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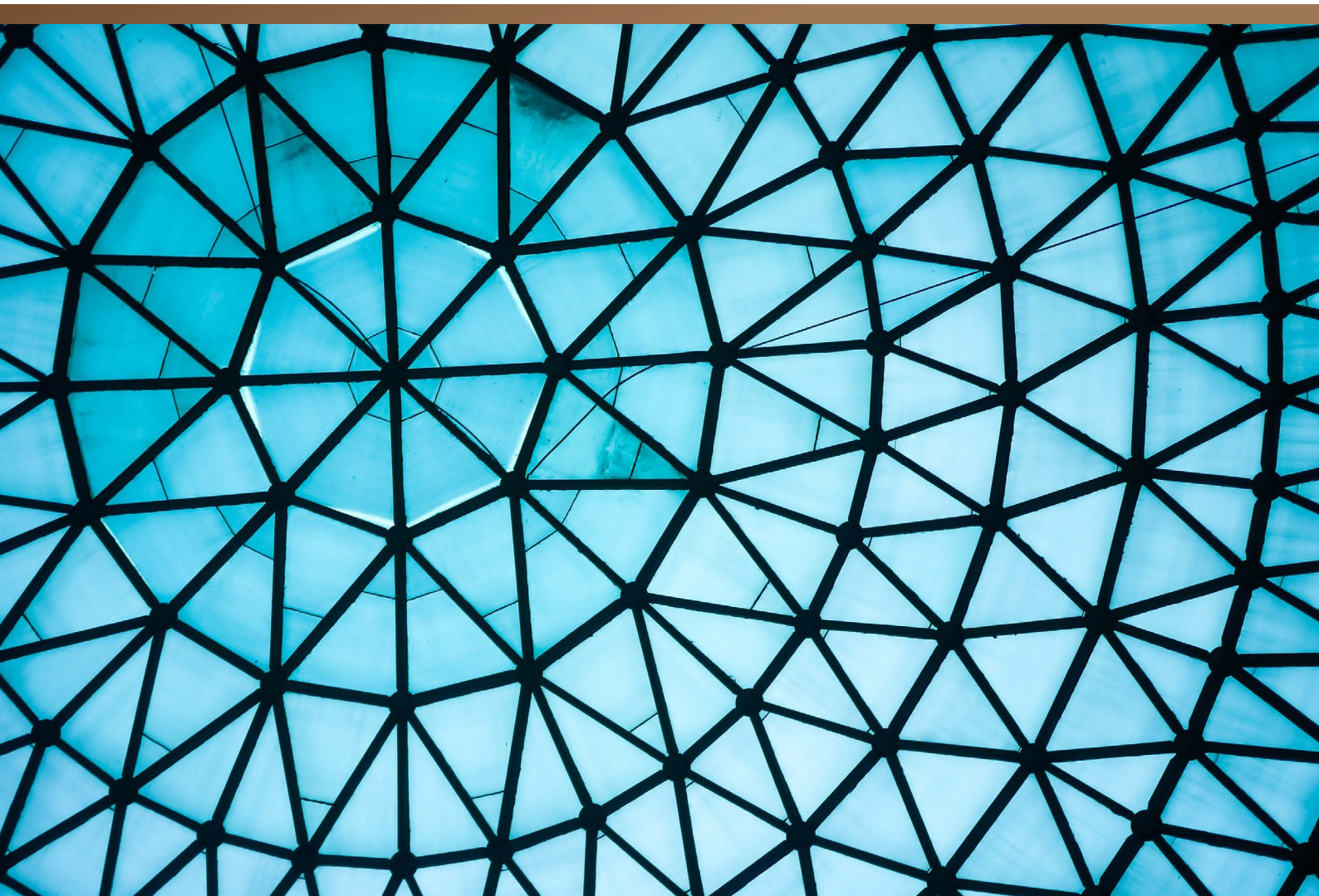
The Future of Distributed Ledger Technology in Capital Markets



"The genesis of blockchain can be traced back to David Chaum's dissertation in the 1980s or the Satoshi Nakomoto papers published in 2008. Either way, we have had many years of hype-cycle around blockchain and its capabilities. There have been plenty of false dawns, but hype is at last giving way to practical and pragmatic use cases.

The capabilities of the current generation of blockchain technologies, and the willingness of financial market participants to collaborate around common standards, is driving uptake and increasing interconnectivity between institutions. This is likely to lead to trusted networks that create unparalled levels of effectiveness and efficiency in capital markets."

Sukand Ramachandran, Managing Director and Senior Partner, Boston Consulting Group

"Since mid-14th century Italy, at the advent of modern banking we have used the terms 'nostro' and 'vostro' – 'mine' and 'yours' as a representation of ownership on each independent ledger... blockchain as a shared, distributed ledger means the market can move to 'ours'...This creates the opportunity for a fundamental change in how the infrastructure of markets work, driving efficiency and enabling further developments in how we manage risk and enable the flow of capital. Capital markets have always driven towards efficiency; the deployment of blockchain technology is just another step in the continuing evolution of the market. We believe that in the current phase of market evolution, blockchain technology is playing a growing role, and it will continue to, becoming a fundamental component of capital markets."

Scott Lucas, Head of Markets DLT, J.P. Morgan

Foreword

Distributed ledger technology (DLT) could reshape capital markets. From securities issuance, to settlement, trading, and servicing, DLT creates benefits that include faster processing, more transparency, lower costs, and reduced risks. DLT is also a catalyst for innovation—democratizing access to capital and helping issuers and other market participants unlock new opportunities. The net impact of these advancements is a step change in the way that markets could operate, and an opportunity to embrace new ways of working that will shape the evolution of capital markets for years to come.

Capital markets have historically been characterized by intermediation. At every stage of the securities lifecycle, banks, brokers, information providers, and other market participants play an important role. The result is a highly-complex environment, in which costs are often high. Against this backdrop, DLT remains a work in progress. However, recent years have seen an acceleration in adoption, with banks and other market participants graduating from experimentation to more practical, real-world initiatives. Indeed, in some activities, DLT is beginning to push the boundaries in efficiency and effectiveness.

DLT utilizes a shared database maintained by multiple participants across a decentralized network. The database provides a golden source of data and record keeping. An underlying principle of the technology is that it requires collaboration to make it work. Without a compatible approach to data, taxonomies, and processes, distributed ledgers will not function effectively. Based on this understanding, the recent period has seen increasing numbers of partnerships across capital markets. One example is the collaboration between Marketnode, a joint venture between Singapore Exchange and Temasek, and a consortia of banks to create DLT-based solutions. This represents a marked departure from the "entity-centric" innovation of the past.

Of course, there remain significant hurdles to adoption. These include regulatory uncertainties, the need for more standardized data and record keeping, and the implications of enhanced transparency on distribution and liquidity provision. Multiple DLT platforms are in the process of development, and further work is required to establish interoperability and build trust in their capabilities. Furthermore, increased collaboration is required to agree common standards, workflows, and operational checks and balances.

This paper, a publication by Boston Consulting Group in partnership with J.P. Morgan, explores the application of DLT in capital markets. It addresses how the technology is developing and explores its impact through the securities lifecycle. Along the way, it discusses how DLT is solving, or could solve, pain points in capital markets processes, and become a powerful driver of innovation.

As DLT matures, the onus is on market participants to act. Indeed, with the DLT proof of concept established, the future will be about collaboration and execution. From the C-Suite down, there is a need to fully understand the risks and opportunities, and to formulate strategies for engagement. That will mean gauging potential impacts, preparing for adoption, and building solutions. Many participants are already moving forward and seeing promising results. Their investments will help early adopters insulate against technology debt, establish an innovation agenda, and lay the foundations for the digital capital markets of the future.

Trends in capital markets and the path to DLT

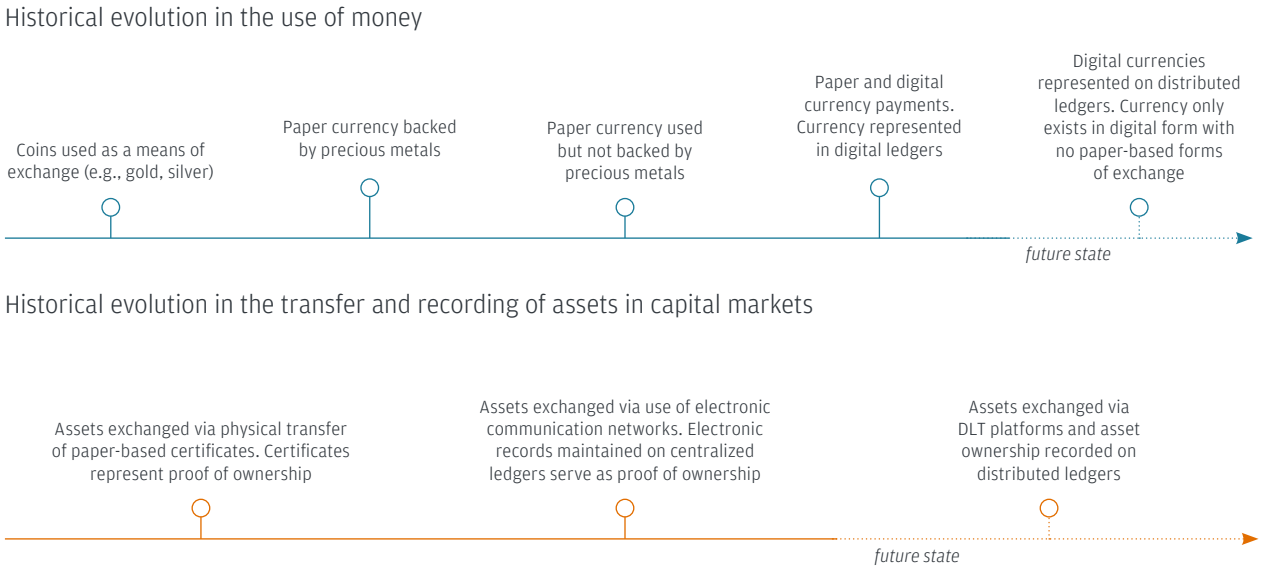
DLT is perhaps best known as the underlying enabler of cryptocurrencies such as Bitcoin and Ether, but its potential outside of cryptocurrencies is vast. Indeed, DLT has wide applications across capital markets, including in the native issuance of securities, tokenization of assets, and the creation of Central Bank Digital Currencies (CBDCs). This paper primarily focuses on the first of these.

The adoption of DLT in capital markets represents a natural next step in the dematerialization journey that has taken place both in the use of money and in capital markets. (See Exhibit 1). While technological change such as electronification has taken capital markets to new levels of efficiency, DLT can go further—offering cost, liquidity, transparency, and innovation benefits. From securities issuance, to trading, clearing, settlement, and securities servicing, DLT's unique characteristics have the potential to enhance processes across the securities lifecycle.

To obtain the full benefits of natively-issued digital assets, a cash-on-ledger framework is required, whereby digital assets can be exchanged for digital currencies in the form of either CBDCs, stablecoins or other cash-on-ledger solutions. While CBDCs are beyond the scope of this paper, it is important to acknowledge the growing interest among financial institutions and central banks in these currencies. According to a Bank for International Settlements survey, approximately 90 percent of central banks are exploring the use of CBDCs, reflecting policy makers desire to continue to provide safe and efficient payments processes. Meanwhile, stablecoins such as USDT are supporting billions of dollars of financial transactions, mostly in the crypto space. In parallel, several leading banks are exploring cash-on-ledger solutions, and J.P. Morgan has begun offering blockchain-based deposit accounts. Private and public DLT platforms are the enabling architectures for these new versions of money.

Beyond CBDCs, there have also been significant developments in the tokenization of traditional assets. This entails recording existing assets on DLT platforms. Initiatives are underway to explore the potential for tokenization across a range of asset classes, from real estate all the way through to art. However, a major area of focus and where there is a significant opportunity in the near term, is in native issuance via DLT. There has been a wave of DLT activity in bond and loan markets, as well as broader initiatives in other asset classes.

Exhibit 1. DLT is an evolutionary step in market development

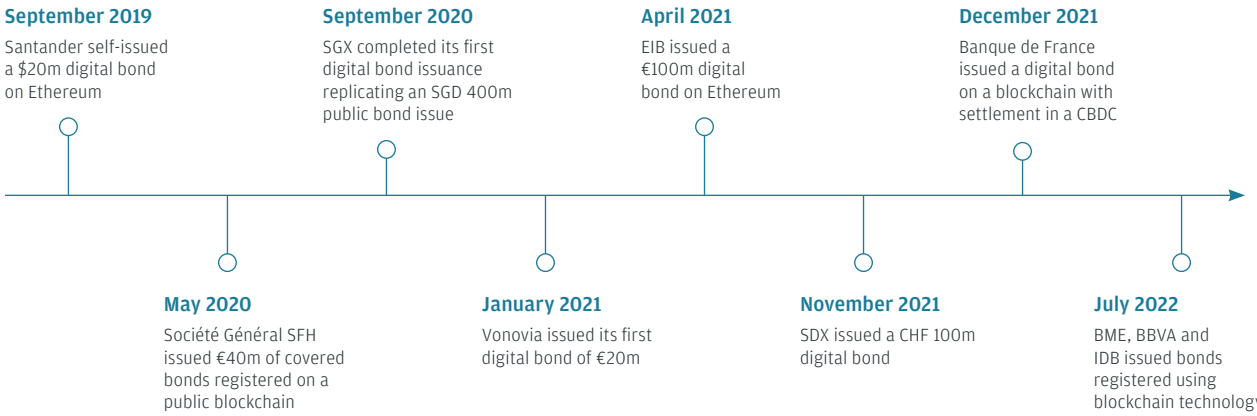


How does DLT work in capital markets?

In simple terms, a distributed ledger is a digital database that is shared, recorded, and synchronised in multiple places at the same time. The data is validated and maintained by multiple participants within the system rather than by a single authority. Blockchain is a type of DLT through which data is stored as secure blocks that are chained together using a cryptographic signature called a hash. Once a block or transaction is validated and approved, it is added to a ledger. Once approved, the data is immutable in the sense that any further changes are submitted as amendments, resulting in full transparency of how the data evolved. This creates an environment in which trust is guaranteed and counterparties can operate with a single version of the truth. There is no need for reconciliations, matching, or other data processing steps. DLT supports native issuance of digital assets, allowing direct dealing between a wide range of investors and significantly cutting settlement times. Trading can be peer-to-peer and around the clock, and smart contracts can enable execution of corporate actions such as coupon payments. Smart contracts are automatic digital instructions that are executed when pre-determined conditions are met.

Recognition of the potential benefits of natively issued digital assets has prompted fintechs, banks, and other market participants to embrace DLT partnerships to develop solutions. In many cases, these initiatives are starting to move from proof of concept to real life applications that can be scaled. (See Exhibit 2). Examples include Societe Generale SFH's issuance of €40 million of covered bonds registered on a public blockchain and SIX Digital Exchange's issuance of a CHF100 million digital bond using DLT, with Credit Suisse, UBS, and Zürcher Kantonalbank as joint lead managers.

Exhibit 2. Select examples of digital bond issuance



Looking ahead, more widespread adoption of DLT solutions will be contingent on financial markets infrastructure developing to accommodate digital assets. This will mean that market participants move away from siloed approaches to technology development, address compatibility challenges, and create standardized data and workflows. Our view is that while these challenges are significant, they are not insurmountable. Collaboration and the measurable benefits of DLT outweigh the difficulties associated with implementation at scale.

DLT capital markets opportunities

Through the securities lifecycle, there are pain points that currently inhibit capital markets efficiency and prevent innovation and growth. These include siloed data structures, large numbers of agents, and entrenched manual processes. In addition, workflows are often fragmented and non-standard, while timeframes are stretched, leading to unnecessary costs. (See Exhibit 3).

Through automation and access to shared data and records, DLT has the potential to enhance capital markets effectiveness, trust, transparency, and efficiency. Furthermore, the benefits are transmittable through the value chain. One of the clearest impacts is on process effectiveness. DLT can enable a transition from multiple parties managing their own records (usually across several internal systems) to data-synced processes and an immutable multi-party source of record.

Issuance timeframes can be accelerated through greater ease of access to shared financial, legal and regulatory data on-chain, as well as reduction of manual processes. In secondary markets, decentralized trading platforms can facilitate extended trading hours across regions, and fractionalisation can provide the potential for enhanced liquidity in select asset classes. Settlement risk can be reduced through the automation of clearing and settlement processes and asset servicing can be improved through automation of corporate actions, such as coupon payments, via smart contracts.

J.P. Morgan has utilised its in-house blockchain platform Onyx Digital Assets to facilitate repo transactions and accelerate their settlement. The platform enables repo transactions to be traded, settled and matured within a day, facilitating real-time transfer of cash and collateral and reducing settlement risk for clients.

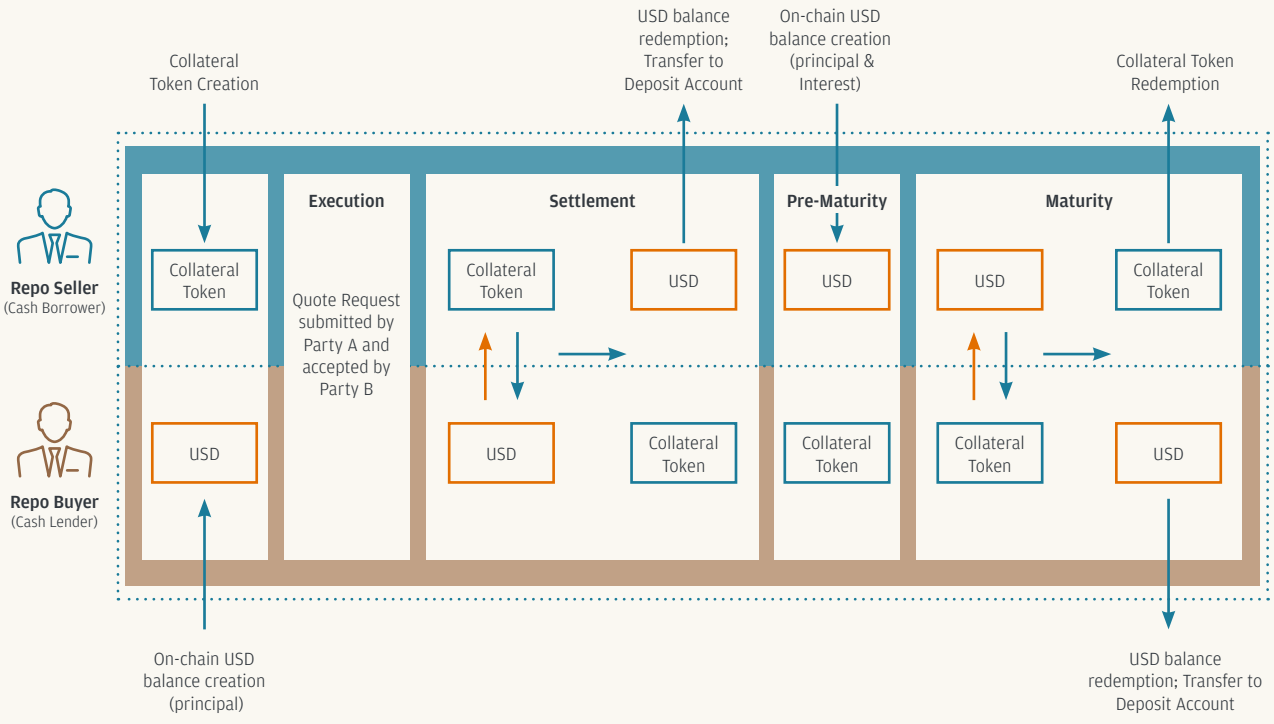
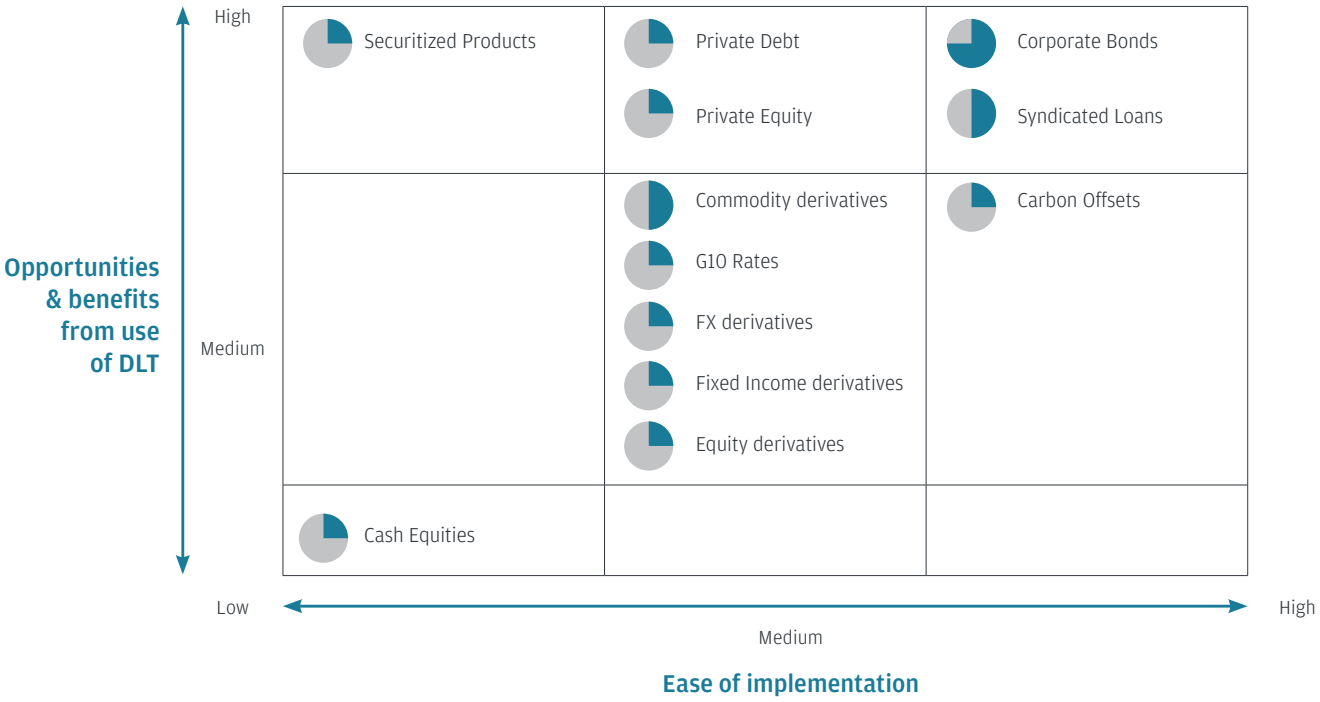


Exhibit 3. Lifecycle pain points and DLT efficiency gains

Value Chain	Select lifecycle process pain points	Select efficiency gains from DLT
 **Issuance**	• Siloed data and manual processes lead to process inefficiencies • Large numbers of agents • High cost of issuance creates a barrier for low frequency and low volume issuers	• Shared, permissioned access to all required due diligence, legal and accounting data on chain • Automation of manual processes • Reduction in number of agents
 **Trading**	• Fragmented liquidity • Diversity of assets requires bespoke trading processes • Restricted trading hours	• Creation of decentralized trading platforms enabling accelerated trading and greater transparency for select products • Enablement of extended trading hours
 **Clearing & Settlement**	• Extended clearing and settlement timelines (T+1 – T+3) creates risks to counterparties • Low data quality leads to reconciliation and trade matching	• Automation of clearing and settlement • Single, immutable record of truth on all transactions
 **Custody**	• Fragmented and manual workflows facilitate transfer of assets • Siloed data can lead to complex and opaque chains of custody	• Automation of workflows via smart contracts • Enablement of digital custody on-chain and the self-custody of assets
 **Asset servicing**	• Siloed data structures lead to inefficiencies in communications • Manual processes facilitate execution of corporate actions	• Automation of corporate actions via smart contracts e.g., coupon payments

While we expect DLT can lead to improvements across capital markets, we expect the impact will be greatest in asset classes that are either less mature, less digitized, or less efficient. For example, we see much more of a functionality uplift in the $41 trillion corporate bond market, as well as in syndicated loans and securitized products, which are less digitized and have lower levels of liquidity, than in the highly-liquid cash equities market. (See Exhibit 4). Indeed, much DLT investment to date has focused on addressing pain points in markets such as corporate bonds and syndicated loans.

Exhibit 4. Opportunities from DLT based on current initiatives and ease of implementation by asset class



Harvey balls indicate maturity of DLT market initiatives

DLT can also provide a platform for product innovation, creating flexibility for issuers and growth opportunities for investors and other market participants. Product lifecycles can be significantly enhanced and customized with smart contracts. They can support issuance in different currencies and maturities and automate dividend or coupon payments based on simple if/when parameters. DLT can also enable emerging asset classes such as sustainability-linked instruments and carbon offsets, as well as facilitate the creation of new products. For example, DLT can enable issuers to tokenize dividend or coupon payments, allowing investors to access cash flow streams without the need to own the underlying equity or debt instrument. (See Exhibit 5).

Exhibit 5. Select DLT-based product innovation across categories

Category	Product
 **Enabling emerging assets**	**Sustainability-Linked-Securities** • DLT could simplify and expedite the issuance process and enable increased transparency into the meeting of ESG covenants **Carbon Offsets** • DLT could provide an enhanced infrastructure to scale this product e.g., through immutable and trustworthy records, fractionalization of units to improve liquidity and smart contracts connected to off-chain data sources
 **Unbundling existing assets**	**Fixed Income Cashflow Tokens** • DLT could enable issuers to tokenize the interest payments of a bond or loan to give investors access to interest payments without owning the underlying debt instrument **Business Line-Specific Equity** • DLT could enable companies to raise additional capital for a specific business line by issuing equity tokens for specific units targeted to investors that do not want to have exposure to all assets of a company **Equity Dividend Tokens** • DLT could enable issuers to tokenize equity dividend payments to provide investors who do not want to have exposure to equity price fluctuations a pure income stream (i.e., token does not confer any ownership or voting rights)
 **Customising assets**	**Recurring Revenue-Based Financing** • DLT could create a financing option for issuers to return a pre-determined portion of revenue as a dividend; there is a small market today, but this could be expanded using DLT **Bespoke Coupon Frequency Bonds** • DLT could enable corporates to issue bonds with bespoke coupon frequencies (e.g., monthly, weekly) using smart contracts **Adjustable Equity Tokens** • DLT could enhance dividend payments or voting rights for investors utilizing smart contract capabilities, depending upon length of equity ownership

Many applications of DLT in capital markets have already gone live, and we are witnessing a growing number of initiatives whose scale and ambition is increasing. In corporate bonds, SGX collaborated with Temasek and HSBC to complete a digital bond issuance, replicating a S$400m 5.5-year public bond issue and a follow-on S$100m tap of the same issue by Olam International. The European Investment Bank (EIB) issued a €100m digital bond on Ethereum in collaboration with Goldman Sachs, Santander and Societe Generale, with the payment to the EIB represented on the blockchain via a CBDC. In syndicated loans, BBVA, BNP Paribas and MUFG facilitated the issuance of a €150m syndicated loan for Red Electrica Corporation using DLT, while a new syndicated loan platform, Versana, which launched in 2022, is aiming to digitally capture agent banks' reference data directly from its source on a real-time basis.

Case study: Corporate bonds and lifecycle impacts

While DLT can have a transformative impact across capital markets, the corporate bond market stands out as a significant area of opportunity. Bond lifecycles are subject to well-established workflows, but there are multiple pain points, many of which can be addressed through the use of DLT.

Corporate bond markets are smaller than equity or government bond markets, less standardized, and in their current evolution, less efficient than other asset classes. In the primary market the average issuance time is two to three weeks for existing issuers and the cost of issuance can be high, due to regulatory requirements and complexities in issuance. In the secondary market, settlement is usually on a T+1 or T+2 basis, creating settlement risk. In over-the-counter secondary markets, it is common to see pricing inefficiencies and liquidity constraints. Furthermore, siloed data structures create challenges for custodians and asset servicing. (See Exhibit 6).

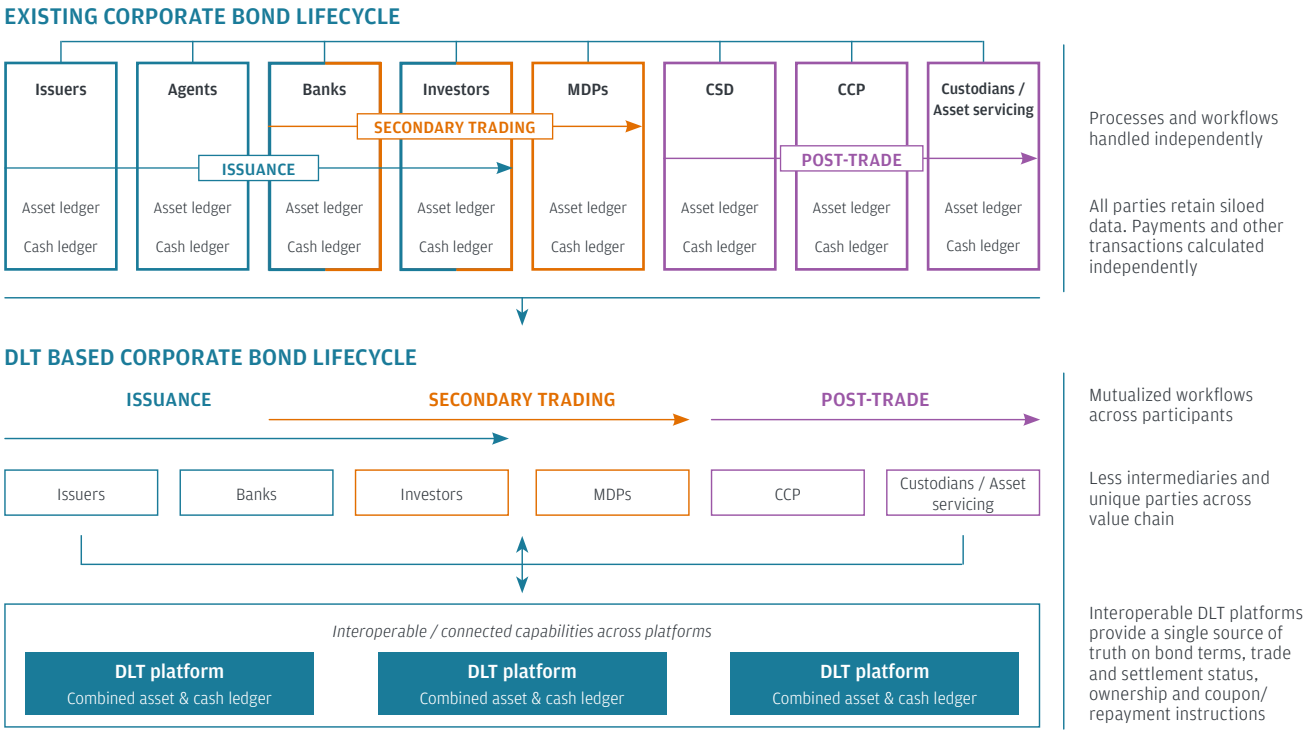
Exhibit 6: Corporate bond market pain points

Value Chain	Existing process	Stakeholders	Existing pain points
 **Issuance**	• Banks co-ordinate the structuring and syndication of corporate bond issuances mostly via manual processes • Book build process involving banks has seen little digitization in recent years	• Issuers • Banks • Agents • Investors	• Siloed data structures and manual processes lead to process inefficiencies • High cost of issuance creates a barrier for low frequency and low volume issuers
 **Trading**	• Trading activity is largely conducted OTC • Price discovery is a manual process	• Banks • MDPs • Investors	• Fragmented liquidity • Manual trading processes • Pricing inefficiencies • Restricted trading hours
 **Clearing & Settlement**	• Clearinghouses and central securities depositories clear and settle securities and cash, post trade execution	• Banks • Investors • CSD • CCP	• Extended clearing and settlement (T+1/T+2) creating risks to counterparties • Siloed data structures can lead to manual reconciliation processes
 **Custody**	• Custodians custody assets for investors post clearing and settlement and support with post trade processing	• Investors • Custodians • CSD	• Fragmented and manual workflows to facilitate transfer of assets • Siloed data can lead to complex and opaque chains of custody
 **Asset servicing**	• Custodians support their clients with applicable corporate actions (e.g., collection of coupon payments)	• Issuers • Custodians	• Siloed data structures leading to inefficiencies in communications • Manual processes to facilitate execution of corporate actions by issuers

DLT platforms can streamline many corporate bond processes. By providing a single source of truth, the technology enhances the transparency of bond terms, transactions, and ownership. These platforms would also intermediate the relationship between market participants and post-trade infrastructure and service providers. Issuers can benefit from accelerated issuance timeframes, the ability to tailor bond issuance more effectively to short-term needs, and reduced costs. Investors will have the opportunity to trade beyond the time constraints of existing markets, experience accelerated settlement timeframes and will face a reduced risk of trade fails. Both issuers and investors will gain from the simplification of asset servicing, with smart contracts facilitating the automation of corporate actions such as coupon payments. (See Exhibits 7 and 8).

There will also be meaningful opportunities for innovation. This could include creating bonds with a bespoke frequency of coupon payments, enabling fractionalisation of issuance, or facilitating greater customization, with the ability to include tailored terms via smart contracts. The efficiency and innovation potential from DLT could lead to increased participation from a broader range of issuers and investors. Through these benefits, there is an opportunity to create a much more efficient and nimble corporate bond market.

Exhibit 7: A DLT-enabled corporate bond lifecycle



Note: Interoperability is inclusive of legal, operational, regulatory and technical interopability
MDP – Multi-dealer platform, CSD – Central Securities Depository, CCP – Central Counterparty Clearing House

With these benefits in mind, many banks and fintechs are currently working on projects to build native-issuance bond platforms, issue assets, and create scalable DLT-based solutions across the value chain. Examples include Goldman Sachs using Digital Asset Modeling Language (DAML) to develop its end-to-end tokenized asset infrastructure. This will support the digital lifecycle across asset classes on permissioned and public blockchains. In another initiative, Marketnode is seeking to build out an end-to-end DLT-enabled fixed income infrastructure, with products focusing on digital issuance services and digital asset depository infrastructure.

Exhibit 8: DLT benefits in corporate bond markets

Market participants	Select Opportunities / Benefits	Select Challenges / Risks
 **Issuers**	• Accelerated issuance timeframes • Lower cost of issuance • Increased frequency of issuance and potential for issuance at a smaller ticket size • Enhanced traceability of transactions and clarity on bond ownership • Automation of asset servicing	• Maintaining natively issued and non-DLT based bonds in parallel
 **Banks**	• Accelerated issuance timeframes with potential for more issuance • Reduced costs from increased digitization of issuance and automation of post-trade processes	• Navigating changes in transaction economics • Supporting parallel DLT and non-DLT based platforms
 **Investors** (Asset managers, pension funds etc)	• Enhanced secondary trading liquidity • Extended trading hours • Accelerated settlement timeframes • Reduced risk of trade fails • Automation of asset servicing • Enhanced real-time insights into portfolio risk and performance reporting	• Supporting parallel DLT and non-DLT based platforms
 **MDPs**	• Increased revenues from more frequent issuance of bonds	• Supporting parallel DLT and non-DLT based platforms
 **Custodians**	• Lower costs from automation of corporate actions • New digital asset custody business	• Lower fees if clients choose to self-custody • Elimination of some existing roles
 **Infrastructure** (CCP, CSD)	• Providing oversight or governance of DLT platforms	• Adapting existing roles and responsibilities to a DLT-based ecosystem
 **Other intermediaries & agents** (Trustees, transfer agents)	• Potential for new lines of business	• Automation of lifecycle events and greater transparency poses a risk to existing business models

Building successful DLT platforms

To realize DLT's full potential and achieve widespread adoption, DLT platforms must achieve the depth and scale of traditional platforms and meet the needs of issuers and investors. This will require a specific set of characteristics. First, they must be able to scale to handle tens of thousands of transactions a second, which is still beyond the reach of most platforms. That said, we are seeing progress towards this goal in private blockchains such as Quorum and SETL.

Another prerequisite for adoption at scale is a set of common standards, including in areas such as DLT platform governance, data, digital identity, and network upgrades. The Enterprise Ethereum Alliance and Hyperledger Foundation are among those leading efforts in these areas. A critical component of these common standards will be the ability to facilitate interoperability between DLT platforms. Interoperability will provide the means for DLT platforms to interface with each other and with existing technology infrastructure across the securities value chain. Interoperability will provide market participants with the means to communicate and transact across DLT platforms, and this will support viability and adoption, and enable scale. Meanwhile, interoperability between DLT platforms and existing market infrastructure will prevent the high cost and impracticality of decommissioning significant components of existing trading and post-trading systems. Still, it is conceivable that overall technology costs may rise in the near term as a result of the parallel operation of traditional and DLT-enabled infrastructure.

EEA and Hyperledger: working together

The Enterprise Ethereum Alliance (EEA) sponsors the development of specifications and standards with a goal to be the global standards organization for the enterprise Ethereum blockchain. The EEA standard specification and associated testing model aims to drive interoperability and help accelerate the development of the enterprise blockchain market. EEA member organizations have collaborated to drive enterprise Ethereum standards with the aim of accelerating adoption of Ethereum blockchain solutions. Hyperledger fosters the development of open source software for establishing, managing, and connecting enterprise blockchain networks. EEA and Hyperledger have similar objectives and complementary approaches to achieving them. They are members of each other's organization, enabling collaboration across working groups and their respective developer networks. For example, EEA community members working on specifications and standards have the potential to collaborate with Hyperledger on software implementations of those standards.

For many market participants, there are concerns around cybersecurity and trust, driven by the risk of fraud, interruptions to the network, and loss of assets. Therefore, an important aspect of scaling DLT platforms will be to demonstrate they have effective cybersecurity protocols in place. DLT platforms will also need to ensure they can support stringent KYC and AML processes for all network participants to meet regulatory requirements.

The market will need clear regulatory and legal frameworks for digital assets and the use of DLT both domestically and across borders. Laws and regulations will need to be adapted or created to specifically address applications of DLT in capital markets so that market participants are clear on the frameworks that govern them. Data privacy will be a key issue; shared networks must be reconciled with the need for client and business confidentiality. Solutions in this space are already being worked on through need-to-know private networks such as Corda and zero-knowledge proof networks such as Fireblocks. These can provide secure methods to validate information to complete transactions while keeping data private.

DLT platforms by their nature create transparency for those with access to the network. The potential negative consequences may be seen in asset classes such as corporate bonds, where banks are accustomed to privacy in relation to inventories and some trading activities. However, these can be overcome through privacy characteristics that can be encoded into platforms. On the other hand, enhanced transparency is a benefit to regulators, and may be a spur to regulation that supports DLT adoption. Ideally, all parties would maintain privacy in relation to each other, while regulators could have access to all data on distributed ledgers.

One significant potential issue for DLT platforms is inadequate liquidity. There needs to be sufficient liquidity to encourage both issuers and investors to participate. For this to happen, the market needs a minimum viable ecosystem, with an active issuer and investor base. While corporate native issuance is expected to grow steadily over time, and potentially exceed traditional issuance in select asset classes, a base level of issuance and liquidity is required in the early stages of adoption to ensure platforms are utilized.

Finally, there has been significant publicity around the energy consumption of proof of work- based public blockchains such as Bitcoin, where significant amounts of computation is used to register transactions. However, these concerns are not relevant to DLT platforms in capital markets, which use more efficient validation mechanisms such as proof of stake and proof of authority. These can be significantly more energy efficient.

A future unlimited

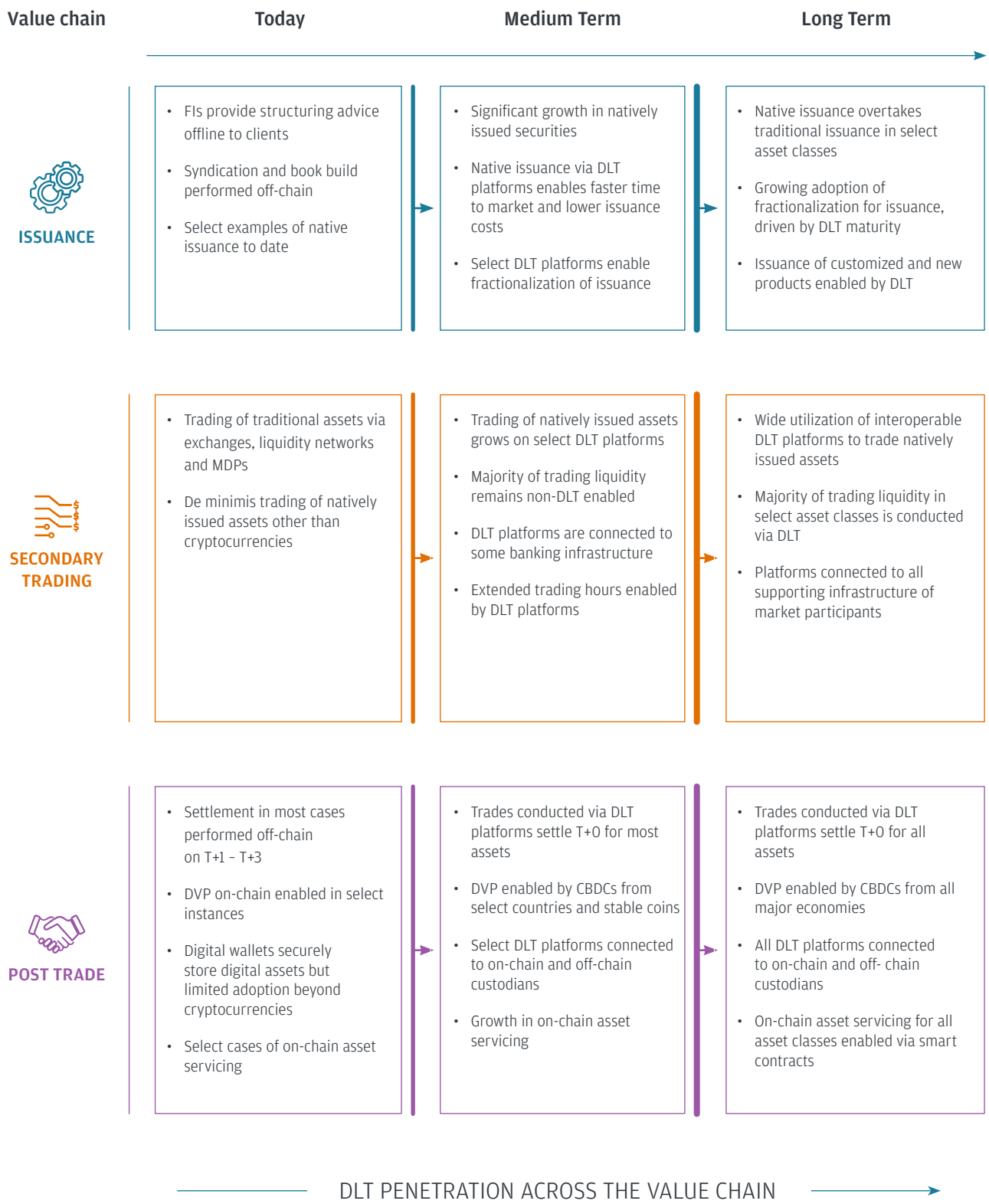
DLT offers capital markets a potential step-change in innovation and efficiency. Through the securities lifecycle, there are opportunities to streamline processes, unlock liquidity, and boost transparency and innovation. Indeed, the technology is already adding value in many activities, and over time will displace some entirely.

The innovation and efficiency benefits that are driving DLT adoption are well understood. Indeed, we are now on a path to scale up DLT based solutions. Amid increasing levels of investment and collaboration, we expect to see more DLT platforms that facilitate issuance, trading, settlement, and custody of natively-issued assets at scale. (See Exhibit 9). Within the next five years, natively-issued securities could account for a meaningful share of the market, with participants embracing product opportunities enabled by DLT that can unlock new revenue streams and value propositions. In the post-trade space, T+0 settlement will become a reality, and platforms will connect directly to on-chain and off-chain custodians.

Looking further ahead, the pace of innovation will accelerate, with DLT potentially facilitating the majority of issuance in select asset classes. As market participants prepare for this evolution, they should consider a number of questions: How will DLT platforms impact capital markets as a whole, and what are the implications for the value chains and asset classes most relevant to them? How will business models need to change, and what can be done now to lay the groundwork?

An important consideration is how collaboration can be enhanced, creating the network effects that will drive transparency, efficiency, and innovation. There are a broad range of potential collaborative approaches, including supporting the development of end-to-end platforms for specific asset classes, testing applications in discrete segments of the value chain, joining foundations to develop standards, and engaging with regulators to shape future laws and frameworks. Through these kinds of initiatives, market participants can ensure they have a seat at the table, and are ready to capitalize on opportunities as DLT continues its transition from the fringes to the mainstream. To engage effectively, market participants will also need to make adjustments to their operational capabilities. These will include more standardized data, workflows, and common protocols through the securities lifecycle. Based on these foundations, DLT is set to play a key role in building capital markets of the future.

Exhibit 9: Evolution of the use of DLT in the value chain



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Glossary

Carbon offsets – a carbon offset is an instrument that represents the reduction or avoidance of emissions of carbon dioxide or other green house gases

CBDC – a central bank digital currency is the digital form of a country's fiat currency

CCP – a central counterparty clearing house is a financial institution that takes on counterparty credit risk between parties to a transaction and provides clearing and settlement services

CSD – a central securities depository is a financial organization that holds securities, either in certificated or uncertificated form, allowing ownership to be easily transferred through a book entry rather than by a transfer of physical certificates

Digital Assets – assets that only exist in digital form and are created and stored digitally in a distributed ledger

Fractionalization – splitting up ownership of assets to enable increased investor access

MDP – multi-dealer platforms enable trade matching between counterparties, offering pricing from a selection of market participants

Native issuance – the issuance of digital assets via DLT

OTC – Over-the-counter trading is done directly between two parties, without the involvement of a formal exchange

Proof of authority – a variant of the Proof of Stake consensus mechanism where instead of tokens, network participants stake their identity and reputation

Proof of stake – Proof of stake is a type of consensus mechanism for processing transactions used by blockchains to achieve distributed consensus

Stablecoins – a stablecoin is a digital currency that is pegged to a "stable" reserve asset like the U.S. dollar or gold

Sustainability-linked securities – a type of instrument in which the financial and / or structural characteristics can vary depending on whether the issuer achieves predefined sustainability objectives

Tokenization – the process of converting any rights or assets into a digital token that can then be used, owned and transferred by the holder through DLT

USDT – the code for the asset-backed stablecoin Tether

Zero knowledge proof – a verification method whereby one party can prove the truth of specific information to another party without disclosing any additional information

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