In Collaboration with Boston Consulting Group

Digital Assets, Distributed Ledger Technology and the Future of Capital Markets

INSIGHT REPORT

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Contents

Foreword

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In recent years, the financial institutions comprising the capital markets have begun to approach digital transformation with a level of urgency previously seen only in consumer-facing financial services. The need to improve client service delivery, achieve greater efficiency and enable new services (e.g. through monetization of data) have converged on imperatives for all capital markets executives to explore how technology should be used to redesign product offerings and operations.

At the same time, distributed ledger technology (DLT), of which blockchain is the most widely known example, has gone through several pendulum swings in terms of industry and public interest. Depending on one's perspective, this technology could disintermediate the capital markets as we know them, radically simplify operations for leading capital markets players, help expand access to markets for small businesses and retail investors or fade into irrelevance.

Since the World Economic Forum published The Future of Financial Infrastructure in 2016, we have seen relatively little of the blockchain-enabled transformation explored in the report. Yet we are potentially approaching an inflection point, with meaningful DLT use cases going live and many institutions acknowledging that this technology will likely play some role in the future of capital markets. This report explores the various ways in which this technology is starting to be used, as well as the challenges involved in attempting industry-wide transformation.

Consistent with the World Economic Forum's multistakeholder approach, the insights presented here are based on dialogues and interviews with expert practitioners from across the capital markets ecosystem. We thank all who participated in this initiative and shaped our understanding of this space.

Context

Distributed ledger technology (DLT)* has existed for more than a decade. For nearly as long, advocates have argued either that this technology could be used by financial institutions to radically simplify operations or that its decentralized capabilities would enable an entirely new financial system, wherein capital could flow without traditional intermediaries. DLT's detractors – perhaps just as numerous – have pointed out challenges in both of these visions, stemming from the potential costs of transformation, the capital markets' reliance on relationships of trust and the existence of other technologies that might be better suited for certain uses. In this context, firms have invested heavily in DLT efforts, with a wide range of strategic motivations.

Over the past two to three years, several regulators have expressed greater comfort with this technology, and some DLT-enabled products and services have moved from exploration and experimentation to commercialization. It has become clear that, at a market-wide level, DLT offers the potential for significant transformation. This report explores what has been learned from these efforts. While ultimately neutral as to what the capital markets of the future will look like – and what role or roles will be played by DLT – it aims to provide capital markets executives and regulators with the strategic insights needed to understand the current state of use-case developments and potential future scenarios.

What use cases have been developed across asset classes, and how are they being adopted?	**Which DLT use cases are gaining traction, in which jurisdictions and why?**
What are the impediments to adoption, and what has been learned as a result?	**How are industry dynamics – collaboration and competition – shaping adoption and demand?**

*This paper uses the term "DLT "to refer to distributed ledger technology and blockchain.

Introduction

Over the past year, financial services and technology experts were engaged in a series of global workshops and expert interviews

Global workshops*

Eight workshops were conducted over the course of 2020 – all virtually. These brought together executives from banks, asset managers, exchanges and infrastructure providers, financial technology companies and regulators for a series of interactive discussions. Three workshops were focused on developments from a regional perspective (North America, Europe and Asia-Pacific), while five were focused on emerging uses of DLT within specific asset classes or product lines (equities, debt, securitized products, derivatives and securities financing, and asset management).

Expert interviews*

In-depth interviews were conducted with almost 200 executives from leading financial services and financial technology firms, as well as with experts from outside the industry.

Survey*

More than 60 firms participated in an anonymized survey focused on details of DLT use cases that their firms are developing. While not a scientific sampling, this survey enabled the team to effectively map out where DLT experiments are being conducted within the capital markets.

*Please see Acknowledgements for a list of individuals who participated in workshops and interviews.

The inclusion of company case studies within this report does not reflect an endorsement of the company or its products and services by the World Economic Forum.

This report will provide executives, regulators and policy-makers with insights on the emerging uses of DLT in capital markets

This report will…

– Explore many of the ways in which capital markets institutions and technology firms are experimenting with or building products enabled by distributed ledger technology

– Illustrate how individual DLT use cases may address challenges or inefficiencies in specific markets

– Share insights from relevant experts on potential paths forward, challenges or enablers for these use cases

– Highlight examples of firms bringing specific use cases to market, with summary details on each

This report will not…

– Focus on DLT-related use cases outside the capital markets, including payments, digital currencies, lending, working capital solutions and trade finance (except as they relate to specific capital markets use cases)

– Explore cryptocurrencies, non-fungible tokens (NFTs) or decentralized finance (DeFi) applications

– Provide detailed technical explanations of financial, operational or technological dimensions of use cases

– Evaluate use cases or make recommendations on strategies that individual institutions should pursue

This report seeks to help…

– Strategic decision-makers at financial institutions to understand the potential roles DLT is beginning to play in the capital markets, critically assess different use cases and explore how their institution might operate within different future state visions

– Regulators and policy-makers to understand how financial institutions in different jurisdictions are adopting DLT-enabled solutions so that they may craft responses that appropriately balance innovation and market safeguards
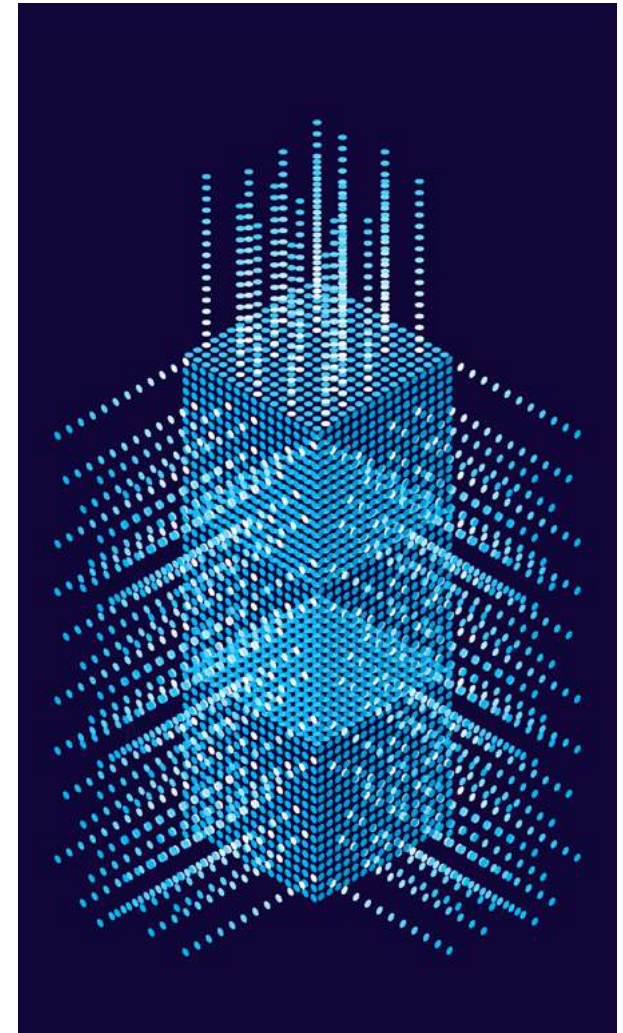
Key insights

DLT is beginning to reshape capital markets, but the future is uncertain

1

Market forces, supported by regulatory and technical developments, are pushing participants in capital markets to digitize and consider the use of distributed ledger technology (DLT). Key trends include growing institutional and regulatory comfort with blockchain technology, the potential for central bank digital currencies (CBDCs) in several jurisdictions, and commercial dynamics, such as cost pressures and client service expectations.

2

The underlying challenges that DLT is trying to solve in capital markets are real and substantial. Inefficiencies vary by asset class and jurisdiction, but legacy processes and technology systems have created complexity, opacity and fragmentation across markets, which likely has a meaningful impact on costs, market liquidity and firms' balance sheet capacity. While DLT is not necessarily the optimal technology option for every proposed use case, **experiments are proving its viability in addressing significant operational inefficiencies and increasingly improving balance sheet management**.

3

After years of experimentation, many DLT and smart contract use cases in capital markets are **live** across jurisdictions. Market participants are launching solutions designed to improve existing processes for defined ecosystems in numerous asset classes and in some cases are reimagining value chains as we know them today. **However, grand visions of disintermediation or total digital transformation at scale are still far from being realized**.

4

While most emerging DLT use cases are being developed collaboratively, there is no industry-wide vision of the future in most jurisdictions – due in part to substantial competing incentives and the risk of value migration across market participants – potentially limiting the ability to scale up many solutions.

5

While greater digitization is inevitable, substantial headwinds may continue to limit adoption of DLT solutions, including limited leadership buy-in and uncertain business cases, the need for significant restructuring of business operations, challenges relating to bridging legacy systems with new solutions, and perceptions about regulatory uncertainty.

1. Significant tailwinds may support adoption of DLT solutions in capital markets

Mutually reinforcing developments supporting financial institutions' exploration of DLT…

…are intersecting with broad capital market trends

Market developments	Policy developments	Technical developments
Growing retail and institutional investor interest in digital assets, most notably cryptocurrencies	Growing regulatory comfort with DLT across several jurisdictions	Technical advancements in DLT/ blockchain: growing maturity, platform consolidation and improvements in interoperability
Developments in adjacent markets, including stablecoins and DLT-based trade finance and payment solutions	Serious exploration of CBDCs in numerous jurisdictions, including some based on DLT	Institutional-grade infrastructure in digital asset markets

- Increased competition, including the rise of digital disrupters challenging the roles of traditional intermediaries and service providers

- Emergence of a bifurcated client service model, with a focus on digitization and simplification for all client types

- Balance sheet capacity continuing to be a major constraint

- Acceleration of digital adoption due to COVID-19 pandemic

- Sustained cost pressures across the value chain

Across the capital markets ecosystem, broad trends are accelerating the digital push

2. DLT may be able to address significant challenges across the capital markets

The scale and nature of inefficiencies varies across markets, but legacy structures tend to:

– Require firms **to independently maintain siloed records** of transactions, securities and other data, with each institution independently processing events and subsequently reconciling records. This **adds complexity to operations, increases the risk of error, limits the ability to automate processes and likely adds costs across the capital markets ecosystem**

– Limit the **flexibility of transaction windows** and time frames in order to accommodate the need for sequential processing and verification. While many highlight the costs of liquidity needed to fund multi-day trade settlement cycles, this dynamic also **limits the ability to optimize balance sheets**, as firms are unable to rapidly move securities and cash to address funding and liquidity needs and availability

DLT is proving well-suited for addressing operational inefficiencies, and is increasingly demonstrating the possibility of better resource management across firms and markets:

DLT capability	Create trust in a real-time, shared source of truth across multiple parties in a market or transaction	Automate and synchronize business processes across entities using smart contracts	Enable assets to be more efficiently and flexibly transferred across entities
Business benefit	Minimize the need for reconciliations and manual data verifications	Reduce manual interventions, risk and cost across processes	Unlock liquidity and enable better balance sheet management across and between firms
DLT use case example	Mortgage-backed securities with underlying loan data recorded on DLT	Derivatives post-trade life-cycle management platforms	Intraday repo using tokenized collateral and digital cash

3. DLT applications are going live across the capital markets

After years of experimentation, financial institutions and technology providers have begun to launch DLT-based products and projects. While capital markets are not necessarily moving inexorably towards a global, fully digitized, DLT-based utopia as many predicted, DLT-enabled use cases are becoming a reality across a range of asset classes, business cases and ecosystems.

Examples of use cases gaining traction (as of April 2021)

Proof of concept

Launch scheduled

Live in production

● Soon

Major market infrastructure replatforming using DLT

● Soon

Bilateral/intracompany repo

● Live

Corporate bond issuances

● Live

Securitization of blockchain-originated loans

● Live

Intraday repo

● Live

Private equity tokens issued on blockchain

Corporate bond origination workflow

● Soon

End-to-end digital market infrastructure from major infrastructure provider

Public fund distribution

Public fund administration

● Soon

Equity/credit derivatives life-cycle management

● Soon

Cross-border collateral mobility

● Live

Private fund administration and distribution

4. Strategic considerations are driving divergent visions of the future

Institutions are deciding where to invest across a range of strategic choices, including:

Digital product strategy

1. **Market selection:** focus on developing solutions for individual asset classes or develop an asset-class agnostic infrastructure solution

2. **Value chain breadth:** focus on addressing challenges in one slice of the value chain or build an end-to-end solution

3. **Degree of change:** attempt to improve existing processes or fundamentally disrupt the market as it exists today

4. **Technology fit:** identify whether DLT is the most appropriate technology for a specific set of challenges and how it will be used

Go-to-market strategy

1. **Commercial and technical approach:** attempt to build a new ecosystem, work with an existing set of partners or another approach

2. **Transformation management:** determine whether to build a new system and migrate all participants or build and operate in parallel

3. **Interoperability:** determine whether and how solutions will integrate with other platforms and systems, technically and commercially

But as different players embark on varying strategies, these choices are creating tensions:
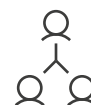
Redistribution of value pools and the "collaboration paradox"

DLT-enabled transformation could make the industry more efficient, but it would likely shift value pools among both incumbent firms and new entrants. Given the potential for new business opportunities and the possible disintermediation of some existing roles – a conceivable reality as regulations adapt to DLT – firms may be increasingly reluctant to participate in collaborative initiatives. Without collaboration, however, ecosystem-wide value will be difficult to achieve.
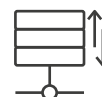
A complex patchwork of initiatives, spanning different institutions, business lines and geographies, limiting the ability to reach scale

Since many DLT-based initiatives would independently require a substantial level of transformation, institutions' focus on a limited set of initiatives or consortia – which makes sense from the perspective of any individual firm – can prevent the cross-institution alignment needed for many use cases. Similarly, while regulations can help define the guardrails for innovation, in some cases, vastly different regulatory frameworks have led to very different technology needs in different markets.

Short-term vs. long-term strategies

While achieving short-term objectives will build comfort with the technology, it may, counter-intuitively, inhibit the appetite for large-scale transformation. Given the long pathway to transforming entire markets, lack of buy-in for long-term solutions may limit the upfront investment needed.

5. Challenges to DLT adoption remain substantial

Business case and leadership buy-in

Many DLT projects are focused on achieving a long-term (i.e. five-plus years) value proposition but require substantial upfront investment and industry-wide transformation in the short term. Where the business case is long-term, projects must be championed by leaders with the authority to influence industry-wide alignment in order to move forward. Where the business case is unclear or the technology is not necessarily fit-for-purpose, leaders should consider whether these projects are diverting energy from other worthwhile digitization efforts.
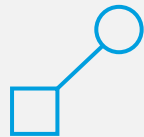
Bridging the old with the new

Maintaining legacy systems while building and scaling new solutions is likely to be costly and complex. While common technical and financial standards are essential for many DLT use cases, they may also prove essential for enabling interoperability between legacy systems and DLT-based solutions. Nevertheless, institutions and markets attempting parallel (DLT and legacy) infrastructures will have to effectively manage costs and risks.

"Chicken and egg" dilemmas

For most use cases, achieving scale may be more challenging than reaching production. Except for completely internal systems, all use cases will require a "minimum-viable ecosystem" of participants (e.g. at least one of each of the relevant parties for a certain type of transaction). However, some DLT solutions will create new markets that will exist in parallel to traditional markets. With neither an active investor base nor an active issuer base, these parallel markets may not have a clear path to liquidity, thereby limiting the willingness of investors to participate or issuers to issue in these markets.

Coordination challenges combined with limited risk appetites

In many cases, realizing the anticipated benefits of DLT will require significant restructuring of roles, processes and operations, potentially introducing new risks as markets adjust. While industry consortia have tackled large-scale challenges and transformations before, the appetite for system-wide change remains limited without a "burning platform" for change.

Regulatory and legal uncertainty

Without a clear playbook for regulatory compliance and generally agreed-upon principles for the legal standing of DLT-enabled transactions and securities, market participants are unlikely to make the substantial investments required to fundamentally change processes. Further, regulation varies across jurisdictions, complicating global solutions. While many regulators have expressed openness to DLT-based innovation, a perception remains that the future path is unclear, particularly as most new entrants have not yet faced prudential regulation.

Summary

Securitized products
– End-to-end origination, securitization and servicing platform
– Tokenizing loans for servicing and data management
– Facilitating security servicing on DLT

Debt markets
– Platform for digital bond issuance
– Distributed order book for bond trading
– Platform covering full corporate bond life cycle
– Retail bond issuance and distribution
– Stand-alone blockchain bond issuance

Derivatives
– Platform for OTC derivatives post-trade life cycle
– Replatforming existing infrastructure on DLT
– Platform managing collateral for cleared derivatives
– Platform for exchange-traded derivatives trade life cycle

This report explores emerging DLT use cases across the capital markets

Equity markets
– Replatforming existing post-trade infrastructure
– Supplementing post-trade infrastructure
– Digital platform covering full securities life cycle
– Equity tokens issued on blockchain

Securities financing
– DLT platform for repurchase agreements
– Securities swaps across collateral pools
– Replatforming securities lending infrastructure

Asset management
– DLT-based fund distribution and register platform
– Investor-facing end-to-end platform for tokenized funds
– End-to-end fund distribution, administration and servicing network

Enablement use cases
– Wholesale payments
– Facilitating capital markets digitization
– Custody services for digital assets
– Digital asset issuance platforms

① Background

- – Business and technology developments in capital markets

- – Overview of DLT in the capital markets context

- – Timeline of major technical, regulatory and business developments

Across the capital markets ecosystem, institutions are facing a combination of new market dynamics and technology advancements, presenting opportunities and challenges…

	Key business developments	Broad technology implications	DLT implications	Likely impact on DLT interest
				Immaterial ● ● ● ● Significant
1	**Acceleration of digital transformation, especially following COVID-19:** once-emerging technologies continue to gain scale, and client demand for digital assets grows	Increasing experience with artificial intelligence, machine learning, cloud and DLT solutions	Increasing comfort with DLT; potential for increased interest in solutions that benefit from multiplicative effect of DLT with other technologies	● ● ● ●
2	**Bifurcated client service model:** transition to a low-touch digital service model for certain clients and transactions	Increasing need for digital self-service client solutions, as well as digital enablement solutions to support teams servicing high-touch clients	DLT and smart contracts can facilitate solutions offering greater automation, with potential for integration with self-service solutions	● ● ● ●
3	**Sustainable finance as a source of growth:** demand for products that meet clients' sustainability objectives	Increasing need for solutions that capture sustainability impact	Potential demand for DLT-enabled solutions for measuring, reporting and transacting with sustainability-related data, potentially linked to financial instruments	● ● ● ●
4	**Consolidation of trading venues:** emergence of a small set of trading venues that will attract the bulk of liquidity in certain markets	Potential for more electronic trading and greater standardization in more concentrated markets	More consistent and scalable digital processes and convergence of market-wide standards could be a tailwind for DLT implementations, but DLT use could actually stimulate more trading venues	● ● ● ●
5	**Monetization of data:** insights from trade, position and client data to power customized offerings	Increasing need for effective data capture and analytic solutions (e.g. machine learning)	DLT solutions may offer better data quality and data accessibility than existing systems	● ● ● ●

…while margin pressures are forcing all players to identify meaningful cost savings and sustainable sources of revenue growth

|	Key business developments	Broad technology implications	DLT implications	Likely impact on DLT interest (Immaterial → Significant)
6	**Sustained cost pressures across the value chain:** continued need to realize meaningful efficiencies via operating model transformations and infrastructure redesigns	Increased investment in modernizing technologies, with growing demand for solutions that unlock step-change cost reductions	DLT-enabled automation and operational transformation could unlock significant cost efficiencies, but the scale of investment might be prohibitive for some	● ● ● ●
7	**Scale continues to be a key competitive advantage:** subscale players will exit or transition to "white-labelled" products	Consolidation of tech solutions and providers where critical mass takes hold	Increasing returns for the DLT solutions that gain scale and magnify competitive advantage (i.e. first-mover advantage with network effects)	● ● ● ●
8	**Balance sheet capacity continues to be a constraint:** financial resources continue to be judiciously allocated to clients, business lines and products	Increased interest in tech solutions that facilitate better capital/liquidity management	Increased demand for DLT-based solutions that offer meaningful improvements to balance sheet management, with potential for interest in new models for custody	● ● ● ●
9	**Increased focus on core competencies:** non-core functions that are not a source of competitive differentiation will continue to be transitioned to industry utilities or external service providers	Service providers become tech leaders, offering cost and quality advantages via their solutions	Increased comfort with DLT solutions that power non-core functionality, with growing competition among service providers	● ● ● ●
10	**Increased competition:** the competitive landscape is intensifying among both traditional players and new entrants, with continued value migration across the sell-side, buy-side and service and infrastructure providers	Firms will continue to seek to differentiate with technology, both as a vehicle for cost savings and improved client experience	Increased demand for DLT solutions with clear and differentiated client benefits or that enable step-change cost savings	● ● ● ●

What is distributed ledger technology?

DLT is an immutable distributed database that governs the flow of data between decentralized participants.

By ensuring data is consistent, accurate and up-to-date, DLT/blockchain aims to enhance trust among all participants.[1]

The technology is built on a foundation of four key elements:[2]

1. **Distributed ledger and peer-to-peer network:** data representing assets or transactions is replicated across each node on the network, ensuring resiliency and transparency

2. **Digital signatures and hash functions:** strong encryption and anti-tampering measures guard against data being retroactively altered

3. **Consensus algorithms:** a consensus mechanism authenticates the underlying data to ensure that all participants have the same view of the data, potentially eliminating the need for trusted intermediaries in a transaction

4. **Smart contracts:** machine-executable code is automatically triggered to enforce contractual obligations under predefined circumstances

Today Centralized intermediaries and separate databases
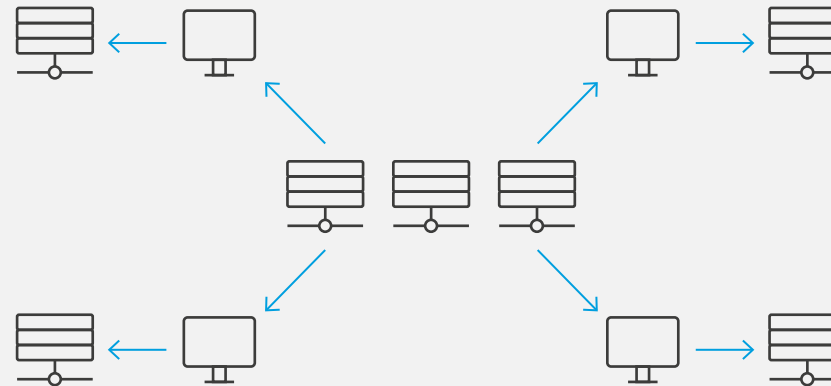
- Siloed participants interact via a central authority

- Central authority can be a single point of failure, limiting resilience

- Centralized maintenance and administration

DLT Distributed, synchronized ledger

Decentralized network

Decentralized data
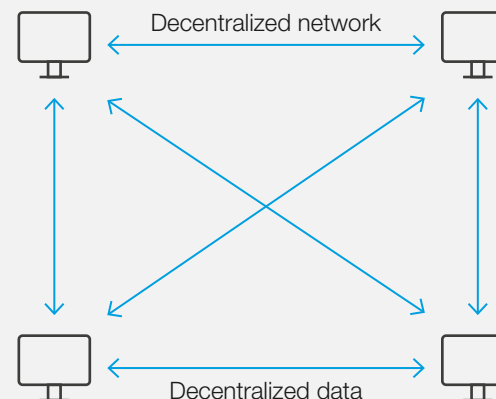
- All parties interact directly and access the same, synchronized information (with permissions)

- Highly resilient (e.g. no single point of failure, and numerous redundant data stores with continuous syncing)

DLT's unique technical properties could provide material benefits to capital markets

DLT offers the potential for mutualized infrastructure for efficiently managing shared data and workflows, based on three interrelated technical capabilities:

Trusted sharable data

Multiple parties have identical, immutable and perpetually synchronized "copies" of a shared ledger, eliminating the need for each party to maintain its own data silo.

Data consensus eliminates manual reconciliations, minimizes disputes and increases data sharing, accuracy and transparency across the ecosystem

Tokenization

Financial instruments are established as a digital token, with the token serving as either a representation of the asset or as the asset itself. Custody of the token's cryptographic key confers ownership similar to the custody of a physical bearer stock certificate.

Tokenization benefits include:

– Faster and lower-cost asset transfers
– Fractionalized securities
– Increased liquidity for niche markets

Smart contracts

Smart contracts define market rules, terms of an individual security and/or rules for shared business processes, creating the possibility for seamless, automated execution of operations among multiple parties without manual intervention.

Smart contracts enable fast and reliable zero-touch processing, reducing costs and risk in transaction settlement, asset servicing and compliance

Reduced costs through automation and elimination of redundant activities

Balance sheet optimization through faster and more efficient capital and liquidity deployments

Reduced complexity, risk and cost through removing counterparty credit risk in settlement

Newer DLT platforms have addressed concerns about scaling and environmental impact

Bitcoin, the earliest and most notable DLT platform, can process only a few transactions per second, while transaction confirmations can lag by 10+ minutes.[3] Bitcoin's "proof of work" consensus algorithm requires highly energy-intensive mining. By some estimates, Bitcoin mining globally consumes more electricity than the entire country of Argentina.[4]

In contrast, modern DLT platforms, which typically rely on alternative consensus algorithms such as "proof of stake", are orders of magnitude more energy efficient, while also demonstrating far better performance. A 2018 study conducted by the Depository Trust and Clearing Corporation, R3 and Digital Asset showed that Corda could sustain throughput of 6,300 trades per second.[5] In addition to using more energy-efficient consensus algorithms, most enterprise DLT use cases in the capital markets also use private and/or permissioned ledgers, which consume far less energy than public ledgers.[6]

Is DLT necessary to achieve business outcomes?

Key conditions that favour DLT

– **Multiple parties requiring trustful interactions**
There must be multiple parties that wish to interact via well-understood and shared business processes with pre-agreed workflows, rules and exceptions. Similarly, these parties need to rely on a trusted data source to facilitate their interactions.

– **Multiple parties require a shared understanding**
There must be substantial value in a single shared version of truth that enables greater transparency, efficiency or ease of transaction.

– **Challenges with central intermediary**
Markets with no central intermediary – or where reliance on an intermediary presents challenges (e.g. excessive cost or intermediary does not obviate need for verifying data) – stand to benefit more from DLT.

While other technologies enable secure data sharing, cryptography can ensure trust in shared data

As data moves through APIs, institutional boundaries and the patchwork of systems that comprise a typical value chain, there are many factors that can cause data to become out of sync (e.g. translation errors, propagation delays, conflicting updates). Even when there is no data disagreement at the business process level, these small data variations put substantial pressure on reconciliation processes, which remain both labour-intensive and costly, to detect and fix data issues both internally and between institutions.

DLT seeks to obviate reconciliations by using cryptography to ensure that data, once written, can never be altered. This golden data source is propagated to all authorized parties in real time so they can automatically audit the complete data lineage to ensure that it hasn't been altered – thereby ensuring that both parties' data remain in-sync, with verifiable proof that their records are accurate and complete.

Can smart contracts achieve the desired outcomes – synchronized, automated workflows – without a distributed ledger?

Increasingly, some firms are developing smart contract solutions that do not necessarily run on a distributed ledger.[7] Smart contract languages have been designed to empower domain experts to create inter-company applications that enforce strict data governance and complex workflows, without transforming the underlying database technology. Without a DLT, data integrity would need to be provided by a trusted central intermediary. In these solutions, smart contracts could enable straight-through processing across firms by orchestrating multiparty workflows, enforcing rights and obligations of the involved parties and ensuring the appropriate level of data privacy. In principle, these smart contracts could eventually be migrated to a DLT-based platform with little effort.[8]

PROJECT SPOTLIGHT

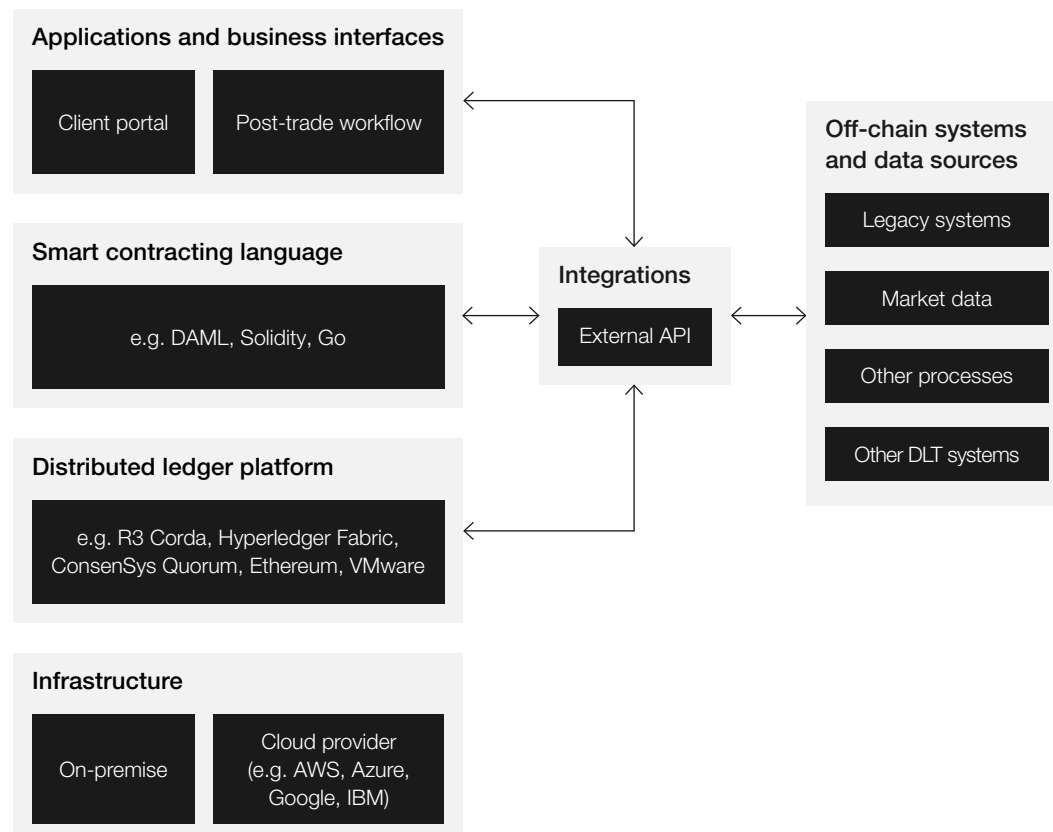**HKEX** 香港交易所   **DTCC** **Digital Asset**

HKEX Synapse

HKEX is currently developing a solution that enables participants in the Northbound Stock Connect programme to meet the shorter equities settlement window of Mainland China (). Rather than building a new settlement infrastructure based on a distributed ledger, this tool will use smart contracts on top of the existing centralized infrastructure to synchronize the workflow among parties.[9]

Technology stack and technology choices

While some technology choices have limited implications for underlying business considerations, other choices may have a direct impact on the features and functionalities of business applications

Illustrative technology stack for a DLT-based application

Applications and business interfaces

Client portal | Post-trade workflow

Smart contracting language

e.g. DAML, Solidity, Go

Distributed ledger platform

e.g. R3 Corda, Hyperledger Fabric, ConsenSys Quorum, Ethereum, VMware

Infrastructure

On-premise | Cloud provider (e.g. AWS, Azure, Google, IBM)

Integrations

External API

Off-chain systems and data sources

Legacy systems

Market data

Other processes

Other DLT systems

Degree of system centralization

Distributed ledgers can have controls over who can view, use and validate transactions on the ledger. Unsurprisingly, most capital markets participants are developing applications on permissioned, private, hierarchical ledgers. Some argue that this may limit the benefits of the technology, but others contend that this construct allows for the level of trust and control needed in capital markets, while still enabling data to be shared and processes mutualized.

Updating the ledger	Permissionless	Anyone can validate transaction on the ledger
	Permissioned	Only trusted parties can validate transactions on the ledger
Access to use the ledger	Public	Anyone can read and initiate transactions on the ledger
	Private	Only trusted parties can read and initiate transactions on the ledger
Access to view the ledger	Non-hierarchical	Everyone can hold a full copy of the ledger and can read all of the information on the ledger
	Hierarchical	Only some parties can hold a full copy of the ledger or read all of the information on the ledger. Some parties may have view-only permission for specific data

Source: Adapted from BIS, "On the Future of Securities Settlement", 1 March 2020: https://www.bis.org/publ/qtrpdf/r_qt2003i.htm (link as of 8/4/21), based on Reserve Bank of New Zealand, "Decrypting the Role of Distributed Ledger Technology in Payments Processes", 28 May 2018: https://www.rbnz.govt.nz/research-and-publications/reserve-bank-bulletin/2018/rbb2018-81-05 (link as of 8/4/21).

While DLT promises many benefits, it is a fundamentally new technology, with a range of risks that must be understood and addressed[10]
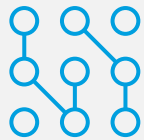
Technology

– Potentially new cybersecurity risks (e.g. 51% attack, Sybil attack)

– Unique concerns about data security and privacy

– Interoperability and integration with other systems

– Long-run performance and reliability uncertainty in production

Operational governance and controls

– Limited experience with validating and auditing smart contracts

– Challenges with enforcing data standards across a network

– Unique governance risks (e.g. coordinating software upgrades, emergency patches and "hard fork" issues)

Implementation

– Ecosystem-wide change management

– Potential challenges running parallel operations for certain asset classes or processes

Legal and regulatory

– Fragmented and incomplete regulatory landscape

– Lack of a standard regulatory "playbook"

– Challenges with new legal requirements (e.g. smart contracts, settlement finality)

Additional detail on DLT-related risks[11]
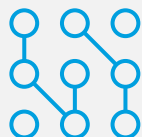
Technology

While solutions and platforms are increasingly tested in different scenarios, DLT is still a bleeding-edge technology that has yet to be tested in all areas (e.g. extended operations in production environments). There are potential risks associated with how DLT-based systems will integrate with other DLT-based systems and legacy technology and data platforms, including the extent to which interoperability will even be possible. While DLT is resilient to hardware and infrastructure failures by design, the unique decentralized architecture may pose novel cybersecurity risks, particularly in terms of the security of private keys and preventing unwanted data dissemination. Given the decentralization of confidential data, DLT systems require new data privacy controls to ensure that parties may access only certain data; zero-knowledge proofs, stealth addresses and several other solutions have emerged to address these risks.

Operational governance and controls

Implementation of DLT-based applications, especially when used by multiple parties, is complex, as decentralized systems introduce new governance questions. Key questions to answer include: How are these networks upgraded and maintained? How are smart contracts enforced, audited and validated (both at the point of creation and throughout the life cycle of a particular asset)? What are the risks due to incorrect representation of terms in smart contract code? Is there a risk of a "hard fork" of the blockchain (i.e. modifying past transactions or bringing about other structural changes to the blockchain)? Conversely, is there a risk of theft or loss of digital assets because of the irreversible nature of transactions in the blockchain protocol? And lastly, how is the real-world change of assets ownership made consistent and reflected on-chain, if necessary, under the legal framework?

Implementation

As DLT-based solutions may offer a radically different way of doing business for some organizations, effective change management is critical. Not only must firms build the ecosystem, they must also ensure that the organization has the requisite processes and talent to effectively assess, develop, measure, monitor and respond to risks. Data standards, data governance and data privacy standards must be adopted and enforced. Additionally, in instances where an institution is building parallel processes for similar assets (e.g. traditional and digitally native assets in the same asset class), there may be risks associated with additional complexity for operational teams.
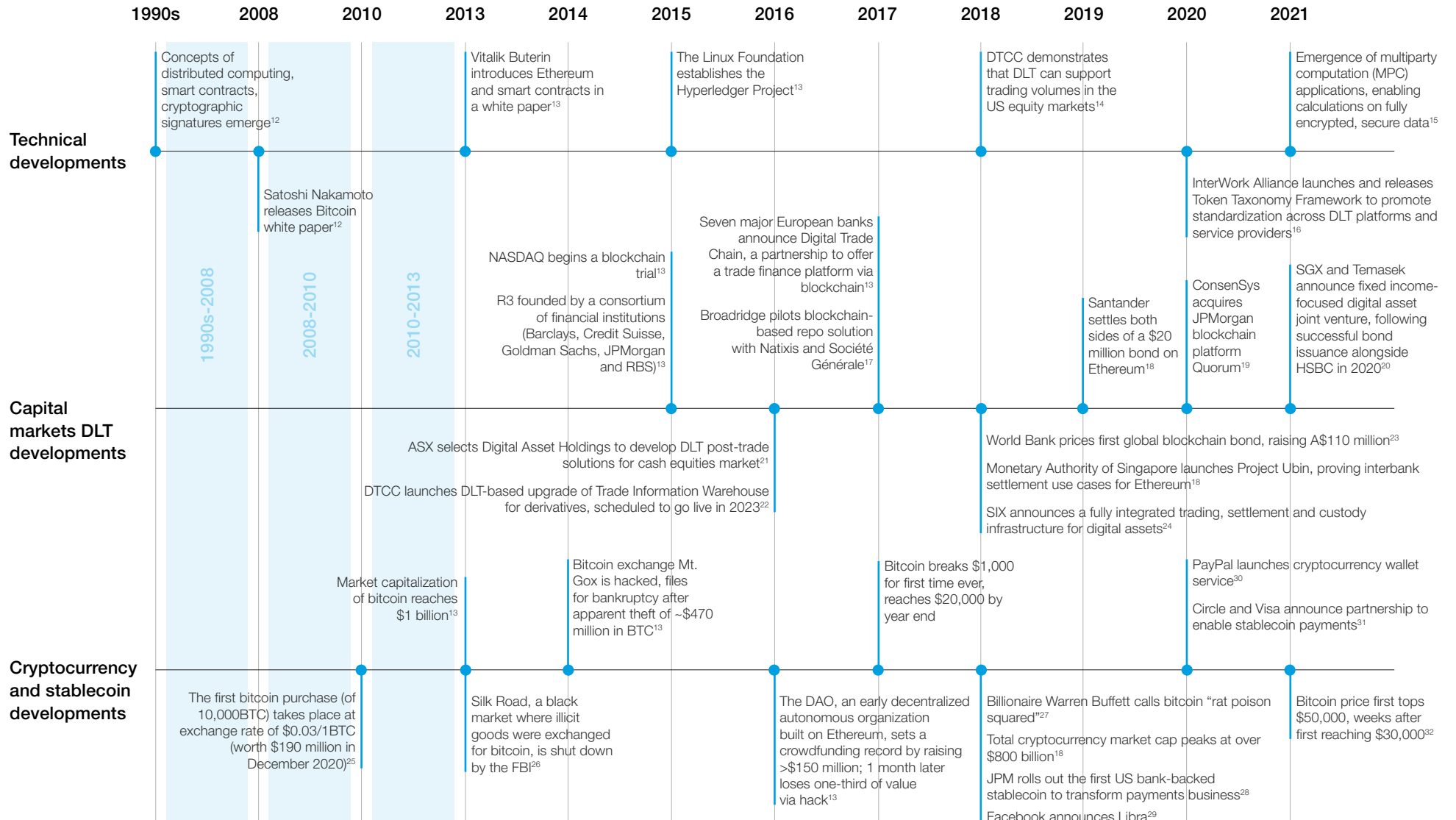
Legal and regulatory

In many jurisdictions, financial and capital markets regulators have not made definitive statements or rulings on the applicability of existing regulatory frameworks to DLT-based solutions or platforms. Thus, there is a risk in some instances that a key feature of a particular DLT application may one day fall foul of future regulations. Even in jurisdictions with more developed regulatory frameworks, many institutions have not yet developed a standard regulatory "playbook" to ensure that products are developed in line with regulatory requirements. Legal and regulatory risks include uncertainty about security registry requirements, cross-jurisdictional regulations, anti-trust violations, smart contract enforceability, anti-money laundering (AML) and know-your-customer (KYC), and intellectual property (IP) protection.

DLT is one of several technologies transforming capital markets: some are complementary, and some potential substitutes
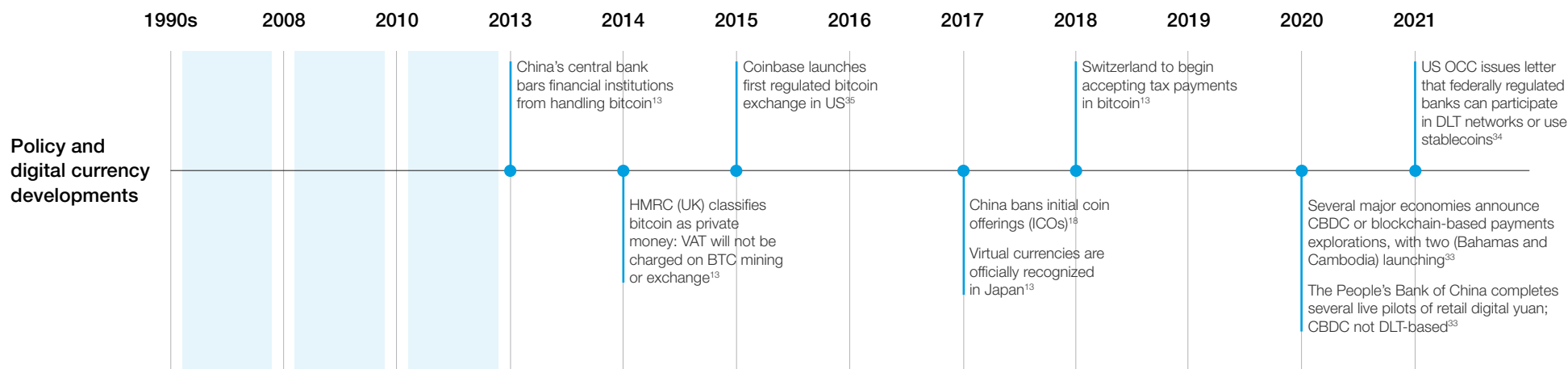
Technology	Cloud computing	AI + machine learning	Robotic process automation	Next-generation APIs
Description	The on-demand availability of computing resources (e.g. computer power, storage, databases, application software etc.), without the need to manage the supporting infrastructure. Cloud computing typically offers a flexible pay-as-you-go model that minimizes upfront infrastructure costs compared to traditional data centres	The application of advanced analytical methods, including advanced analysis of unstructured data, to create multidimensional predictive models that support and/or automate human decision-making	A productivity tool that runs predefined scripts to automate repetitive tasks including data entry and transformation. The script mimics the actions taken by a human worker – within or across applications – in order to execute business processes, albeit in a narrow and highly structured way	An application programming interface, or API, is an interface that provides programmatic access to service or data within a remote application or a database. APIs that allow minimal, more efficient data transfer – a component of microservices design patterns – along with new data interchange standards (e.g. ISO 20022) have renewed financial institutions' interest in APIs
Benefits	Cost efficiencies, faster deployments, reliability, global scale, improved productivity and performance, and flexible capacity	Increased automation, enhanced decision-making and process optimization	Increased automation of repetitive tasks, process optimization	Real-time data integration among parties, increased automation, process optimization, increased standardization
Key capital market applications/ use cases	Infrastructure as a service especially for big data services and analytics, and software as a service, especially in HR and sales	Enhancing pre-trade and execution activities such as predicting M&A opportunities/valuation features, producing trading signals or servicing client flow	Focused on post-trade and support segments, with a high number of repetitive tasks (e.g. payments processing and client onboarding)	Primary market intelligence, digital payments, innovative customer applications and experiences
Relation to DLT	**Complementary** Use of cloud can be an important enabler for DLT use, accelerating development with prebuilt infrastructure	**Potential substitute** Enables straight-through processing for more complicated tasks (e.g. potentially reconciliation) **Complementary** Better data for AI models	**Potential substitute** Mimics straight-through processing for limited sets of tasks	**Potential substitute** APIs are the main system integration tool today, and modern APIs are likely to improve data sharing across institutions **Complementary** DLT use cases with interoperability rely on APIs

Technical and business developments for DLT in capital markets

	1990s	2008	2010	2013	2014	2015	2016	2017	2018	2019	2020	2021

Technical developments

Concepts of distributed computing, smart contracts, cryptographic signatures emerge[12]

Vitalik Buterin introduces Ethereum and smart contracts in a white paper[13]

The Linux Foundation establishes the Hyperledger Project[13]

DTCC demonstrates that DLT can support trading volumes in the US equity markets[14]

Emergence of multiparty computation (MPC) applications, enabling calculations on fully encrypted, secure data[15]

Satoshi Nakamoto releases Bitcoin white paper[12]

1990s–2008 *2008–2010* *2010–2013*

NASDAQ begins a blockchain trial[13]

R3 founded by a consortium of financial institutions (Barclays, Credit Suisse, Goldman Sachs, JPMorgan and RBS)[13]

Seven major European banks announce Digital Trade Chain, a partnership to offer a trade finance platform via blockchain[13]

Broadridge pilots blockchain-based repo solution with Natixis and Société Générale[17]

Santander settles both sides of a $20 million bond on Ethereum[18]

ConsenSys acquires JPMorgan blockchain platform Quorum[19]

InterWork Alliance launches and releases Token Taxonomy Framework to promote standardization across DLT platforms and service providers[16]

SGX and Temasek announce fixed income-focused digital asset joint venture, following successful bond issuance alongside HSBC in 2020[20]

Capital markets DLT developments

ASX selects Digital Asset Holdings to develop DLT post-trade solutions for cash equities market[21]

DTCC launches DLT-based upgrade of Trade Information Warehouse for derivatives, scheduled to go live in 2023[22]

World Bank prices first global blockchain bond, raising A$110 million[23]

Monetary Authority of Singapore launches Project Ubin, proving interbank settlement use cases for Ethereum[18]

SIX announces a fully integrated trading, settlement and custody infrastructure for digital assets[24]

Market capitalization of bitcoin reaches $1 billion[13]

Bitcoin exchange Mt. Gox is hacked, files for bankruptcy after apparent theft of ~$470 million in BTC[13]

Bitcoin breaks $1,000 for first time ever, reaches $20,000 by year end

PayPal launches cryptocurrency wallet service[30]

Circle and Visa announce partnership to enable stablecoin payments[31]

Cryptocurrency and stablecoin developments

The first bitcoin purchase (of 10,000BTC) takes place at exchange rate of $0.03/1BTC (worth $190 million in December 2020)[25]

Silk Road, a black market where illicit goods were exchanged for bitcoin, is shut down by the FBI[26]

The DAO, an early decentralized autonomous organization built on Ethereum, sets a crowdfunding record by raising >$150 million; 1 month later loses one-third of value via hack[13]

Billionaire Warren Buffett calls bitcoin "rat poison squared"[27]

Total cryptocurrency market cap peaks at over $800 billion[18]

JPM rolls out the first US bank-backed stablecoin to transform payments business[28]

Facebook announces Libra[29]

Bitcoin price first tops $50,000, weeks after first reaching $30,000[32]

Regulatory, policy and digital currency developments

	1990s	2008	2010	2013	2014	2015	2016	2017	2018	2019	2020	2021

Policy and digital currency developments

China's central bank bars financial institutions from handling bitcoin[13]

Coinbase launches first regulated bitcoin exchange in US[35]

Switzerland to begin accepting tax payments in bitcoin[13]

US OCC issues letter that federally regulated banks can participate in DLT networks or use stablecoins[34]

HMRC (UK) classifies bitcoin as private money: VAT will not be charged on BTC mining or exchange[13]

China bans initial coin offerings (ICOs)[18]

Virtual currencies are officially recognized in Japan[13]

Several major economies announce CBDC or blockchain-based payments explorations, with two (Bahamas and Cambodia) launching[33]

The People's Bank of China completes several live pilots of retail digital yuan; CBDC not DLT-based[33]

Notable regulatory developments

Singapore

JULY 2020 Monetary Authority of Singapore (MAS), proposes new regulations for digital tokens created in Singapore. Among other things, the provisions strengthen anti-money laundering (AML) compliance procedures and expand MAS's power to impose requirements on technology risk management, including cybersecurity risks and data protection.[36]

AUG 2017 MAS clarifies when securities tokens must comply with Securities and Futures Act.[37]

Germany

DEC 2020 The German government abolishes its paper-based certificate requirement, which paves the way for dematerialized securities, including securities recorded solely on distributed ledgers.[38]

OCT 2019 In an effort to be "at the forefront of innovation", the German government publishes a comprehensive blockchain strategy, which includes prioritizing the development of a digital identity system.[39]

China

DEC 2020 China regulates cryptography, a key component underpinning all DLT platforms. The regulation defines a standard for all "encrypted" behaviours, arguing that the existing "loose" systems are not suitable for either the industry or national interests.[40]

JAN 2019 The Cyberspace Administration of China (CAC) releases Administrative Provisions on Blockchain Information Services (i.e. blockchain provisions), which encourage industry self-regulation and define security requirements and penalties.[41]

Switzerland

SEPT 2020 New DLT regulations include sanctioning digital assets trading venues with trading between regulated market participants and private customers, and custody, clearing and settlement for digital assets. These regulations also clarify the treatment of digital assets in a bankruptcy event, and create a new type of digital security, "uncertificated register", affording these the same protection and functionality as a traditional security.[42] The regulations seek to enable DLT-based innovation while remaining technology-neutral.[43]

United States

DEC 2020 SEC issues guidance for broker-dealer custody of digital assets to be in place for five years, clarifying requirements separate from traditional securities.[44]

AUG 2020 INX is the first security token IPO registered with the SEC that is not currently listed on either a stock or crypto exchange.[45]

JULY 2019 SEC and FINRA issue a joint staff statement on custody of digital asset securities.[31][46]
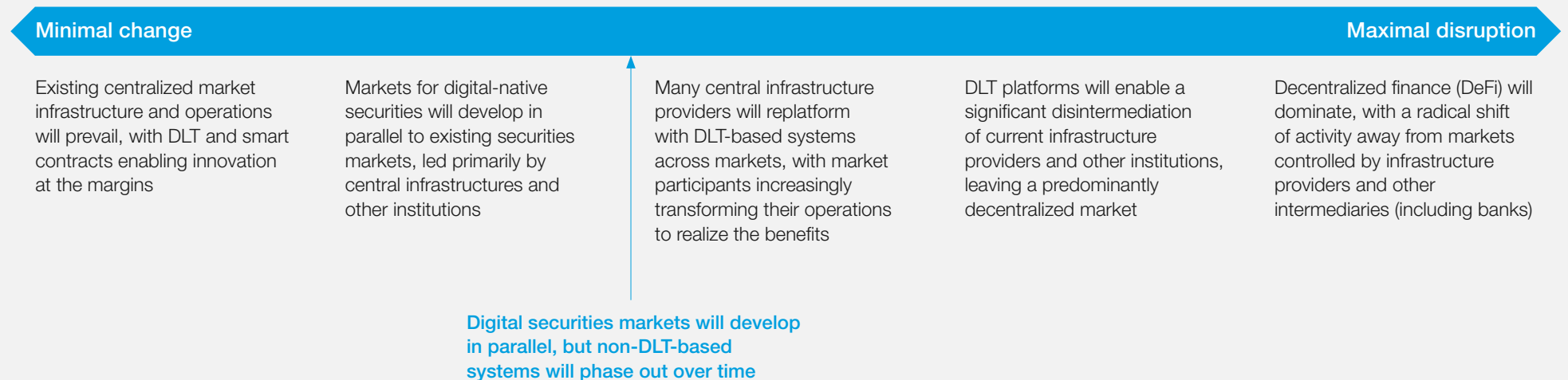
2 DLT and digital assets in capital markets

– Spectrum of future scenarios

– DLT-related considerations for different capital markets actors

– Framework for different approaches to DLT solutions

Financial institutions and technology providers have developed a range of views on how DLT will be used moving forward

DLT is unique as an enabling technology in the capital markets because it offers a potential pathway both to operational simplification for many institutions and to disruption, where existing processes and roles may be made redundant. As a result, the way in which it is employed – influenced by the institutions "leading the charge" – will have a significant impact on the structure of markets moving forward, leading to great

uncertainty about what the future may look like. Adding to the uncertainty is the reality that, in the near term, the technology is likely to be implemented for different use cases across different asset classes and jurisdictions, likely leading to a range of different future states. An imperfect mapping of these potential future states would encompass a spectrum of possibilities:

Minimal change ——————————————————————————————— **Maximal disruption**

Existing centralized market infrastructure and operations will prevail, with DLT and smart contracts enabling innovation at the margins

Markets for digital-native securities will develop in parallel to existing securities markets, led primarily by central infrastructures and other institutions

Many central infrastructure providers will replatform with DLT-based systems across markets, with market participants increasingly transforming their operations to realize the benefits

DLT platforms will enable a significant disintermediation of current infrastructure providers and other institutions, leaving a predominantly decentralized market

Decentralized finance (DeFi) will dominate, with a radical shift of activity away from markets controlled by infrastructure providers and other intermediaries (including banks)

Digital securities markets will develop in parallel, but non-DLT-based systems will phase out over time

Each potential future state implies a different set of roles for different institutions and a different level of disruption for existing market processes and operations

Strategic considerations differ for players across the capital markets, though there are common themes

Corporate issuer

– Potential opportunity for lower cost of funding due to wider investment base, greater secondary market liquidity, lower transaction costs and/or direct participation in capital markets

Investment bank

– Potential opportunity for new lines of business from emergence of new asset classes or parallel markets

– Potential cost savings from streamlined or automated processes and operations

– Potential loss of business if issuers access markets directly

Broker/ dealer

– Potential cost savings from streamlined or automated processes and operations, and capital/ liquidity savings from more flexible settlement

– Potential loss of business from greater market concentration in over-the-counter markets

Custodian bank

– Potential cost savings from streamlined or automated processes and operations, and capital/liquidity savings from more flexible settlement

– Potential for better optimization of collateral due to greater flexibility in collateral mobility

– Potential risk to business model if there is a radical change to the "custody" role

Asset manager

– Potential opportunity for new lines of business from emergence of new asset classes or parallel markets

– Potential cost savings from streamlined or automated processes and operations (e.g. lower custody costs), and capital/liquidity savings from more flexible settlement

Asset owner/ investor

– Potential opportunity for improved liquidity in secondary markets for some asset classes

– Potential opportunity for investments in new asset classes, parallel markets or markets that were previously difficult to access

Exchange

– Potential opportunity to expand role in the value chain or into additional asset classes

Infrastructure provider

– Potential risk to business model if markets shift away from traditional model of central securities depositories, but strong regulatory support in favour of continued role as systemic infrastructure

– Potential opportunity for new lines of business in governing decentralized platforms and smart contracts

Other institutions

(e.g. trustees, transfer agents, registrars)

– Potential risk to business models due to greater transparency in securities and automation of reporting and life-cycle activities, but legal/regulatory basis for roles remain in many markets

– Potential opportunity for new lines of business in providing value-add

Capital markets DLT products or platforms are being developed across several dimensions, reflecting key differences between institutions
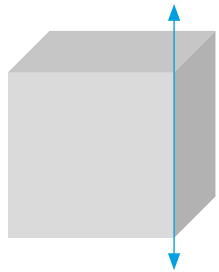
Degree of change implied

Improving existing processes
e.g. DLT-based infrastructure offering greater transparency of asset-servicing processes

Reimagining
e.g. fully digital securities with life-cycle events automated through smart contracts
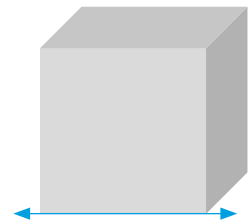
Scope of value chain included

One part of the value chain
e.g. DLT-based equity post-trade infrastructure

End-to-end
e.g. DLT-based equity issuance, trading, custody and settlement platform
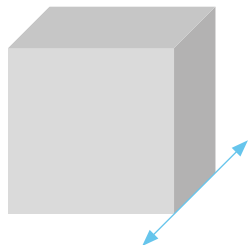
Asset class focus

Single asset class
e.g. DLT-based bond-origination platform

Asset class-agnostic
e.g. security token issuance platform

Combined, these choices reflect:

Where an institution's core competencies lie (e.g. providing trust and data verification, building technology, banking services)

What the institution sees as the critical business problems that can be addressed by a DLT-based solution (e.g. over-reliance on reconciliation for processing transactions, limited transparency and high levels of complexity)

How the institution believes DLT will be used in the capital markets in future (e.g. Will DLT be used on the margins to solve discreet challenges? Will DLT-based central infrastructures dominate? Will DLT remove the reliance on central infrastructures and intermediaries?)

Within and across asset classes, institutions are developing DLT-based solutions to **improve** or **reimagine** value chains

Degree of change

	Narrow focus	End-to-end
Reimagining	2	4
Improving	1	3

5

Scope of value chain
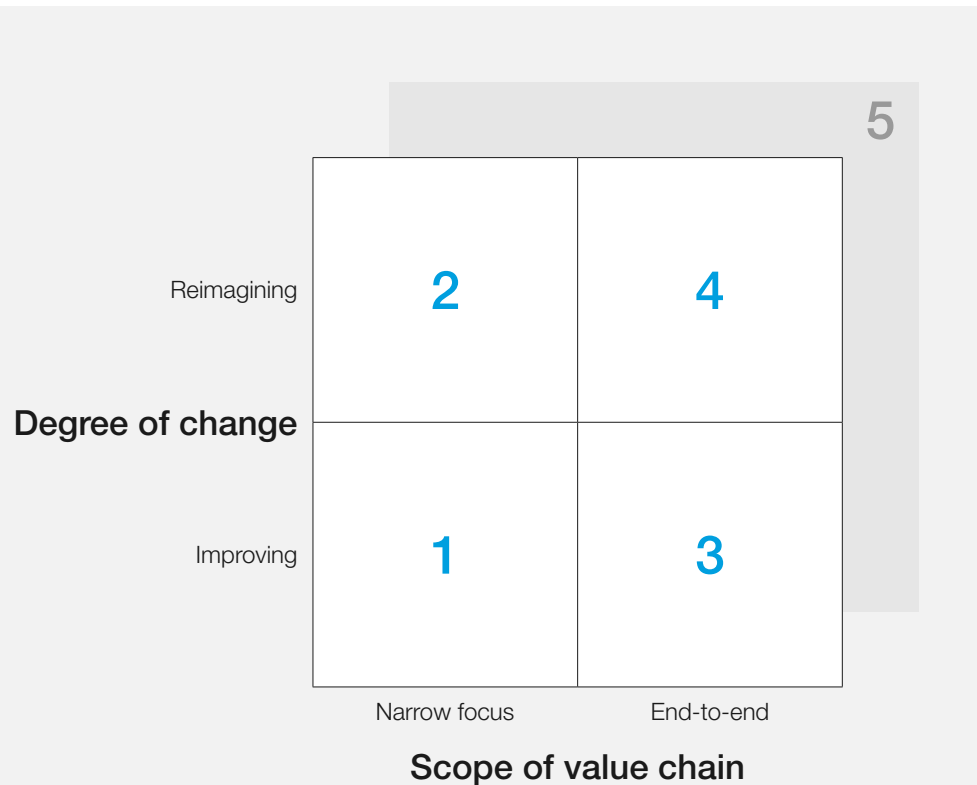
Considerations

1 **Pointed improvements**
Solutions focused on optimizing specific areas of the value chain

> Even with a narrow focus, ecosystem-wide transformation may still be needed, but the **path to implementation may be clearer and easier**

2 **Narrow reimagining**
Solutions focused on redefining specific areas of the value chain

> While narrowly focused on the value chain, these use cases may gain traction with only a **limited ecosystem**

3 **Broad improvements**
Solutions focused on optimizing many (or most) aspects of the value chain

> End-to-end use cases **require change across front-, middle- and back-office processes** and teams, introducing additional complexity

4 **Broad reimagining**
Solutions focused on redefining many (or most) aspects of the value chain

> These use cases are more likely to build **parallel "digital asset" ecosystems to traditional markets**, often facing the "chicken or egg" challenge of generating liquidity

5 **Wholesale disruption**
Solutions, such as DeFi, focused on entirely rethinking how the capital markets operate (out of scope)

Use cases in development today reveal a fragmented and divergent set of visions

Degree of change

2 · Reimagining · 4 · Improving · 1 · 3

Narrow focus — End-to-end

Scope of value change

Project status

● Live in production ● Production ● build/test ● Pilot Proof of concept ● Strategic formation

We surveyed more than 60 companies, representing banks, infrastructure providers, fintech firms and asset managers.

The collective responses validated the great diversity of use case applications and approaches. Summary findings include:

70% of projects are live or nearing release (vs. 30% in earlier stages of development)

~60% lean more towards improving existing operations (vs. 40% reimagining)

~60% target specific portions of the value chain (vs. 40% targeting more end-to-end)
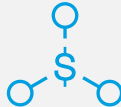
3 Use case analysis by asset class/ product line

This chapter examines DLT-related developments in the capital markets from the starting point of traditional asset classes and business lines, to understand how DLT and smart contracts use cases are being adopted or explored in the industry. Each section examines the different use cases emerging for each asset class – or specific ways in which DLT could be used across the relevant value chain, whether aiming to improve existing processes or disrupt markets as we know them.

– Equity markets

– Debt markets

– Securitized products

– Derivatives

– Securities financing

– Asset management/fund administration

– Enablement use cases
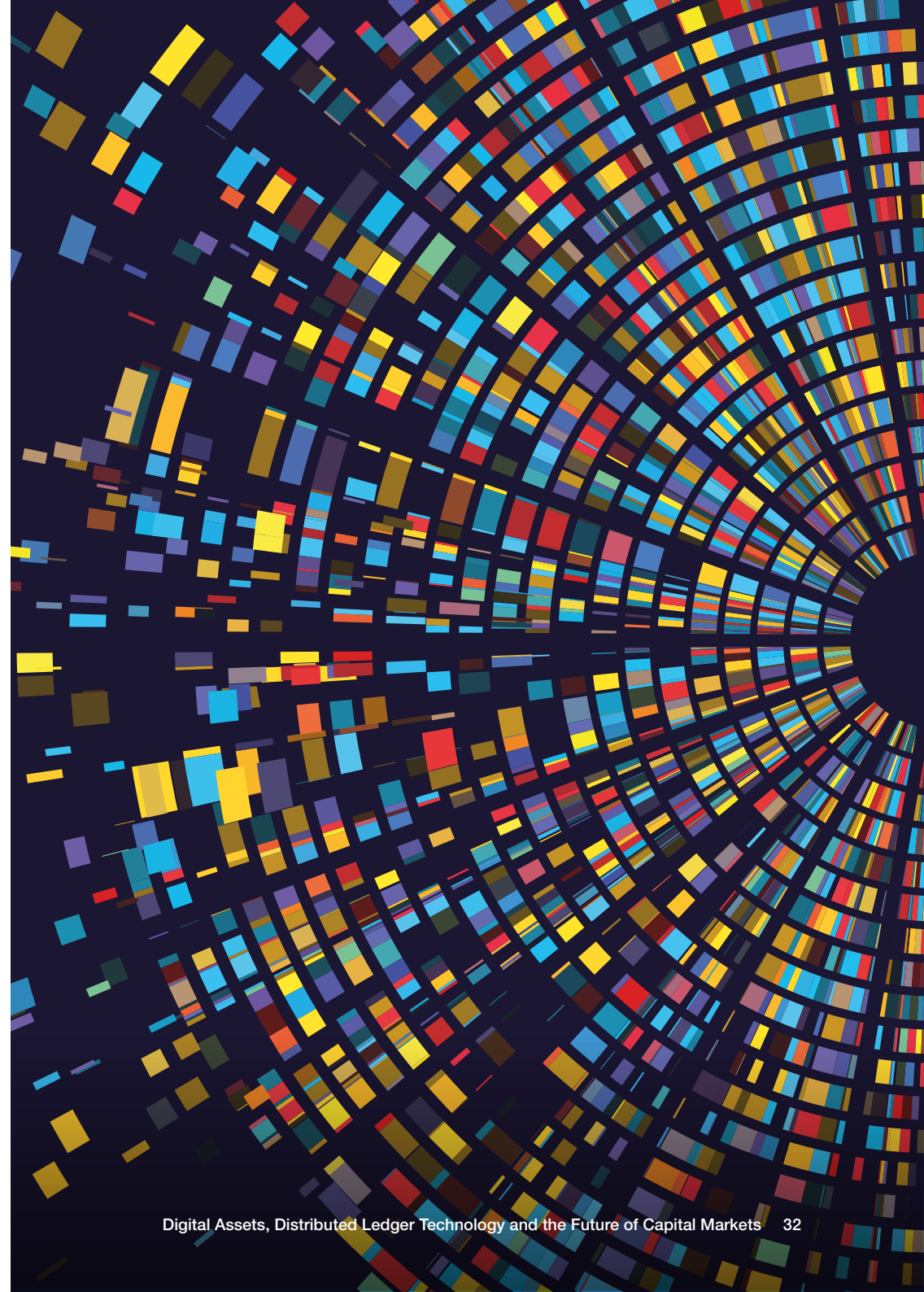
While DLT use cases are being explored across capital markets, this report offers a deeper examination of efforts in core securities markets and related businesses

	Securities markets				Adjacent product lines	
	Equity markets	**Debt markets**	**Securitized products**	**Derivatives**	**Securities financing**	**Asset management**
Focus areas	– Publicly listed equities	– Corporate bonds – Commercial paper – Government bonds	– Mortgage-backed securities – Asset-backed securities – Collateralized loan obligations	– Exchange-traded and OTC derivatives	– Repurchase agreements – Securities lending	– Mutual funds – Private funds (private equity, debt and hedge funds)
Key processes	– Primary issuance – Secondary markets – Clearing and settlement – Custody and asset servicing	– Primary issuance – Secondary markets – Clearing and settlement – Custody and asset servicing	– Loan origination – Loan servicing – Securitization/ issuance – Secondary markets – Security servicing	– Trading – Clearing – Position management – Settlement	– Collateral allocation – Clearing and settlement – Collateral swaps	– Fund origination – Fund distribution – Transfer agency – Fund administration – Securities services – Custody

Enablement use cases
DLT-enabled or supporting products and services being developed in order to facilitate digitalization across asset classes: wholesale payments; digital asset custody and services; digital asset issuance and life-cycle management tools

How to read the following sections

The subsequent pages examine DLT use cases for each asset class or product line. Each section includes:

– A high-level summary of opportunities and developments in the asset class

– An overview of the asset class or product line, including a summary of market characteristics and major relevant participants

– An illustrative value chain for the asset class or product line, including existing pain points and potential DLT roles

– A summary of the use cases to be examined

Each detailed use case description (one or two pages) includes:

– A summary description of the use case

– The use case plotting on the "degree of change" and "scope of value chain" framework (presented on slides 29-31)

– Value chain components that may be affected/addressed by the use case

– Major intended changes to processes or operations from the current state (at a high level, as these are likely to vary for different solutions)

– Proposed benefits of the use case, along with potential risks or challenges

– What the potential path forward might look like, including enablers and impediments

– Examples of solutions being developed by different firms, as well as a spotlight on notable examples
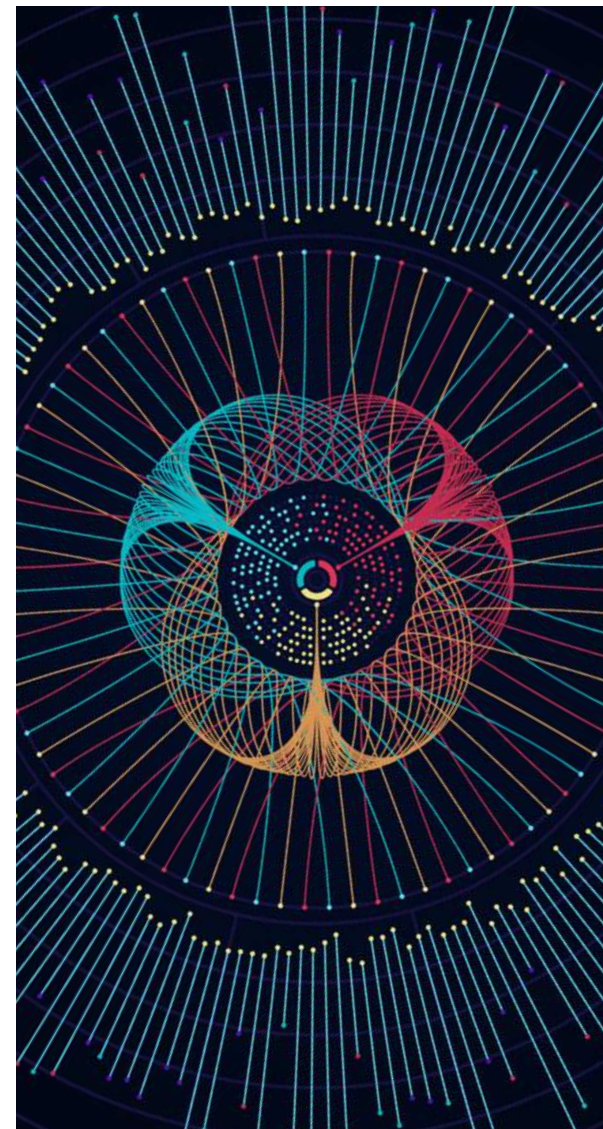
The inclusion of a firm's solution or discussion as a spotlight does not reflect an endorsement of the company or its products and services by the World Economic Forum.

Equity markets: summary

While most market participants and service providers consider operations and infrastructure in public equity markets to be efficient, a range of parties are exploring or bringing to market DLT-based or smart contract solutions, including applications aiming to:

– Introduce greater flexibility in clearing and settlement timelines

– Reduce or eliminate settlement risk

– Address operational burdens associated with data siloes in post-trade processing

Given the scale of transformation required to achieve the potential benefits of most DLT-based solutions in centralized public equities markets, these developments are primarily in the early stages.

Privately held equities – which do not benefit from the central infrastructures, standardized processes and ample liquidity of the public markets – are likely to continue to be a focus for many parties. Many of the solutions in development attempt to bring the efficiencies of public equity markets to private and SME shares using DLT and tokenization.
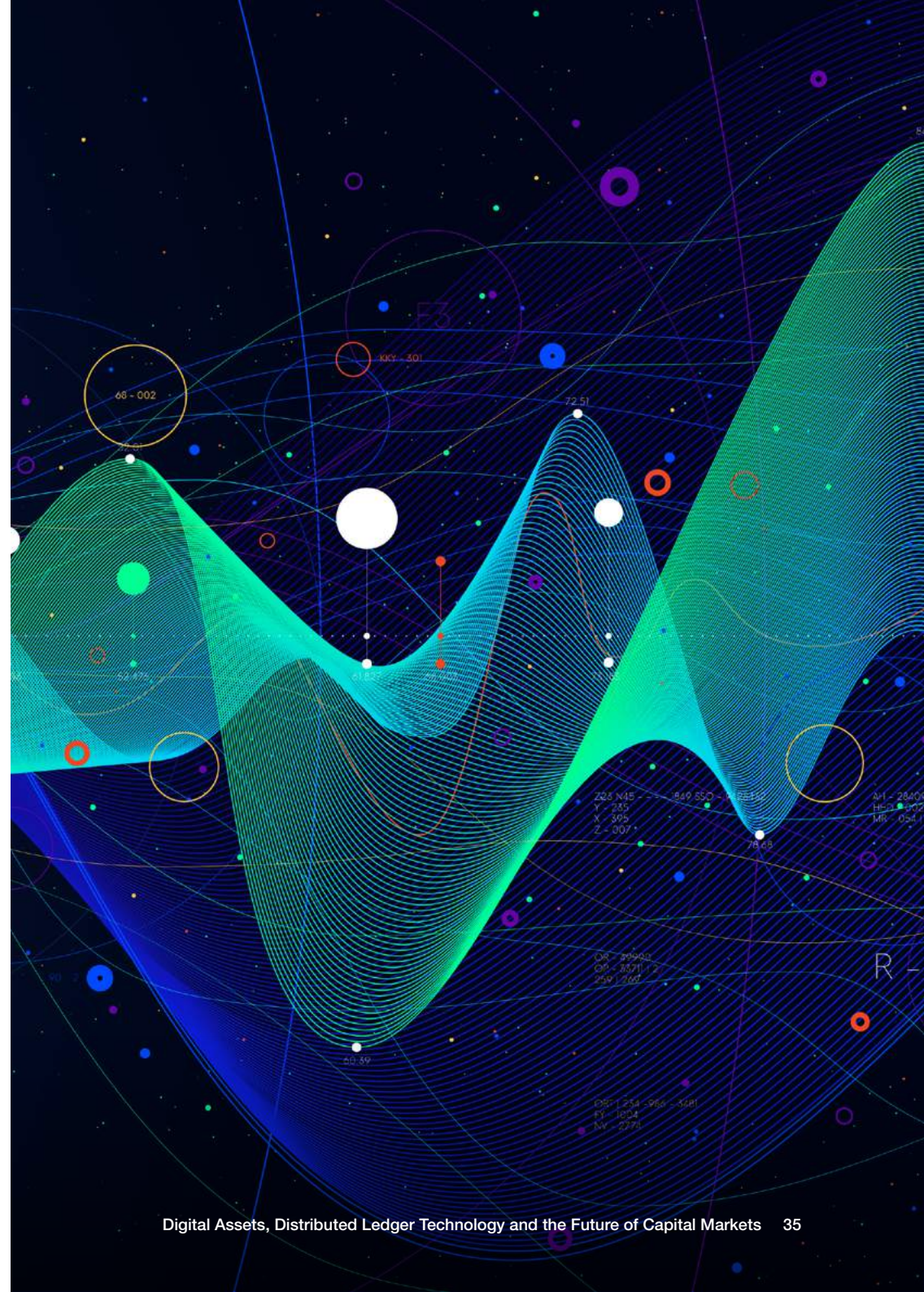
Overview of asset class

Market overview

Globally, the market capitalization of publicly traded equities totalled more than $95 trillion at the end of 2019.[47] With an average of $500 billion–$750 billion in annual issuance (over the preceding decade), equity markets remain an important funding tool for corporations and an essential asset class for investors. While market liquidity varies by country and market, most equity markets are deep and liquid relative to other asset classes, with significant daily trading volumes.

Key characteristics

Equity markets are primarily concentrated in a limited number of public exchanges for each jurisdiction, which tend to be highly regulated. Increasingly, trading also takes place in dark pools, or private trading venues operated by broker-dealers or other parties, to facilitate large trades by institutional investors. Both public exchanges and private trading venues rely primarily on electronic trading between registered brokers. Trades tend to be centrally cleared by central counterparties (CCPs). These markets rely on central securities depositories (CSDs), which register ownership, safekeep either physical or dematerialized securities and effect transfer of ownership through their securities settlement systems.

Several intermediaries and infrastructure providers facilitate the flow of capital from investors to equity issuers, trading between investors, and processing of corporate actions

Investment banks/ underwriters

Exchange/trading venue

Global custodians

Corporate issuers

Central counterparty

Broker-dealers

Asset owners/ investors

Transfer agents

Central security depository

Local custodians
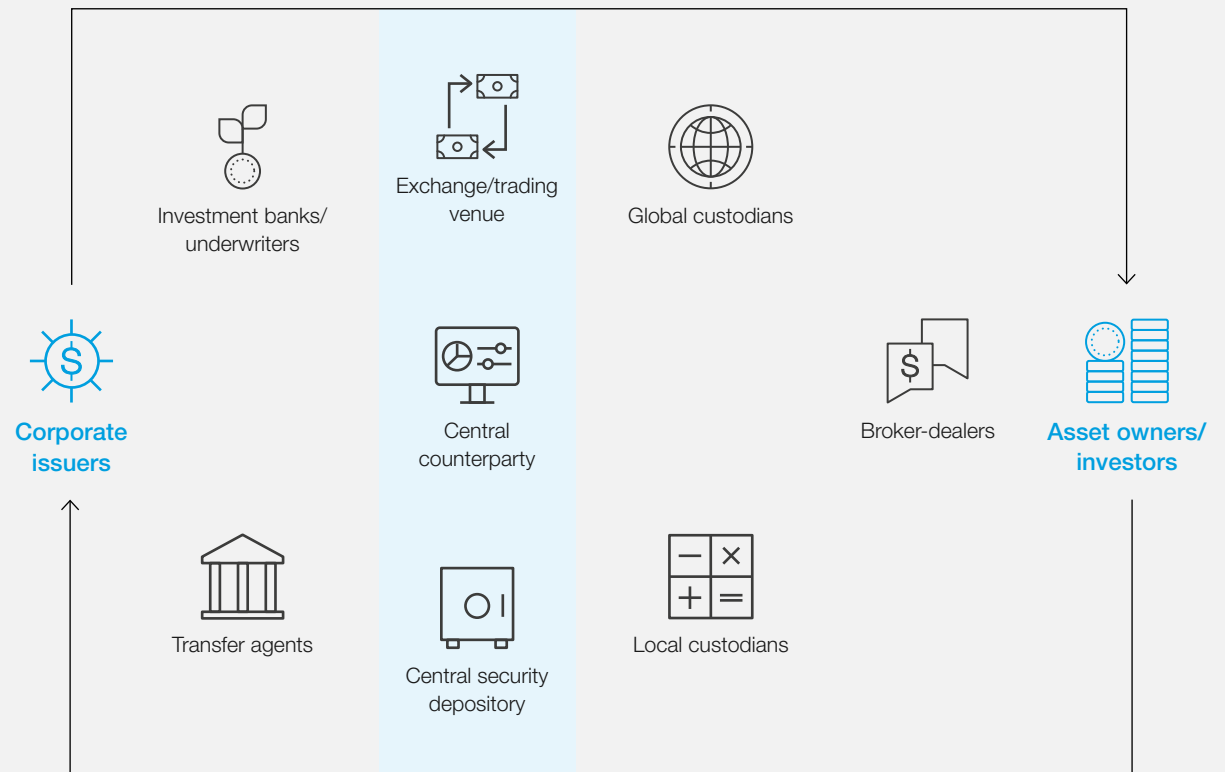
DLT in the equity market value chain

Primary market	Secondary market	Post-trade		Life-cycle management	
Issuance	**Trading**	**Clearing**	**Settlement**	**Custody**	**Asset servicing**

Primary market
Issuance
– Pre-issuance workflow
– Registration with CSD, exchange/trading venue, regulator(s)

B C

Secondary market
Trading
– Order instructions
– Trade capture/routing
– Order book matching
– Trade validation
– Confirmation sent to clearing agent/venue

B C

Post-trade
Clearing
– Margins calculated and requested
– Centrally cleared trades novated
– Obligations netted
– Net security/ cash obligations communicated

B C D

Settlement
– Cash payments sent and confirmed
– Ownership of securities transferred
– Reconciliation by relevant parties

A B C D

Life-cycle management
Custody
– Maintenance/ safekeeping and reporting of ownership records
– Corporate action management on behalf of asset owners

B C

Asset servicing
– Processing dividend payments, splits, rights issues etc. on behalf of issuer

B C

Anticipate biggest changes in post-trade and life-cycle activities

Existing pain points

Although equity markets are a largely mature ecosystem with efficient processing, participants still face challenges associated with legacy processes and systems:

A Settlement/counterparty risk, requiring costly margins and capitalization of the central counterparty

B Data siloes between institutions, requiring manual reconciliation across the life cycle of equities

C Substantial numbers of intermediaries involved in transactions, many required by regulation

D Ageing legacy infrastructure systems in some jurisdictions

These factors combine to make equity issuance relatively expensive, limiting issuers to only the largest companies in any market.

Potential DLT roles in equities

While there are opportunities to apply a range of technology solutions to address pain points and modernize many participants' technology stacks, DLT may be uniquely suited to optimize post-trade operations and life-cycle management, by:

– Synchronizing references and mutualizing workflows across all parties involved in trading, settlement, custody or corporate actions, thereby limiting the need for reconciliation

– Automating settlement instructions and/or corporate actions processes using smart contracts

– Reducing settlement risk and/or settlement time frames or enabling greater flexibility in settlement time frames

Summary of emerging use cases in equity markets

1

Replatforming existing post-trade infrastructure

What? Replace existing centralized post-trade infrastructure (e.g. CSD, settlement system and/or clearing house) with a DLT-based system

Who? Led by the existing central infrastructure provider, but likely to require operational changes by all clearing participants

Why? Enable operational efficiencies from a shared single source of truth and the use of smart contracts; potential for settlement flexibility; potentially enable future innovation and interoperability with emerging payments systems (e.g. CBDCs)

2

Supplementing post-trade infrastructure

What? Introduce a DLT-based system on top of the existing post-trade infrastructure for a specific use case and/or set of users

Who? Led by either the existing central infrastructure provider or a challenger; likely to require adoption by a more limited ecosystem

Why? Varies by specific example, but generally designed to take advantage of the ability to mutualize workflows across participants (thereby reducing the time required to process certain transactions) and/or the ability to settle atomically in real time (thereby eliminating the need to fully fund central counterparties)

3

Digital platform covering full securities life cycle

What? Introduce a DLT-based end-to-end platform enabling the issuance, trading, post-trade and servicing of digitally native securities

Who? Can be led by existing central infrastructure providers, challenger infrastructure providers (e.g. digital asset exchanges) or other parties; ecosystems may include participants across the value chain, including direct access by corporate issuers and/or investors

Why? Enable the full potential of digital assets (end-to-end processes automated by embedded smart contracts, risk-free atomic settlement etc.) in a regulated environment in parallel to existing infrastructure

4

Equity tokens issued on blockchain

What? Issue equities as security tokens on a public or permissioned distributed ledger, with trading across multiple digital asset exchanges

Who? Can be led by financial technology providers, with potential for this model to intersect with end-to-end digital platforms and/or DeFi exchanges; currently regulatory environments would permit only privately listed securities to be issued in this manner

Why? Enable the full potential of digital assets (end-to-end processes automated by embedded smart contracts, risk-free atomic settlement etc.) at a potentially significantly lower cost, enabling greater access

Replatforming of existing equities post-trade infrastructure

Replatforming / Supplementing / End-to-end / Equity tokens

Overview

In several jurisdictions, market infrastructure providers are replacing, or considering replacing, existing systems with DLT-based solutions, essentially moving the CSD onto a distributed ledger. While some aim to address specific market inefficiencies, others are focused on DLT as a replacement for ageing legacy systems. A replacement can be a massive undertaking in terms of investment and market-wide education, but the objective is to improve existing processes via new technologies, rather than reinvent or disrupt an existing value chain.

Replacements are also targeted in scope, applying DLT to a specific use case, for example, in post-trade infrastructure, rather than attempting an end-to-end solution. This approach tends not to disintermediate any stakeholders, even though some roles can be redundant, with activities performed by the technology or by other parties.
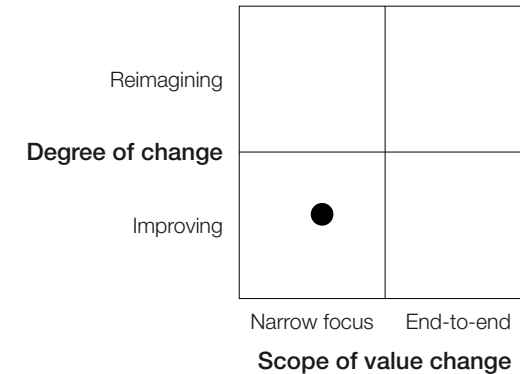
Reimagining

Degree of change

Improving

Narrow focus — End-to-end

Scope of value change

Value chain components in scope

● In scope ● Partially in scope ● Not in scope

| Issuance | Trading | Clearing | Settlement | Custody | Asset servicing |

Major changes from current state*
– Introduce a single source of truth on trade data, accessible by all participating parties (via a node on DLT network or API interface)

– Potential to mutualize workflows associated with asset servicing (e.g. processing corporate actions) through shared data and smart contracts

– Introduce ability to conduct non-batch delivery vs. payment (DvP) settlement

Proposed benefits*
– Introduce a single source of truth on trade data, accessible by all participating parties (via a node on DLT network or API interface)

– Potential to mutualize workflows associated with asset servicing (e.g. processing corporate actions) through shared data and smart contracts

– Introduce ability to conduct non-batch delivery vs. payment (DvP) settlement

Potential risks/challenges
Requires all clearing participants to migrate to the new platform and adopt new operating procedures

While, in principle, flexible and/or shorter settlement should reduce counterparty risk, new (or multiple) settlement timelines would introduce the need for new risk management practices, regulatory capital requirements and market structures and processes that might take time to perfect

* May differ by exact model.

Replatforming of existing equities post-trade infrastructure

Potential path forward

Despite being driven by a central infrastructure, this approach requires moving an entire ecosystem. As such, the market can transition only when all participants are comfortable with the new processes and operational requirements. But phased transition plans enable the central infrastructure to "switch on" additional features and functionalities of the new system over time, thereby limiting the degree of operational change required at one time. Participants may not realize the core benefits at first. For example, rather than maintaining a node on the distributed network, clearing participants may still be able to use traditional messaging interfaces for communicating with the CSD. However, over time, they could transition to directly participating in the DLT network by hosting their own node. In this example, clearing participants would receive the maximum platform benefits only by hosting a node.

Enablers

– Markets where securities are already dematerialized require limited change to regulation/legislation to pursue a DLT-based CSD

– More concentrated equity markets with fewer participants are more likely to be able to make this transition (given fewer and less diverse stakeholders to consult)

– Availability of CBDC could prompt greater comfort with DLT among both infrastructure providers and market participants, as CBDCs would allow for atomic DvP settlement in central bank money

– Most equity markets are electronically traded, so market participants are used to high levels of straight-through processing

Impediments

– Despite standardization in many markets, decades of building upon legacy systems has led to significant fragmentation across market processes and internal systems, thereby making it difficult to develop standard playbooks for transitioning

– Clearing participants and regulators may see infrastructure providers as too systemically important to be early movers with cutting-edge technology, thereby limiting many institutions' willingness to pursue this model

Example firms/projects/products

ASX (in partnership with Digital Asset): CHESS Replacement	Status: in production build, scheduled to go live 2023
TMX and Bank of Canada (in partnership with R3): Project Jasper Phase III	Status: successful proof of concept in 2018

ASX CHESS Replacement
The Australian Securities Exchange (ASX) is in the process of replacing its legacy post-trade system (CHESS) with a DLT-based system. Participants will be able to communicate with the system using ISO 20022 messages over SWIFT or a web interface (operationally similar to the status quo) or by hosting a DLT node, which would introduce new functionalities. The project has been under way since late 2017, with a plan to go live in spring 2023, following extensive consultation with stakeholders.[48]

Supplementing post-trade infrastructure

Overview

Central infrastructure providers and new entrants are developing solutions that supplement existing market infrastructure to address specific challenges. While specific approaches vary, the common theme is an attempt to use DLT (or smart contracts) to automate clearing and settlement processes while still relying on the core underlying CSD. This might enable greater flexibility or speed in settlement, or alternatively could enable bilateral (rather than central) clearing for certain

transactions. Importantly, these use cases do not require the entire market ecosystem to migrate to new technologies or processes, enabling a subset of operationally prepared parties to benefit from advantages offered by the technology. Though focused on improving existing processes via new technology, this approach can potentially reimagine a portion of the equities value chain as participants develop comfort with the technology.
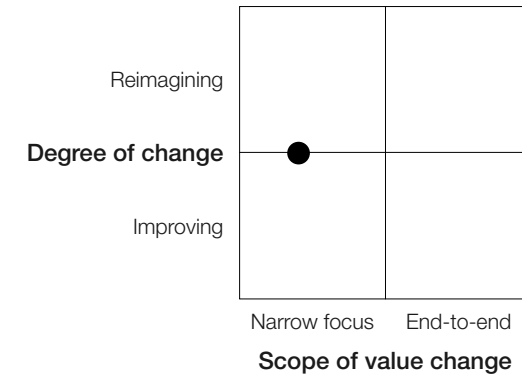
Reimagining

Degree of change ●

Improving

Narrow focus   End-to-end

Scope of value change

Value chain components in scope

● In scope   ● Partially in scope   ● Not in scope

Issuance	Trading	Clearing	Settlement	Custody	Asset servicing

Major changes from current state*

– Ability to settle atomically on a continuous basis or net settlement obligations on a bilateral basis, rather than novating trades and clearing centrally in batch processes

– Potentially introduce the ability to settle certain trades on a shorter timeline

– Introduce a single, shared source of truth on settlement instructions/obligations, accessible by all relevant parties (or a subset of parties) for specified transactions

Proposed benefits*

– Clearing participants do not need to capitalize the central counterparty, but need only to fund margin for their own settlement obligations, thereby freeing up liquidity

– Enable better balance sheet management (e.g. reduced funding requirements for risk capital, clearing fund and/or settlement liquidity)

– Ability to mutualize and automate workflows across parties, and potentially conduct processes in parallel (with potential to reduce settlement time as a result)

– Greater transparency into settlement status and open positions throughout the day

Potential risks/challenges

A supplemental clearing system could introduce additional operational complexity for some participants, thereby introducing additional risk

Supplementing post-trade infrastructure

Potential path forward

By enabling a limited number of technologically and operationally prepared participants to become early adopters of a DLT-enabled solution, use cases following this approach have the potential to build trust in the underlying technology. Building upon this foundation, new entrants are well positioned to enlarge the scope of their offering over time, possibly expanding vertically and/or horizontally to offer a full additional market infrastructure to challenge dominant market players. Similarly, existing infrastructure providers would likely be able to build on the technology more confidently, expanding the scope of DLT- or smart contract-enabled services, either to further supplement their existing offering or eventually replace it. Regardless of whether they are offered by existing infrastructure providers or new entrants, it is unclear how these services would coexist with an end-to-end digital market infrastructure or DLT-based replatforming of existing infrastructure.

Enablers
– Since these use cases are aimed at solving specific problems, they are likely to be developed in close consultation with initial partners, thereby ensuring an interested client base

– Availability of CBDCs would likely prompt greater comfort with DLT among both infrastructure providers and market participants, as CBDCs would allow for atomic DvP settlement in central bank money

Impediments
– For new entrants in the infrastructure space, regulatory scrutiny is likely to be substantial given the potential for systemic importance

– For some use cases, it might be difficult to expand the user base quickly; and given network effects, this may limit the potential benefits realized by participants

Example firms/projects/products

HKEX (in partnership with Digital Asset, DTCC): Synapse	Status: in production build, scheduled to go live 2022
Paxos: Securities Settlement Service	Status: live in production for limited set of participants (with permission of US SEC)
DTCC: Project Ion	Status: in prototype development

HKEX   DTCC
香港交易所 **Digital Asset**

HKEX Synapse
HKEX is in the process of developing a solution to streamline post-trade workflows for participants in the Northbound Stock Connect. While using a centralized system (not a distributed ledger), this product aims to ensure that different parties' settlement processes can take place in parallel to facilitate compliance with Mainland China's t+0 settlement window. The system will be built on top of the existing Stock Connect post-trade infrastructure, using smart contracts, API connectivity (built on ISO 20022 standards) and DTCC's trade processing systems to facilitate a single source of truth for settlement instructions and instantaneous status updates. Announced in November 2020, this is scheduled to go live in 2022.[49]

Digital platform covering full securities life cycle

Overview

Some central market infrastructures or financial technology firms are building new, end-to-end digital platforms to integrate the full life cycle of securities and other digital assets. The platforms enable market participants and intermediaries to list or issue, trade, settle trades and provide custody services for digital assets – in this case, digitally native equity tokens – in a fully regulated environment. These platforms exist in parallel to existing market infrastructure and existing securities markets, offering an alternative digitized version of a standard asset class. While DLT may be the core technology on which the "Central Securities Depository" is maintained, some functions/processes may use existing technologies if there is no clear case for using DLT. This approach does not necessarily disintermediate any parties, although some roles may become redundant.

Reimagining

Degree of change

Improving

Narrow focus　　End-to-end

Scope of value change

Value chain components in scope

● In scope　　● Partially in scope　　● Not in scope

| Issuance | Trading | Clearing | Settlement | Custody | Asset servicing |
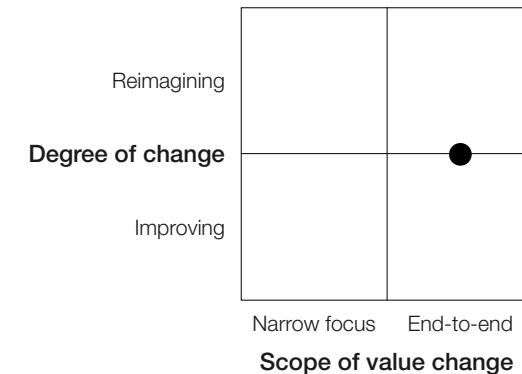
Major changes from current state*

– Introduce a single, shared source of truth on all aspects of the security, including ownership and post-trade activities

– Enable programmability of securities from issuance

– Potentially introduce the ability to settle certain trades on a shorter or more flexible timeline

– Potential for investors and issuers to interact directly with market infrastructure or exchange (or with one another)

Proposed benefits*

– Greater transparency for all parties

– Potential to reduce complexity in operations and/or operational burdens associated with reconciliation activity

– Potential for streamlining/automating all processes associated with servicing security, clearing and settling and/or maintaining compliance

– Enable better balance sheet management (e.g. reduced funding requirements for risk capital, clearing fund and/or settlement liquidity)

– Issuers could potentially list directly and/or have greater transparency of ownership, without relying on additional intermediaries, potentially lowering cost of capital

Potential risks/challenges

A supplemental market infrastructure could introduce additional operational complexity for participants

Need for mechanisms to verify smart contract terms upon issuance

Need to rethink regulation requiring separation of responsibilities in securities value chain

Digital platform covering full securities life cycle

Potential path forward

A range of potential (not mutually exclusive) future states exist: (1) infrastructure coexists with traditional infrastructure indefinitely, providing regulated services to a select group of investors and issuers; (2) participating parties begin to realize cost savings (from process streamlining and risk mitigation) and/or greater liquidity from access to global markets, leading to a preference for this platform and therefore a "sunsetting" of traditional infrastructures; (3) regulation evolves to permit issuing, trading, settlement or custody without certain parties, leading to those parties' roles being eliminated/scaled back; (4) a DLT-based platform is deemed essential only for cryptocurrencies and a limited set of digital assets, limiting applications to regulated securities markets.

Enablers

– Regulators are more likely to be open to new infrastructures (especially from existing providers), rather than attempts to replace systemically important systems with new technology

– Growing institutional investor interest in cryptocurrencies could drive enough initial interest in digital issuances to create a virtuous cycle

– Availability of CBDCs would likely prompt greater comfort with DLT among both infrastructure providers and market participants, as CBDCs would allow for atomic DvP settlement in central bank money

Impediments

– "Chicken and egg" scenario: liquidity begets issuance, which begets liquidity, but without strong incentives to issue or invest in this market (vs. traditional markets), both will remain limited

– In order to truly open a global liquidity pool, a range of regulations need to be harmonized across jurisdictions, in addition to further development in technological interoperability between systems

Example firms/projects/products

SIX Digital Exchange (SDX)	Status: in production build
DTCC: Project Whitney (for private markets)	Status: proof of value
SBI Holdings, SMFG: Osaka Digital Exchange	Status: in production build
SDX, SBI: Singapore-based digital asset exchange	Status: in production build
Gibraltar Stock Exchange: GRID	Status: live in production

Swiss Digital Exchange
SIX Swiss Exchange is in the process of building SDX, an end-to-end, fully regulated exchange and CSD for the listing, trading, settlement and custody of digital assets. It aims to allow financial institutions to trade digitized shares, bonds and other assets with the help of distributed ledger technology. SDX is not targeting publicly listed equities as one of the initial asset classes on the platform (choosing instead to focus on asset classes with more significant inefficiencies, including private SME equity shares). SDX was founded in 2018, launched its prototype in September 2019 and plans to go live with several asset classes in 2021.1[50]

Equity tokens issued on blockchain

Overview

This approach is potentially the most disruptive threat to existing equity markets, with DLT being used to replace most of the traditional intermediaries and processes in equity markets. By listing securities directly on public blockchains – either on their own or with the help of banks – issuers could eliminate many of the processes associated with each component of the value chain (e.g. operations designed for legacy environments or required by current regulations). Security tokens are one area where traditional markets could intersect with DeFi (decentralized finance), through decentralized exchanges, allowing for multiple trading venues and a range of additional applications. While, to date, the focus has been on private shares – whose fragmented markets and largely manual processes could benefit from the potential for standardization and automation offered by DLT – many anticipate a future blurring of the lines between traditional publicly listed equities and tokenized private company shares.
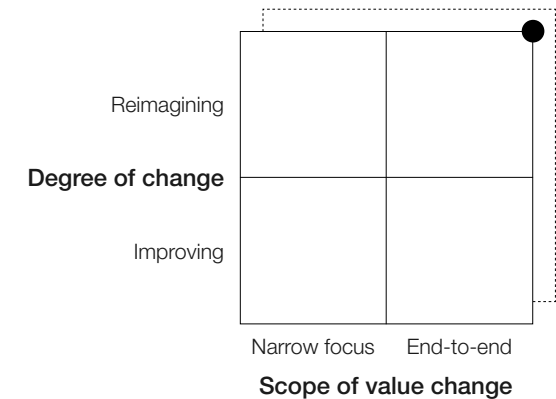
Reimagining

Degree of change

Improving

Narrow focus End-to-end

Scope of value change

Value chain components in scope

● In scope ● Partially in scope ● Not in scope

| Issuance | Trading | Clearing | Settlement | Custody | Asset servicing |

Major changes from current state*
– Rather than issuing on a centralized exchange with a single CSD, tokens would be issued on a public or permissioned blockchain, with investors accessing markets and trading through multiple decentralized exchanges

Proposed benefits*
– Potentially significantly lower cost of issuance, thereby opening access to smaller firms

– Without consideration for legacy architecture or processes, a likely easier path to realizing the workflow and operational benefits offered by the technology

Potential risks/challenges
Fundamental change to existing market functioning, with no fundamental agreement on how roles (e.g. custody) are defined In many jurisdictions, changes to securities legislation could be required for public equities to be issued directly to blockchains, thereby limiting activity in the space for all but the smallest firms

In some jurisdictions, regulatory requirements around disclosures and transparency could be prohibitive to smaller companies interested in issuing shares on DLT platforms Potentially exposes participants to a new class of cyber risks, thereby necessitating an entirely new control framework

Potential path forward

This approach faces the greatest uncertainty, but most see strong potential for SME issuance and significantly less opportunity in the traditional public equity markets. However, a range of future scenarios exists: (1) issuance is driven primarily by SMEs and other firms traditionally excluded from capital markets, but limited demand from investors prevents the market from taking off; (2) investor demand and DeFi growth leads to robust private markets for private equity shares issued on blockchain, bringing liquidity to the market and blurring the line between public and private shares; and (3) archetypal bottom-up disruption, beginning with SMEs and private firms but eventually expanding to other market segments as participants realize the benefits and cost savings associated with listing on public blockchains vs. traditional markets.

Debt markets: summary

Fixed income – and bonds, in particular – has been seen by many observers and participants as an asset class with significant potential for digital transformation, with several major DLT-based projects under way (including a number of highly publicized "blockchain bonds" issued in recent years). While there is substantial variation in market characteristics and functioning between different fixed-income markets, challenges that could potentially be addressed by DLT-based digitalization include:

– Inefficiencies in issuance, trading and post-trade processes

– Illiquidity in secondary markets and limited primary market issuance

– Limited access to markets due to high minimum transaction sizes

As with other asset classes, various institutions attempt to address these challenges through both end-to-end platforms and solutions that are more narrowly focused on specific components of the value chain. Given the fragmented, over-the-counter nature of secondary market trading, bonds are seen as both likelier to benefit from DLT-based solutions and easier to transform, without necessarily requiring wholesale market transformation.

Overview of asset class

Market overview

Fixed-income debt markets are highly diverse, with instruments defined primarily by their issuers (investment-grade corporates, high-yield corporates, national governments and subnational governments) and their maturity (shorter-term paper and longer-term bonds). In some cases, markets for retail and wholesale investors are also separate. Within each of these categories, bonds differ in terms of their seniority in the capital structure and, most importantly, the terms of the debt. As such, even in bonds from the same issuer, there is relatively little fungibility between issuances. Globally, the notional value of bonds outstanding totalled $106 trillion at the end of 2019, with a range of $17 trillion–$21 trillion in annual issuance over the preceding decade.[51]

Key characteristics

Market operations and functioning vary significantly across countries and types of instruments. In general, bonds tend to be traded over-the-counter (OTC), with some trading taking place on exchanges. While recent years have seen an increase in electronic trading, most trading involves orders placed telephonically with broker-dealers. Some markets are entirely or partially centrally cleared, while many instruments always settle bilaterally. Liquidity in bond markets ranges dramatically, from the deep and highly liquid US Treasury market to many syndicated corporate bonds that are held to maturity.

Several intermediaries and infrastructure providers facilitate the flow of capital from investors to corporate or sovereign bond issuers, trading between investors and the flow of funds from coupon and principal payments:

Bond registrars

(For some bonds) Exchanges/ trading venues

Global custodians

Broker-dealers

Issuers

Agents/ trustees

(For some bonds) Clearing houses

Local custodians

Market makers

Asset managers

Asset owners/ investors

Investment banks/ underwriters

Settlement system/central security depository

Law firms

Ratings agencies

Numbering agency

DLT in the fixed-income debt value chain

Primary market   **Secondary market**   **Post-trade**   **Life-cycle management**

Issuance	Trading	Clearing	Settlement	Custody	Asset servicing
– Rating agency analysis – Legal documentation preparation – Investor roadshow – Issuance announced and book opened – Allocation and pricing – Registration with CSD	– Price/liquidity discovery and order instructions – Trade capture/routing – Order book matching – Trade validation – Confirmation sent to clearing agent/venue	If centrally cleared: – Margins calculated and requested – Net security/ cash obligations communicated	– Cash payments sent and confirmed – Ownership of securities transferred in the CSD – Reconciliation by relevant parties	– Maintenance/ safekeeping and reporting of ownership records – Life-cycle management/ processing on behalf of asset owners	– Maintenance/ safekeeping and reporting of ownership records – Life-cycle management/ processing on behalf of asset owners
(A)	(B) (C) (D) (E)	(B) (F)	(F) (G)	(D) (F)	(F)

While pain points are concentrated in secondary market trading, they also reflect challenges and inefficiencies across the entire value chain

Existing pain points
Given the diversity in bond markets, pain points vary somewhat between different debt instruments:

(A) The corporate bond issuance process is highly manual and prolonged, with significant time required to issue and receive proceeds

(B) Because secondary markets are largely over-the-counter, liquidity tends to be fragmented, with limited ability to accurately price trades

(C) Corporate bond markets tend to face limited secondary market liquidity overall, thereby limiting some investor interest and affecting cost of capital

(D) Trading processes are largely manual, leading to significant inefficiencies and poor data quality for all participants

(E) Relatively high minimum ticket sizes (given high transaction costs) exclude most retail investors

(F) All parties retain siloed data structures, calculating payments and other transactions independently using reference data, thus creating inefficiencies

(G) Extended settlement time frames add additional cost and risk

Potential DLT roles in debt markets
While the inefficiencies in debt markets could be addressed by a range of technologies replacing or augmenting manual processes, there may be opportunities for which DLT is particularly well suited, such as:

– Establishing a single source of truth for reference data on bond terms, trade and settlement status, ownership and coupon/repayment instructions

– Automating settlement instructions and/or life-cycle events using smart contracts

– Creating a low-cost new infrastructure for bond markets without established infrastructures (e.g. retail issuances in emerging markets)

– Fractionalization of debt instruments

– Entirely new products enabled by smart contracts (e.g. creating a new instrument by separating coupon payment cash flow from a bond)

DLT in the fixed-income debt value chain

1

Platform for digital bond issuance

What? Replace existing manual pre-issuance processes with a digital platform that connects all relevant parties

Who? Led by third-party technology provider or exchange/infrastructure, with the goal of including all parties involved in a bond issuance (e.g. issuer, banks, CSD, registrar, ratings agencies, law firms etc.)

Why? Reduce the time and cost required to issue a bond by digitizing current manual processes and patchwork of paper documentation; possible to achieve with traditional technologies, but DLT may allow for greater certainty in data

2

Distributed order book for bond trading

What? Establish a distributed platform for consolidating trade orders, where orders are visible only to potential trading matches

Who? Led by third-party technology provider, but including both buy- and sell-side market participants involved in secondary market trading

Why? Reduce fragmentation and manual price/liquidity discovery in the corporate bond markets by creating a concentrated trading venue with minimal data leakage

3

Platform covering full corporate bond life cycle

What? Introduce a DLT-based end-to-end platform enabling the issuance, trading, settlement and custody of digitally native bonds

Who? Led primarily by exchanges/infrastructure providers and/or bank consortia, with participant ecosystem including issuers, infrastructure providers and a range of other service providers

Why? Enable the full potential of digital assets (end-to-end processes automated by embedded smart contracts, risk-free atomic settlement etc.) in a regulated environment in parallel to existing infrastructure

4

Retail bond issuance and distribution

What? Develop DLT platform to facilitate retail investor access to corporate and government bonds (via tokenizing and fractionalizing bonds)

Who? To date, primarily governments and financial institutions in emerging markets seeking to develop a trusted, low-cost infrastructure and distribution channel for bond investments by retail owners

Why? Enable a larger population of retail investors to both own and trade bonds efficiently and at low costs, where the existing infrastructure supports only high-ticket-price investments

5

"Stand-alone" blockchain bond issuance

What? Issue a stand-alone bond via DLT to test the underlying technology and prove its value

Who? Generally speaking, the issuances have been arranged by one bank or a small syndicate, with a limited number of investors and limited secondary market trading

Why? Affirm DLT's potential ability to modernize/optimize the bond issuance process (e.g. faster time to market, increased scalability, lowering issuance costs etc.)

Platform for digital bond issuance

Overview

Numerous firms are developing digital solutions to address inefficiencies in the processes to issue bonds. While some of these solutions use DLT outright, others use a combination of connected, centralized databases and smart contracts, with the potential for interoperability with DLT-based platforms in the future. These solutions are designed to bring together the relevant parties involved in a bond issuance through a streamlined digital channel, replacing the current patchwork of paper documentation shared via email and fax. In doing so, they reduce the time required to issue a bond and the cost of issuance. These solutions do not necessarily aim to achieve downstream efficiencies in trading, settlement or life-cycle management – though some are built to issue digital bonds that will integrate with other platforms to achieve end-to-end efficiencies.

Reimagining

Degree of change

Improving

●

Narrow focus — End-to-end

Scope of value change

Value chain components in scope

● In scope   ● Partially in scope   ● Not in scope

| Issuance | Trading | Clearing | Settlement | Custody | Asset servicing |
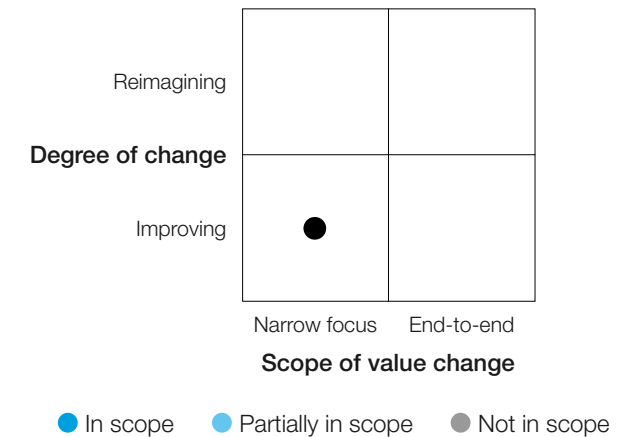
Major changes from current state*
Replace existing manual issuance processes with a digital platform (either DLT-based or centralized); existing initiatives focus on one or both components of issuance:

– Document preparation processes

– Primary issuance allocation and pricing

Proposed benefits*
Expedited issuance by streamlining communication and document preparation (elimination of inefficiencies including substantial manual back-and-forth, errors, lack of transparency and lack of standardization and structured data)

Potential risks/challenges
Given the need to integrate workflows from non-financial institutions (e.g. law firms, ratings agencies, issuers), coordination/onboarding challenges may be substantial

Uncertainty about technology fit (i.e. whether DLT is uniquely able to address issuance workflow inefficiencies)

Example firms/projects

Nivaura Aurora	Status: live in production
agora Digital Capital Markets (building end-to-end smart bonds, but initial focus on issuance)	Status: production scheduled 2021
DirectBooks (not DLT-based)	Status: live in production

Potential path forward

While a digital bond issuance platform could achieve stand-alone efficiencies (without changing the underlying security status), observers believe these platforms will earn significantly more value when combined with an end-to-end digital infrastructure. Securities can subsequently be issued on a distributed ledger, with smart contracts to automate compliance and life-cycle management, and ultimately traded and settled in a more frictionless manner. By introducing greater standardization in bond issuances, platforms can expedite the development of a broader digital infrastructure. Conversely, some market participants also believe that issuance processes can be improved with relatively straightforward digital tools, potentially limiting market participants' appetite for DLT or other emerging technologies. Either way, the successful transition to digital operating models during the COVID-19 pandemic is likely to encourage institutions to replace manual correspondence with digital collaboration platforms.

Distributed order book for corporate bond trading

Overview

Some firms seek to use DLT and related technologies to address core inefficiencies in secondary markets for corporate bonds. Rather than tackling bond issuance, the underlying infrastructure for custody and settlement or end-to-end tokenization, efforts are focused on bond trading to bring greater transparency and liquidity into bond markets while allowing market participants to

maintain control of their trading data. This could promote greater liquidity for corporate bonds, which generally face illiquidity due to both the idiosyncratic nature of individual securities and the structure of bond markets, where trading primarily takes place over-the-counter.
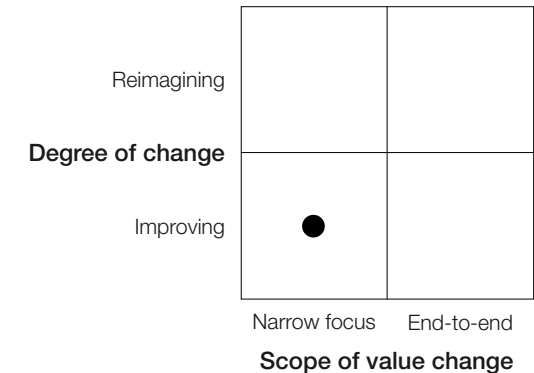
Reimagining

Degree of change

Improving

●

Narrow focus   End-to-end

Scope of value change

Value chain components in scope

● In scope   ● Partially in scope   ● Not in scope

Issuance	Trading	Clearing	Settlement	Custody	Asset servicing

Major changes from current state*
Rather than contacting multiple dealers to locate inventory/ trade matches, orders are routed to a DLT-based platform, where orders are visible only to potential trading matches

Proposed benefits*
– Reduce fragmentation in corporate bond trading (assuming sufficient adoption)

– Allow better data controls, limiting leakage of trade information (and potentially allow participants to monetize their trading data)

Potential risks/challenges
Achieving benefits requires substantial trading activity to migrate to platform, potentially centralizing risk in a new trading venue

Uncertainty about technology fit (i.e. whether DLT is uniquely able to address trading inefficiencies), particularly as electronic trading platforms gain trading market share

Example firms/projects

LedgerEdge   Status: in development; scheduled to launch autumn 2021

Potential path forward

Since corporate bond trading is decentralized across many venues and market participants, a stand-alone DLT-based trading platform could drive value without requiring the entire ecosystem to transform. However, observers question whether a DLT solution for trading would limit interest in other DLT-based bond market solutions (e.g. issuance tools or underlying custody and settlement infrastructure) or if it might lead market participants to be more open to such solutions.

Platform covering full corporate bond life cycle

Overview

As with the equity market, several exchanges/ infrastructure providers and financial technology firms are developing end-to-end platforms for debt-fixed income securities. The platforms enable market participants and intermediaries to list or issue, trade, settle trades and provide custody services for digital assets – in this case, digitally native bonds – in a fully regulated environment. These platforms exist in parallel to existing market infrastructure and existing bond markets, offering an alternative digitized version of standard bonds. While DLT may be the core technology on which the "Central Securities Depository" is maintained, some functions/ processes may employ existing technologies if there is no clear case for using DLT (e.g. trading). This approach does not necessarily disintermediate any parties, although some roles may become redundant over time.
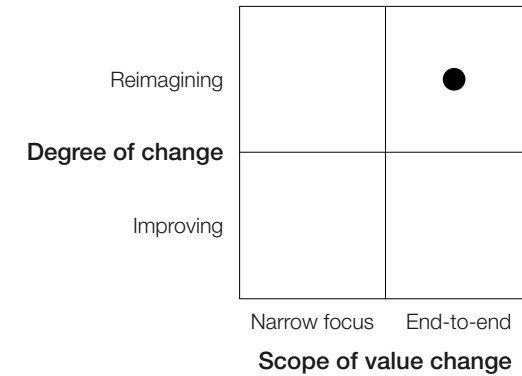
Degree of change — Reimagining / Improving

Scope of value change — Narrow focus / End-to-end

Value chain components in scope

● In scope ● Partially in scope ● Not in scope

| Issuance | Trading | Clearing | Settlement | Custody | Asset servicing |

Major changes from current state*
– Introduce a single, shared source of truth on all aspects of the security, including terms, ownership and trade/ post-trade activities

– Digitize bond terms, enabling programmability of securities from issuance (replacing document-based manual processes)

– Potential for investors and issuers to interact directly with market infrastructure (or with one another)

Proposed benefits*
– Greater transparency for all parties

– Potential to reduce complexity in operations and/ or operational burdens associated with reconciliation activity, thereby reducing transaction costs for all parties

– Potential for streamlining/automating all processes associated with coupon and principal payments, clearing and settling and/or maintaining regulatory compliance

– Issuers could potentially list directly and/or have greater transparency of ownership, without relying on additional intermediaries, reducing costs to issue

Potential risks/challenges
Need for mechanisms to verify and validate smart contract terms among all relevant parties upon issuance

Potential for interoperability issues assuming multiple platforms in coexistence (i.e. how to ensure that ecosystems do not remain closed)

* May differ by exact model.

Platform covering full corporate bond life cycle

Potential path forward

Fragmentation, inefficient processes and limited liquidity in secondary markets make end-to-end transformations desirable in corporate bonds. However, this requires coordination and adaptation across a range of participants throughout the entire value chain, most of whom do not interact directly in existing markets (e.g. issuers, front and back-office staff from multiple business lines, infrastructure providers, et al.). Nevertheless, many participants and observers believe that a series of smart bond issuances by prominent corporates would significantly increase investor and issuer interest in such a platform.

Enablers

– Compared to equity markets, generating liquidity is less likely to be a significant impediment for bonds, since the alternative is the status quo of fragmented and generally illiquid markets

– The successful transition to digital operating models during the COVID-19 pandemic is likely to encourage greater openness among financial institutions to replacing manual correspondence with digital collaboration platforms

– Availability of CBDCs would likely prompt greater comfort with DLT among both infrastructure providers and market participants, as CBDCs would allow for atomic DvP settlement in central bank money

Impediments

– DLT-enabled bonds are seen by many issuers, investors and intermediaries as experimental, thereby limiting the willingness to be early movers in listing new bonds or investing in the limited supply of existing securities

– "Chicken and egg" problem: liquidity begets issuance, which begets liquidity, but without strong incentives to issue or invest in this market (vs. traditional markets), both will remain limited

Example firms/projects

HSBC, Temasek, SGX Digital bond issuance and life-cycle management	Status: successful pilot/ proof of value (Sept 2020)
SIX Digital Exchange End-to-end digital market infrastructure	Status: in production build
Bursa Malaysia/Labuan Financial Exchange (Project Harbour) End-to-end digital bond issuance, trading, and depository venue	Status: proof of concept

PROJECT SPOTLIGHT

SGX

TEMASEK   HSBC

SGX/Temasek Marketnode
Following a successful proof of value co-led by SGX, Temasek and HSBC (during which a digital, smart contract-based bond was issued and settled on DLT using HSBC's on-chain payments solution), SGX and Temasek announced the creation of a digital asset exchange focusing on the bond market. Partnering with bond issuance software provider Covalent Capital, the combined platform will be an end-to-end solution employing DLT and smart contracts for relevant value chain components (using Covalent's existing non-DLT digital issuance platform for book building).[52]

Retail bond issuance and distribution

Overview

Particularly in emerging markets, financial institutions and governments are developing solutions to facilitate retail investor access to corporate and government bonds. Since issuance and trading infrastructure have high fixed costs, bond investments often have equally high minimum ticket sizes and transaction costs for primary and secondary markets. By tokenizing bonds and distributing them via a digital platform accessible by retail investors (through which bonds can be fractionalized and traded with instantaneous, low-cost settlement), issuers can expand access to a wider group of retail investors.
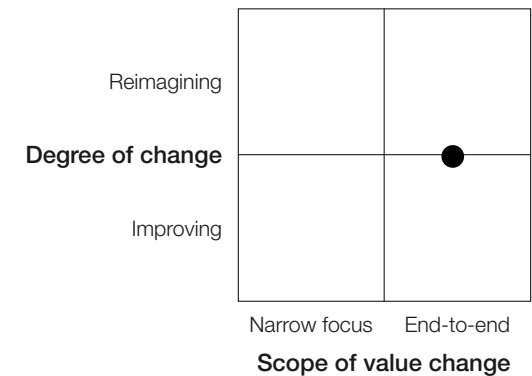
Reimagining

Degree of change

Improving

Narrow focus   End-to-end

Scope of value change

Value chain components in scope

● In scope   ● Partially in scope   ● Not in scope

| Issuance | Trading | Clearing | Settlement | Custody | Asset servicing |

Major changes from current state*

Establish a platform to facilitate both issuing bonds directly to retail investors and secondary market trading among retail investors, without costs associated with legacy infrastructure and/or intermediaries

Proposed benefits*

– Enable a larger population of retail investors to both own and trade bonds

– Potential to interact with broader financial and digital inclusion efforts (e.g. digital identity programmes)

Potential risks/challenges

Developments are likely to be limited to jurisdictions in which governments are taking an active stance in favour of DLT in financial markets

There may be regulatory/consumer protection issues to be addressed in terms of custody/cryptographic key management, fraud and privacy concerns

Example firms/projects

Philippines: Union Bank and Standard Chartered (tokenization platform for retail corporate bonds)	Status: proof of concept completed Dec 2020
Philippines: Union Bank and PDAX (Bonds.PH retail government bond distribution platform)	Status: in production build
Thailand: Bank of Thailand (government savings bond platform)	Status: production scheduled 2021

Potential paths forward

For jurisdictions with limited retail investor participation in bond markets, DLT will likely not offer a panacea. However, some governments and financial institutions may find that DLT provides a low-cost basis for establishing a retail bond market infrastructure without requiring too many intermediaries. In these jurisdictions, while most expect the DLT-based retail market to develop separately from wholesale markets, many believe that if there are significant cost savings from the new infrastructure, governments and issuers may push for the application of DLT to wholesale bond market infrastructures.

'Stand-alone' blockchain bond issuances

Overview

"Stand-alone" issuances of "blockchain bonds" have been an important means for financial institutions to test the underlying technology and prove its value. Most issuances have been arranged by one bank or a small syndicate, with a limited number of investors and limited secondary market trading. In these experiments, bonds have either been "mirrored" or simulated on a distributed ledger, or they have been fully issued on DLT as the official record. Across the board, they have proven the technical feasibility of establishing a bond with terms codified in smart contracts and have clarified the various roles that are essential in managing a DLT-listed bond throughout its life cycle. While, in general, these tests have affirmed blockchain's potential ability to streamline and optimize the bond issuance process, they have also underlined the challenges of ensuring regulatory and legal compliance in uncertain regulatory environments, as well as the benefits and challenges of developing solutions collaboratively.

Notable issuances

Lead arranger	Issuer	Date	Comments
Commonwealth Bank of Australia (with RBC and TD Securities for 2019 issuance)	The World Bank ("Bond-I")	2018 and 2019	World Bank issued A$110 million bond on blockchain, with life-cycle events managed through smart contracts. Follow-on transaction in 2019, with more investors and additional arrangers/market makers, allowed for secondary market transfer on-chain.[53]
JPMorgan	National Bank of Canada	2018	NBC issued a $150 million one-year floating rate note, mirrored/simulated on Quorum blockchain, with several investors participating in the trial.[54]
Sberbank	MTS	2018	Sberbank placed a RUB 750 billion commercial bond for MTS, a Russian telecom company, using the National Settlement Depository's (NSD) blockchain, with the full life cycle managed through smart contracts.[55]
Santander CIB	Banco Santander	2019	Self-issuance of a $20 million bond on public Ethereum; Santander Securities Services serves as tokenization agent and custodian (of cryptographic keys), with Santander CIB as dealer. All cash payments are tokenized.[56]
Société Générale	Société Générale SFH	2019	Self-issuance of €100 million covered bond on public Ethereum blockchain.5[57]
BBVA	BBVA	2019	Structured €35 million green bond (earmarked for sustainability efforts) issued to MAPFRE using BBVA blockchain platform.[58]
Bank of China (BoC)	Bank of China (BoC)	2020	BoC completed the issuance of 20 billion yuan ($2.8 billion) worth of bonds using its proprietary blockchain system.[59]

Securitized Products: summary

Securitized product markets are highly heterogeneous, given significant differences in the loans underlying mortgage-backed securities, asset-backed securities, collateralized loan obligations and other instruments. However, across the board, there are widely acknowledged inefficiencies associated with manual processes and limited trust in data between institutions. Beyond the challenges that are common across other securities markets, securitized products face a unique set of issues associated with the fact that these securities effectively bundle the cash flows and risks of a large number of underlying loans.

While most would agree that there is significant opportunity to better use technology across the value chain for securitized products, a number of observers and market participants believe that DLT may provide unique benefits to these markets. In particular, DLT-based solutions may enable all relevant participants in the value chain to access the same data on underlying loans in real time, thereby reducing the need to verify and audit data throughout the security life cycle.

Overview of asset class

Market overview

Securitization is the process of converting the cash flows from illiquid financial credit assets into tradeable securities. As such, securitized products are highly diverse, but are generally categorized as mortgage-backed securities (MBS, consisting of both residential and commercial mortgage loans), asset-backed securities (ABS, consisting of non-mortgage consumer credit, such as credit cards and auto loans) and collateralized loan obligations (CLOs, consisting of corporate loans). Generally, these securities are issued by a bank or a non-bank originator, responsible for pooling the exposures, structuring the security and selling to investors. The US MBS market, by far the world's largest, stood at $10 trillion at the end of 2019.[60] European MBS, ABS and CLO markets totalled $1.2 trillion at the end of 2019.[61]

Key characteristics

While the core processes of consolidating loan exposures, structuring and issuing securities and secondary market trading are consistent across securitized asset classes, there are fundamental differences in the underlying loans and in secondary market liquidity and operations. However, across MBS, ABS and CLOs, there are similar inefficiencies associated with manual and duplicative processes, limited transparency of underlying loans and associated costs and delays.

The securitized product landscape is highly complex, consisting of participants in underlying loan markets, participants in the securitization process and primary market issuance, participants in the secondary markets, and entities involved in lifecycle management for both the loan and the security.

Loan origination/ underwriting
- Borrowers/ obligors (e.g. home owners)
- Loan originators (e.g. banks)
- Loan servicers

Securitization and primary issuance
(pooling loans, establishing SPV, structuring security, issuing security)
- Arrangers/ sponsors (e.g. banks)
- Broker-dealers/ derivatives counterparties
- Special purpose vehicles/entities (SPV/SPE)
- Investors (asset owners, asset managers)
- CSD

Secondary market
- Investors (asset owners, asset managers)
- Broker-dealers
- Trading venues
- Custodians
- CSD

Life-cycle management
- CSD
- Loan servicers
- Custodians
- Trustees
- Broker-dealers/ derivatives counterparties

DLT in the securitized products value chain

Primary market

Secondary market

| Loan origination | Security structuring and distribution | Trading, clearing and settlement |

A
- Application
- Processing
- Underwriting
- Closing

B
- Pooling/transferring loans and establishing SPV
- Structuring, underwriting and rating security
- Documenting, closing and issuing security

C
- Investor due diligence
- Price and liquidity discovery
- Trade matching/ confirmation
- Clearing and settling

Life-cycle management

| Security structuring and distribution |

D
- Collecting interest, principal and escrow payments
- Administering and ensuring funds come in
- Tracking/monitoring overdue payments
- Addressing defaults/credit events

| Security servicing |

E
- Holding cash in escrow; monitoring collateral
- Distributing payments to investors
- Managing ongoing swaps/hedges
- Ongoing credit monitoring and cash-flow modelling
- Ensuring regulatory criteria are fulfilled

—— Opportunities for transformation across the entire value chain ——

Existing pain points
Across the value chain, inefficiencies today include:

A Origination and underwriting of underlying loans: long lead times; lack of data standardization (contract terms, credit profiles, collateral); highly paper intensive; decentralized information and storage; costly to access and reconcile data

B Security structuring: complex, manual and costly processes to evaluate, rate and pool loans, which is often duplicated across multiple parties; slow, opaque and manual settlement processes

C Trading: except in certain MBS, relatively shallow over-the-counter markets, with constraints in liquidity and significant market information asymmetry

D Loan servicing: manual process to monitor and collect payments; limited insights offered to investors; fragmented account management

E Security servicing: costly due diligence and research due to absence of single source of truth; time lags leading to out-of-date or imperfect information; manual/slow reconciliation (time lags between loan payments and investor distributions)

Potential DLT roles in securitized products
While many digitization efforts could reduce the inefficiencies in lending and securitization, DLT-based systems could provide unique benefits, such as:

- Creating an accepted single source of truth on loan data, thereby increasing transparency for all parties and limiting the need for duplicative audits across the value chain

- Reducing the time and/or level of manual processing required for settlement of trades, processing payments and other life-cycle events (via smart contracts)

- Reducing the need for manual reconciliations throughout the life cycle of the security

Summary of emerging use cases

1

End-to-end origination, securitization and servicing platform

What? Introduce a DLT-based platform enabling loan origination, securities issuance, exchange, settlement and servicing processes on one platform

Who? Led by third-party technology providers and/or bank consortia

Why? Eliminate the need for each party to reverify each individual loan at every step of different processes; improve transparency of underlying loans (improved risk management); reduce reconciliations and complexity in operations; potentially reduce capital required to settle trades

2

Tokenizing loans for servicing and data management

What? Create a digital representation of a loan on a DLT platform that can then be used to facilitate loan payments and data sharing

Who? Driven by technology providers to support loan servicers, investors and other participants in the value chain

Why? Eliminate the need for each party to reverify each individual loan at every step of different processes; improve transparency of underlying loans (improved risk management) and flexibility (loans can be brought on or off DLT at any point)

3

Improving security servicing through DLT

What? Develop a DLT-enabled tool to facilitate better and more efficient servicing of securitized products and underlying loans

Who? Led by trustees or other service providers involved in servicing securities

Why? Enable greater transparency of performance of underlying loans and to automate elements of security servicing

End-to-end origination, securitization and servicing platform

Overview

Given inefficiencies across the value chain for many securitized products, some firms have focused on end-to-end solutions, bringing together the loan origination, securities issuance, exchange, settlement and servicing processes on one platform. While not all relevant applications and processes will necessarily be built on a distributed ledger, the basic premise is to create a single source of truth on the underlying assets (data, terms and cash flows) that is connected to a single source of truth

on the securities, accessible by all relevant parties to improve processes associated with trading and managing the life cycle of securities. While focused on delivering end-to-end value, the platform can be designed to integrate with other systems for processes that would not necessarily benefit from a distributed ledger or would require transforming an additional complex ecosystem (e.g. an initial loan issuance or exchange).
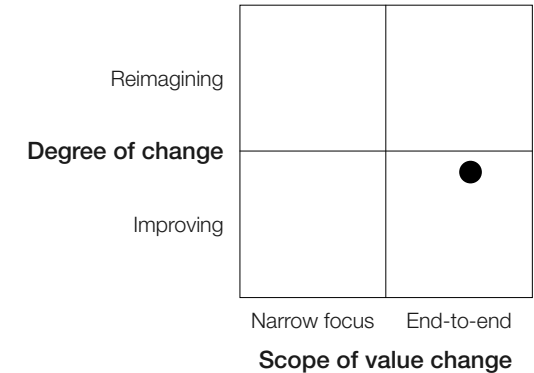
Reimagining

Degree of change

Improving

Narrow focus   End-to-end

Scope of value change

Value chain components in scope

● In scope   ● Partially in scope   ● Not in scope

Loan origination	Security structuring	Trading, clearing, settling	Loan servicing	Security servicing

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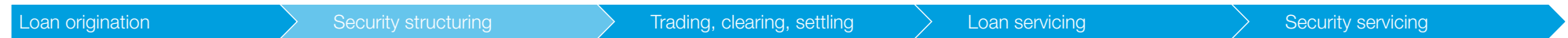
Major changes from current state*

– Loans are originated on a DLT system, or loan data is brought onto the chain immediately after origination (using a standard data model); all downstream transactions are based on this loan data and associated smart contracts

– Securities are created as digital assets on a distributed ledger, enabling both a shared source of truth on the security (e.g. terms, ownership) and programmability of securities from issuance (replacing paper-based manual processes)

Proposed benefits*

– Eliminate the need for auditing/verifying individual loan files at every step for every party (e.g. loan warehousing/sales, credit enhancements, primary market, trading)

– Transparency of underlying loans for all parties at all times, enabling investors to better understand risk

– Reduce complexity in operations and/or operational burdens associated with reconciliation activity, thereby reducing transaction costs for all parties

– Potential to reduce capital required to fund settlement

– Streamline or automate all processes associated with coupon and principal payments, clearing and settling, and/or maintaining regulatory compliance

Potential risks/challenges

To benefit, all participants need to acknowledge the accuracy of the underlying loan terms with limited or no auditing; this will require governance and upfront verification by multiple parties, and, depending on the jurisdiction, could require regulatory approval

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* May differ by exact model.

End-to-end origination, securitization and servicing platform

Potential path forward

Given the limited liquidity and inefficient, manual processes across the value chain, there is significant potential for end-to-end transformation in some securitized product markets. Since secondary markets are largely fragmented and over-the-counter, a small, minimum-viable ecosystem of relevant institutions could realize value and drive interest among investors, which in turn could drive greater demand for loans "originated" on DLT among securitized product issuers. With significant diversity in securitized product markets, however, some are unlikely to adopt any end-to-end digital solutions without pressure from key institutions (e.g. agency-backed MBS markets in the US) or are unlikely to benefit significantly from an end-to-end solution (e.g. CLOs according to many industry participants).

Enablers
– Markets with greater data standardization (in the terms of underlying loans) – or ability to impose standardization on a limited ecosystem of participants – will be more easily digitized

– It may be easier to build a minimum viable ecosystem for securities whose underlying loan originations involve a smaller network of participants

– Integrations between digital asset trading venues (and potentially off-chain trading venues) could create a larger investor base, reducing the likelihood that limited demand on any individual end-to-end platform limits issuance

Impediments
– In highly complex markets with heterogeneous underlying assets, end-to-end digitalization will be difficult, and potentially of limited value (e.g. CLO markets, whose underlying corporate loans are often highly bespoke due to both borrower and investor demands)

Example firms/projects

Figure Technologies DLT-enabled mortgage/ HELOC lending, securities issuance, trading and servicing platform	Status: live in production (ongoing lending, with two securitizations completed)
Vanguard, Citi, BNY Mellon, State Street, in partnership with Symbiont[62] DLT-enabled platform for ABS issuance, settlement, custody, and servicing (loans onboarded after origination)	Status: successful pilot announced in June 2020

Figure/Provenance securitizations
Figure Technologies has developed an integrated platform for originating mortgages and home equity loans, securitizing loans and distributing/exchanging securities, using its permissioned blockchain Provenance. In 2020, Figure completed two securitizations, detailing the efficiencies all parties realized in two white papers. These efficiencies included the use of automation through smart contracts (for loan compliance, warehousing and servicing), the use of stablecoins to speed up cash payments and, most significantly, the transparency and data certainty for all parties, limiting the need for subsequent audits.[63]

Tokenizing loans for servicing and data management

Overview

One approach to addressing the lack of transparency at the loan level is to create a digital representation of each loan that can then be used to facilitate loan payments and data sharing. Rather than originating loans directly on a distributed ledger – which could be challenging given the fragmentation in participants in underlying loan markets – a tokenized version of the loan is created after origination that then becomes the single source of truth for the loan.

Parties involved in a securitization, subsequent investors in the securities and loan servicers are then able to access verified data on the underlying loans without each party necessarily having to audit the full loan pool at every step. While the shared data source still creates downstream benefits throughout the life of the loan, this approach is not focused on applying DLT to address challenges with securitization or the securities market infrastructure.
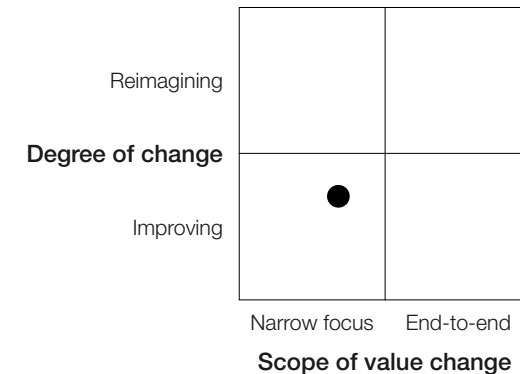
Reimagining

Degree of change

Improving

Narrow focus   End-to-end

Scope of value change

Value chain components in scope

● In scope   ● Partially in scope   ● Not in scope

Loan origination ＞ Security structuring ＞ Trading, clearing, settling ＞ Loan servicing ＞ Security servicing
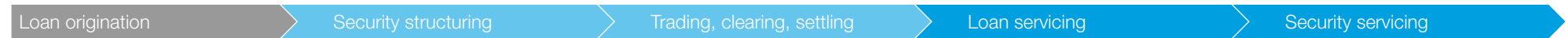
Major changes from current state*
– Underlying loans are "onboarded" to a DLT-based platform after origination, which becomes the single source of truth on the underlying loans for all parties (e.g. investors, servicers, borrowers)

– While borrowers still interact with their servicers directly, their payments are recorded by the servicers on the distributed ledger, ensuring accurate data on loan performance

Proposed benefits*
– Reduce the need for auditing/verifying individual loan files at every step for every party (e.g. loan warehousing/ sales, credit enhancements, primary market, trading)

– Transparency of underlying loans for all parties at all times, enabling investors to better understand risk

– Loans can be brought on or off DLT at any point in their life, depending on the interests of the owner/servicer

Potential risks/challenges
To benefit, all participants need to acknowledge the accuracy of the underlying loan terms with limited or no auditing; this will require governance and upfront verification by multiple parties, and depending on the jurisdiction, could require regulatory approval

Despite not being end-to-end, benefits would still require bringing a relatively large ecosystem to the platform, potentially limiting uptake

Example firms/projects

Liquid Mortgage
(focused on US mortgage market, but applicable for other loan markets)

Status: live in production

Improving security servicing through DLT

Overview

A number of market participants are focused on developing DLT-enabled tools to facilitate better and more efficient servicing of securitized products and underlying loans. While these approaches could create efficiencies across the value chain, the focus on a relatively narrow slice of services has the potential to enable faster development of a minimum-viable ecosystem of participants. These approaches vary somewhat, but the

basic premise is for the party responsible for servicing the security and reporting to investors – generally the trustee of the special purpose vehicle that holds the underlying assets – to use DLT both to ensure greater transparency of performance and to automate elements of servicing.

Degree of change

Reimagining

Improving

Narrow focus   End-to-end

Scope of value change

Value chain components in scope

● In scope   ● Partially in scope   ● Not in scope

Loan origination ＞ Security structuring ＞ Trading, clearing, settling ＞ Loan servicing ＞ Security servicing

Major changes from current state*

– Approach 1: create a DLT-based platform for originators, servicers, trustees and investors with digital/smart contract representations of loan terms (e.g. origination and servicing guidelines)

– Approach 2: create a DLT-based platform to connect trustee and servicer for managing ongoing servicing

Proposed benefits*

– Ensure transparency and shared source of truth on loan ownership and performance in the event of defaults or other adverse events, thereby reducing the potential for disputes and/or litigation

– Achieve better investor transparency (e.g. faster and more accurate trustee reports) without having to bring investors directly onto a shared platform

Potential risks/challenges

Could be difficult to achieve validation/consensus on loan terms and other data (such that smart contracts will be accepted) if not built into the issuance/ securitization process

A proliferation of "single sources of truth" could lead to a return to relying on reconciliation between multiple data sources, thereby limiting the operational efficiencies achieved

Example firms/projects

WSFS Institutional Services[64]
Automate trustee reporting for ABS (including loan-level details) and payment calculations

Status: prototype in development

Wilmington Trust[65]
Focus on US MBS; DLT used to connect loans to origination/ servicing guidelines to automate reviews for violations

Status: prototype in development

* May differ by exact model.

Derivatives: summary

Managing derivatives contracts is complex and involves coordinating activities across several parties. While the industry has moved somewhat towards digital solutions, many operations are hampered by inefficiencies, most notably around the need to reconcile position-related data on an ongoing basis. As a result, a number of market participants and service providers have developed or explored a range of DLT-based solutions to address key inefficiencies and risks, with some already live in the market. These solutions allow for shared sources of truth and mutualized processing across ecosystems or within institutions, including:

– Establishing a shared platform for managing post-trade life cycle of derivatives across counterparties

– Replacing post-trade infrastructure with a DLT-based system (in the case of markets with existing central infrastructures)

– Establishing a platform for institutions to manage their margin- and collateral-pledging workflows across all of their derivatives counterparties

– Creating a platform for mutualizing the data and workflow for finalizing derivatives trades
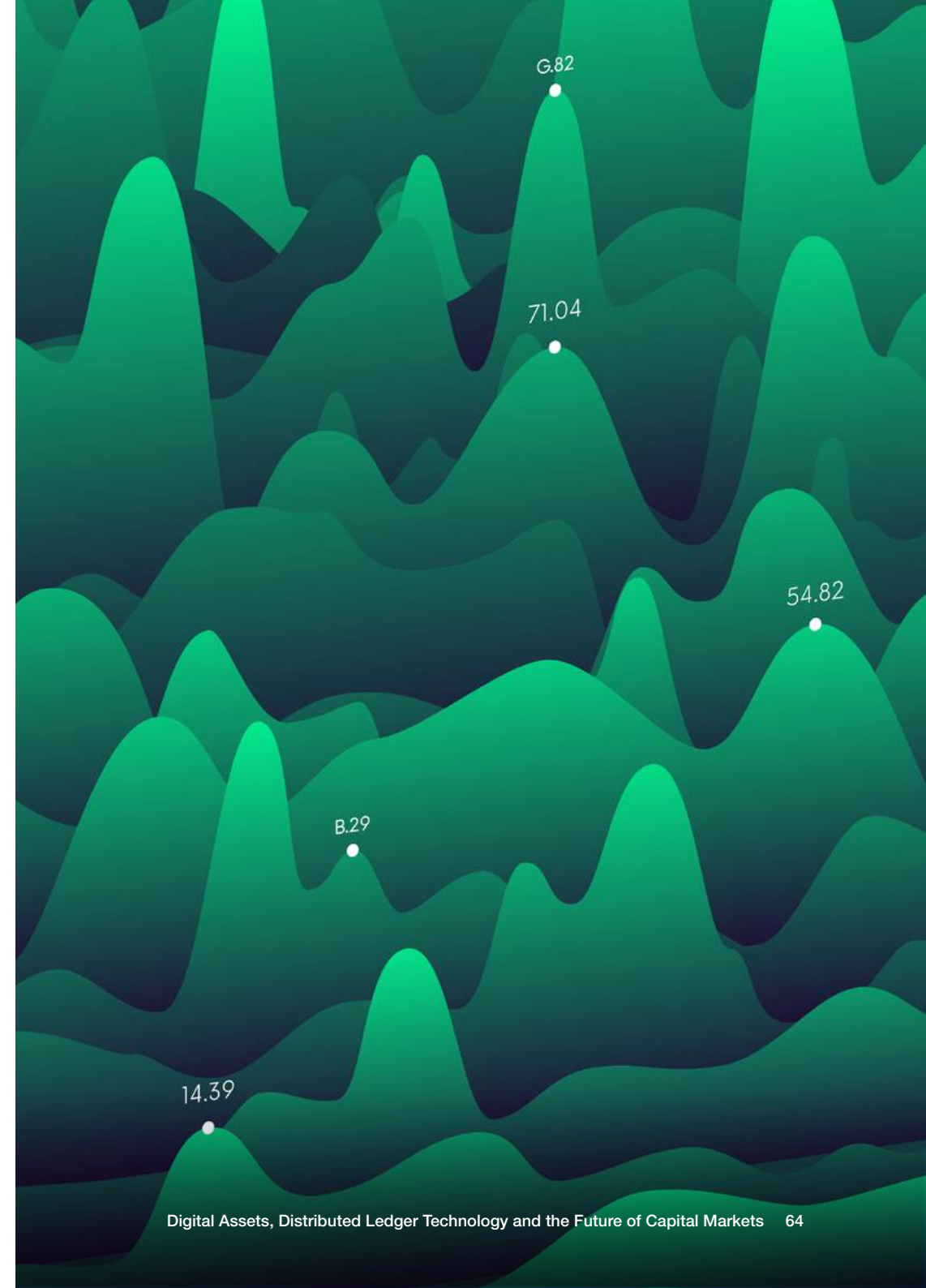
Overview of asset class

Market overview

Derivatives – both forward commitments and contingent claims – are an essential tool for risk management and cash-flow smoothing for investors, corporates and financial institutions. As of year-end 2019, the notional amount of outstanding over-the-counter derivatives globally stood at $560 trillion,[66] whereas the gross market value of these contracts was $11.6 trillion.[67] The notional principal of exchange-traded futures and options stood at $96 trillion.[68] Interest rate derivatives dominate derivatives markets, representing more than three-quarters of contracts, followed by foreign-exchange-linked derivatives. While the volume of equity- and credit-linked derivatives is lower, they are essential tools for many investors, with a notional outstanding amount in the trillions of dollars.

Key characteristics

Derivatives are traded either on exchanges or over-the-counter (OTC). While exchange-traded derivatives are always centrally cleared, OTC derivatives may be settled bilaterally or cleared through a central counterparty. Exchange-traded derivatives and cleared OTC derivatives tend to follow standardized contract terms, whereas uncleared OTC derivatives are generally more bespoke. While exchanges have long employed electronic trading, OTC derivatives trading has increasingly moved towards electronic platforms. ISDA, which administers the industry-standard master agreement used in many OTC derivatives contracts, has developed the Common Domain Model (CDM) as a common digital representation to be used across potential digital transformations in the asset class.[69]

	Loan servicing	Trading	Clearing and position management	Settlement, payment and delivery
Listed/exchange-traded	Order originated with broker-dealer and routed to exchange	Order matching on exchange	– Central novation and multilateral netting (or bilateral netting) of contracts by clearing house – Reconciliation of trades – Daily margining calculations and collateral pledges managed by clearing house – Managing trading party defaults – Position and trade reporting	– Clearing house generates settlement instructions for payments/asset transfers (if necessary) – For credit derivatives: life-cycle event processing
Cleared –over-the-counter (OTC)	Order originated with broker-dealer, potentially routed to other dealer through inter-dealer broker (including offsetting contracts used to cancel existing contracts)	Bilateral trading between broker-dealer and counterparty (often using electronic or multilateral OTC marketplace for common derivatives)		
Uncleared OTC			– Trading parties and derivatives dealers manage open contracts – Potential for bilateral netting – Position and trade reporting	Trading parties initiate payments or asset transfers (if necessary)

Existing pain points

– Institutions maintain separate data siloes, requiring ongoing reconciliation and causing substantial errors

– Manual processing associated with continuous valuation and maintenance and reporting of ownership records

– Manual processing associated with managing margin obligations across systems/depositories

– Global failure rate for OTC derivatives of 2%, representing significant cost to the industry[70]

Potential DLT roles in derivatives

– Create a single source of truth on derivatives contracts (post-trade) that can be used to manage derivatives position and life cycle

– Automate manual processes and verifications across institutions using smart contracts

Summary of emerging use cases

1

Platform for OTC derivatives post-trade life cycle

What? Platform for maintaining a shared source of truth accessible by all relevant parties on derivatives contracts across the post-trade life cycle, with smart contracts to manage life-cycle activities

Who? Financial institution consortia and/or third-party technology providers, with network effects from integrating more counterparties

Why? Replace manual, independent bilateral clearing and position management processes with a mutualized infrastructure and workflow; reduce the need for ongoing reconciliation while also reducing errors, discrepancies and complexity

2

Replatforming existing infrastructure on DLT

What? Replacing existing shared derivatives infrastructure (e.g. trade data warehouse and life-cycle processing system) with a DLT-based system, creating a shared source of truth across parties

Who? Led by existing infrastructure provider, but likely to require operational changes by all clearing participants

Why? Reduce operational cost and complexity by eliminating reconciliation activity and transitioning to a modern infrastructure

3

Platform managing collateral for cleared derivatives

What? Platform that provides real-time visibility into an institution's margin requirements across derivatives central counterparties and automates the collateral pledging workflow across CCPs

Who? Led primarily by individual custodians, but requires integration with derivatives clearing houses

Why? Increased operational efficiencies stemming from the end-to-end automation of collateral workflows and, potentially, optimizing collateral and cash balances through faster payments and capital deployment

4

Platform for exchange-traded derivatives trade life cycle

What? For buy-side participants and custodians, streamline the process of executing exchange-traded derivatives by creating a shared data platform for calculating broker fees and automating trade matching and enrichment

Who? Financial institution consortia and/or third-party technology providers, with network effects from integrating more counterparties

Why? Minimize trade breaks stemming from data discrepancies, enabling greater end-to-end automation

Platform for OTC derivatives post-trade life cycle

Overview

A number of market participants are focused on developing DLT-enabled tools to facilitate better and more efficient servicing of securitized products and underlying loans. While these approaches could create efficiencies across the value chain, the focus on a relatively narrow slice of services has the potential to enable faster development of a minimum-viable ecosystem of participants. These approaches vary somewhat, but the basic premise is for the party responsible for servicing the security and reporting to investors – generally the trustee of the special purpose vehicle that holds the underlying assets – to use DLT both to ensure greater transparency of performance and to automate elements of servicing.

Reimagining

Degree of change

Improving

Narrow focus   End-to-end

Scope of value change

Value chain components in scope

● In scope   ● Partially in scope   ● Not in scope

| Pre-trade | Trading | Clearing and position management | Settlement, payment and delivery |

Major changes from current state*

– Trades booked digitally to platform using standardized contract terms, verified by parties

– Platform serves as a single source of truth on derivatives positions, instead of separate data sources maintained by each party (with verification via email/phone)

– Daily valuation calculations and event processing conducted automatically based on shared position data and shared reference data, thereby minimizing the occurrence of discrepancies and reducing the need for reconciliation

Proposed benefits*

– Reduce the likelihood of errors and discrepancies in trade terms and valuation calculations, which likely also reduces the incidence of trade failures

– Potential to reduce complexity in operations and/or operational burdens associated with reconciliation activity, thereby reducing operational expenses and potentially transaction costs for all parties

– Greater transparency of derivatives positions for all parties, including transparency of calculation logic

Potential risks/challenges

– Given the reliance on manual reconciliation to identify errors, the magnitude of change management required may be substantial

– Parties will need new, robust mechanisms for verifying contract terms as trades are booked and smart contracts established

Platform for OTC derivatives post-trade life cycle

Potential path forward

Given the highly inefficient alternatives in several OTC derivatives classes, many experts expect specific markets to see a significant transition towards DLT-based platforms. However, others see greater standardization as an end in itself, where traditional technology solutions can be used to increase efficiency without significant transformation to the market. Since the CDM is technology-neutral, this debate is likely to persist. Key questions remain on whether (and how) DLT platforms will integrate with other systems and processes. For example, regulatory reporting is viewed as a potentially easy win for streamlining or automating. There is also the possibility of integrating with payment, collateral management and securities settlement systems in order to automate more of the value chain (including margin and collateral posting and settlement events).

Enabler
– The roll-out of the ISDA Common Domain Model – including smart contract-based derivatives contracts representations developed by Digital Asset and other technical standards developed with market participants and service providers – is likely to serve as a tailwind for digitalization in OTC derivatives markets (though the transition might be slower than expected)

– Adoption of DLT-based systems for collateral management and securities financing may encourage greater openness to DLT solutions for derivatives (assuming some degree of interoperability)

Impediments
– Lack of clarity on regulatory jurisdiction (due to uncertainty about data domiciling) may limit adoption

– Uncertainty about interoperability between DLT systems and between legacy and new systems may slow implementation

– A proliferation of derivatives-focused post-trade platforms might lead to slower uptake, as institutions need to adjust complex business processes across multiple derivatives classes and platforms

Example firms/projects

Axoni Equity Swap Platform[71]
Shared distributed platform for managing equity swaps, currently used by consortium of 15 major buy- and sell-side firms

Status: live in production

Fragmos Chain[72]
Shared platform for managing OTC derivatives post-trade processes

Status: in development

Replatforming existing infrastructure on DLT

Overview

At least one major infrastructure provider is currently migrating a component of central derivatives infrastructure to a DLT-based system (DTCC's Trade Information Warehouse, for credit default swaps). While markets for standardized derivatives with existing centralized record retention and asset servicing infrastructures (e.g. CDS) are generally more efficient than others, a distributed ledger system could enable parties to further streamline operations and reduce costs. In the case of DTCC's TIW, the centralized database on CDS contracts will transition to a distributed ledger system, with the possibility to manage life-cycle events automatically with smart contracts. In this case, DLT is one element of a broader upgrade to a more modern, cost-effective infrastructure.
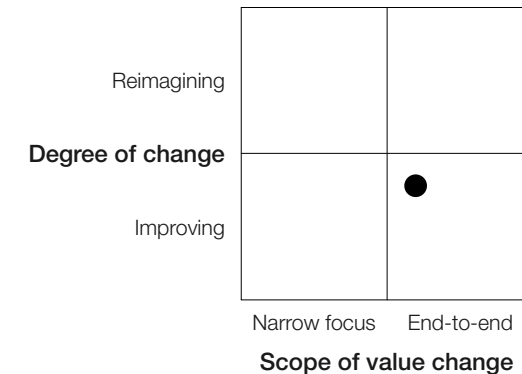
Reimagining

Degree of change

Improving

Narrow focus   End-to-end

Scope of value change

Value chain components in scope

● In scope   ● Partially in scope   ● Not in scope

| Pre-trade | Trading | Clearing and position management | Settlement, payment and delivery |

Major changes from current state*

– Establish a shared distributed ledger for derivatives contracts, ensuring all participants have an identical copy of relevant data on an ongoing basis

– Automate and share workflows across institutions using smart contracts, for life-cycle/credit events, ongoing clearing/netting, and payment calculations

Proposed benefits*

– Increase transparency for all participants, potentially facilitating better risk management

– Potential to eliminate operational burdens associated with reconciliation activity, or further reduce complexity in operations, thereby reducing operational expenses and potentially transaction costs for all parties

Potential risks/challenges

– Challenges associated with moving an entire market to a new infrastructure, where transition may be limited by specific institutions

– Challenges associated with integrating with other critical infrastructure/data systems

Example firms/projects

DTCC Trade Information Warehouse Replatforming[73] In partnership with R3, Axoni and IBM, DTCC is replacing the functionality of the TIW, the primary global infrastructure for CDS contracts, with a DLT database and smart contracts

Status: in production build, scheduled to go live 2022–2023

Platform for managing collateral for cleared derivatives

Overview

Several institutions are developing solutions that use DLT to enable real-time visibility of margin requirements and automation of the collateral workflow across central counterparties. While traditionally brokers and custodians need to manually coordinate across a range of different systems to facilitate margin payments – a costly and time-consuming set of processes – a DLT-based system can allow for faster, synchronized processing across institutions. These solutions are narrowly focused on solving the challenges of collateral and margining, but they could potentially integrate with other platforms to create a shared digital record of all aspects of a derivative transaction post-trade.
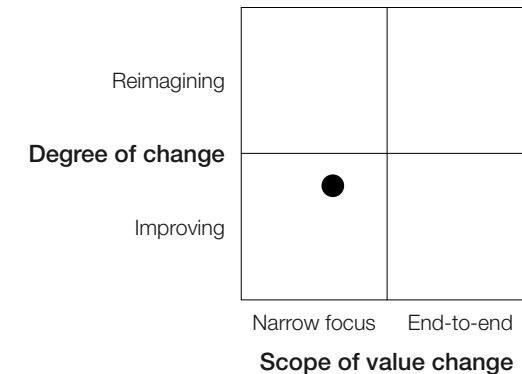
Reimagining

Degree of change

Improving

Narrow focus   End-to-end

Scope of value change

Value chain components in scope

● In scope   ● Partially in scope   ● Not in scope

| Pre-trade | Trading | Clearing and position management | Settlement, payment and delivery |

Major changes from current state*
– Centralize institution's visibility of collateral/margin obligations across derivatives clearing houses

– Further automate margining and collateral workflows using smart contracts

– Integrate collateral/payment instructions for derivatives central counterparties directly into collateral and treasury optimization systems

Proposed benefits*
– Potential for significant operational efficiencies stemming from end-to-end automation of collateral workflows

– Better optimization of collateral and cash balances through faster payments and capital deployment, potentially reducing the need to prefund margins

– Reduce risks and costs associated with manual processing

Potential risks/challenges
– While individual institutions can implement it (without the entire market), efficiencies are tied to being able to integrate as many central counterparties as possible onto the platform

– Speed of payments and collateral transfers is still limited by existing rails even if data is visible and instructions sent in real-time

Example firms/projects

Baton Systems, in partnership with JPMorgan, Citi, SGX and other institutions[74]
Platform focused on automating margin and collateral workflows with derivatives clearing houses (using integrations into existing treasury systems)

Status: live in production (JPMorgan); in production build (Citi, SGX)

Bolsa de Valores de Colombia, in partnership with Contrato Marco[75]
Platform focused on automating margin and collateral workflows for OTC derivatives

Status: in development

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* May differ by exact model.

Platform for exchange-traded derivatives trade life cycle

OTC post-trade / Replatforming / Collateral management / **Trade life cycle**

Overview

Despite operational advantages compared to OTC derivatives, buy-side participants and custodians still face challenges associated with processing and executing exchange-traded derivatives. At least one financial technology company is developing a solution focused on avoiding trade breaks – which require manual reconciliation and investigation – by creating a shared data platform so that trading fees can be calculated in real time across participants, trade matching and enrichment can be automated in real time and participants can share a distributed ledger for trade capture. While such a platform would benefit from network effects, it does not require the entire market to move (e.g. one asset manager and a custodian could use the platform to realize the proposed benefits).

Reimagining

Degree of change

Improving

Narrow focus   End-to-end

Scope of value change

Value chain components in scope

● In scope   ● Partially in scope   ● Not in scope

| Pre-trade | Trading | Clearing and position management | Settlement, payment and delivery |

Major changes from current state*
– Trade capture occurs on a shared ledger, minimizing the need to match trades across disparate systems

– Broker trading fees are calculated on the platform using shared data in real time

– Trade matching and enrichment on same day (or in real time), with concurrent processing by all parties

Proposed benefits*
– Potential to significantly reduce the incidence of trade breaks, thereby reducing the cost of investigating and reconciling fails

– Increase transparency for counterparties and intermediaries in trades

– Potential to reduce risk via same-day trade matching, enrichment and clearing

Potential risks/challenges
– While there are clear benefits to a single source of truth on trade life-cycle data, it will be necessary to effectively integrate with post-trade systems (DLT-based or traditional)

Example firms/projects

STACS Mercury Platform
Platform for real-time management of exchange-traded derivatives, currently in use by BNP Paribas Security Services and Eastspring[76]

Status: live in production

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* May differ by exact model.

Securities financing: summary

Securities financing transactions – repurchase agreements and securities lending – have emerged as an area to which distributed ledger technology may be particularly well suited. These transactions are often operationally complex, generally involving an exchange of collateral, cash and some margin. They also tend to be conducted in a relatively narrow time frame and to be relatively low-margin lines of business. As such, there is an interest in solutions that:

– Ease the operational burden associated with conducting transactions

– Reduce the time required for settlement, as well as the risk

– Allow for better collateral management and mobility

DLT and smart contracts use cases have been developed that use the features of the technology to achieve these ends, without requiring a complete end-to-end market transformation (e.g. issuance of digital securities). As such, many market participants see the digitalization of these collateral-based transactions as an enabler of broader market digitalization in future, as institutions realize benefits while developing comfort with the technology.

Overview of securities financing transactions

Repurchase agreements

Market overview

A repurchase agreement (or repo) is a form of short-term loan collateralized by securities (most commonly, US Treasury bonds). In a repo, securities are sold in exchange for cash, with an agreement to repurchase the securities at a later time. Most repos are short-term, with the majority being overnight transactions.[77] The average daily volume outstanding for US repos is more than $4 trillion, making the transactions central to many institutions' short-term funding.[78]

Key characteristics
The repo market is generally split into bilateral and tri-party repo. In bilateral repos, broker-dealers directly exchange cash and securities with counterparties (e.g. asset managers, hedge funds or financial institutions). Bilateral repos can be centrally cleared or uncleared. In tri-party repos, a clearing bank or other clearing house serves as an intermediary between the two parties, handling the collateral selection and valuation, margining and processing. While repo deal flow primarily takes place telephonically, there is growing adoption of electronic solutions.[79]

Existing pain points
– Institutions lack centralized visibility of their available collateral, which may lead to suboptimal allocation

– Generally inflexible in terms of settlement times, and the timing and frequency of netting

– Fragmented, manual and inefficient workflows between institutions to facilitate the exchange of collateral

– Lack of transparency between institutions increases collateral requirements, fees and late delivery charges

Securities lending

Market overview

Securities lending involves the owner of specific securities lending them to another party in exchange for a fee, with the loan generally being collateralized by other securities or by cash. As of January 2021, the aggregate volume of securities on loan globally was estimated at €2.4 trillion, with €24.2 trillion of lendable assets available through securities lending programmes.[80] Generally speaking, securities lending allows asset owners to earn additional return on assets held long-term, while enabling a range of institutions to meet specific needs.

Key characteristics
Securities lending is generally facilitated by third-party securities lending agents, primarily custodian banks but including a range of other institutions.[81] These institutions provide services to asset owners looking to lend their securities. On the borrowing side, broker-dealers generally intermediate on behalf of clients.

Existing pain points
– Rigid restrictions on available windows for transferring assets, often complicated by time-zone differences, with added difficulties for transferring assets between CSDs in different jurisdictions

– Limited visibility of use of lent assets (limited understanding of collateral reinvestment risk)

– Fragmented, manual and inefficient workflows between institutions to facilitate the exchange of collateral

Summary of emerging securities financing use cases

1

DLT platform for repurchase agreements

What? Platform for tokenizing and immobilizing collateral to be used in repo transactions, executed via smart contracts

Who? Led by technology providers or banks, serving all repo participants (e.g. broker-dealers, banks, tri-party agents)

Why? Enable repos with shorter duration (e.g. intraday vs. overnight terms), eliminate failed transactions, reduce need for manual processing and reconciliation and ensure greater transparency of life cycle

2

Tokenizing loans for servicing and data management

What? Platform for swapping baskets of securities across depositories and/or jurisdictions, without requiring actual transfer of securities

Who? Led by technology provider, custodians and/or depositories, with need for a network of custodians, depositories and banks

Why? Enable better optimization of collateral holdings, because securities can be exchanged in real time, at any time of day, at low cost and without additional operational complexity

3

Replatforming securities lending infrastructure

What? Replace infrastructure for securities lending with distributed ledger network, creating a single source of truth for participants

Who? Can be led by existing central infrastructure providers (e.g. central counterparties) or other parties

Why? Reduce the need for reconciliation of transaction data, thereby creating operational efficiencies and reduction in risk

DLT platform for repurchase agreements

Overview

Despite operational advantages compared to OTC derivatives, buy-side participants and custodians still face challenges associated with processing and executing exchange-traded derivatives. At least one financial technology company is developing a solution focused on avoiding trade breaks – which require manual reconciliation and investigation – by creating a shared data platform so that trading fees can be calculated in real time across participants, trade matching and enrichment can be automated in real time and

participants can share a distributed ledger for trade capture. While such a platform would benefit from network effects, it does not require the entire market to move (e.g. one asset manager and a custodian could use the platform to realize the proposed benefits).

Reimagining

Degree of change ●

Improving

Narrow focus   End-to-end

Scope of value change

Major changes from current state*

– Collateral (eligible securities) are onboarded to the platform; digital representations of collateral are created

– By securely immobilizing the collateral at the custodian using smart contracts, the need to actually transfer collateral between parties is eliminated

– Establish a single source of truth on eligible or available collateral within an institution

– Establish a single source of truth on status of repo transactions throughout the life cycle

– Mutualize workflows across institutions; automate processes through smart contracts

If digital cash is used, payment leg is completed atomically and instantaneously

Proposed benefits*

– Eliminate the need for reconciliation between institutions

– Reduce operational burden/costs by automating the full repo life cycle

– Reduce (or eliminate) the potential for disputes and/or failed transactions

– Better optimize collateral allocation due to immobilization and transparency

– Potentially improve overall market liquidity and lower the cost of secured financing

Introduce the ability to complete repos intraday, creating a new intraday secured financing option

Potential risks/challenges

If parallel systems/platforms are employed as a DLT platform is implemented, there is the potential for added operational complexity for some institutions, introducing a new source of operational risk

DLT platform for repurchase agreements

Potential path forward

The core questions for DLT-based repo platforms are about how they will interact with a broader shift in market infrastructure towards digital securities and cash. Would wide uptake of a DLT-based repo platform hasten the move towards a future in which a broader range of asset classes are native digital assets on distributed ledgers? Would usage of these systems in turn build comfort with the technological, legal and regulatory certainty relating to how DLT-based transactions and contracts work and expectations about flexible and lower-risk settlement? Or would the broad use of such a platform deliver enough operational improvements that core market infrastructures no longer feel overly pressured to innovate?

Enablers
–   Repo markets are fairly concentrated, so a limited
    number of participants are needed for a minimum-
    viable ecosystem

–   Intra-company repos are used widely to allocate
    collateral and liquidity across internal legal entities,
    which could represent a "testing ground" for bilateral
    and tri-party repos for some institutions

Impediments
–   "Chicken and egg" problem: liquidity begets liquidity,
    so it is essential that early uptake of a new platform/
    product is strong

PROJECT SPOTLIGHT

Broadridge: DLT Repo
Broadridge has worked with Digital Asset to develop a DLT-based repo platform for clients (broker-dealers and sell-side firms). The platform has been built to accommodate both intra-company repo and bilateral repos, with the idea of firms building comfort with the system while building a network for bilateral repos among existing repo clients. The platform does not use digital cash for the cash legs of the repos, instead integrating with existing payment systems (with the possibility to use on-chain cash in the future). Given the operational efficiencies, better liquidity and collateral management and reductions in risk, Broadridge estimates all parties will realize cost savings almost immediately, while requiring minimal changes to implement. Following pilots with clients, the platform is expected to launch in 2021.[82]

PROJECT SPOTLIGHT

JPMorgan Chase Onyx: Intraday Repo
JPMorgan Chase has developed an intraday repo offering, as the first application of its Onyx digital assets platform. By using digital cash built into the Onyx platform, both legs of the repo can be settled instantaneously, thereby making it possible to conduct repos intraday. JPMC serves as the "collateral token agent", responsible for creating, immobilizing and transferring the tokenized ownership interest of securities still held at the tri-party agent or custodian. Intraday repo opens up a secured intraday funding source that did not previously exist. Following internal pilots and tests with Goldman Sachs and BNY Mellon (as a tri-party agent), the platform is expected to launch in 2021.[83]

DLT platform for securities swaps across collateral pools

Overview

Despite operational advantages compared to OTC derivatives, buy-side participants and custodians still face challenges associated with processing and executing exchange-traded derivatives. At least one financial technology company is developing a solution focused on avoiding trade breaks – which require manual reconciliation and investigation – by creating a shared data platform so that trading fees can be calculated in real time across participants, trade matching and enrichment can be automated in real time and participants can share a distributed ledger for trade capture. While such a platform would benefit from network effects, it does not require the entire market to move (e.g. one asset manager and a custodian could use the platform to realize the proposed benefits).

Reimagining

Degree of change

Improving

Narrow focus   End-to-end

Scope of value change

Major changes from current state*
– Custodians create digital representations of securities, with baskets "held" by a trusted third party and a distributed collateral registry accessible across participants (with data controls)

– Collateral baskets to be used in swaps are created and immobilized, with swaps occurring at a specified day/time on ledger (while underlying collateral stays with custodians)

Proposed benefits*
– Enable firms to better optimize securities holdings at precise points in time, minimizing the balance sheet cost of satisfying regulatory ratios

– Reduce intraday credit exposures and/or intraday capital requirement for traditional collateral transfers

– Ensure better operational controls and transparency

– Reduce (or eliminate) the potential for fails

– Potentially finance more illiquid assets

Potential risks/challenges
Will be essential to ensure that all parties – custodians/tri-party agents and underlying asset owners – adapt to the platform as a single source of truth on collateral ownership

If platform is used for narrow/single use within institution, could introduce additional complexity in institution-wide collateral management

PROJECT SPOTLIGHT

HQLA^X
HQLAX is a technology provider that has developed a securities lending platform to enable institutions to seamlessly swap the high-quality liquid assets needed to meet the liquidity coverage ratio, enabling institutions to better optimize their holdings. The platform has onboarded most major European custodians/tri-party agents, including Euroclear, JPMorgan, BNY Mellon, Citi, Clearstream and BNP Paribas. Several banks have conducted tests or live swaps using HQLAX, including ING, UBS, Credit Suisse and Goldman Sachs.[84]

* May differ by exact model.

Replatforming securities lending infrastructure with DLT

Overview

Some infrastructure providers are developing DLT-based solutions to digitize operations for traditional securities lending contracts. In one case, a derivatives clearing house, which serves as a central counterparty in securities lending transactions (e.g. loans of stocks), is replacing the underlying infrastructure for settling cleared securities lending transactions with a permissioned distributed ledger network. This network will be governed – and initially operated – by the clearing house. In another approach, a stock exchange is developing a central securities lending platform where one did not exist previously. These DLT-based infrastructures will allow all clearing participants to have a single source of truth with real-time visibility of securities lending contracts, reducing the need for manual reconciliation and enabling broader improvements to operations.

Degree of change — Reimagining / Improving

Scope of value change — Narrow focus / End-to-end
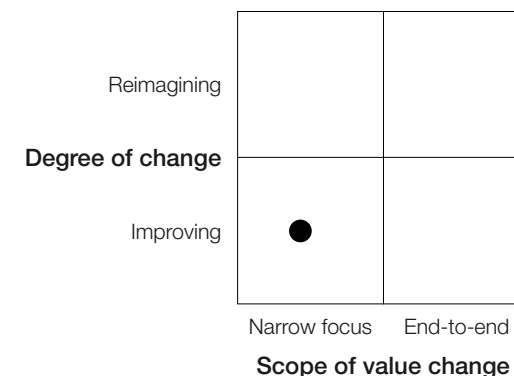
Major changes from current state*

– Underlying infrastructure for settling cleared securities lending will be transitioned to DLT (or a new securities lending platform established)

– Participants who run a network node will have access to a single source of truth on stock loans

Proposed benefits*

– Greater transparency of transactions in real time

– Potential to reduce complexity in operations and/or operational burdens associated with reconciliation activity, thereby reducing transaction costs for all parties

– Potential for interoperability with other derivatives or securities infrastructure/systems

Potential risks/challenges

There may be challenges with ensuring clearing participants provide real-time accurate information on securities available for loans, given other markets will still be running on traditional infrastructure and processes

Example firms/projects

OCC Stock Loan Program	Status: in production build
Tel Aviv Stock Exchange Blockchain Securities Lending Platform[85]	Status: in production build
JPX Stock Lending and Collateral Management Platform[86]	Status: ongoing pilot

PROJECT SPOTLIGHT

Options Clearing Corporation (OCC)

OCC's Stock Loan Program allows its clearing members to borrow/lend equities (which are ultimately transferred through the DTC) in which it serves as the central counterparty. In 2020 it enlisted Axoni to develop a distributed ledger network for cleared stock loan transactions, through which clearing members could access a real-time single source of truth on securities lending activities and contracts. Following a proof of concept in 2019 that included JP Morgan, Bank of America, BlackRock and others, the platform is expected to go live in 2022.[87]

Asset management: summary

Asset management is central to the capital markets ecosystem, representing a large share of investment dollars globally. In addition to being very actively involved in the broader markets that may be transformed by DLT and other technologies, asset managers themselves – and their service providers – face inefficiencies and other challenges for which distributed ledgers and smart contracts may offer solutions. While they vary greatly, some are focused on:

– Streamlining the client onboarding and fund share issuance process

– Improving data sharing across specific ecosystem participants

– End-to-end transformation of "back office" asset management operations

While asset managers have also increasingly offered cryptocurrency-based products, this section focuses on solutions aimed at improving operations and client services across traditional fund products.

Over time, as additional financial assets are tokenized or issued digitally, the asset management industry may transform further. Potential innovations could include tokenized fund shares tied directly to underlying asset pools via smart contracts and replacement of traditional fund structures with fully customizable portfolios.

Overview of asset management landscape

Market overview

Asset managers invest funds on behalf of retail and institutional clients, offering a range of fund products geared at different client segments. Funds may be defined by the asset classes or subclasses they invest in, by the investment strategies they employ and/or by the investor base able to participate in them. At the end of 2019, assets under management by asset managers totalled $89 trillion globally, with significant growth over the preceding decade. Given the scale of assets invested by asset managers, they are core to the capital markets. Despite strong growth, the asset management industry faces a set of structural challenges brought on by fee compression and mounting cost pressures.[88]

Key characteristics

The asset management industry is diverse, with significant variation in the size of firms and their product offerings. Generally speaking, investors buy shares in one or several funds, either directly or through intermediaries. Funds invest in public or private markets, relying on broker-dealers and market makers as trading counterparties. Custodian banks clear and settle transactions on behalf of asset managers, and hold these assets in custody, while also providing value-add services on top (e.g. securities lending and cash management).

The asset management landscape is complex, with significant differences across regions. At a high level, the ecosystem supports investors' purchasing and selling of fund shares, and asset managers' investments in financial markets, with a range of parties providing services:

DLT in the asset management value chain and ecosystem

	Fund distribution	Investment management	
Front office	**Marketing, sales, client service** **Key activities:** Marketing, client acquisition, platforms for fund share investment/trading, customer insights/guidance, customer analytics	**Portfolio management and trading** **Key activities:** Portfolio modelling/optimization, scenario analyses, portfolio stress testing, market research, order creation and management, trade execution	
Middle office	**Client onboarding and reporting** **Key activities:** Profiling and onboarding (risk profiling, KYC/AML), portfolio monitoring and reporting	**Risk, compliance and support reporting** **Key activities:** Risk management and analytics (fund compliance monitoring, portfolio simulations), data collection and aggregation, legal admin duties	**Across the ecosystem, inefficiencies today include:** Distribution and client onboarding inefficiencies (e.g. slow, manual and duplicative KYC processes; paper-based processes for fund subscriptions etc.) Extended clearing and settlement cycles for fund shares Separate data siloes maintained by asset managers, custodians and other parties in the ecosystem, leading to limited transparency and the need to reconcile trades and other activities Manual, error-prone compliance and regulatory reporting
Back office	**Fund share clearing and settlement** **Key activities:** Fund share order routing, creation/redemption, clearing/settlement, reconciliation	**Custodian services** **Key activities:** Trade reception, transfer of ownership, asset custody, servicing and accounting, reporting and account management (corporate action management, proxy services)	
	Fund administration **Key activities:** Fund set-up/administration, accounting and NAV calculations, client reporting, transfer agency		

Summary of emerging DLT use cases in asset management

Given the central role of asset managers in allocating capital globally, asset management firms and the ecosystems that service them are likely to be affected by any major digitization of specific markets or asset classes. Faster or more flexible trade settlement, shared sources of truth on securities or derivatives transactions and operational simplification – these changes and others would all have implications for fund managers, custodians and fund administrators. For example, a shared, real-time source of data on all underlying portfolio holdings could greatly simplify the

processes associated with fund accounting and net asset value calculations. Moreover, new digital-native asset classes or products are likely to offer new product opportunities to asset managers and their service providers.

Beyond use cases predicated on broader market digitization, a range of institutions are developing solutions designed to address the challenges, inefficiencies and risks unique to asset and fund management. These use cases include:

Use case	Summary*	Potential benefits and challenges	Example firms
DLT-based fund distribution and register platform	DLT-based distribution platforms focused on streamlining the operations associated with fund distribution, linking together the various institutions involved via a single source of truth – e.g. automating fund register management and fund transaction processing, improving client onboarding (including sharing of KYC/AML verifications across network participants) and enabling secure data sharing for other elements of processing	**Benefits** – Reduce inefficient, manual and/or redundant processes, potentially reducing costs for end investors – Speed up access to fund investment for end investors – Potential for enhanced liquidity in secondary markets **Challenges** – May be challenging to onboard a minimum-viable set of participants, particularly with multiple networks	**FundsDLT:**[89] a Luxembourg-based start-up, owned by Clearstream, Credit Suisse, LSE and Natixis, has created a DLT platform for improving efficiency across fund transaction processing. Status: live **Allfunds Blockchain:**[90] partnered with ConsenSys to create a DLT platform that aims to streamline communication in the fund distribution value chain. Status: in development **Calastone Distributed Market Infrastructure:**4[91] platform aiming to streamline and connect participants and elements of the fund transaction process via DLT. Status: live **IZNES:**[92] platform for subscriptions and redemptions of European funds, compatible with different distribution channels, focuses on transaction processing at the fund-unit level. Status: live

Summary of emerging DLT use cases in asset management

Use case	Summary*	Potential benefits and challenges	Example firms
Investor-facing end-to-end platform for tokenized funds	Consumer/investor-facing, end-to-end platform for tokenized funds. Includes tools for fund origination, client onboarding, fund distribution (including back-end processes), fund trading and some elements of fund administration	**Benefits** – Potential for a wider investor base for some funds, increasing access and fund liquidity – Streamline operations for funds, particularly valuable for small or private funds with less complex operations, potentially lowering costs **Challenges** – A new distribution model may require significant client education (not specific to DLT-based platforms) – May be challenging to onboard larger funds reliant on a broader set of ecosystem partners	**Figure Digital Fund Services:**[93] Figure Technologies, a US-based financial technology company, has used the Provenance blockchain to offer an end-to-end blockchain solution for digital fundraising and ongoing fund management. Status: live
End-to-end fund distribution, administration and servicing network	DLT-based solution to enable fund creation, fund administration and fund servicing, connecting all relevant parties through a shared source of truth. The goal is to streamline all processes associated with managing fund operations by mutualizing workflows across relevant parties via smart contracts, based on a shared source of truth for participants across the fund life cycle	**Benefits** – Potentially reduce inefficient or redundant processes and reconciliation, possibly reducing costs for end investors – Immediate settlement on net asset value availability – Improved compliance and regulatory reporting – Increased transparency for asset managers and investors **Challenges** – May be challenging to onboard a minimum-viable set of participants given the breadth of activities covered – Data needs to be standardized across a wide ecosystem	**FundAdminChain:**[94] A UK-based start-up, founded by buy-side and DLT experts, in collaboration with R3, is building a DLT-platform to integrate the various fund management servicing functions on one platform. Status: in development

Enablement use cases: summary

While many institutions are focused on directly transforming specific securities and derivatives markets, others are developing technology solutions or infrastructure to support digitization across the capital markets. Still others are developing technology solutions in adjacent areas in the financial services ecosystem. Collectively, these use cases may be enablers of transformation in the capital markets. These include:

– Products developed in areas adjacent to the capital markets, but upon which many capital markets operations rely (e.g. wholesale payments)

– Solutions that equip institutions to adapt to a distributed ledger technology environment (e.g. institutional custody for digital assets)

– Tools that allow institutions to take full advantage of the potential benefits of this technology (e.g. digital identity and document sharing)

These use cases do not fit neatly into asset class buckets, and in many cases are essential elements of solutions explored elsewhere in the report.

Wholesale payments: facilitating capital markets digitalization

Since most capital markets transactions involve a cash component, almost all capital markets processes and systems have some form of integration with wholesale payments systems. With one of the promises of DLT being the ability to settle securities trades and other transactions atomically – instantaneous delivery vs. payment (DvP) – integrations with DLT-based payment systems, or other real-time cash settlement systems, will be essential to realizing this benefit.

To date, institutions across the public and private sectors have explored payments solutions that could integrate with securities settlement systems and other market infrastructure, with experiments and live transactions proving a range of models as viable. While this report does not go into great detail on these developments, they tend to fall into one of several categories:

Wholesale stablecoins
Developed by individual firms or consortia, these instruments are a digital token entirely backed by cash reserves. While a number of stablecoins now exist in different currencies, at least two are designed specifically for high-value wholesale transfers between financial institutions, including for the purpose of securities settlement:

– JPM Coin: enables instantaneous payments between JPMorgan clients on a DLT network, with integrations with other JPM DLT products/services[95]

– Fnality: consortium of 15 financial institutions building a network of local currency DLT-based payment systems backed by central bank reserves[96]

Integrations with existing systems
Public- and private-sector participants have built mechanisms for integrating DLT or token-based securities with traditional account-based wholesale payment systems. These include tools for sending payment messages from DLT-based platforms and direct integrations with payments systems:

– SWIFT Global Payments Innovation (gpi): platform that will enable DLT-based platforms to initiate payments on traditional payments systems[97]

– Direct interface with central bank systems: some central banks are developing ways to allow DLT-based systems to interface with core payments systems. For example, one of the features of the Bank of England's new real-time gross settlement (RTGS) system will be some level of interoperability with DLT-based systems.[98] Project Helvetia, between the Swiss National Bank, BIS and SIX, proved the feasibility of linking DLT platforms to the existing payment system for settlement[99]

Wholesale central bank digital currencies (CBDCs)
Several central banks are experimenting with both retail and wholesale CBDCs, with a number of retail CBDCs currently in production globally. Among the central banks exploring wholesale CBDCs for use in securities settlement are the Banque de France, the Hong Kong Monetary Authority, the Monetary Authority of Singapore, the Swiss National Bank and the Bank of Thailand. While experiments have proven that it is possible to settle DLT-based securities trades in central bank money using existing payments systems, many believe that wholesale CBDCs will provide market participants with greater comfort in the underlying technology, and therefore serve as a critical enabler for wider adoption and scalability.

Custody services for digital assets

Given the fundamental differences between digital assets and traditional assets, the concept of "custody" may, in some ways, be redefined. While one of the early claims about a DLT-based capital markets ecosystem was that service providers such as custodians would be disintermediated, the growing institutional investor interest in bitcoin and other cryptocurrencies has made it clear that not only do asset managers and investors rely on custodians to meet regulatory requirements and manage risk, but they will also continue to expect a range of value-add services on top of the standard custody role. The main question now revolves around what custody will look like, from both an operational and a technical perspective.

Since digital assets are essentially digital bearer instruments – meaning that ownership of the cryptographic key is considered ownership of the asset – the way a custodian handles digital assets will differ from how traditional assets are custodied. From the physical systems that must be built to safeguard assets (e.g. "cold", offline storage of keys) to the digital integrations that ensure that custodians and their clients actually benefit from the unique single source of truth offered by DLT, financial institutions are developing custody solutions that build on their relationships of trust with clients.

PROJECT SPOTLIGHT

BNY Mellon: digital assets platform
In February 2021, BNY Mellon – the world's largest asset servicer – announced the development of a client-facing digital custody and administration platform for both traditional and digital assets. The platform will allow clients to safeguard, transfer and manage the life cycle of their digital and traditional assets on one consolidated platform, building upon BNY Mellon's existing frameworks for cybersecurity, regulatory compliance and broader risk management. The platform will have value-add services built in, including securities lending, collateral management, cash management and risk management tools. It will be designed to integrate with a range of solutions built by external technology partners, and over time BNY Mellon aims to expand the capabilities offered.[100]

PROJECT SPOTLIGHT

Pyctor: distributed custody
Developed by ING Bank in collaboration with several industry partners, Pyctor is an institutional-grade custody and asset transfer infrastructure for digital assets, including assets issued on the major public and private distributed ledgers. Designed for use primarily by custodians, the platform is built with regulatory compliance and a robust legal framework at its core. The platform is built as a private, distributed ledger, with validating nodes hosted by participating institutions, thus offering a decentralized approach to digital asset custody. The focus is currently on managing institutional digital asset wallets for custodians, as well as managing smart contracts on behalf of securities issuers.[101]

Conclusion

DLT presents both an opportunity and a threat to traditional capital markets institutions

DLT is not a panacea for the capital markets, but harnessing its unique capabilities could address major inefficiencies and challenges.

While there are many considerations in assessing whether DLT is the best available technology for particular use cases,1 there are certain circumstances in which DLT may offer uniquely powerful benefits:

– **Substantial redundancy in low-value-add tasks:** DLT may offer particularly valuable benefits in markets or transactions where the lack of a shared source of truth requires multiple institutions to devote resources to tasks associated with data verification. For example, in securitized product markets, all actors in the value chain must independently verify and audit the loans underlying a security; a shared source of truth eliminates the need for additional complete audits throughout the life cycle.

– **Unnecessary complexity and counterparty risk:** Some intermediaries play an essential role in guaranteeing trust in capital markets, but in some cases, existing market structures require multiple firms to take on significant counterparty credit risk in the intermediation chain. In many use cases, DLT

and smart contracts enable the exchange of assets without the need for additional complexity, thereby limiting risk and cost for all parties.

A few conditions have emerged as critical enablers for successful DLT use cases:

– **Possibility for standardization:** DLT use cases are most valuable when enabling shared sources of truth across ecosystems, so it is no surprise that market-wide standardization of contracts and data fields is an important enabler for DLT adoption. Even in asset classes or transaction types where common standards have not been accepted across the market, the possibility of introducing broad standards is a necessary condition for most use cases.

– **Minimum-viable ecosystem:** In order to get off the ground, any use case needs a set of relevant participants on board from inception. For many use cases, the need to reach agreement across a larger number of actors has limited the ability to test solutions and bring them to market. Increasingly, firms are shifting from market-wide, consortium-led models to approaches with a smaller set of participants committed to testing and eventually adopting the solution if economically and technically worthwhile.

Capital markets firms must continue to hone their strategies around this technology

Across the capital markets, executives need a deeper understanding of: 1) how DLT can be used; 2) how different applications of DLT led by different parties may ultimately affect aspects of their business or operations; and 3) what role their firms should play in building, supporting or challenging DLT-based solutions. While different institutions will face different challenges, a general framework for this strategy should include:

Defensive positioning
Firms must understand where they currently stand in the value chain for different markets, whether and how those positions may be threatened by DLT-based solutions and whether they wish to maintain those positions. While the approach will vary depending on the type of market and institution, firms should explore whether to join existing initiatives, partner with other financial firms to develop solutions or build solutions on their own.

Offensive positioning
Firms should explore where significant inefficiencies exist that could be addressed by DLT-based solutions or where new products may be enabled by features of this technology. After assessing whether there is white space or opportunity in the current competitive landscape, they can explore paths to developing solutions independently or collaboratively with relevant firms.

DLT is beginning to address real challenges, but there is no agreed-upon path for market-wide adoption

DLT is moving from experimentation to commercialization across asset classes, value chains and jurisdictions…

In a range of proofs of concept and live experiments, DLT has proven capable of addressing core inefficiencies in the capital markets, including both operational inefficiencies and balance sheet management limitations.

While this technology offers a consistent set of benefits, firms are building solutions that take very different approaches to solving market challenges: some are end-to-end solutions reinventing the entire value chain, while others aim to improve existing processes.

Reflecting growing comfort with some jurisdictions' frameworks for regulation and the legal certainty of smart contracts, firms have started to bring DLT use cases to market.

…but market participants are still far from adopting this technology at scale

Shifting value pools
DLT solutions offer opportunities for automation and the potential to shift roles in the capital markets ecosystem, which will likely lead to value migrating among participants and service providers, across the buy-side and sell-side and between incumbent players and new entrants. This has led to both general uncertainty about the technology for many incumbents, and a complex patchwork of initiatives reflecting very different end-state visions.

Network effects
Most DLT use cases attempt to establish ecosystems that enable participants to realize the benefits of shared data; as such, network effects are significant. Without a coordinated approach among market participants – either to use a particular platform, or to enable interoperability between platforms – individual platforms may struggle with attracting both securities issuers and investors.

Parallel infrastructures
In some cases, a DLT-based solution may introduce new costs and risks, given the need to run parallel operations to support multiple infrastructures. Without clear roadmaps to harmonizing operations – or solutions that allow relevant parties to bridge new and old systems operationally – many firms may be less willing to adopt DLT solutions at scale in existing asset markets, preferring instead to focus on those without legacy infrastructures.

> **The coming years are likely to see increasing digitization of markets, including more DLT use cases going live. Nevertheless, there is still little market-wide agreement on how DLT will ultimately be used and whether it will fundamentally reshape all elements of the capital markets.**

Fundamentally transforming markets will require new ways of thinking and working across the industry

Today's capital markets are rife with industry-wide inefficiencies and limitations. In the long term, DLT-enabled solutions may or may not be at the core of addressing these challenges. However, the emergence of these solutions – and the competitive pressures from new entrants and migration of value pools – presents an opportunity to fundamentally reimagine how the capital markets operate, perhaps a once-in-a-generation opening. Making progress on these challenges will require action, collaboration and innovative thinking from many parties, regardless of which technologies are ultimately used.

Standardization

Global industry associations and standard-setting bodies must continue to develop common market-wide data standards, model contracts and other taxonomies, in partnership with representative industry actors and technology service providers. Industry-wide efforts to introduce and adopt standards and replicable models will help reduce inefficiencies and help ensure that firms and markets will be able to make the best technology choices available. Adoption of standards is likely to continue as an enabler for DLT and smart-contract-based solutions, but broader use of standards in more asset classes and transaction types is also likely to have significant efficiency benefits regardless of what technologies are used.

Breaking down siloes

Innovative capital markets firms must work outside of traditional organizational siloes to ensure that they are able to deliver the kinds of technology-enabled products and services that deliver real value to clients. Front office vs. back office, technology vs. business, fundamentally different systems for different asset classes: these siloes have developed in line with economic realities, regulation and technical limitations, but they likely limit firms' ability to explore truly transformational opportunities. At an industry level, they contribute to the challenges of coordinating around a common vision.

Regulatory engagement

Many regulators have shown an openness to digital experimentation in the capital markets. Regulators should continue to fine-tune approaches that encourage innovation while mitigating risks to markets and investors – including setting guardrails that help the industry consolidate on future visions – and they should attempt to mitigate the risk of global fragmentation by working together at a global level. As new solutions with very different risk profiles are developed, regulators must be open to rethinking traditional frameworks aimed at regulating both institutions and activities. As new regulatory standards are developed, firms must be proactive and transparent in engaging regulators early in transformation efforts.

Open questions and future research agenda

There are many open questions as firms continue to navigate the uncertain future of capital markets technology

Investor demand

– Will institutional and retail investor interest in cryptocurrencies translate into demand for digital-native securities? Will growth in DeFi applications spill into the mainstream capital markets?

– Will investors expect a fundamentally different experience with digital securities (vis-à-vis traditional securities markets)?

– How will banks and other intermediaries ensure that this demand reaches issuers?

Global divergences

– Will jurisdictions with less developed and complex markets continue to be early adopters of DLT-based solutions?

– How will firms with global operations apply lessons learned in different markets?

Regulatory questions

– How will DLT-based technology solutions interact with data privacy and localization policies? How can solutions be built to ensure data privacy considerations are maintained without limiting the global reach essential to today's capital markets?

– How can regulators work together to ensure that fragmentation in approaches to DLT regulation does not limit innovation or the development of global markets?

Path forward

– How will firms effectively manage parallel operations for different infrastructures and begin sunsetting legacy systems?

– How will the potential emergence of DLT-based CBDCs and other payment systems shift how firms view DLT in the capital markets?

While this report focuses on developments in today's public capital markets, there are other areas where further ecosystem-wide exploration is needed

Private capital markets

While this paper touched on developments in private markets (e.g. developments in markets for private equity tokens), open questions remain around how these markets will adapt to DLT and other technologies. Looking ahead, as private markets continue to grow in importance, there are many questions about how DLT may contribute to a blurring of some lines between public and private markets.

Sustainable finance

Green bonds, carbon credit markets and other opportunities for linking sustainability-related data to financial instruments will all be increasingly important as the capital markets help finance the transition to net-zero economies. While there has been discussion about the potential use of DLT to facilitate these activities and products, this is an area ripe for further dialogue and analysis.

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