money tokens. However, neither MiCA nor the E.U. Pilot Regime, as currently drafted, provide a framework that enables the creation of a payment platform that tokenizes money and can provide settlement by facilitating the cash leg of a digital security transaction.
3. **Cross-border issuance.** The E.U. Pilot Regime is only available for issuers established in one of the E.U. member states, which makes it difficult to rely on cross-border frameworks. Multi-jurisdictional access is a key benefit of DLT-based systems, and this limitation is a drawback of the E.U. Pilot Regime.

U.K. FMI Sandbox

The Financial Services and Markets Bill (the FSMB) was introduced in the U.K. in July 2022 and sets out proposed amendments to current U.K. legislation that would allow for the creation of a sandbox (or multiple sandboxes[442]). These sandboxes allow FMI to implement and test the efficiency and effectiveness of technology, including, but not limited to, DLT-based systems (the FMI Sandbox). The FMI sandbox is analogous to the E.U. Pilot Regime, in that it will allow certain entities to apply to be temporarily exempted from specific requirements under financial services legislation.

A distinguishing feature of the U.K.'s FMI Sandbox is that it envisages the modification and application of certain existing laws to permit the issuance of DLT-based Securities. This is a key difference of the FMI Sandboxes compared to the E.U. Pilot Regime, which only allows the disapplication of existing laws. As currently proposed, the scope of the FMI Sandbox is limited to certain relevant enactments, including the Companies Act 2006 and requirements under the USRs. However, it may not be wide enough to cover other legislation that impacts on the ability to trade DLT-based Securities, such as tax legislation.

The FSMB goes further than the E.U. Pilot Regime by allowing HM Treasury to permit a broad participation in the FMI Sandboxes, including FMI providers, participants in these systems and, theoretically, unregulated service providers such as technology companies.

Until the FSMB becomes law, it will not be possible to complete a full analysis of how it differs from the E.U. Pilot Regime, and it will be at HM Treasury's discretion to exercise its powers and determine the exact terms of the FMI Sandboxes.

An area in which the FMI Sandbox could differentiate itself from, and improve upon, the E.U. Pilot Regime, is to provide a framework that enables the creation of a payment platform that tokenizes money and can provide settlement by facilitating the cash leg of a digital security transaction.

442 Clause 13(9) of the FSMB allows for the creation of more than one FMI sandbox.

Comments on the Pilot Regimes

While the Pilot Regimes address certain E.U.-level legal and regulatory hurdles to adoption of DLT-based Securities and DLT-based systems, issuers and market participants must still consider jurisdiction-specific issues, such as those raised and discussed in Chapter 4.1.

A potential outcome of both Pilot Regimes (subject to the review of the relevant authorities) is that the applicable legal and regulatory regimes in the U.K. and E.U. would be permanently amended to provide the same regulatory and legal landscape as experienced by participants in the respective Pilot Regime. Permanent amendments akin to those proposed under the Pilot Regimes would arguably be a significant step forward in supporting the adoption of DLT and DLT-based Securities in capital markets. However, there will need to be further work undertaken to address the shortcomings under the proposed Pilot Regimes, as set out above.

4.2.2.4 Other elements of the regulatory framework in the near future

Certain proposed pieces of legislation will have an impact on Tokenization in capital markets, particularly in respect of the cash leg. The FSMB in the U.K. and the Markets in Cryptoassets Regulation (**"MiCA"**) in the E.U. both contemplate frameworks for DLT-based Payment Instruments, which they refer to as 'digital settlement assets' and 'e-money tokens' respectively.[443]

As stated, in Chapter 4.1.2.2 there is nothing precluding a provider in the U.K. using a DLT-based system from qualifying as: (i) a designated payment system (regulated by the Payment Systems Regulator); (ii) a recognized payment system (regulated by the Bank of England pursuant to the Banking Act 2009); or (iii) a designated system under the Settlement Finality Regulations. Obtaining such status has the additional benefit of allowing access to the Bank of England's RTGS system, which now allows operators of payment systems to hold funds in an omnibus account. The FSMB may provide the desired legal clarity on the legal framework for "digital settlement assets" and may also facilitate access to the market for potential digital payment systems. However, a change in law in the U.K. is not strictly necessary for the cash leg to function.

Currently, it is possible to issue e-money subject to certain base level requirements, including appropriate safeguarding and ringfencing of the reserves in respect of the e-money. When it comes into force, MiCA will provide a framework for entities in the E.U. to issue e-money tokens. However, this will be subject to more stringent requirements, and will present a further licensing requirement for e-money issuers.

Digital Euro proposal

The European Central Bank is pushing forward strongly with its digital euro proposal. The investigation phase began in October 2021 and is expected to conclude in October 2023. The digital euro will constitute a liability of the European Central Bank and the euro system offered in digital form for use by citizens and business to make payments.[444] While the E.U. Pilot Regime allows a DLT-FMI to settle transactions using CBDC, it is unlikely that the digital euro under the current project will be able to be used to facilitate the cash leg of DLT-based Securities settlements, as this project relates exclusively to CBDC or retail purposes.

Digital Pound joint consultation

In February 2023 HM Treasury and the Bank of England published a joint consultation on the potential case for a digital pound and the key features of such a model. However, HM Treasury and the Bank of England have emphasized that this work should be seen as positioning the U.K. to act decisively should it want to introduce a digital pound, rather than a commitment or initiative to build the necessary infrastructure.[445]

443 European Commission, Regulation of European Parliament and of the Council on Markes in Crypto-assets, September 2020.
444 Report on a digital euro October 2020.
445 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1134845/CBDC_WEB_PDF_-_7_FEB_2023_1130am.pdf.

Capital Treatment

As discussed earlier in this report, in December 2022, in December 2022, the Basel Committee on Banking Supervision endorsed a prudential standard on banks' cryptoasset exposures.[446] This delineated cryptoasset exposures into separate categories. For the purposes of this report, it is anticipated that parties will focus their attention on DLT-based Securities that fit into the category of Group 1 cryptoassets. It is anticipated that the market will take great comfort from the decision to update earlier proposals so that the 2.5% RWA infrastructure add-on will not be applied automatically. Authorities would be empowered to activate this add-on if they observed any weaknesses in the infrastructure on which particular cryptoassets are based. The activation of such infrastructure add-on would constitute a potential impediment to market development, for example if firms were concerned that an add-on might be applied in the future, causing assets to depreciate as firms become incentivized to divest themselves of their holding. This should act as a persuasive factor against authorities' application of the infrastructure add-on.

4.2.3 – Hong Kong

4.2.3.1 DLT-based Securities

1. The regulators in Hong Kong have adopted a technology-neutral regulatory approach and are seeking to regulate cryptocurrencies, digital tokens and related activities by introducing new legislation or issuing guidelines around the existing regulatory framework. By contrast, DLT-based Securities are not regulated by default. However, the SFC issued a statement on September 5, 2017, clarifying that where certain digital tokens have terms and features that would classify the digital assets as "securities" under the SFO (e.g. where they represent equity ownership or debt issuance akin to "shares" or "debentures"), they would fall within the ambit of regulatory oversight.[447] As such, depending on the terms and features of the digitized security, they could be subject to the securities laws of Hong Kong. The SFC also clarified in its Statement on Security Token Offerings on March 28, 2019, that digital assets that are digital representations of ownership of assets (e.g. commodities or real estate) or economic rights (e.g. a share of profits or revenue) utilizing DLT are likely to be securities under the SFO. [448]

2. If a digital security falls within the definition of "securities" under the Securities and Futures Ordinance, the full securities regulatory regime in Hong Kong applies. For example, any person who markets and distributes DLT-based Securities in Hong Kong is required to be licensed by the SFC. In addition, the SFC has issued a host of additional requirements applicable to parties engaging in digital assets activities. For example, in the SFC's Statement on Security Token Offerings on March 29, 2019, the SFC introduced enhanced investor protection measures that apply to parties engaging in securities token offerings, such as selling restrictions (limiting offerings to professional investors only), enhanced due diligence requirements on issuers, and warning disclosure requirements.166

3. However, Hong Kong regulators have increasingly recognized the need to regulate digital assets that do not strictly conform to the definition of "securities". In the SFC and HKMA Joint Circular on intermediaries' virtual asset activities on January 28, 2022, the SFC set out additional requirements applicable to intermediaries engaging in virtual asset activities, and the definition of virtual asset was designed to capture a broad range of non-central bank issued digital tokens, irrespective of whether they constituted "securities" or not.[449]

446 https://www.bis.org/bcbs/publ/d545.pdf.
447 SFC, "Statement on initial coin offerings", 5 September 2017: https://www.sfc.hk/en/News-and-announcements/Policy-statements-and-announcements/Statement-on-initial-coin-offerings.
448 SFC, "Statement on Security Token Offerings", 29 March 2019: https://apps.sfc.hk/edistributionWeb/gateway/EN/circular/doc?refNo=19EC19
449 SFC and HKMA, "Joint Circular on intermediaries' virtual asset-related activities", 28 January 2022: https://apps.sfc.hk/edistributionWeb/gateway/EN/circular/intermediaries/supervision/doc?refNo=22EC10

4. In October 2022, the SFC announced a wealth of measures in a push to encourage growth of the digital asset market and DLT innovation. The SFC has indicated that it will set out a detailed modified Security Token regime in due course which is expected to relax current rules, such as the removal of the automatic classification of Tokenized Securities as "complex products" (which are subject to enhanced suitability requirements), such as simple Tokenized Securities which have similar characteristics as traditional financial instruments[450]. The Hong Kong government has also indicated that it is open to future review on property rights for DLT-based Securities and the legality of smart contracts in order to provide a solid legal foundation for their development[451].

4.2.3.2 DLT-based Payment Instruments

The current stance of the HKMA is that cryptocurrency (in the context of bitcoin) is to be regarded as "virtual commodity" and not legal tender and it does not qualify as a means of payment or electronic/digitized money. Further, in a statement released by Hong Kong's Customs and Excise Department (C&ED) in April 2014, it was stated that: "Bitcoin and other similar virtual commodities are not 'money' and do not fall within the regulated regime administered by C&ED". The Financial Services and the Treasury Bureau also stated in its Consultation Conclusions to the consultation on legislative proposals to enhance anti-money laundering and counter-terrorist financing regulation in Hong Kong that virtual assets are not legal tender.[452]

There is currently no specific regulation on digital money operations. Various regulatory regimes may apply that have not been harmonized or tailored to cater for the structure and reality of digital money and similar products. These include the existing securities law regime mentioned in Chapter 4.2.3.1, banking and money broker licensed activities under the Banking Ordinance, money lender licensed activities under the Money Lenders Ordinance, stored value facility operator licensed activities under the Payment Systems and Stored Value Facilities Ordinance, and money service operator licensed activities (with respect to money changing and money remittance) under the Anti-Money Laundering and Counter-Terrorist Financing Ordinance. Issuers and intermediaries involved in digital money operations typically have to assess each product on a case-by-case basis, some of which may be riskier than others from a regulatory perspective.

As such, the HKMA has been reviewing the need to enhance the existing regulatory framework and issued a discussion paper in January 2022 to consult the industry regarding future regulation of digital money, with a particular focus on regulation of payment-related tokens (such as stablecoins and asset-backed payment tokens) at this stage.[453] The HKMA have now concluded this consultation, and have formally proposed the introduction of a stablecoin licensing regime in their consultation conclusion, published on January 31, 2023.[454] The proposal sets out the regulatory perimeter for stablecoins, including the activities that will be regulated and the entities that will require licensing.

In addition, ongoing efforts by the HKMA are exploring the issuance of a retail CBDC in Hong Kong, namely the e-HKD. In October 2021 and April 2022, the HKMA published a discussion paper to consult the public regarding various design considerations (including issuance mechanism and legal considerations) as well as use cases of e-HKD on both the technical and policy front.[455] After collecting feedback from market consultation, the HKMA

450 SFC, "Embracing Innovation, Regulation and the Future of Finance Keynote address at Hong Kong FinTech Week 2022", 31 October 2022: https://www.sfc.hk/-/media/EN/files/COM/Speech/HKFW-Speech---Eng_20221031.pdf?rev=34b90c7d8dce42ad9215da652cd77dc5&hash=E11F1164D81137053A27C6CEEFACE9D3

451 SFC, "Policy Statement on Development of Virtual Assets in Hong Kong", 31 October 2022: https://gia.info.gov.hk/general/202210/31/P2022103000454_404805_1_1667173469522.pdf.

452 Financial Services and the Treasury Bureau, "Public Consultation on Legislative Proposals to Enhance Anti-Money Laundering and Counter-Terrorist Financing Regulation in Hong Kong Consultation Conclusions", May 2021: https://www.fstb.gov.hk/fsb/en/publication/consult/doc/consult_conclu_amlo_e.pdf.

453 HKMA, "Discussion Paper on Crypto-assets and Stablecoins", January 2022: https://www.hkma.gov.hk/media/eng/doc/key-information/press-release/2022/20220112e3a1.pdf.

454 "conclusion of Discussion Paper on Crypto-assets and Stablecoin": https://www.hkma.gov.hk/media/eng/doc/key-information/press-release/2023/20230131e9a1.pdf, Hong Kong Monetary Authority, January 2023.

455 HKMA, "e-HKD: A technical perspective", October 2021: https://www.hkma.gov.hk/media/eng/doc/key-functions/financial-infrastructure/e-HKD_A_technical_perspective.pdf and HKMA, "e-HKD: A Policy and Design Perspective:", April 2022 https://www.hkma.gov.hk/media/eng/doc/key-functions/financial-infrastructure/e-HKD_A_Policy_and_Design_Perspective.pdf.

in September 2022 released a position paper titled "e-HKD: Charting the Next Steps" to announce the next steps in launching e-HKD, which would involve the identification of areas in which legislative amendment is required to enable a digital form of fiat currency with legal tender status, and the launch of CBDC pilot programs.[456] Similar projects are underway in relation to the research and development of utilizing CBDC for wholesale cross-border payments.[457]

4.2.4 – Japan

4.2.4.1 Current framework for transactions in tokens representing securities

As mentioned in Chapter 4.1.4, a regulatory framework for transactions in respect of DLT-based Securities has already been implemented in Japan. The FIEA was amended in 2019 to regulate transactions of tokens representing securities in an attempt to facilitate capital formation in this manner while protecting investors. The amendment came into force in May 2020.

Characterization as security

Under the amendment to the FIEA, tokens representing (i) a conventional class of financial assets listed as "Type I Securities" under the FIEA (such as shares and bonds) or (ii) an interest in a collective investment scheme, would be deemed to be "securities".

Issuance of Type I Security Tokens

As a general rule, the issuer of the securities must file a Securities Registration Statement prior to the commencement of the offering of the securities, unless the offering satisfies the conditions for relying on a private placement exemption.

The FIEA introduced a new private placement framework for the situation where the Type I Securities are recorded and transferable electronically by means of DLT. The tokens representing such Type I Securities (Type I Security Tokens) may be offered for sale without registration if the tokens are, in the Primary Markets, offered only to qualified institutional investors (QIIs) as defined in the FIEA or to a small number of investors (fewer than 50), and a technological restriction is implemented to limit transfers in the Secondary Market. Such restriction might be that, for example, (i) only QIIs can acquire the tokens or (ii) the transferor can only transfer the tokens it holds all together to one transferee. A person who visits the website on which an offering of Type I Security Tokens is announced or reported could be deemed an offeree, and therefore, in practice, it will be important to limit persons with access to any marketing website to ensure that applicable restrictions are complied with when conducting private offerings of Type I Security Tokens without securities registration.

Issuance of Type II Security Tokens

The legal treatment of tokens representing an interest in a collective investment scheme and transferable electronically by means of DLT differs depending on whether certain technological restrictions on transfer are imposed or not.

456 HKMA, "e-HKD – Charting the Next Steps", September 2022: https://www.hkma.gov.hk/media/eng/doc/key-information/press-release/2022/20220920e4a1.pdf.
457 HKMA and Bank of Thailand, "Leveraging Distributed Ledger Technology to Increase Efficiency in Cross-Border Payments": https://www.hkma.gov.hk/media/eng/doc/key-functions/financial-infrastructure/Report_on_Project_Inthanon-LionRock.pdf.

Without a satisfactory technological restriction that makes (i) the tokens capable of transfer only to QIIs or certain eligible investors, and (ii) each transfer of tokens requires an offer by the transferor and consent from the issuer, the tokens will qualify as "FIEA Security Tokens" and will be regulated in the same manner as Type I Security Tokens as explained above.

However, satisfaction of the technological restriction conditions above means the tokens are not classified or regulated as **"FIEA Security Tokens"**, which means that they can be offered and sold more easily. The marketing of those tokens (Type II Security Tokens) must be handled by a Type II FIBO licensed entity (which is regulated to a lesser extent than a Type I FIBO licensed entity). Or, if the investors to whom the Type II Security Tokens are marketed are limited to a group comprised of at least one QII and fewer than 50 certain experienced investors, the issuer of the Type II Security Tokens may seek to rely on the FIEA Article 63 exemption from the Type II FIBO licensing requirement to conduct the marketing of the Type II Security Tokens. In terms of the management of the funds raised by way of an offering of the Type II Security Tokens, the issuer must be registered as an Investment Manager. Otherwise, the issuer would need to rely on the FIEA Article 63 exemption from the investment management license requirement.

Secondary Trading:

The secondary trading of any financial instruments in the course of business will, in most circumstances, trigger licensing requirements for any operator of trading and this regime equally applies to activities in respect of trading of Type I Security Tokens or Type II Security Tokens given that Type I Security Tokens and Type II Security Tokens fall under "securities" under the FIEA.

Clearing:

There is no mandatory clearing requirement for issuance of debt and equity instruments under the FIEA. Accordingly, Type I Security Tokens and Type II Security Tokens can be issued without clearing requirements, as is the case for debt and equity instruments regulated under the FIEA.

Listing:

There is no mandatory listing requirement for the offering of debt and equity instruments under the FIEA (the relevant requirement was abolished in 1998). Accordingly, Type I Security Tokens and Type II Security Tokens can be offered without listing requirements, as is the case for debt and equity instruments regulated under the FIEA. However, it is required to obtain proprietary trading system operation permission for Type I FIBO to operate proprietary trading system for the Type I Security Tokens and Type II Security Tokens.

4.2.4.2 Scope of Tokenization Legislation in Japan

Financial regulation inevitably raises the question of extraterritorial application. As long as a Japanese resident can possibly access the transactions of Security Tokens or cryptoassets, extraterritorial application of the FIEA or Japanese Payment Services Act arises even if the transaction is based in another jurisdiction and is in a language other than Japanese. As Japanese residents can be solicited in these circumstances, the FIEA or Japanese Payment Services Act would apply, as would the relevant regulatory regime(s) in other jurisdictions where the ICO is based.

The scope of Security Token regulations under the FIEA

As discussed above, a regulatory framework for transactions in respect of Type I Security Tokens and Type II Security Tokens has already been implemented in Japan. Having said that, it has been only a few years since the new regulatory framework was implemented, and further regulatory consideration is required.

One matter which needs further consideration is, if the financial asset that the tokens represent is designed so that it does not fall within any of the definitions of Type I Securities or interest in a collective investment scheme, whether the tokens may be sold without the regulatory constraints under the FIEA. Within the current framework, the answer seems to be yes as the definition of Type I Securities encompasses a limited list of specific instruments and does not include a catch-all category to capture instruments that do not fall within any of the specific instruments but have the general nature of securities.

However, such tokens might fall within the definition of crypto-assets under the Japanese Payment Services Act, which imposes registration requirements on dealers in crypto-assets. Therefore, in determining business strategy in Japan, both the definitions of Type I Securities and collective investment schemes under the FIEA, as well as the definition of crypto-assets under the Japanese Payment Services Act, must be considered.

The regulation of stablecoins in Japan

In June 2022, an amendment to the Japanese Payment Services Act, which aims to regulate digital money to be used for fund transfers and payments, including stablecoins, was enacted in Japan. The amendment reflects the international discussion surrounding stablecoins, especially the Financial Stability Board's final report and recommendations on the Regulation, Supervision and Oversight of "Global Stablecoin" Arrangements published in October 2020 (**"the 2020 FSB Recommendations**"), and is therefore in line with regulations being considered in other jurisdictions such as the U.S. and E.U., which regulate similar digital assets. Japan has opted out of a central bank digital currency (CBDC) approach (although the Bank of Japan has announced that it will commence a demonstration experiment with Japanese mega banks in early 2023), instead allowing private firms to issue stablecoins. The amendment enables the use of legislatively permitted stablecoins in Japan. Permission to issue stablecoins in Japan is only granted to licensed banks, fund transfer agents, and trust companies. A registration requirement will also be introduced for the distribution of stablecoins, to strengthen investor protection and measures against money laundering, although assessment of the exact details will require analysis of the implementing ordinances, which are yet to be published.

As set out in the 2020 FSB Recommendations, stablecoins can be categorized according to the various types of stabilization mechanisms used. Stablecoin designs currently reflect two broad types of mechanisms, i.e., asset-linked and algorithmic.

The issuance of stablecoins in Japan has already been restricted to licensed banks, fund transfer agents and trust companies, but the transfer and management of stablecoins were not previously regulated. This means that, from the viewpoint of investor protection, the amendment has introduced a new licensing requirement for performing intermediary functions such as the transfer and management of stablecoins. A firm obtaining the new license will be subject to codes of conduct, such as anti-money laundering and countering the financing of terrorism.

4.2.5 – Singapore

The regulatory approach in Singapore has been to look beyond the label of an asset, and examine its features and characteristics:

- For instance, if the digital asset has the characteristics of a security such as a share or a bond, it would be regulated under the Securities and Futures Act 2001, similar to other capital markets products. If the digital asset is not such a regulated product but is used as a medium of exchange for payment, then it is regulated as a digital payment token under the Payment Services Act 2019.In relation to stablecoins, MAS has stated that it takes a technology-neutral stance and will examine the characteristics of the stablecoin to determine the appropriate regulatory treatment. MAS will continue to review industry developments relating to stablecoins and assess its appropriate regulatory treatment accordingly. In October 2022, MAS published a consultation paper on the Proposed Regulatory Approach for Stablecoin-Related Activities (which sets out MAS' policy

regarding the overall regulatory approach on stablecoin-related issuance and intermediation activities).[458] The consultation closed on December 21, 2022. In the consultation paper, requirements such as reserve asset backing, timely redemption at par and disclosure requirements are being proposed in relation to the issuance of stablecoins.

- Payment token derivatives (i.e., derivatives contracts that reference payment tokens as underlying assets) as a general asset class are currently not regulated under the Payment Services Act 2019 as digital payment tokens or the Securities and Futures Act 2001 as derivatives contracts. However, MAS regulates payment token derivatives that are offered on approved exchanges, as these are considered systemically important trading facilities, as well as where MAS-regulated entities offer such payment token derivatives to retail investors.

MAS FinTech Regulatory Sandbox

The MAS established the FinTech Regulatory Sandbox in 2016 to encourage and enable experimentation of technology innovation in financial services, within a well-defined space and duration where MAS would provide the requisite regulatory support. The Regulatory Sandbox was enhanced with Sandbox Express in 2019 to provide firms with a faster option for market testing of certain low-risk activities in pre-defined environments. This FinTech Regulatory Sandbox framework is available for firms looking to apply technology in an innovative way to provide new financial services that are regulated by MAS and is not specific to the use of DLT.

Other elements of the regulatory framework in the near future

The Financial Services and Markets Act 2022 was passed by Parliament in Singapore on April 5, 2022. It is not yet in force. The FSMA will regulate virtual asset service providers created in Singapore that provide virtual asset services outside of Singapore in order to fully align with enhanced FATF standards on virtual asset service providers and mitigate reputational and money laundering and terrorist financing risks.

MAS does not currently see a compelling case for retail CBDCs in Singapore. However, it continues to actively explore good use cases for digital currencies. Project Orchid launched in November 2021 aims to build the technical capabilities and competencies necessary for MAS to issue a retail CBDC, should the need arise.[459]For example, Phase 1 of Project Orchid explored the concept of Purpose Bound Money (bearer instruments, with self-contained programming logic and transferrable between two parties without intermediaries) in the form of government vouchers and government payouts.[460]

4.3 Considerations for Legal and Regulatory Next Steps

To encourage widescale adoption of DLT and Tokenization in the context of capital markets, market participants generally need two key elements from a legal/regulatory perspective. First, there must be legal certainty that the digital security created in a given instance legally qualifies as the asset it is intended to be, with associated rights that can be enforced against the relevant parties (including, for example, the issuer, a counterparty to the transaction, and/or a third party, if applicable). To that end, any framework needs to (i) clarify conflicts of laws, ownership of digital assets and how to effectively pledge and perfect digital assets as collateral, and (ii) clarify insolvency treatment of digital assets. Second, there must be a regulatory framework that provides certainty that the activities carried on by market participants in respect to these DLT-based Securities are permissible. Such a framework could provide clarity as to (i) how financial institutions can hold DLT-based Securities; and (ii) the roles of financial institutions as, among other things, intermediating entities and custodians, in the context of DLT-based systems. These two requirements apply to all use cases for DLT and Tokenization in capital markets and are jurisdictionally agnostic. However, the steps required to achieve these are specific to each jurisdiction.

458 MAS, Proposed Regulatory Approach for Stablecoin Related Activities, October 2022.
459 MAS, Project Orchid – Programmable Digital SGD, November 2022.
460 Ibid.

4.3.1 Legal/Regulatory framework—U.S.

Clear, Established Regulatory Perimeter

- Clear differentiation should be made between, on the one hand, DLT-based Payment Instruments and DLT-based Securities and all other categories of digital assets on the other. For example, US bank regulators recently issued a joint statement highlighting key risks to banks on cryptoasset risks.[461] In the guidance, the regulators stated that "By 'crypto-asset,' the agencies refer generally to any digital asset implemented using cryptographic techniques."[462] However, as described in this paper, DLT-based Payment Instruments and DLT-based Securities have significantly different underlying structures and market volatility relative to other cryptoassets.
- Policymakers should seek to ensure banks' role in providing credit to the economy is not undermined. In this regard, they should limit CBDCs to special purpose wholesale CBDC limited to banks who have pre-existing access to the FRB's payment systems and should subject all market participants to the same prudential standards.
- Furthermore, the pseudonymous nature of some DLT-based systems increases the importance of being able to transact with trusted identities on these networks. Ensuring that requirements for DLT-based Payment Instruments and DLT-based Securities transactions be conducted through regulated entities would support safe and stable financial markets and effectively subject all intermediaries to the same expectations as currently apply to the rest of the traditional financial system, consistent with the principle of "same risks, same activity, same regulatory outcomes."
- Regulators should engage in an active dialogue with industry participants to accomplish these goals.

Issuance and Disclosure

- The SEC should reconsider what material information is needed by investors of DLT-based Securities and whether certain traditional disclosures are unnecessary or should be modified, for example, if such information is already publicly available on DLT. Further consideration about what disclosure is needed with regard to aspects of the digital security, its issuer, and its maintenance, including with respect to administrative and DLT-related functions, would aid the development of a DLT-based Securities marketplace.

Listing Requirements and Secondary Trading

- Additional guidance and clarity by the SEC and FINRA for broker-dealers that trade DLT-based Securities with respect to registration, trading, Custody, and other broker-dealer requirements would help facilitate greater uptake of a DLT-based Securities marketplace and trading.

Transfer Agents

- Additional clarity by the SEC about when and how transfer agents can rely on DLT as the master security-holder file (instead of the transfer agent's private database) would assist in the development of DLT-based Securities markets. Regulator consideration and clarity over the need for an intermediary such as a transfer agent in a DLT-based Securities market may be warranted, especially in environments where ownership records are publicly available.

Custody

- Additionally, clarity and guidance by the SEC and FINRA for how broker-dealers can Custody DLT-based Securities would help facilitate the growth of the DLT-based Securities market. The current guidance and limitations placed on SPBDs and more broadly the Custody of DLT-based Securities have made compliance and even registration difficult.[463] Issues such as what constitutes a good control location for DLT-based Securities,

461 FRB, FDIC, OCC "Joint Statement on Crypto-Asset Risks to Banking Organizations," Jan. 3, 2023.
462 Ibid.
463 In particular, more work needs to be done regarding SPBDs for custodial use cases, without impractical requirements such as requiring SPBDs to only deal in DLT-converted securities.

the Customer Protection Rule and DLT-based Securities, and FINRA approval of SPBDs are hindering the further development of a DLT-based Securities marketplace.[464] Therefore, a path should be available for broker-dealers to Custody digital assets. Furthermore, the SEC has recently proposed a rule regarding the definition of an exchange as well as a proposed rule regarding Custody by investment advisors of digital assets; depending on what is contained in the final rules, work needs to continue to ensure that adequate protections for investors is provided without hindering access to DLT-based Securities.

- Further, there appears to be a lack of rational convergence on accounting and prudential standards for digital assets to date, which should be resolved. As noted, SEC staff recently issued SAB 121, requiring a firm safeguarding a cryptoasset to present a liability (and recognize a corresponding asset) on its balance sheet equal to the fair value of the safeguarded cryptoasset. This treatment of cryptoassets deviates from existing accounting treatment of safeguarded assets held in a custodial capacity, which does not result in assets or liabilities reported on the custodian's balance sheet. In turn, this has impacted the number of banking organizations that seek to act as custodian for cryptographic keys due to the capital inefficiency of accounting for such activities on balance sheet, even though safekeeping and Custody by banking organizations have traditionally been understood to be within the scope of permissible banking activities.
- To resolve this issue, a clear mandate for cryptoassets to be held by a regulated custodian and conducted off balance sheet should be adopted and, correspondingly, the regulatory standards for custodial activities should be set to ensure clear and well-disclosed property rights, including in the case of insolvency.

Settlement and Clearing

- Additional clarity and guidance by the SEC and clearing agencies about issues such as whether validator nodes used to run a DLT are performing functions of a clearing agency, who can become a member of a CCP that clears DLT-based Securities, and even the role of clearing agencies for DLT-based Securities on a distributed ledger would be helpful.

DLT-based Payment Instruments

- Regulators should provide a clear path for banks to issue DLT-based Payment Instruments to facilitate settlement and financing transactions, including by providing any clarifications or modifications that may be necessary to reflect the unique ways in which DLT technology functions and help further develop the legal principles that aid parties with the legal bases for settlement finality within their relevant authorities.
- To achieve the cross-border benefits of DLT technology for securities and payment settlement, U.S. regulators also should adopt rules for institutional arrangements involving DLT-based Payment Instruments that are consistent with FMI principles.

4.3.2 Legal/Regulatory framework—U.K./E.U.

As discussed in Chapter 4, E.U.-level legislation (as implemented in E.U. Member States and retained in U.K. legislation) can present legal challenges in the context of DLT-based systems, often due to a lack of clarity as to its application. Examples include certain requirements under CSDR and MiFID II, some of which has been addressed to an extent by the legislative proposals included in the Pilot Regimes.

The Pilot Regimes are expected to perform a constructive role in incentivizing market participants, regulators and legislators to actively engage with the barriers to widescale adoption. However, as set out in Chapter 4.2.2.3, the E.U. Pilot Regime has a number of issues, including the imposed thresholds, lack of clarity on access, licensing requirements for participants and cross-border issuance difficulties. These issues should be considered by the relevant authorities when conducting interim and final reviews, and ultimately addressed when developing a permanent legal and regulatory framework for DLT-based systems in capital markets. One area in which the FMI sandbox could differentiate itself from, and improve upon, the E.U. Pilot Regime, is to provide a framework that

464 This is particularly important because broker-dealers need FINRA approval before materially changing their business operations.

enables the creation of a payment platform that tokenizes money and as such can provide settlement by facilitating the cash leg of a digital security transaction.

Broadly speaking, the Pilot Regimes fall short in that they do not apply across the full legal framework, but instead to a limited set of financial services legislation. In particular, they do not deal with the valid creation of native DLT-based Securities, which will remain a point of legal uncertainty unless there is legislation put in place to clarify or allow for this (as noted in Chapter 4.2.2, legislative frameworks contemplating this have only been implemented in certain jurisdictions). Market participants may be reluctant to take on the legal risk associated with engaging in the issuance and trading of DLT-based Securities without the appropriate legislation or regulators providing clarity that the issuance of DLT-based Securities is possible under legal frameworks in the relevant jurisdictions.

In addition, there is further work to be done to establish an effective framework for the issuance and implementation of DLT-based Payment Instruments in the settlement of DLT-based Securities, as discussed in Chapters 4.1 and 4.2. There are also many jurisdiction-specific issues relating to the issuance and trading of DLT-based Securities across the U.K. and the E.U.

There are further legislative and regulatory issues beyond financial services. As set out in Chapter 2.2, for example, clarity is required as to the application of applicable AML/KYC regulations in the context of DLT-based systems.

In each case, to encourage adoption of DLT-based systems in capital markets, legal and regulatory clarity is required as to whether: (i) such requirements can be satisfied using DLT-based systems; or (ii) parties utilizing DLT-based systems are exempt from complying with such requirements. This could be achieved via the publication of regulatory guidance, or the direct amendment of the relevant pieces of legislation. Considering the U.K. by way of example, as mentioned in previous sections, for the purposes of issuing financial instruments under the USRs (as is common for equity securities and sovereign bonds in the U.K.), it should be clarified whether the requirement for U.K. registrar can be satisfied when using a DLT-based system using a multi-jurisdictional spread of nodes.

Additionally, in a DLT ecosystem, market participants will require legal certainty relating to the transfer of DLT-based Securities, so that in each case they can be certain that the transaction has actually occurred. As discussed in Chapter 4.2.2, the E.U. Pilot Regime goes some way to address issues surrounding transfer, for example by disapplying relevant requirements under the CSDR. However, even under the E.U. Pilot Regime, there are certain other requirements that prevent adoption either because they require existing authorized persons to adapt their business model and invest in the requisite technology to adopt DLT where they may not want to. As such, adoption is arguably at the discretion of these incumbent authorized persons. Additionally, while the E.U. Pilot Regime is open to new entrants, the required authorizations to act as, for example, a CSD, create a barrier to entry for these entrants, both in terms of expense and time. Greater regulatory clarity regarding how the relevant FMI and other participants can obtain the requisite authorizations to operate DLT-based systems would support adoption.

As discussed in Chapter 4, permanent amendments of applicable legislation akin to those proposed under the Pilot Regimes would arguably be a significant step forward in supporting the adoption of DLT and DLT-based Securities in capital markets. However, there will need to be further work undertaken to address the shortcomings under the proposed Pilot Regimes, as set out above, and in Chapter 4.2.2.

4.3.3 Legal/Regulatory framework – Hong Kong

The regulators in Hong Kong have adopted a "same risk, same activity, same regulatory outcome" principle (that is technology-agnostic) and are seeking to regulate virtual assets, digital tokens and related activities by introducing new legislation or issuing guidelines around the existing regulatory framework. While early guidance on whether different virtual assets might fall under the definition of "securities" under the SFO had provided clarity in the initial stage of developing the digital asset ecosystem in Hong Kong, the proliferation of and rapid changes in the landscape from new technologies to new products including the Tokenization of traditional securities necessitate more digital asset specific laws and regulations, especially with regards to:

1. a legal framework that provides for recognition of documentary formalities and evidence of title consistent with DLT-based, electronic and/or smart contract solutions;
2. the adaptation of securities market transaction structures that are compatible with DLT, especially around areas of issuance, secondary trading and clearing mechanisms of various forms of securities;
3. clear statutory definitions of the rights, obligations and valid forms of ownership and transfer of various classes of regulated digital assets in light of the use of distributed ledger and smart contracts, including creating regional/market standards as applicable for DLT-native securities; and
4. replacement of the blanket restriction on distribution of certain types of digital asset-related investment products to retail investors with categorization of investors that is sensitive to market development and responsive to different investor risk characteristics in order to allow more retail access to digital assets.

   On top of recent initiatives to regulate the digital assets which do not strictly conform to the definition of "securities" (e.g. through imposing additional requirements applicable to regulated intermediaries engaging in virtual asset activities as discussed in Chapter 4.2.3), regulators should stay close to market developments and issue timely guidance to provide greater market clarity and confidence.

4.3.4 Legal/Regulatory framework – Japan

As mentioned in Chapter 4.2.4 above, a regulatory framework for transactions in respect of DLT-based Securities has already been implemented in Japan. However, there are still open questions about more substantial matters, for example, when the transfer of title to DLT-based Securities is recognized and how to perfect the transfer of title to DLT-based Securities. If these outstanding questions are solved (ideally, resolved legislatively), it would be easier and more secure to conduct transactions for DLT-based Securities in Japan and Japan may be able to move towards a DLT-based ecosystem.

4.3.5 Legal/Regulatory framework – Singapore

In October 2022, MAS published two consultation papers on (i) Proposed Regulatory Measures for Digital Payment Token Services (which sets out proposed consumer access measures and business conduct measures for digital payment token services); and (ii) Proposed Regulatory Approach for Stablecoin-Related Activities (which sets out MAS' policy regarding the overall regulatory approach on stablecoin-related issuance and intermediation activities). The consultation closed on 21 December 2022. In the consultation paper on Proposed Regulatory Approach for Stablecoin-Related Activities, requirements such as reserve asset backing, timely redemption at par and disclosure requirements are being proposed in relation to the issuance of stablecoins.

The MAS is also understood to be working closely with other regulators to design a prudential framework for banks' exposures to digital assets.[465] Such framework is intended to provide banks with clarity on how to measure the risks of their digital asset exposures, and maintain adequate capital to address these risks and reduce risks of spillovers into the traditional banking system.

4.3.6 Legal/Regulatory framework – Conclusion

Generally, regulators and legislators should refer to industry preference for incremental development of regulation and/or legislation, so that innovation is allowed to flourish. There are specific considerations at national and international level that must be taken into account when considering the future framework for DLT-based Securities and DLT-based Payment Instruments. Specific consideration is also required as to the differences in legal and regulatory treatment when considering private or public DLT networks (with or without a permissioned environment).

465 "Yes to Digital Asset Innovation, No to Cryptocurrency Speculation", Opening Address by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at Green Shoots Seminar on 29 August 2022 (https://www.mas.gov.sg/news/speeches/2022/yes-to-digital-asset-innovation-no-to-cryptocurrency-speculation).

Chapter 05

Towards a Future DLT Ecosystem and Barriers to Adoption

This chapter defines the core components of a future DLT-enabled capital market ecosystem, considers how the evolution toward this ecosystem could occur, and identifies the key barriers that could prevent adoption.

5.1 Future DLT-Based Ecosystem

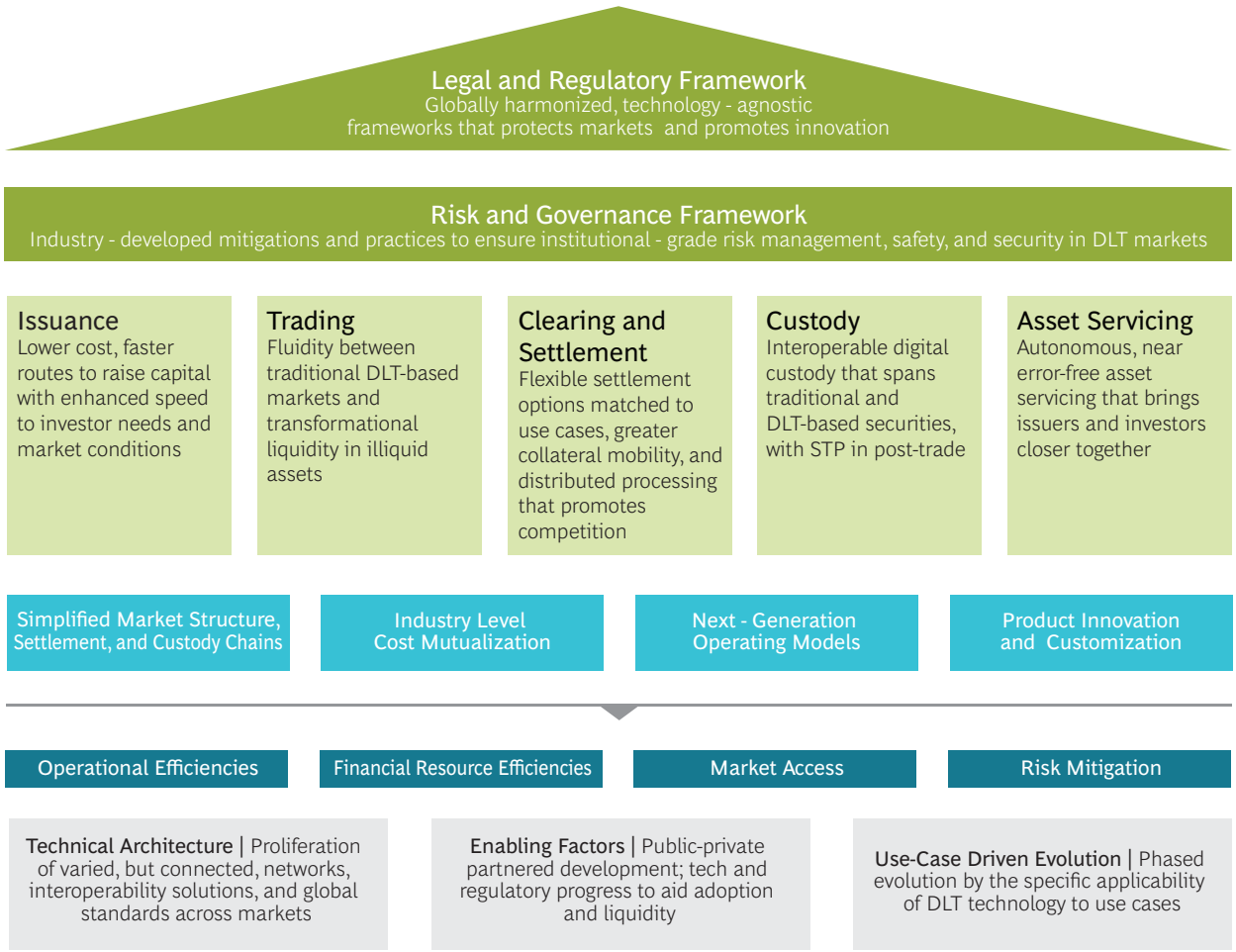
DLT is a topic that has attracted a vast body of thought leadership and research over the past few years, with divergent opinion across key topics such as the use of public DLT networks, technical constraints to support scale, and divergent legal and regulatory positions across jurisdictions such as the status of Security Tokens and requirements for settlement finality. As policymakers continue to ask questions and advance their collective understanding, the pace of DLT-based innovation in capital markets has not relented. Primary issuances of digital securities, DLT-based Books and Records, and Tokenization use cases have all been demonstrated through 2023.

Despite the momentum that has been building, critical challenges to adoption remain. Chief among these is the lack of consensus among market stakeholders worldwide. With the varying perspectives of policymakers in different jurisdictions and among financial institutions, there is a risk that a DLT-based ecosystem will fail to organically develop in a coordinated fashion that sets it up for success and maximizes value creation for all stakeholders. For example, interoperability across DLT platforms and with existing infrastructure – to form liquidity across Primary and Secondary Markets – requires collaboration on an industry-wide scale, with public-private partnership to set technical standards and requirements, governance, and risk management.

This chapter therefore seeks to capture the core components of a future DLT-enabled capital market ecosystem, along with the enablers that would make it possible. This blueprint is intended to align objectives in high priority areas: the establishment of sound legal, regulatory, and institutional risk management frameworks, and a description of a future securities lifecycle, along with attributes and outcomes that DLT could enable. These components were captured as an outcome of the research published in this report, with a consensus-driven approach across GFMA members.

Exhibit 5.1

Core Components of a DLT Ecosystem



Source: BCG Analysis, GFMA Member Interviews

As established in the Executive Summary, the evolution toward a future DLT-based ecosystem will not be homogeneous across markets and asset classes. Adoption is likely to be phased and focused in markets and asset classes where both opportunity and market readiness are best suited. In addition, there are a range of key enablers, which are likely to develop in parallel and could significantly impact timelines in both directions. These factors will influence how the journey towards a future DLT ecosystem unfolds across the near-term, medium-term, and long-term, described in the following exhibit.

Exhibit 5.2

Possible Future Developments of a DLT Ecosystem

	Today: Experimentation 1-3 years	Medium-term: Commercialization 3 - 5 years	Long-term: Scaling 5 - 10+ years
	Partnered experimentation to validate technical capabilities & pilots move to production (e.g., repos, bond issuance). Public-private partnerships on legal ambiguities, regulation, and best practice risk mitigants.	Commercial viability driven by rising issuer and investor demand in selected asset classes, as liquidity establishes. Legal and regulatory frameworks crystallize as benefits proven across jurisdictions.	Large-scale growth in issuer and investor demand across primary and secondary markets in selected asset classes. Robust and globally harmonized legal and regulatory frameworks established as DLT -ecosystem matures.
Primary Markets	**Limited demand for DLT-based securities; experimental issuances** - Mix of tokenized security and native security token issuance - Majority of process (e.g., structuring, syndication, book build) performed traditionally, no cost savings - Limited innovation around fr bespoke products	**Demand emerges in selected asset classes** - Native security token issuances outstrips tokenized securities - Native security issuance process party enabled on DLT, driving speed to market and lower issuance costs - Fractionalized issuance on select DLT platforms; issuers test new products	**Demand overtakes traditional issuance in selected asset classes** - Native security tokens is default format over tokenized securities - Native security issuance process fully enabled on DLT, driving further market responsiveness & savings - Scaled (retail) investor adoption of fractional issues and products tailored to investor needs
Secondary Trading	**Few secondary markets for DLT-based securities; liquidity is low** - Majority of trading venues (exchanges, OTC networks, MDPs) do not offer DLT-based securities - Where trading is possible, participants leverage non-FMI, purpose-built DLT-trading platforms	**Growth in DLT-based secondary market liquidity** - Trading of DLT-based securities emerges in selected trading venues for selected asset classes (e.g., illiquids) - DLT Platforms are integrated with traditional, non-DLT, FMI (e.g., FedNow for payment settlement)	**Majority of liquidity and trading in selected asset classes is via DLT** - Interoperable DLT market allows aggregation of liquidity across OTC markets and greater velocity - DLT-specific FMI matures (e.g., post-trade) - Fractionalization allows precise hedging and risk management
Clearing & Settlement (C&S)	**Testing of DLT-based C&S operational processes** - PoCs demonstrate instant DvP with traditional payment rails (e.g., RTGS) - Instant DvP in live production across repos, enabling intra-day use cases - DvP driven by tokenized commercial bank money, deposits and/or other forms of DLT-based Payment instruments	**DLT-based C&S emerges as alternative DvP channel in selected asset classes** - Instant DvP in live production across selected asset classes - Traditional settlement continue to dominate markets - DvP driven primarily by tokenized commercial bank money, and deposits	**Automated, continuous DLT-based C&S is the default in selected asset classes** - Settlement choices driven by needs of market participants - DLT-based C&S enables Opex & capital efficiencies, and mitigates risk - DvP driven by either tokenized commercial bank money or deposits depending on use case
Custody	**Digital custody solutions are limited, propositions focused on cryptoassets** - Custodians focused on custody of cry collateral mobility platforms in repos and OTC derivatives	**Growth in digital custody solutions, with move away from cryptoassets** - Custodians build or buy solutions for DLT-based security custody (recordkeeping and automation in post-trade operations) - DLT-based collateral mobility platforms become default option - Clarity on role of national CSDs across major markets	**Digital custody solutions offer DLT-based and traditional custody** - Custodians provide seamless interoperability between DLT-based and traditional securities - DLT simplifies post-trade operations reducing Opex and mitigating risk - Harmonization on roles of CSD across markets
Asset Servicing	**Limited ecosystem around smart contracts (standards, regulation etc.)** - Proof-of-concept testing for smart contracts supporting DLT-based income payments (e.g., coupons, dividends) - Partnerships to build capabilities but open questions remain (e.g., legal, regulatory, risk and governance, standards)	**Growth in piloting of DLT-based asset servicing** - Standardization of smart contracts drives traction in DLT-based income payments (e.g., coupons, dividends) - Functionality to support tax and regulatory reporting processes piloted - Clarity across legal, regulatory, risk, and governance frameworks	**DLT-based asset servicing becomes default in selected asset classes** - Corporate actions embedded in smart contracts tied to securities at issuance - Dividends, coupons, and tax withholding processes automated and settled with DLT-based payments - Targeted 'embedded supervision' introduced for real-time regulatory visibility and monitoring
Key Enablers	Cross-industry, public-private partnerships	Regulated, accepted, DLT-based cash	Industry-aligned taxonomy and educative materials	Updated fund and investment mandates	Global legal and regulatory framework	Interoperable networks and markets	DLT-specific FMI

Source: BCG Analysis, GFMA Member Interviews

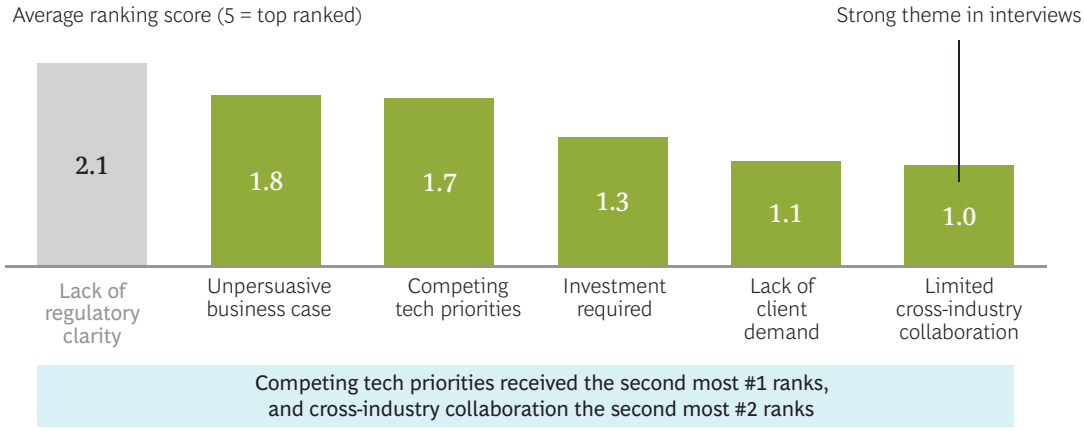
5.2 Barriers to Adoption

The journey towards a future DLT ecosystem will involve overcoming several challenges. Though the potential for benefits could be considerable, and momentum appears to be forming from continued use case development, the adoption of DLT-based Securities remains limited and major barriers to adoption must be overcome.

Use cases have often been experimental and focused in Primary Markets. While experimentation is a necessary stage in this evolution, there is a danger that it is failing to mobilize the tangible, coordinated outcomes required to establish a DLT-based ecosystem that meets the needs of investors and issuers, and becomes commercially viable for all stakeholders. In addition to the regulatory ambiguity discussed in Chapter 4, GFMA members attributed the lack of market development to a series of interrelated, industry-wide barriers to adoption (see Exhibit 5.3).

Exhibit 5.3

Barriers to Adoption Cited by Survey Respondents



Source: GFMA tokenized securities survey; n=39
Rankings are weighted avg.

In interviews, an increasingly fragmented DLT-based landscape was described by GFMA members, with specific concerns around the lack of interoperable initiatives forming "islands of liquidity."[466] In line with this, issuers have reported confusion over the various platforms and exchanges available, noting that they are unclear on how to reach their target investor base for DLT-based Securities.[467] In line with this, investors have mentioned challenges in identifying the best channels to invest in DLT-based Securities to optimize the burdensome and costly process of onboarding and integrating multiple platforms.[468] Issuer and investor demand is therefore limited, with DLT-based Securities remaining thinly traded overall and relatively illiquid. This slow pace of market traction and the lack of larger, marquee issuances are also described as barriers to broader issuer and investor interest.[469]

Interviewees raised other constraints as well, particularly the lack of DLT-based Payment Instruments to facilitate programmable use cases and DvP settlements on a distributed ledger. As highlighted in this report, a wCBDC is one of many payment solutions possible in a DLT-based ecosystem and to-date none have been deployed at institutional scale. In light of this, tokenized commercial bank money solutions must rapidly rise to fill this void in research and development, as well as in full implementations.[470]

466 GFMA member interviews, 2022.
467 ASIFMA, "Tokenised Securities in APAC—A State of Play", 2021.
468 Ibid.
469 Ibid.
470 See, for example, the Regulated Liability Network, exploring the use of tokenized commercial bank money on distributed ledger technology.

Business cases have also experienced some isolated challenges. ASX's AUD ~$250M USD write-off of its post-trade infrastructure project with Digital Asset,[471] while Fnality's recently delayed launch of its securities settlement system until Q3 2023 reflect these challenges.[472] Though belief in the long-term market potential was almost unanimous, survey respondents ranked their concerns around business cases and payback as the second highest barrier (after regulatory and legal), driven by uncertainty over the development of a viable DLT-based market.[473] Many interviewees mentioned the competing backdrop of ongoing digital transformations and other technology initiatives, the third highest barrier in the survey. Interviewees also described the challenge of sizing benefits in the near to medium-term, significant capital expenditure, and incremental operating costs, as well as a minority shared that they were following a wait-and-see strategy.

These barriers are analyzed across four broad categories below: (1) Operational Capabilities; (2) Minimum Viable Liquidity; (3) Investment Case Viability; and (4) Cross-Industry Consensus.

5.2.1 Operational Capabilities

Market participants are focused on creating new organizational capabilities. These include developing and integrating new enterprise DLT infrastructure into existing technology architectures, attracting and retaining a talent pool to deliver these capabilities, rolling out new DLT-enabled workflows, and standardizing data transparency requirements.

Interoperability | Firms may need to (a) build and (b) integrate DLT networks with legacy systems throughout the securities lifecycle. Lack of standardization in the market today could lead to the proliferation of siloed, incompatible development. When integrating DLT and non-DLT systems, mission-critical platforms, like those routing large volumes of client money, could need checks and controls to ensure proper function. Here again, firms may face a series of nuanced questions and trade-offs. Firms may use API gateways, but this creates a single-point-of-failure risk within the architecture.[474] Oracles, which provide external data inputs, could provide another solution to obtain non-DLT data feeds, but the associated risks with these have been discussed previously. Data formats from systems on and outside of a distributed ledger could need standardization as well.[475]

New Ways of Working | The implementation of DLT-based operations may gradually require a mindset shift from trusting well-established reconciled data silos to trusting a distributed system that is verified by the consensus of cross-industry market participants.[476] Management could need to invest in significant training and enablement efforts across the organization. Additional considerations include the operational impacts of DLT-enabled settlement on processing and fail resolution workflows and further implications on treasury and risk management functions within financial institutions.

471 Four technical drivers were identified by Accenture in an independent review: latency, concurrency, batch processing, and technical constraints related to the API used for batch processing. See here for details: Accenture, "ASX CHESS Replacement Application Delivery Review", 2022.
472 Ledger Insights, "Institutional DLT payment platform Fnality delays launch", 2022.
473 Security Tokenization survey of GFMA members was run by Boston Consulting Group from November to December 2022; n=39.
474 World Economic Forum, "Interoperability Module", 2020.
475 Ibid.
476 GFMA member interviews, 2022.

Data Transparency | As described in Chapter 1, a distributed ledger provides clear benefits around data transparency and consistency in operational processes. However, confidentiality serves many important purposes in capital markets from preserving competitive advantages to protecting investor privacy.[477] Regulators may request and monitor confidential data from select market participants. Even within investment firms, barriers such as "ethical walls" exist to prevent conflicts of interest from arising between the advisory and underwriting business units. Some interviewees highlighted that ledger transparency, without permissioning and shielding of sensitive trade data, may erode anonymity in secondary trading, which may challenge competitive dynamics and the potential for alpha generation. Privacy-enhancing technical solutions are under development.[478]

Technology challenges | DLT – like other technology infrastructure – may also be vulnerable to the emerging concern of quantum computing, with the potential to penetrate best-in-class modern-day encryption. Quantum computing techniques enable orders of magnitude improvements in the speed with which computers can 'crack' or break the security of industry-standard encryption processes. It should be noted, however, that to date, elliptic curve public-key cryptography (characteristic of many DLT-based systems) has been rendered uncrackable by using very long key-pairs.

In traditional computing infrastructure, existing computing power has been unable to break these cryptographic methods – a classical computer would need around 300 trillion years to break an RSA/ECC-2048-bit encryption key.[479] In contrast, a quantum computer could break the same encryption key in just 10 seconds but would require 4099 stable qubits (quantum computer bits) for those 10 seconds. As of today, the biggest quantum computer, IBM Osprey, has only 433 qubits, and can only keep these qubits stable for a median of 70-80 microseconds.[480,481] Development in quantum computing is advancing rapidly, but true disruption to cryptographic integrity is far from institutional scale. **Additionally, the impact of quantum computing on cryptographic integrity is not a concern unique to DLT** and it is likely that cross-industry advances in cybersecurity (that can also use quantum computing defenses) could rise to meet future encryption needs should quantum computing threaten current-day encryption standards.

5.2.2 Minimum Viable Liquidity

New markets for DLT-based Securities would likely emerge alongside traditional capital markets. For these new markets to be commercially viable and liquid, a minimum level of market participation will need to be drawn. Market illiquidity is a self-perpetuating phenomenon; issuers would be disincentivized to issue, and investors not interested in participating.[482] This "chicken and egg" dilemma is further compounded by an uncertain outlook on support for the technology. There are three areas of focus:

Demand | Though long-term market growth projections for DLT-based Securities are material (~$5 trillion USD in tokenized equity, bond, and investment fund assets by 2030), current DLT-based Securities held in Custody are less than $0.3 trillion USD.[483] Interviewees cited the market's nascency and issuers' and investors' unfamiliarity with DLT-based Securities relative to traditional securities as drivers for this.

477 European Central Bank, "Dark pools in European equity markets: emergence, competition and implications", 2017.
478 European Securities and Markets Authority & Bank of Japan, "Balancing confidentiality and auditability in a distributed ledger environment", 2020.
479 Quintessence Labs, "Breaking RSA Encryption – an Update on the State-of-the-Art", 2019.
480 Reuters, Jane Lee, "IBM Launches its Most Powerful Quantum Computer with 433 Qubits", 2022.
481 Popular Science, Charlotte Hu, "IBM's Biggest Quantum Chip Yet Could Help Solve the Trickiest Math Problems", 2022.
482 World Economic Forum & Boston Consulting Group, "Distributed Ledger Technology & the Future of Capital Markets", 2021.
483 Boston Consulting Group and ADDX, "Relevance of On-Chain Asset Tokenization in Crypto-Winter", 2022.

There would likely emerge several pull factors into DLT-based Securities: (1) longer-term benefits cases such as reduced cost and increased utility of collateral; (2) new asset classes and trading solutions; and (3) prospect of lowering risk.

Fragmented Liquidity Pools | As shown in Chapter 3, recent use cases have been siloed in nature. Interviewees described concerns with the lack of industry-level interoperability and poor formation of secondary liquidity with investors left without security valuation data and exit options. Mechanisms are proposed in Chapter 2.1.2 to bridge liquidity across security formats and integrate liquidity pools into existing systems and workflows.

Scalability | The significant cost of building DLT-based infrastructure requires application across many markets. Market nuance by jurisdiction, asset class, and investor type may impede scalability of the infrastructure. Further technical constraints, such as transaction throughput, may present a barrier to scale.[484]

5.2.3 Investment Case Viability

The long-term market potential of DLT-based Securities and value drivers for financial institutions has already been highlighted in this report; however, business case uncertainty is driven by the significant upfront investment, increased near-term operating cost, and uncertain payback period. There are two factors to this equation:

Investment | Financial institutions are investing heavily to develop DLT networks, putting funds upfront in infrastructure build, talent attraction, product iteration, and risk mitigation. Private layer 1 and layer 2 protocols are particularly expensive. In the early and mid-stages of market development, participants could likely also experience higher cost to operate duplicative systems.

Payback | The return on investment is unclear; interviewees estimated it could take five to ten years for DLT-based Securities to become a material market and offer attractive returns. It is also unknown which solutions may succeed and gain traction. In the short-to-medium term, members are receiving the benefits from building recognition as an innovative brand and strong engagement with clients. Similarly, the extent of payback of investment through realized benefits is highly dependent on critical levels of adoption – thereby making the investment case less certain.

5.2.4 Cross-Industry Consensus

As shown in Chapter 3, market use cases have been characterized by the experimentation of individual companies and small consortia, many of whom are operating on closed, private networks based on different technologies, standards, and protocols. If left unaddressed, this fragmentation could lead to non-interoperable 'digital islands' of DLT around the globe. This fragmentation was strongly reflected in interviews, with the lack of cross-industry collaboration a consistent theme. For a DLT-based Securities ecosystem to fundamentally reshape capital markets, consensus may need to be reached from market participants and network effects sufficiently formed.

Interoperability is an essential component of DLT-based market infrastructure and GFMA members have highlighted the need for early consideration of solutions to enable it. As a result, the next stage of ecosystem development may require broader market engagement to build consensus on key components. This could include defining risk and governance frameworks covered in this report, but also roles and responsibilities, technology, and infrastructure. Additionally, regulatory harmonization and interoperability should be coordinated across different financial market infrastructures and jurisdictions.

484 Vitalik Buterin, "Why sharding is great: demystifying the technical properties", 2021.

Chapter 06

DLT Ecosystem Recommendations and Calls to Action

These recommendations have been developed with the common goal of establishing network effects, governed by clear legal, regulatory, and risk management frameworks that ensure safe and secure innovation. They are each accompanied by specific calls to action, intended as practical next steps to drive impact.

As shown through this report, there are critical enabling steps required to drive the next stage of development toward a DLT ecosystem in capital markets. The current DLT-based ecosystem is still nascent. Primary and Secondary Markets have yet to reach a critical mass. **At this early, foundational stage, all market stakeholders should come together and proactively shape the emerging ecosystem across the core components as identified in this report.** The critical priorities are captured below to resolve open questions, establish cross-industry consensus, and work towards concrete solutions.

Recommendation #1: Drive towards legal certainty and regulatory clarity

In the recent past, the global regulatory community has come together to support important, coordinated policy development. The opportunity is ripe for a consolidated, global effort to modernize financial infrastructure using DLT.

It is worth stressing how important it is that this effort be globally focused. One of the core benefits of DLT is its promise for interoperability. International coordination, however, is needed to achieve this goal. It is therefore essential for international regulators and lawmakers to capitalize on DLT's core promise of interoperability by engaging in a coordinated approach to the regulation of DLT-based Securities.

The current regulatory frameworks for DLT-based Securities across jurisdictions paint an incomplete and ambiguous picture of how digital assets are regulated that hinders the growth and development of the DLT-based Securities market and, thereby, inhibits strong investor and customer protections. Policymakers and stakeholders need to take the lead by defining clear rules that the industry can build upon.

The primary objective of financial regulation, irrespective of asset class, is to protect investors and consumers and to mitigate risks to financial stability. By relegating DLT-based Securities to a quasi-regulated asset class where essential questions relating to issuance, trading, and Custody and property rights linger, some regulators appear at odds with these objectives. Regulators and lawmakers should thus endeavor to offer market participants a clear articulation of how the unique characteristics of DLT environments may be reconciled with existing legal and regulatory regimes.

Specifically, the global regulatory community should come together to develop common objectives for the following key areas when creating a regulatory framework for DLT-based Securities:

1. **Scope of Risk:** Regulators should work to understand the distinction between DLT, the technology, the use cases built on top of it, and the risks DLT poses. Like a traditional database model, there are ways to develop DLT environments to be more controlled—not only to comply with existing regulation but also to make such compliance more seamless, comprehensive, and effective.
2. **Intermediary Regulation:** Digital asset markets have developed without a clear way for regulated intermediaries to participate; thus, clarity needs to be provided to allow regulated intermediaries to participate in digital asset markets.
3. **Infrastructure Regulation:** Regulators should require entities that engage in Clearing and Settlement, payment activities for DLT-based Securities, and DLT-based Payment Instruments transactions to be subject to regulation and supervision; where necessary, the existing framework should be adapted to allow regulated entities to participate in digital asset markets.
4. **Custody Standards:** Clear standards are needed to ensure that assets are custodied by regulated entities in a manner that is safe, with property rights that are clear and well disclosed. Users should have the option

of using regulated entities, such as banking organizations for such services. Without rationalizing accounting and regulatory standards, participating in such activities at scale would be too costly for most banking organizations, which are often the favored choice of the market to serve as independent custodian.

Call To Action | Harmonize Global Regulatory and Legal Frameworks: Current laws and regulations applied to DLT assets are generally those developed for traditional assets. This approach can create inadvertent outcomes, either de facto prohibitions or imposition of contradictory requirements. Considering whether and to what extend adaptations should be made to existing legal and regulatory structures requires significant intellectual resource for the public sector. We regard the making of this commitment as important to promote the development of transparent, disciplined, and effective markets and infrastructures. Also, different jurisdictions have different issues today, and policy development in these areas is not formally coordinated. We believe that the development of coordinated policy positions across different jurisdictions would be a significant benefit both for the market and for governments and regulators.

Recommendation #2: Enable interoperability

Most use cases in the market today are built on different private-permissionless networks with unique design choices and standards that can prevent them from easily interoperating. As the ecosystem matures, interoperability will be required across distributed ledgers and with existing financial market infrastructure. To achieve this, participants must align technical design, a framework of standards, and core governance considerations to build compatibility.

- **Technology architecture design:** Participants should engage in dialogue as to approaches for interoperability across different DLT networks (public vs. private, permissioned vs. permissionless), selection of consensus algorithms, governance of oracles and APIs between each ecosystem, and common latency requirements for infrastructure. While an ideal solution would realize the efficiencies of all participants operating on the same, or natively compatible systems, it is more prudent to prepare for an environment where different solutions exist and interoperability frameworks can be used between networks and platforms. At the level of the data itself, participants will need to build consensus around common taxonomies and definitions, as well as data formatting standards, similar to efforts made by ISDA with the Common Domain Model.
- **Smart contract standards:** Dialogue on smart contract technical standards (e.g., ERC-20), as well as principles to control execution risk, may help to bring interoperability to life. This is a critical enabler to establishing DeFi-like composability in the application layer. Financial institutions should agree on audit and verification standards for smart contract code, the use of kill switches and fail-safes to enable manual interventions, and the ability to render a smart contract void (e.g., if coding errors are made or terms breached).
- **Governance:** In a truly interoperable system, dependencies on information and outputs of smart contracts and software code provided by partners are significant. The governance and commercial model should therefore stipulate how members are compensated for work and specify recourse when errors arise. Members of the system may also need to engage in dialogue regarding practices to protect privacy and network security and ensure regulatory compliance, in accordance with existing regulation.
- **Roles and responsibilities:** Given the level of change that DLT may deliver to activities, especially in post-trade Clearing and Settlement, Custody, and Asset Servicing and Lifecycle Management, industry participants should engage in dialogue regarding updated controls for those roles. In Custody, for example, the wallet and key model could introduce the need for best practices on key management to minimize the risk of loss. Industry participants should also align on the roles of CSD and CCP, given the overlap between their current roles and the services offered by DLT. Here, the industry should engage actively and extensively with regulators given that changes to these roles may require changes to established law or regulation.

Call To Action | Form joint working group to agree common data, architecture, and integration standards: Market participants can build on existing initiatives (e.g., Common Domain Model, CAJWG etc.) and experimentation to align on a framework of standards that would govern market-wide interoperability. These standards should define technology architecture design, smart contract standards, governance, and issue resolution and include stakeholders from across functions, businesses, and geographies.

Recommendation #3: Establish viable Primary and Secondary markets for high-potential asset classes

Market participants have been notably collaborating on specific DLT-related technology and financial market infrastructure initiatives. This cooperation can be seen in DLT platforms (e.g., R3), financial market infrastructure (e.g., Fnality), and, more recently, with particular services like collateral management (e.g., HQLA[x]). Such collaboration could be deployed to pool liquidity in high potential asset classes (e.g., bonds, OTC derivatives, illiquid assets) and push the formation of liquidity to establish viable DLT-based markets.

An effective approach could be to focus narrowly on a small number of attractive asset classes where there is a clear opportunity and market readiness for adoption. After building that industry-level business case, liquidity can be pooled. Such coordination would need to additionally build on recommendation #1, bridging across distributed ledger systems and existing infrastructure.

Call To Action | Focus on viable asset classes and build liquidity: Market participants should launch initiatives to better enable development of relevant Primary and Secondary Markets for high potential asset classes to (a) test and validate the benefits case of DLT and (b) realize the risk mitigation potential. These efforts should focus on asset classes where inefficiencies are well documented and the cost of conversion minimal.

Recommendation #4: Collaborate on the advancement of DLT to promote new technical solutions

The impact that DLT and Tokenization can have on capital markets is gated by the ability of the underlying technology to meet the requirements of a highly regulated, cross-jurisdictional, complex system. As set out in Chapter 1, a wide variety of potential technology considerations exist, each with their own advantages and trade-offs. However, across these various permutations, fundamentally open questions remain around:

- **Scalability:** Can both private and public networks alike scale to reach the required large-scale throughput of existing technology infrastructure that serves capital market transaction activity?
- **Cybersecurity:** How will networks handle new risk implications, such as cyberattacks on bridges and collusion on public networks, the use of external data and oracle networks, procedures to manage improperly functioning smart contract, deployment of malicious or incorrect code, or an expired smart contract?
- **Regulatory compliance:** Replications of existing KYC/AML/CFT processes, particularly on public-permissionless networks, requires workarounds and bespoke approaches as highlighted in the Executive Summary. What data privacy protections will need to be implemented, including those related to confidentiality of financial transactions on private-permissioned and public-permissionless networks?

Current solutions are experimental and require further development and testing before deployment within the tightly regulated space of capital markets. Therefore, the GFMA and its members recommend industry participants promote, sponsor, and collaborate on further research and development of DLT-specific solutions that address these issues. Cross-industry participation not only distributes the cost of a venture but multiplies the effort behind it. Industry participants must continue on the path of deliberate, specific experimentation that characterizes the market today, but ensure the direction of travel is toward open problems that provide broad benefits.

Financial institutions must also maintain a dialogue with regulators and lawmakers as a part of this development process, ensuring coordination; education and development should happen in parallel. R3, Fnality, and RLN are all industry consortium-led efforts to develop market-wide solutions. Cross-industry venture funding and committed support throughout the years has helped these platforms continue to develop. R3, with its infrastructure Corda, is a trusted platform for more than 400 of the world's organizations, including some of the most prominent financial services firms.[485]

Call To Action | Strive to achieve consensus in solutions for common challenges: Innovation in DLT is currently characterized by localized or individual experimentation, which could lead to widespread market fragmentation in the long-run. Industry practitioners should consider promoting, sponsoring, and working cooperatively on further research, highlighting priority areas of DLT development, and creating DLT-specific solutions to address DLT-specific challenges.

Recommendation #5: Work towards sound, safe, and compliant DLT-based Payment Instruments

DLT-based payment mechanics are a key enabler for settlement for any form of DLT-based capital markets. Existing payment infrastructure can be aligned with DLT-based systems for securities transactions, but this would undermine many benefits made possible through DLT such as enhanced automation and programmability through smart contracts. DLT-based Payment Instruments, in the form tokenized commercial bank money and deposits, should be broadly developed to support more efficient and effective payment tools. The GFMA and its members recognize that many DLT-based settlement assets exist and must be further developed in concert, rather than isolation. The priority DLT-based settlement assets that enable DLT-ecosystems are:

- **Tokenized Commercial Bank Money and Deposits:** Tokenized commercial bank money is the representation of deposit account balances at commercial banks, reflected on a distributed ledger to support settlement by Tokenization.
- **Wholesale CBDC (wCBDC):** A DLT-based form of cash issued and backed directly by a central bank or monetary authority. This would have no credit or default risk, issued directly by the central bank. Though some wCBDCs are in development or pilot, none have yet been issued.[486]

Development of any form of DLT-based settlement asset must be based upon dialogue among financial institutions, central banks, and regulators. This includes building, piloting, and soliciting regulatory approval. Joint development ensures early alignment and lockstep coordination between all required parties. Public-private partnership can drive resolution of open questions around risk, governance, cybersecurity, and interoperability. Further on the point of interoperability, ongoing initiatives to enable cross-border DLT-based Payment Instrument payments is on-going. Projects like Jasper (Canada, U.K., Singapore), mBridge (China, Hong Kong, Thailand, UAE), and Dunbar (South Africa, Australia, Singapore, Malaysia) all have initiated pilots to test multi-country, DLT-based, payments with promising results.

485 R3, www.r3.com/company/, 2023.
486 Atlantic Council, "CBDC Tracker", taken January 2023.

Call To Action | Achieve DvP Settlement with DLT-Based Commercial Bank Money: No future of DLT-based capital markets can be complete without compliant DLT-based payment, as part of securities transaction settlement. Although DLT-based integrations with traditional payment systems can work in the interim, all desirable future states are where DLT-based Payment Instruments, in the form of tokenized commercial bank money or deposits, is used to in DvP settlement. Market participants, regulators, and lawmakers must all collaborate to ensure this is a safe, compliant, reality.

Closing Remarks

A future DLT ecosystem has a critical dependency on the alignment of policymakers and market participants across jurisdictions on appropriate regulation that provides appropriate protections and promotes innovation.

Through this report, the transformative potential of DLT in capital markets has been clearly set out. Alongside this, an extensive assessment on DLT-specific risk management across implementation models, differing lifecycle activities, and DLT network archetypes has been shared. Jurisdiction-specific legal and regulatory commentary and go-forward considerations have been proposed. Finally, key calls to action have been proposed for all market stakeholders to come together and work towards a coordinated DLT ecosystem that can achieve network effects.

This report has demonstrated how DLT-specific risk management can be achieved through existing risk management frameworks and emerging DLT-based risk mitigants. The high standards of existing risk management frameworks, regulatory requirements, and oversight – together with new DLT risk mitigants recommended by GFMA members in this report – can be applied to manage DLT-specific risk. Together, these negate the need for an additional infrastructure risk add-on to risk-weighted assets for the use of DLT.

Policymakers should avoid regulation that could act as a detriment to innovation, following the "same risk, same activity, same regulatory outcome" and "technology-agnostic", risk-based guiding principles that support, rather than deter, industry innovation and adoption.

This report has also emphasized how legal and regulatory clarity could enable a level playing field that promotes safe and sound innovation. There remains considerable uncertainty and variance across jurisdictions regarding core legal and regulatory issues such as Security Tokens and settlement finality.

As these issues are worked through across jurisdictions, harmonizing approaches across markets is a critical enabler to a future, globally interoperable DLT-based market with consistent regulatory perimeters. This would ensure that DLT-based innovation would be driven by responsible, regulated financial institutions instead of being driven by non-regulated institutions who may not be subject, nor adhere to, the same strict standards expected of capital markets technology.

To do so, regulatory supervision globally should be guided by established "same risk, same activity, same regulatory outcome" and "technology-agnostic" regulatory principles that avoid blanket, technology-specific approaches to protect market participants and promote responsible innovation. The regulatory burden for DLT-based Securities should not be higher than for its traditional counterparts as it would discourage the development and deployment of efficient and risk-mitigating technology that could improve how capital markets function today.

The Road Ahead: Areas of further study to progress the development of DLT-based capital markets

As DLT continues to gain prominence, the body of work underpinning it necessarily expands. No study can adequately, nor comprehensively, cover the topics, technology, and innovations in this area in sufficient detail. Therefore, the GFMA and its members recommend the following four areas as priority for further study and cross-industry collaboration:

(1) **Fractionalization** | Fractionalization and its impact on Secondary Market liquidity, existing and DLT-based technological solutions, and operational processes should be assessed in detail. This is a core feature of DLT-based Securities that could broaden access and improve liquidity across global markets, but its impact must be fully understood before any institutional-grade adoption can occur.

(2) **Interoperability** | DLT-based technologies must integrate with other DLT-based platforms and existing technology. To do so, clear standards should be investigated and defined, across global markets to future-proof current innovations and ensure they remain backwards-compatible with crucial pieces of legacy infrastructure.

(3) **Harmonization** | Law and regulation, especially as relating to securities law, requirements, and rulebooks for settlement finality on DLT networks, data residency, and data privacy should be harmonized across geographies. Regulators should ensure consistency where interconnected markets exist. Key areas of focus include (a) regulatory and prudential treatment, (b) data privacy and access, and (c) approaches to, and the definition of, settlement finality.

(4) **Transition** | The evolution of DLT-based markets will necessitate a gradual transition from traditional infrastructure to DLT-based infrastructure, likely running both in parallel during the immediate-, near-, and potentially medium-term. Key areas to investigate include (a) financial and operational cost of running two sets of infrastructure in parallel, (b) timelines for 'go-live' of institutional-scale DLT-based platforms (e.g., post-trade processing), (c) updates to the applicable laws and regulations for these technologies, and (d) operational considerations for execution of transition to DLT-based infrastructure. Expanding on operational considerations, talent attraction and retention capabilities (including ongoing dialogues with academic institutions), developing new ways of working (e.g., back-office workflows will need to adapt to the automation of DLT-based Securities; front-office staff will need to market, sell, and service client inquiries on new products), and change management capabilities will all need to be explored and developed as part of any transition to DLT-based capital markets.

Annex 1: GFMA Proposed Approach for the Classification and Understanding of Digital Assets

Initial Proposed Approach for the Classification and Understanding of Digital Assets[487]

The Global Financial Markets Association (GFMA) developed the following approach to classification of digital-assets to support our response to the Basel Committee on Banking Supervision (BCBS) discussion paper on **'Designing a Prudential Treatment for Crypto-Assets'**[488] **and** FSBs recent consultation on the **"Regulation, Supervision and Oversight of Crypto-Asset Activities and Markets".** The approach reflects the principle that the treatment of digital-assets should be underpinned by clear methodology for identifying different types of digital-assets' risk which will allow for tailored regulatory treatment, as appropriate.

We believe this provides an initial basis for a taxonomy and it is key that there is close engagement between the industry and the regulatory community on this topic. We therefore recommend a joint industry-regulatory task force is formed to urgently develop a global taxonomy as a priority in 2023.

Approach to classification and understanding of digital assets

Broadly, digital assets may serve a variety of economic functions, such as an agent for payments[489], a vehicle for investment or trading[490], or a utility to access other goods or services[491]. Within those functions, when those assets have the characteristics of existing regulated instruments, a specific regulatory framework may apply. However, given the features of digital-assets, other key attributes beyond economic function, may need to be taken into consideration by regulators in order to classify those assets and determine what regulations should apply, if any (similar to how frameworks such as those that are leveraged for classifying a security/financial instrument function today).

For this initial taxonomy proposal[492] we focused on defining features of digital-assets such as:

- **Issuer** (e.g., central bank)
- **Mechanism or structure underlying the asset value** (e.g., pegged to or in reference to an underlying asset or access to a network product or service)
- **Rights conferred** (e.g., entitlement to cash flows, redemption rights, voting)
- **Nature of the claim** (e.g., claim on an issuer or claim on an underlying asset)

487 As discussed in our Note to the Reader, we believe that 'digital-assets' is a much more appropriate term when discussing DLT based assets in the general sense. However, we would reiterate our initial point that a global taxonomy is urgently needed. We would note that when we discuss digital assets that this does also include fiat deposit accounts where the transfer of ownership is accomplished via blockchain or DLT.

488 GFMA Response to BCBS Discussion Paper on the Prudential Treatment for Crypto-Assets.

489 Payment tokens may also be referred to as exchange tokens in some jurisdictions. Key uses may include, the crypto-asset being held and transferred primarily for the purposes of buying or selling other assets or being used as a store of value.

490 Security/ Investment/Financial instrument tokens provide entitlement to proceeds or a right to vote and could also meet the characteristics or definition of a financial instrument or equivalent regulatory classification.

491 Crypto-assets used as a means of accessing a DLT platform and/or a medium of exchange for the provision of goods and services provided on the DLT platform, and does not have value or application, outside of the DLT platform on which it was issued (Note that the crypto -asset may be used as a means for data and database management, data recordation, or other bookkeeping or recordkeeping activity. As these do not constitute financial instruments, they are intentionally excluded here.)

492 This approach has not been formally endorsed by all GFMA members and is intended as a basis for discussion.

There are additional features that should be assessed against each type of digital-asset to help differentiate and evaluate the risk, including types of users/holders (e.g., retail versus wholesale), **systemic importance,** and if an **asset is linked to a real or off-chain asset,** who or what **type of entity has Custody of that asset,** if any.

Other features that we recommend be considered for a future global taxonomy is the type of network upon which the digital asset exists. There are various configurations of DLTs, each with varying levels of privacy, governance and control. These are set out below:

- **Private-permissioned (e.g., R3 Corda):** Private-permissioned networks are characterized by a centralized authority that can control **access to the network** (private) and **actors that can perform actions on the network** (permissioned). Private networks enable a comparable model to existing infrastructure used by capital markets today, with control over all network layers, and their defining characteristics mean existing legal, regulatory and institutional risk management frameworks (operational risk and cyber resilience frameworks) can be applied.

- **Public-permissioned (e.g., Corda Network):** Public-permissioned networks are characterized by allowing **public access to the network** and a centralized authority to control **actors that can perform actions on the network** (permissioned). Though public-permissioned distributed networks mark a step away from the tight central control of private networks, they also operate as closed networks with centralization retained over key network attributes. Therefore, like private networks, the same legal, regulatory, and institutional risk-management frameworks also provide a sufficient basis to govern these networks, including differentiated considerations around cybersecurity and impacts on operational resilience, and KYC/AML/CFT compliance.

- **Public-permissionless (e.g., Ethereum):** Public-permissionless networks allow unrestricted access to the network and allow anyone to perform actions on the network by default. These publicly available distributed ledger networks have defining characteristics, such as decentralization, pseudonymity, and large-scale user bases, that are different to private-permissioned and public-permissioned networks.

Further to this distinction, digital assets can be subdivided into characteristic types:

- **Fungible:** interchangeable and divisible – like securities, cash, or commodities
- **Non-Fungible:** unique and indivisible – like real estate, fine art, and other nonfinancial assets
- **Digital Only or Real World:** accessed via a centralized bridge that relies on a service provider

Both of these distinctions should also be part of the 'type' that digital assets can belong to in a global taxonomy. Many digital assets have functions and features spanning more than one of the categories or may not even be contemplated at this time [493]

These types of digital assets may have characteristics that enable their use for more than one purpose (means of payment or investment) at any single point in the lifecycle of the asset or have characteristics that change during the course of their lifecycle. Further consideration should be given to these types of assets as well as when and how the rules should apply to them. The GFMA would encourage an approach that is agile and remains robust, providing the market clarity while also allowing innovation as market structures develop, uses evolve, and technology changes, or new assets are created.

While we have used the term 'digital-asset,' as the overarching category to group together a number of instruments, not all the categories (and associated uses and attributes) should be treated as instruments for which

493 As the crypto-asset market evolves and the understanding of uses matures, additional uses beyond those identified as payment, investment, or utility may need to be addressed or identified.

a new financial regulatory framework is necessary or appropriate. A robust regulatory framework (including customer/investor protection safeguards) may already exist for the instruments or activity represented by the 'digital-asset.'

We would reiterate that the proposal below is intended to be an initial starting point for a classification of digital assets. It is designed to help regulators evaluate which types of regulations should apply to which type of assets. We note however that as these assets evolve and potentially new ones are created, this classification may need to be updated over time. We would still encourage that a global taxonomy be developed. This global taxonomy should be comprehensive, but also have the ability to be reviewed and adapt with time and new innovations.

Types of Digital Assets[494,495]

Value-Stable Digital Assets

1. **Tokenized Commercial Bank Money[496]**
   - Digital tokens reflecting a deposit ownership claim reflected on DLT for a fixed amount of fiat money denominated in a single currency by the token-holder against the token issuing bank or other similarly highly regulated depository institution. It may or may not pay interest.

2. **Financial Market Infrastructure (FMI) Tokens (e.g., USC)**
   - Digital tokens representing a claim on an FMI for a fixed amount of fiat money denominated in a single currency by the token-holder, fully collateralized by reserves held at a central bank or deposits held at a commercial bank. It may or may not pay interest.

3. **Wholesale Central Bank Digital Currencies (wCBDC[497], none launched)**
   - Specialized, limited purpose digital tokens representing a claim on a central bank for a fixed amount of fiat money denominated in a single currency, designed for specific use by wholesale market participants who have central bank account access. It may or may not pay interest.

4. **Stablecoins (e.g., USDC):** Tokens designed to minimize price fluctuations relative or in reference to other asset(s) which are not issued by a central bank, FMI, bank, credit institution or highly-regulated depository institution. May represent a claim on the issuing entity, if any, and/or the underlying assets. There are two types of stablecoins.

494 GFMA also notes that the term 'coin' and 'token' are synonymously leveraged below and are not intending to insinuate differences between the two terms.
495 Some of those instruments may meet the 'e-money' criteria in those jurisdictions where that regulatory classification exists and be classified as such for regulatory purposes.
496 Note: Deposits recorded via DLT may not be considered true digital assets as they do not create a new asset class with separate intrinsic value from the fiat currency they represent. However, we have included this to be responsive to varying definitions of digital asset under consideration, and to comprehensively articulate when the use of distributed ledger technology would not require new regulatory treatment, but would be governed by an existing regulatory framework.
497 CBDC can rely on non-DLT/blockchain technology, this taxonomy is intending to capture only those leveraging DLT/blockchain technology.

- Asset Linked Digital-Asset: value may be fixed or variable and in reference to individual structures or include a combination of:
  - Fiat currency linked (e.g., Tether, Paxos, USDC)
  - Other real asset linked (e.g., Sendgold)
  - Digital asset linked (e.g., Maker)
- Algorithmic Digital-Asset: Typically, not linked to any underlying assets and each token can be pegged to a price level or a unit maintained through buying, selling or exchange among assets or some other pre-determined mechanism. To meet the standard defined here, an algorithmic digital asset must be pegged to assets that are highly liquid and hold intrinsic value

DLT-based Securities[498]

- **Tokenized Security (e.g., UBS AG's digital bond dual listed on Swiss SIX and SDX):** Token that represents on DLT infrastructure underlying securities/financial instruments issued on a different platform (e.g., a traditional CSD, registrar, etc.), where such representation itself satisfies the definition of a security/financial instrument under local law.
- **Security Token (e.g., World Bank's "Blockchain Bond"):** Token issued solely on DLT infrastructure that satisfies the applicable regulatory definition of a security or financial instrument under local law

Cryptocurrencies

- Digital representations of value with no redemption rights against a central party and may function within the community (enabled through peer-to-peer networks) of its users as a medium of exchange, unit of account or store of value, without having legal tender status. They may also act as an incentive mechanism and/or facilitate functions performed on the network they are created in; their value is driven by market supply/demand therein.

Settlement Token

- Representation on DLT or blockchain infrastructure of underlying traditional securities/financial instruments issued on a different platform (e.g., a traditional CSD, registrar, etc.) where such representation itself does not satisfy the definition of a security or financial instrument under local law and is used solely to transfer or record ownership or perform other mid/back-office functions (e.g., collateral transfer, recording of ownership)

Utility Token

- A means of accessing a DLT or blockchain platform and/or a medium of exchange which participants on that platform may use for the provision of goods and services provided on that platform (e.g. loyalty rewards programs/systems, gift card rewards, credit points that are only usable within the DLT or blockchain platform, memory and network server space, and other utilities- based value); or
- Tokens that are not native to the underlying network but are used for accessing applications that are built on top of another DLT or blockchain infrastructure platform (dApp)

Other Crypto-Assets (not structured as value-stable crypto-assets)

- Representation on DLT or blockchain infrastructure of ownership in tangible or intangible underlying assets or of certain rights in those assets (such as interest, e.g., loans), which are not securities or financial instruments (e.g., real estate, art, intellectual property rights, precious metals, grains, or non-fungible assets that only exist in digital form on a DLT network); they may represent a claim on the issuing entity or the underlying assets.

498 This category encompasses different regulated instruments from a legal perspective, which may attract different regulatory treatment amongst themselves and across jurisdictions.

Annex 2: DLT-based Security Issuances

Presented here is a non-exhaustive list of DLT-based Security Issuances over the past six years, identified by Issuer, the amount of issuer, the year, geography, and network type. By including these examples, the GFMA and its members seek to demonstrate that capital markets participants, including regulated financial institutions, have been using a combination of private and public network archetypes based on the specific needs of an individual use case.

Issuer	Amount	Year Issued	Security Type	Network Type	Region
Hong Kong Monetary Authority	800M HKD	2023	Bond	Private-Permissioned	Hong Kong
European Investment Bank (Project Mars)	50M GBP	2023	Bond	Private-Permissioned	Europe
City of Lugano	100M CHF	2023	Bond	Private-Permissioned	Switzerland
KfW	20M EUR	2022	Bond	Private-Permissioned	Germany
Union Bank / Standard Chartered	11B PHP	2022	Bond	Private-Permissioned	Philippines
European Investment Bank (Project Venus)	100M EUR	2022	Bond	Private-Permissioned	Europe
UBS	375M CHF	2022	Bond	Public-Permissionless	Switzerland
SIX	100 CHF	2021	Bond	Public-Permissioned	Switzerland
Société Générale	5M EUR	2021	Bond	Public-Permissionless	France
European Investment Bank (Project Mercure)	100M EUR	2021	Bond	Public-Permissionless	Europe
Vonovia	20M EUR	2021	Bond	Public-Permissionless	Germany
Union Bank / Standard Chartered	9B PHP	2020	Bond	Private-Permissioned	Philippines
Singapore Exchange	400M SGD	2020	Bond	Public-Permissionless	Singapore
Société Générale / Banque du France	40M EUR	2020	Bond	Public-Permissionless	France
Bank of China	20B CNY	2019	Bond	Private-Permissioned	China
BBVA	35M EUR	2019	Bond	Private-Permissioned	Spain
Banco Santander	20M USD	2019	Bond	Public-Permissionless	Spain
Société Générale	100M EUR	2019	Bond	Public-Permissionless	France
MTS Bank	750M RUB	2018	Bond	Private-Permissioned	Russia
World Bank	110M AUD	2018	Bond	Public-Permissionless	Australia
Daimler	100M EUR	2017	Note	Private-Permissioned	Germany

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