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FROM VAULTS TO VALIDATIONS: WHAT IS THE FUTURE OF ASSET SERVICING IN THE ERA OF TOKENIZATION?

by Michele Corio* and Ferdinando Mastropietro*

Abstract

The recent hype around tokenization and its potential to transform financial markets raises questions about future developments in custody services. Although promising, tokenization has yet to gain substantial traction, with most initiatives remaining experimental. Combining insights from the literature with market evidence from informal discussions with major market players, our analysis finds a notable lack of new custody solutions beyond such basic services as key custody and account management, despite investors' and market operators' interest. Four main obstacles emerge: (i) the absence of a unified ecosystem; (ii) limited liquidity in tokenized assets; (iii) risk managers' cautiousness towards innovations whose prospects are still uncertain; and (iv) the lack of a clear legal framework. The role of traditional intermediaries will need to adapt to a more digital and interconnected hybrid market architecture. Custody services, in particular, could gradually expand beyond traditional safekeeping, potentially supporting trust, interoperability, and operational integrity across tokenized networks.

JEL Classification: G20, G21, O33, F30.

Keywords: Distributed Ledger Technology, Asset Tokenization, Digital Custody, Financial Market Infrastructures, Blockchain, Post-Trade Services.

Sintesi

Il recente interesse per la tokenizzazione e per il suo potenziale di trasformazione dei mercati finanziari sollevano interrogativi sull'evoluzione dei servizi di custodia. Nonostante le prospettive promettenti, la tokenizzazione non ha ancora raggiunto una diffusione significativa e la maggior parte delle iniziative rimane in fase sperimentale. Combinando le indicazioni della letteratura con informazioni raccolte tramite scambi informali con alcuni dei principali operatori di mercato, la nostra analisi segnala che, nonostante l'interesse di investitori e operatori, la disponibilità di soluzioni di custodia è limitata, a differenza di quanto avviene per i servizi di base quali custodia delle chiavi e gestione dei conti. Emergono quattro principali ostacoli: (i) l'assenza di un ecosistema unitario; (ii) la limitata liquidità degli asset tokenizzati; (iii) la cautela dei risk manager in presenza di novità le cui prospettive rimangono incerte; e (iv) l'assenza di un quadro giuridico chiaro. Il ruolo degli intermediari tradizionali dovrà adattarsi ad un'architettura di mercato ibrida, più digitale e interconnessa. In particolare, i servizi di custodia potrebbero gradualmente estendersi oltre le tradizionali funzioni di custodia degli asset, contribuendo potenzialmente a garantire fiducia, interoperabilità e integrità operativa nelle reti tokenizzate.

* Banca d'Italia, Directorate General for Markets and Monetary Policy Operations.

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1. Introduction[1]

Technological progress has often led to deep innovation in the financial markets and in their structure, redefining the functions of intermediaries, and enabling the emergence of new business models. Tokenization is widely regarded as one of the most promising transformative developments currently underway.

Financial tokenization enables the representation of ownership and associated rights in financial instruments through secure, bearer digital tokens recorded on distributed ledger technologies (DLT). Recognizing the opportunities offered by this innovation, financial institutions, technology providers, central banks, and policymakers worldwide have increasingly intensified their engagement with DLT. A growing body of literature suggests that its adoption may profoundly reshape the financial value chain and improve market efficiency across key functions such as trading, settlement, and custody. The breadth of this transformation is often compared to the shift from paper-based to electronic securities in the 1980s.

From a value creation perspective, tokenization is expected to enhance the efficiency of asset trading and holding by leveraging the distinctive features of DLT, with particularly significant implications for custody-related services. The potential economic impact on a global scale appears substantial: recent studies estimate that tokenization could generate annual gross efficiency gains ranging from USD 31 billion to USD 130 billion, even without full-scale adoption. Such gains, which can reflect efficiency improvements of between 30 and 70 per cent in specific cost components,[2] are primarily attributed to cost reductions and efficiency enhancements across the value chain, notably in issuance, registry maintenance, custody, trading, and settlement.[3]

These early estimates of the beneficial impact of tokenization indicate that this transformation goes beyond a mere change in the form of securities representation. Rather, it affects the entire value chain, reshaping the financial ecosystem as a whole and, in particular, re-designing custody-related services and enabling the development of new business opportunities.

Custody services – defined as the wide range of activities provided by global custodians to ensure the safekeeping, administration, and settlement of financial instruments – are expected to be broadly impacted by this new technology. These services play a critical role in financial markets by guaranteeing secure asset holding, accurate record-keeping, and regulatory compliance, while also encompassing corporate actions processing, income collection, reporting and value-added services such as securities lending and collateral management.

To have an effective representation of the evolving landscape in the integration between traditional and DLT markets, the analysis is focused on assets which have both a traditional and a digital representation. Within this category, two opposite models have emerged in the markets: assets natively issued on a blockchain and then ‘detokenized’ in a book-entry form to allow traditional

[1] This paper builds upon and further develops insights originating from work carried out during 2025 within the Crypto Asset Monitoring Group (CAMEG), a monitoring group created in 2023 by the ECB Directorate General Statistics in conjunction with the Eurosystem Innov8 Forum.

[2] According to Baltais and Sondore (2024), estimated efficiency gains across selected cost components are as follows: (i) compliance costs (30-50 per cent), (ii) middle- and back-office functions (around 50 per cent), (iii) listing and issuance costs (3-10 per cent), (iv) trading and liquidity related costs (around 60 per cent), and (v) cross-border payments (up to 80 per cent).

[3] See Baltais and Sondore (2024).

circulation (detokenized assets)[4] and assets initially issued in book-entry form and subsequently re-issued on a blockchain (assets re-issued on-chain, AROs),[5] thereby potentially enabling parallel circulation. The present analysis is focused only on the latter, AROs, which offer a particularly insightful perspective for understanding the evolution of custody services on DLT, exemplifying the transformation from the traditional to the DLT world. Given their intermediate position between the traditional and digital native assets, they allow us to observe how financial institutions are rethinking their fundamental functions, especially on custody services, in an environment where technology is affecting the role of intermediaries, requiring new technical skills and enhanced security frameworks. Interest in this topic is reinforced by the fact that AROs can serve as a catalyst for a broader adoption of DLTs. Unlike blockchain-native assets, they provide a direct bridge to existing liquid markets and their regulatory constraints. Studying how custody changes when a traditional asset 'moves' to a blockchain makes it possible to understand which parts of the financial ecosystem may benefit from increased efficiency – such as instant settlement or reduced counterparty risk – and which, instead, will require new regulatory or infrastructural adjustments.

Ultimately, examining the development of custody models for AROs means anticipating how the roles of custodians, central securities depositories (CSDs), and other market participants may evolve. For example, whereas traditional custodians safeguard dematerialized securities within centralized infrastructures such as CSDs, the transition to a tokenized finance ecosystem would require hybrid solutions which are reconciled with the asset originally issued off-chain and are able to exploit the potential of DLT, guaranteeing the management of cryptographic private keys and the interaction with smart contracts on decentralized or hybrid platforms. In general, these technological innovations will introduce significant operational challenges. AROs have been attracting growing interest from major market participants. As of May 2023, the market value of these tokenized assets on permissionless blockchains was estimated at approximately USD 2.15 billion,[6] with projections indicating potential growth to nearly USD 4 trillion by 2030.[7] These figures should, however, be treated with caution, given that statistics on tokenized instruments remain quantitatively and qualitatively inadequate.[8]

Notwithstanding its considerable economic potential and growing institutional interest, the development of custody services for AROs in real-world markets remains largely confined to experimental stages. Under the hybrid models currently emerging, many of the traditional functions and institutional arrangements remain largely unchanged, limiting the scope for genuinely novel custody services. Accordingly, the present landscape poses several questions concerning the concrete barriers that continue to hinder the emergence and scaling of innovative custody services, as well as the likely trajectories of their future development. Moreover, while distributed ledger technology can be implemented through a variety of architectural and institutional models, the most profound transformation of custody services is generally expected in a scenario of full adoption, in which

[4] Especially in Europe, this approach has emerged as an alternative to connect native DLT instruments to the traditional market infrastructure and to introduce these new assets to central bank collateral framework.

[5] In the literature, traditional financial assets that are re-issued or mirrored on a distributed ledger are also referred to as 'twin assets' or, more broadly, as tokenized real-world assets (RWA).

[6] Carapella F., Chuan G., Gerszten J., Hunter C., Swem N. (2023). 'Tokenization: Overview and Financial Stability Implications.' (*Finance and Economics Discussion Series* 2023-060)

[7] https://www.coindesk.com/opinion/2025/02/07/rwa-tokenization-is-going-to-trillions-much-faster-than-you-think See Citi GPS (2023) and CoinDesk (2025).

[8] Colantonio R., Coletta M., Renzi R. (2025). 'Le statistiche sugli strumenti finanziari tokenizzati: una sfida per le banche centrali' (Mercati, infrastrutture e sistemi di pagamento – Banca d'Italia)

distributed ledgers redefine rather than complement existing market infrastructures. Any assessment of this full DLT scenario, while potentially significant, remains necessarily speculative.

This paper aims to bridge the gap between theory and real-world practices in the provision of custody services for tokenized assets. Although an expanding body of academic and institutional literature has examined the opportunities and challenges associated with the tokenization of financial instruments, the specific implications for custody services remain comparatively underexplored. Moreover, a key distinguishing feature of the study lies in its integration with empirical insights from semi-structured interviews conducted in the second half of 2025 with a range of market participants, including both traditional financial institutions and crypto-native operators.

The analysis is divided into two main sections. **Section 2 provides a general overview** of the current state of development of the tokenization ecosystem, examining recent trends **and the expected transformation of custody services** offered by market participants. The paper speculates on which services may constitute the backbone of the emerging tokenized economy. **Section 3 shifts the focus to practical implementation, seeking to capture market sentiment through interviews conducted with market players** actively engaged in the field. This empirical perspective is used to highlight the main trends currently shaping custody services for AROs, as well as the key challenges and constraints that are hindering their broader development. Further details on how the main custody services could be impacted by tokenization are provided in Annex I.

2. Reshaping custody services

2.1 Introducing tokenization

A rigorous analysis of custody services for tokenized assets requires, as a preliminary step, a clear conceptual description of tokenization and its various implementations. This task is inherently complex, as financial asset tokenization, broadly defined, encompasses diverse objects with different characteristics and currently lacks a unique definition. Its nature as an emergent and rapidly evolving phenomenon continues to be shaped by the dynamic interplay of technological innovation, ongoing market experimentation, and the progressive consolidation of regulatory frameworks.

This leads to significant inconsistencies across different sources and, in some instances, to formulations that remain conceptually vague. An illustrative example is offered by the definition advanced by the leading crypto data aggregator CoinMarketCap:[9] the tokenization is

> 'The process of creating a digital representation of a real-world or financial asset on a blockchain or other distributed ledger, using tokens that encode ownership rights, shares, or other rights associated with the underlying asset. This enables the buying, selling, transferring, or management of these assets in digital form, potentially with greater efficiency, transparency, and divisibility than traditional methods.'[10]

[9] CoinMarketCap, founded in 2013 and then acquired by Binance in 2020, is one of the world's leading reference sites for cryptocurrency market data, providing real-time prices, market capitalization, and volumes for thousands of assets. With an average of 140 million monthly active users according to SimilarWeb data, it stands as a sector leader, more than doubling its direct competitors.

[10] See CoinMarketCap, *Tokenize*.

In this definition, as in others, the only truly discernible distinguishing feature lies in the shift – enabled by the potential of digital information technologies – away from the traditional book-entry model towards a presumably decentralized and disintermediated paradigm. However, depending on the stage of the process at which the modalities and characteristics of distributed ledger technology (DLT) are introduced, a wide range of possibilities may emerge, leading to different configurations and, consequently, to different legal constructions of the underlying asset.

Notwithstanding the absence of a precise and universally accepted definition, the technology that underpins tokenization is widely portrayed in literature as a potentially foundational innovation capable of reshaping the structure of financial markets. While there is broad consensus among scholars and market participants that its adoption is likely to accelerate in the coming years, expectations regarding its ultimate scale diverge significantly – arguably as a consequence of the underlying definitional ambiguity. Estimates of the market value of tokenized assets by 2030 range from the relatively conservative USD 2 trillion projected by McKinsey to the considerably more expansive USD 16 trillion forecast by the Boston Consulting Group (BCG; fig. 1).

Figure 1

McKinsey and BCG market projections for 2030



Source: Banerjee A., Sevillano J., Higginson M., Rigo D., Spanz G. (2024). 'From ripples to waves: The transformational power of tokenizing assets.' (McKinsey & Company); Kumar S., Suresh R., Liu D., Kronfellner B., Kaul A. (2022). 'Relevance of on-chain asset tokenization in "crypto winter"' (Boston Consulting Group)

These enthusiastic estimates are driven by the supposed benefits of DLT or DLT-like based technologies in terms of efficiency for financial market processes. Four primary areas of improvement with respect to the current financial architecture are usually identified: (i) accessibility, (ii) settlement efficiency, (iii) programmability, and (iv) fractionalization.[11]

(i) A shift towards continuous system availability (24/7/365) is represented as a significant departure from the constraints of legacy financial infrastructures. DLT-based frameworks enable uninterrupted operational cycles, thereby eliminating the friction of weekend and holiday 'blackouts' and enhancing global market liquidity.

(ii) The promise of a near-instantaneous settlement may significantly shorten the settlement cycles traditionally governed by T+x conventions, thereby potentially eliminating counterparty risk and reducing transaction costs.

[11] Agur I., Villegas-Bauer G., Mancini-Griffoli T., Martinez Peria M.S., Tan B. (2025). 'Tokenization and Financial Market Inefficiencies.' IMF Fintech Note 2025/001, International Monetary Fund, Washington, DC.

(iii) Programmability embedded in DLT-based architectures represents the real game changer of this technology; it might allow operational processes to be encoded directly into token logic.[12] Functions such as interest calculation, corporate-action processing, and coupon payments should be automated on an end-to-end basis, reducing operational risk and enabling intermediaries to redeploy resources towards higher value-added activities. The use of smart contracts[13] is also often considered by many publications as a novel form of transparency. Predefined rules embedded *ex ante* are executed deterministically and recorded immutably on the distributed ledger, generating a shared and auditable record of state transitions. This characteristic might be particularly relevant in markets where verification and certification processes are inherently complex, such as those associated with environmental or sustainability-linked assets.

(iv) A further frequently cited advantage is the possible broadening of market access. By lowering the marginal costs associated with servicing smaller holdings and streamlining investor-facing processes, tokenization may allow intermediaries to extend their offerings to market participants historically excluded from wholesale financial infrastructures through fractionalization. However, such a potential democratization of access is contingent upon substantial progress in distribution mechanisms, interface design, and user-experience frameworks.

The transformation brought about by tokenization might also plausibly extend to the underlying market infrastructures. Open-source distributed ledgers can facilitate iterative development and modular innovation at a pace that is generally difficult to achieve within traditional financial-market infrastructures, whose governance arrangements and upgrade cycles tend to be comparatively more rigid. While this does not automatically imply the near-term displacement of existing systems, it points to the increasing relevance of hybrid architectures and interoperable solutions as defining features of future market designs.

All things considered, the concrete ability of financial markets to harness the advantages offered by this set of technologies will depend heavily on the form that what is called 'tokenization' ultimately takes and on which of the driving forces – technological, regulatory, or experimental – will prevail. Views also still differ among scholars, legislators and market operators, especially with regard to the nature of the on-chain representation, the components of the asset lifecycle that are migrated on-chain, or how rights and obligations are encoded, transferred, and enforced across different legal and jurisdictional settings. Clarifying all these uncertainties would make it possible to assess whether tokenized assets should be classified and regulated as closer to traditional instruments or as belonging to more distinct categories and would finally help to increase their market scale.

For our purpose, however, at the current state of the art, the most pragmatic approach for deepening the topic of new specific custodial services is to treat as tokenization all the DLT-based financial projects that self-identify as such, while setting aside technical and legal differences. Moreover, the analysis focuses on a specific class of assets, the so-called assets re-issued on-chain (AROs), which are financial instruments originally issued through traditional market infrastructures and subsequently – either partially or fully – re-issued in digital form on a DLT or like-DLT form. This hybrid form of assets makes it possible to test the benefits promised by DLT using instruments that are already subject to established regulatory frameworks, thereby acting as a catalyst for broader and more scalable adoption.

[12] Schwiderowski J., Pedersen A. B., Beck R. (2023). 'Crypto Tokens and Token Systems' (Springer Science).

[13] A smart contract is a self-executing program stored on a blockchain that automatically enforces and executes the terms of an agreement when predefined conditions are met.

2.2 A transforming ecosystem for custody services

Custody services within traditional finance are facilitated by a multifaceted array of actors, whose specialized functions underpin the financial markets' architecture. These entities constitute the core framework of the current system, which remains fundamentally centred around financial intermediaries. Over the past decades, their mandate has expanded significantly in both breadth and complexity, reflecting rising expectations regarding operational efficiency, heightened regulatory scrutiny (e.g. in Europe: UCITS, AIFMD, MiFID II, CSDR and EMIR), and the growing internationalization of investment activity.

In a nutshell, the custody framework relies primarily on two stratified layers of intermediaries: central securities depositories (CSDs) and custodians. At the core of their function lies the safekeeping and segregation of client assets – held on behalf of institutional investors, asset managers, and retail clients – together with a set of services that underpin risk management, transaction execution, and investor reporting. Through these functions, financial institutions, in the traditional finance environment, ensure that securities and cash are securely maintained and accurately recorded; in addition, they can use a set of tools essential for the proper management of their portfolios.

CSDs constitute the underlying infrastructure, serving as the primary register of positions. Through these entities, issuers place securities on the market, while the CSDs exercise control and provide essential notary and book-entry services. The legislator appointed the CSDs with a central role in the financial system and for its stability; their activities are therefore governed by stringent regulations – notably the Central Securities Depositories Regulation (CSDR) in Europe – which strictly define their functions and activities. Due to their systemic importance, access to CSD services is restricted by law to direct participants identified based on their scale and institutional role, such as custodian banks, primary brokers, and central counterparties (CCPs).

Custodian banks represent the second tier, providing custody services to a broader range of clients by leveraging their relationship with CSDs. Typically, custodians maintain two types of accounts at the CSD level: proprietary accounts for their own assets and omnibus accounts for the collective holdings of their clients. This structure establishes a dual-ledger system: a primary ledger maintained by the CSD (identifying participants) and a secondary ledger managed by the participants (identifying end-investors). Beyond the core services shared with CSDs, custodians offer an extensive suite of commercial value-added services – including know-your-customer (KYC) and anti-money laundering (AML) compliance, tax processing, risk management, reporting, and reconciliation – which are indispensable for investors. Usually, the two layers are governed by different sets of rules reflecting their specific functions. In Europe, for instance, while CSDs fall under the CSDR, the regulatory framework governing custodians is primarily MiFID II.

Against this established backdrop, the emergence of digital finance marks a structural discontinuity in the organization of custodial services. Whereas traditional custody is anchored in centralized and intermediated infrastructures (the two layers of CSD and custodians), digital assets circulate decentralized on programmable distributed ledgers capable of automating transactional and post-trade workflows. The shift from an account-based to a cryptographic-credential-based model of control fundamentally redefines the object of custody itself. Whereas traditional custodians safeguard assets by maintaining securities accounts and legally recognized ownership records, DLT-based systems require custodians to govern the mechanisms through which control over assets is exercised. Custody therefore evolves from a function centred on safekeeping towards one focused on access governance, encompassing the secure generation, storage and administration of cryptographic credentials,

transaction authorization, recovery procedures and access-control policies.[14] The relocation of control from institutional account infrastructures to cryptographic mechanisms substantially modifies the locus of operational responsibility and raises fundamental questions concerning the allocation of liability, operational resilience and the adaptation of investor protection frameworks.[15] The functions and services traditionally performed by CSDs and custodians appear to converge within the technological framework of this new architecture, which is capable of autonomously managing such processes at the infrastructure level, potentially rendering intermediaries redundant. However, this displacement seems merely apparent, as this complex suite of services cannot be initially promoted – nor subsequently fully adopted – without the active participation of these very intermediaries. Consequently, rather than disappearing, these entities are more likely to transform their core business, playing a significant role in the evolution of the new system. The same approach can also theoretically be extended to the case of full DLT adoption, because the role given by the legislator to the CSDs in the current environment goes beyond the mere market infrastructure, being a bridge between the markets and the financial authorities. Therefore, in the absence of structural reforms by the legislator, CSDs would reconfigure their activities still maintaining their role.

This is particularly true for AROs, where the dual circulation across both traditional and DLT circuits produces configurations that, conversely, expand the role and responsibilities of custodians. These institutions are increasingly required to ensure the integrity of traditional circulation while simultaneously supporting the deployment of new digital services. The custodian's role is evolving from safeguarding physical or dematerialized securities to ensuring the secure governance of the cryptographic credentials that authorize access to digital tokens. This transition requires the deployment of institution-grade security architectures – including hardware security modules (HSMs), multi-party computation (MPC), and other threshold-signature techniques – the operation of blockchain nodes, and the provision of value-added services such as real-time on-chain reporting, governance support, and digital-asset reconciliation. Importantly, the custodian retains responsibility for ensuring that the tokenized representation remains legally and economically consistent with the underlying off-chain representation, thereby preserving enforceability within the applicable regulatory framework. Through these functions, custodians, but also CSDs, may continue to serve as core agents of trust, compliance, and settlement integrity in emerging tokenized markets. Five areas or functions can be identified that may evolve as a consequence of the shift from traditional to digital infrastructures (tab. 1):

[14] See ECB (2024) and IOSCO (2020).
[15] See Levitin (2023).

Table 1

Core custodial functions in tokenized asset markets

Function	Key features
Private-key governance	Institutional management, protection, and recoverability of private cryptographic keys controlling tokenized assets, analogous to the safekeeping of physical securities or omnibus account balances in traditional custody.
Blockchain infrastructure operations	Operation of full or validator nodes, maintenance of network infrastructure, and execution of on-chain administrative actions; in permissioned settings, participation in consensus processes and controlled smart-contract administration.
Off-chain/on-chain integration	Dual-layer custodial responsibility ensuring the safekeeping and legal validity of off-chain assets while supervising their corresponding on-chain representations to maintain auditability and legal consistency.
Value-added digital services	Provision of real-time reporting, digital-asset servicing, staking facilitation, and governance-related services enabled by programmable infrastructures.
Regulatory and compliance oversight	Enforcement of regulatory requirements applicable to tokenized instruments, including AML and countering the financing of terrorism (CFT) controls, investor protection measures, and reporting obligations critical for institutional market participation.

Notwithstanding its recent steady growth, the adoption of digital assets in real-world markets remains limited. The market is still in a nascent stage and only some selected initiatives have moved from limited-scale experimentation to live production. For this reason, it is premature to use the current evidence to assess the long-term trajectory of integration between traditional and digital infrastructures. Regarding AROs, the most promising developments are primarily concentrated in three areas: collateral management (specifically in repo transactions), fixed income issuance,[16] and the tokenization of investment funds. These activities have shown that a phase of coexistence – and, in certain configurations, interoperability – appears, at present, to be the most likely near-future scenario.[17]

The new equilibrium that may emerge between traditional and digital finance is likely to be reflected in the evolution of custody services themselves. In traditional markets, decades of legal development, institutional consolidation, and established market practice have produced a mature – albeit still continuously evolving – environment with clearly defined roles and responsibilities, especially in the two-layer configuration between CSD and custodian. By contrast, the future configuration of the financial system, where traditional and tokenized infrastructures may coexist or interoperate to varying degrees, remains substantially more uncertain.

The new operational framework for the tokenized component of financial assets is taking shape within a landscape where boundaries between market participants are not strictly defined and multiple set-ups are possible. This marks a transition from an intermediary-centric definition of roles – where the nature of the entity dictates the services offered – to a techno-centric vision, where distinctions

[16] See ICMA, *What are DLT bonds?*

[17] See GFMA (2025).

between subjects are more fluid and depend on the functional specialization chosen to deliver a specific product.

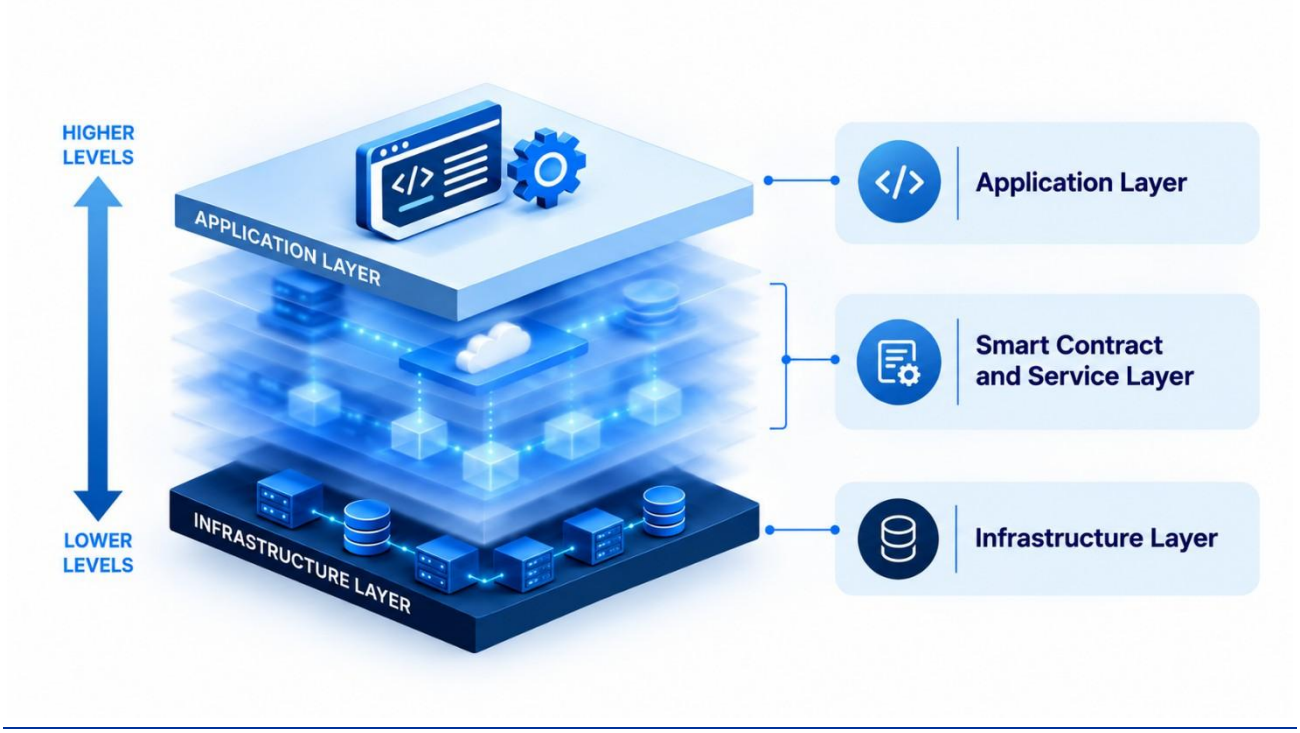
As a first approximation, this can be mapped as a seamless continuum where two blurred areas are distinguishable: (a) the infrastructure layer and (b) the application layer. The positioning on this scale is heavily dependent on the deliverable services. The infrastructure layer, which underpins the DLT's operation, encompasses all services essential to the ledger's existence, such as the network itself, consensus mechanisms, privacy protocols, and integration solutions with other DLTs. This layer is comparable to the functions currently performed by CSDs, CCPs, and market infrastructures; it is often invisible to the end investor, and its primary challenges involve scalability, interoperability, and the balance between privacy and transparency.

On the opposite end of the spectrum lies the application layer, which focuses on financial services such as re-issuance, client onboarding, compliance, reporting, and asset lifecycle management. This layer is comparable to the functions of a custodian bank and serves as the core of the business logic. Its main challenges relate to legal compliance, the judicial recognition of tokens, and integration with legacy systems (fig. 2).

In this techno-centric DLT environment, participants can potentially perform all functions. However, considerations of economies of scale and scope typically lead them to focus on a specific subset where they achieve high specialization, interconnecting with other entities to cover the full range of services along an increasing scale. Rather than eliminating financial intermediaries, this functional specialization is likely to reshape their roles and foster the emergence of new specialized service providers. Alongside traditional market infrastructures, new entities may develop expertise in areas such as cryptographic key management, smart-contract administration, digital identity, oracle services, and blockchain infrastructure operation. Whether these functions will be absorbed by incumbent institutions (particularly CSDs and custodian banks), performed by new specialized providers, or even partially automated, remains an open question. At the centre of this functional division lie key custody services. DLT does not eliminate custody but fundamentally transforms it from ‘asset safekeeping’ to ‘safekeeping of access to assets’. Consequently, cryptographic keys become the pivot upon which all other services are delivered. For CSDs in particular, assuming that they will maintain a role in the financial markets, recent market developments show two main alternatives: they may continue to provide custody services directly by internalizing these new capabilities or instead they may preserve their traditional legal and fiduciary responsibilities, positioning as reference in the new ecosystem of specialized technology providers.

Figure 2

New DLT environment



Within this evolving landscape – where traditional and digital finance may coexist in varying proportions – the tokenization of assets reshapes not only the representation and transfer of financial claims but also the modalities through which they may be safeguarded.

By enabling direct, cryptography-based control over digital representations of value, programmable ledgers broaden the spectrum of custody arrangements beyond the conventional third-party model that historically dominated traditional finance. Custody in a tokenized environment can therefore manifest in multiple forms, reflecting different allocations of responsibility between investors, intermediaries, and the technological infrastructure. These arrangements span a spectrum from fully decentralized self-custody to full third-party custody, with increasingly flexible hybrid configurations emerging in between.

Taken together, these arrangements illustrate a continuum of custodial models that differ not only in their operational and technological design but also in their implications for risk allocation, regulatory compliance, and investor protection. As tokenized markets mature, these configurations are likely to coexist and evolve, shaped by regulatory requirements, technological capabilities, and investor preferences.

Despite the emergence of partially or fully disintermediated models, third-party custodians seem to retain a central role, because they assume a critical coordination function, ensuring that each tokenized position corresponds to a specific real-world asset, that adequate reserves are maintained to support issuance, and that the digital representation remains unique across platforms.

The precise configuration of third-party custody within a tokenized ecosystem will ultimately depend on both investor preferences and the design features of the underlying distributed-ledger technology, including its degree of automation, settlement architecture, and governance model. However, custodianship is likely to remain a cornerstone of institutional trust and operational integrity, though increasingly transformed by the technological and regulatory characteristics of programmable and decentralized financial infrastructures.

As tokenized finance reshapes the modalities through which financial claims are issued, transferred, and held, the perimeter of custodial responsibilities will transform accordingly. In traditional markets, custody functions are embedded within a mature operational architecture – spanning front-, middle- and back-office layers – that orchestrates trade execution, settlement finality, accounting, reconciliation, and asset servicing. The transition to tokenized assets reconfigures this architecture by enabling certain activities to be internalized by investors through self-custody, while others continue to depend on intermediaries operating across the boundary between off-chain and on-chain environments (fig. 3).

Figure 3

Spectrum of custody configurations

ARRANGMENT	FULL CUSTODY	SHARED CUSTODY	HOSTED/EMBEDDED CUSTODY	SELF/NON-CUSTODIAL
Description	A third-party custodian holds and manages private keys on behalf of users or institution, making this ideal for institutional clients requiring regulatory compliance, security and operational efficiency.	Requires multiple parties to approve transactions by distributing control using multiparty computation (MPC), balancing security and decentralization while reducing reliance on a single entity	Integrates custody solutions into applications via APIs or SDKs, offering businesses flexible digital asset management while leveraging MPC for enhanced security and granting end users some control	Users retain full control over their private keys and digital assets without intermediaries, requiring secure key management while ensuring full sovreignity and responsability
Private keys	Third party custodian reteins full control	Designated users have shared control	End user has primary control, while the wallet service provider acts as backup	End users retains full control
Signing patterns	Multisig or MPC	Multisig or MPC	Multisig or MPC	Single signer
Recoverability	Yes	Yes	Yes	No
Account structure	Segregated or omnibus	Segregated	Segregated or individual	Individual
Advantages	Enterprise-level security, reduced operational risk	Reduced risk of key loss No single entity controls keys	Fast, efficient asset transfers Recovery of keys possible	Increased user control Ideal for privacy
Trade-off	Centralization risk: single entity controls assets	Operational complexity: coordinating multiple custodians/signers	Platform risk: possible platform failures	No recovery, no ability to recover lost keys
Applicability	Financial institutions that are transacting or storing a large value assets	Institutions demanding a degree of distributed security	Retail investors prioritizing ease of access while remaining protected	deFi users and privacy-focused investors valuing full control
Risk	Low	Moderate	Moderate	High

Source: WEF (2025).

Custody services for AROs, where a portion of the services is provided on-chain and others through traditional methods, effectively represent the expected trajectory of this transition. This is particularly evident in the connectivity established between current and DLT systems, as these assets already occupy an intermediate position between traditional and digital market infrastructures – consistent with this conceptual transition. AROs exhibit a dual configuration: their legal entitlements and underlying reference assets remain embedded in the conventional off-chain framework, while the issuance of their tokens and the recording and transfer of those tokens occur on programmable distributed ledgers. This mixed structure facilitates greater automation, enhanced transparency, and forms of operational disintermediation that allow certain trading and post-trading activities – historically performed by custodians – to be internalized by investors or codified directly within the technological layer.

At the same time, this duality introduces new operational, legal, and technological challenges, highlighting the need to reconceptualize custodial functions as financial infrastructures progressively incorporate digital components.

2.3 Custody services for tokenized assets

Since the role of the custodian appears to survive even in the new tokenized model, the services performed by these entities in a digital setting can be analytically grouped into two overarching categories:

> **Key-custody services**, which concern governance, protection, and recoverability of the cryptographic credentials that confer control over tokenized assets, and
>
> **Other financial custody services**, which encompass the remaining suite of custody functions that, depending on the specific asset or service configuration, are included within either the application or the infrastructure layer. Unlike traditional frameworks, these services are intrinsically linked to the underlying technology; consequently, they may be delivered by various distinct entities or embedded directly into the asset's technological architecture.

a. Key-custody services

A fundamental dimension of custodianship in tokenized markets concerns the secure governance of cryptographic keys, which constitute the technical means through which investors access, control, and transact tokenized representations of value on distributed-ledger infrastructures. The establishment of a secure, resilient, and institution-grade key-management framework is therefore essential to preserving investor assets and ensuring operational continuity within digital-custody arrangements.

Public-key cryptography lies at the core of this architecture. Through this mechanism, investors – or authorized service providers acting on their behalf – exercise exclusive control over on-chain positions by means of private keys, public keys, and associated wallet addresses. The cryptographic system relies on a pair of mathematically related keys: a public key, which may be disclosed without compromising security, and a private key, which must remain strictly confidential. Data encrypted with a recipient's public key can be decrypted only with the corresponding private key; conversely, digital signatures employ the sender's private key to authenticate transactions, which are subsequently verified using the sender's public key.

This structure has clear custodial implications. The public key – cryptographically derived from the private key – serves as the functional analogue of an account identifier, while wallet addresses – typically derived from the public key – operate as destination coordinates for transfers. Although any participant may send assets to a given address, only the holder of the corresponding private key is authorized to instruct their disposition.

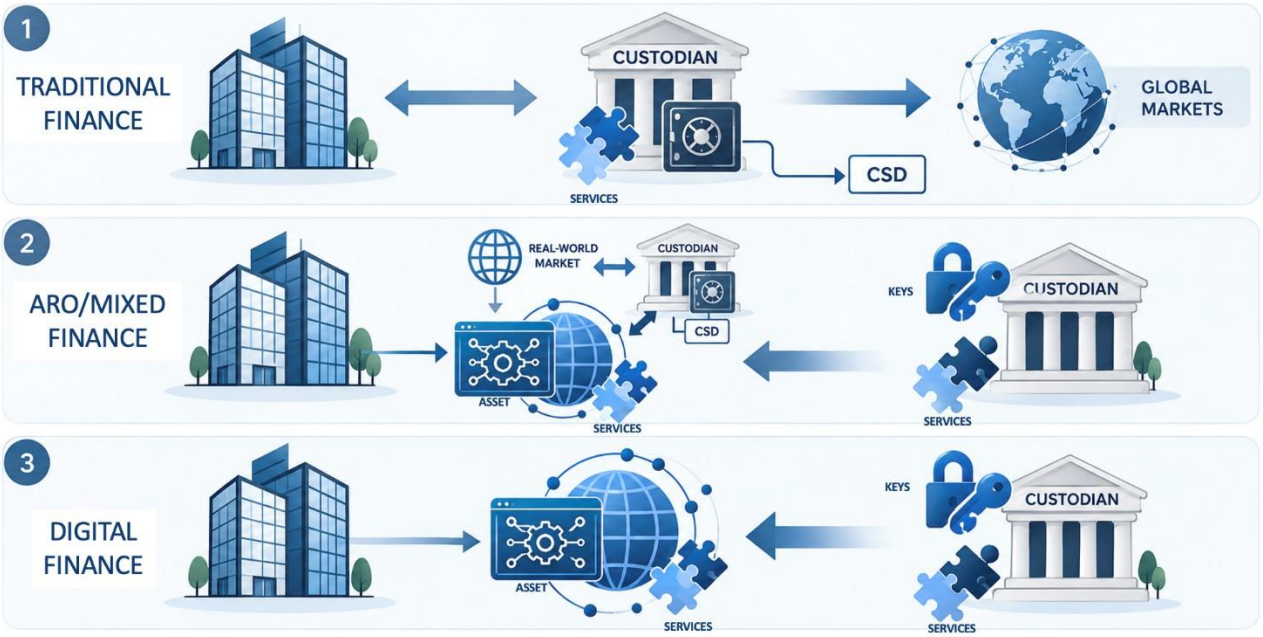
These properties generate several critical requirements for institutional custody:

- the loss of a private key results in the irreversible loss of the associated tokenized asset,
- the compromise of a private key enables unauthorized transfers and undermines asset integrity, and
- institutional custody therefore necessitates secure storage mechanisms, redundancy protocols, recovery procedures, and governance arrangements capable of mitigating operational and cyber risks.

For these reasons, key-custody infrastructures increasingly rely on advanced cryptographic and hardware-based protections – including HSMs, MPC, threshold-signature schemes, and secure-enclave technologies. Together, these mechanisms constitute the foundational security layer of digital custodianship and underpin the reliability, resilience, and trustworthiness of token-based financial market infrastructures. Their operational role closely aligns with the architectural shift, where the locus of asset control progressively migrates from middle- and back-office intermediaries towards cryptographically secured key-governance frameworks (fig. 4).

Figure 4

From traditional to tokenized custody



The transition from the traditional CSD framework to a DLT environment represents a fundamental shift in the 'notary function' – the legal and operational guarantee of an asset's integrity. In the legacy model, the notary role is a centralized, *ex post* reconciliation process: the CSD acts as the 'golden record', manually ensuring that the aggregate of securities held in participant accounts matches the total issuance. Trust is therefore vested in the institution's oversight and its ability to rectify discrepancies through periodic audits.

In contrast, the integration of DLT transforms the notary function into an *ex ante*, algorithmic verification mechanism. Within a decentralized or permissioned ledger, the 'notary' is no longer a mere bookkeeper but a protocol-level validator (or a 'notary node') that prevents double-spending and unauthorized inflation of the money supply in real-time. This evolution shifts the burden of proof from human-led administrative reconciliation to cryptographic certainty. Consequently, the legal concept of 'finality' is redefined; rather than waiting for the completion of a batch-processing cycle (T+2), the notary function is embedded directly into the transaction's lifecycle, ensuring that the issuance's integrity is maintained natively by the code at the moment of settlement (T+0).

b. Other financial custody services

In a tokenized environment, cryptographic keys represent the core of custody services, as they provide the fundamental means of access to the assets. Consequently, the broad spectrum of potential services is positively influenced by the capabilities of the technology itself, which dictate both the service structure and the entities responsible for their administration (fig. 5). While asset safekeeping remains

a foundational pillar, the transition from account-based systems to wallet-based transaction models necessitates new operational configurations for asset segregation, investor protection, and dual-layer reconciliation.

Figure 5

Custody services: infrastructure and application layer



The precise configuration and scope of these services remain largely undefined; consequently, for the time being, there is a strategic preference to maintain them in their traditional form. Many of these functions are still in a formative stage and are likely to evolve in response to the future structure of the market, regulatory developments, and the degree of interoperability achieved across infrastructures. As such, their operational design and allocation of responsibilities will adapt to the eventual equilibrium reached between traditional intermediaries and decentralized architectures.

Furthermore, the integration of programmable ledgers enhances the automation of asset servicing through smart contracts. While traditional systems already employ automated IT procedures for corporate actions, DLT enables the native and deterministic execution of lifecycle events, such as coupon and dividend payments, directly on the protocol layer. This reduces the need for manual reconciliation across multiple intermediaries by providing a shared, synchronized record of truth. However, this shift introduces new dependencies on code correctness, oracle reliability, and the operational resilience of the DLT infrastructure. Settlement processes are similarly transformed by atomic delivery-versus-payment (DvP) mechanisms. Although DvP is a foundational feature of existing real-time gross settlement (RTGS) systems, DLT achieves this through the simultaneous and inseparable exchange of assets and cash on a single ledger. By effectively collapsing the gap between trading and settlement, the technology enables instant (T+0) finality. While this significantly reduces counterparty risk, it necessitates more sophisticated real-time management of liquidity and a clear legal definition of settlement finality within the digital environment.

Additional risks can originate from the increasingly complex regulatory compliance landscape. Custodians are now mandated to maintain a dual-operational perimeter regarding AML and countering the financing of terrorism (CFT) protocols mapping off-chain identities to on-chain behavioural footprints while utilizing advanced analytics to monitor 24/7 transactional flows.

Ultimately, the market developments may also require the custodian to assume the role of real-time risk data provider and a validator of cross-layer integrity (see Annex I).

3. Market prospects

3.1 Rising global attention

In recent years, numerous jurisdictions and financial institutions worldwide have launched pioneering pilots and early production-stage initiatives centred on the tokenization of financial real-world assets. These programmes aim to explore the benefits, risks, and operational implications associated with the adoption of distributed-ledger technologies (DLT) in capital markets, particularly with regard to efficiency, transparency, and accessibility. At the moment, the resulting global landscape is highly heterogeneous: some regions exhibit more advanced legislative developments and early production deployments, while others remain predominantly in the experimental stage.

A broad range of initiatives, looking for example to Europe, illustrates the increasing scale and diversity of tokenization initiatives. Since 2020, the Banque de France has conducted multiple wholesale central bank digital currency experiments for the settlement of tokenized government and corporate bonds. Similarly, in 2024 the Eurosystem conducted extensive exploratory work on new technologies for wholesale central bank money settlement, involving both production-stage trials and controlled experiments. The initiatives comprised actual DLT-based transactions settled in central bank money and additional tests conducted in pilot environments. According to the European Central Bank,[18] the trials involved 64 eligible participants across 9 jurisdictions and facilitated the settlement of €1.6 billion in central bank money. Several of these experiments included use cases directly touching on custody services.

Other examples across Europe demonstrate comparable momentum.[19] The European Investment Bank (EIB), in cooperation with the Banque de France and Banque du Luxembourg, issued a €100 million digital bond on Ethereum.[20] In Germany, Deutsche Börse's D7[21] platform has developed end-to-end digital post-trade services for natively digital securities,[22] while HSBC has introduced tokenized gold solutions for institutional clients. Another noteworthy initiative is the Canton Network pilot, which explored the tokenization of Gilts, Eurobonds, and gold, as well as the mobilization of collateral through 'digital twins' representing tokenized assets. The project involved 27 participants, including Euroclear and Digital Asset, with Euroclear acting as primary custodian and post-trade infrastructure provider for the tokenized assets.[23] Switzerland hosts the SIX Digital Exchange (SDX), one of the world's first fully regulated infrastructures for tokenized securities, supporting issuance, trading, and settlement of digital bonds.

[18] See ECB (2025).
[19] See ECB (2024).
[20] See EIB (2021).
[21] The case of D7, D-FMI and SDX is also significant because they allow digital-native assets to be brought back into traditional CSD form, enabling dual circulation (the so-called 'detokenization').
[22] See Clearstream (2025).
[23] See Canton Network (2025).

Outside Europe, the experimental activity appears to be even more intense. In Singapore, Project Guardian, led by the Monetary Authority of Singapore (MAS), is testing tokenized bonds, deposits, and asset-management products in a DeFi-enabled architecture.[24]

In the United States, J.P.Morgan's Kinexys platform enables the tokenization of assets – such as money market funds and repo transactions – and has adopted an open-architecture model allowing third-party integration. State Street has been appointed as a third-party custodian for blockchain-based debt instruments, providing digital-wallet governance and direct integration with Kinexys for automated settlement and lifecycle events (e.g. interest payments, redemptions). This solution supports delivery-versus-payment (DvP) settlement, including T+0 options, with custody records maintained on-chain.[25] Franklin Templeton has issued tokenized mutual-fund shares on public blockchains, with BENJI tokens held in institutional-grade custody solutions (e.g. BitGo). Goldman Sachs, via its Digital Asset Platform, has piloted the issuance of tokenized debt – including the EIB's €100 million bond – using permissioned blockchains, with Goldman Sachs Custody Solutions acting as primary custodian and Société Générale Securities Services serving as on-chain custodian.[26] In addition, BNY Mellon launched a Digital Asset Custody platform in 2022 and now acts as custodian for BlackRock's BUIDL on-chain money market fund.[27] Regulatory sandboxes in Hong Kong, the UAE, and Japan are supporting experiments involving tokenized real estate, carbon credits, and investment funds, reflecting an expanding scope that extends beyond traditional financial instruments.

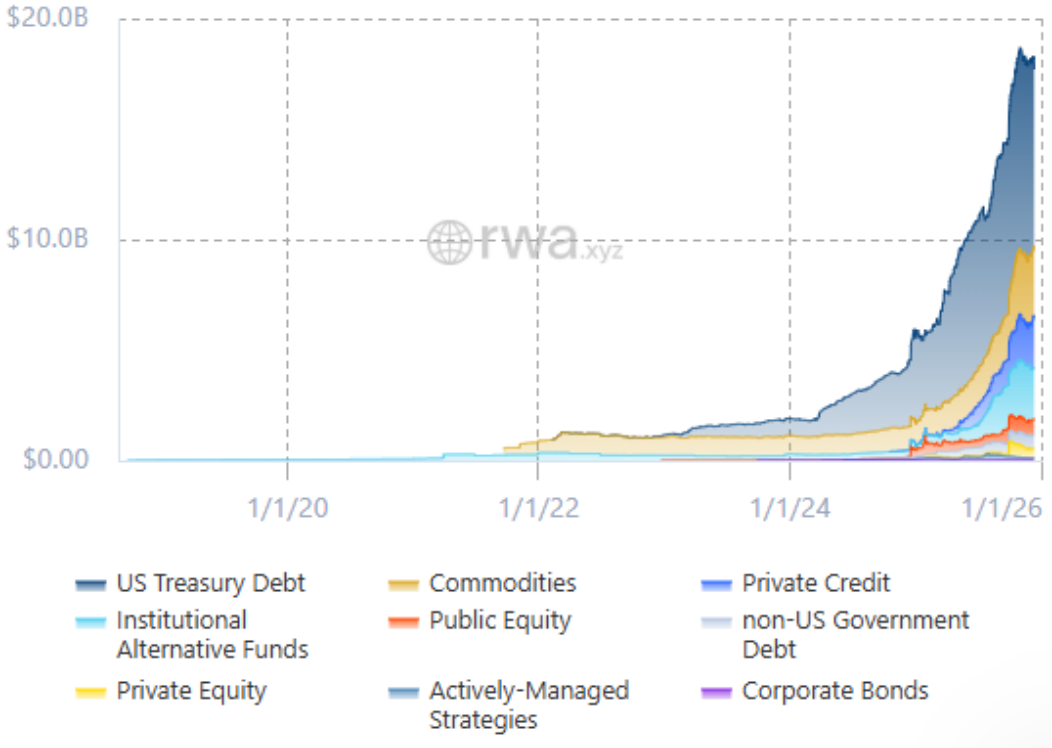
Taken together, these developments show some early progress in the direction of integration between traditional finance and blockchain-based infrastructures, with increasing attention on overcoming issues linked to interoperability, legal certainty, and inclusion in the existing regulatory frameworks. As tokenization moves from experimentation to real-world initiatives, market participants expect it to play a transformative role in reshaping the global financial architecture. Reflecting this trend, the market for tokenized real-world assets reached an estimated value of approximately USD 20 billion as of December 2025 (fig. 6).

[24] See MAS, *Project Guardian*.
[25] See State Street (2025).
[26] See Ledger Insights, *Goldman Sachs unveils digital asset platform with EIB €100m blockchain bond*.
[27] See BNY (2025).

Figure 6

Global on-chain value of AROs

(billions of dollars)



Source: rwa.xyz (cut-off date: 31.12.2025). – Stablecoins are excluded. The re-issuance of assets on distributed ledger infrastructures is often implemented through 'wrapping mechanisms', which enable greater flexibility in the structuring and issuance process decoupling the new asset from the original one.

The evolution of financial market infrastructures for tokenized assets, as shown by the first market initiatives operating at a significant scale, reveals a sophisticated convergence between the established institutional frameworks and some DLT. Rather than constituting a radical displacement of the existing systems, the transition appears characterized by a process of hybridization, whereby DLT-based solutions are architecturally designed to mirror and complement the functional logic of traditional markets. This hybridization has developed along two complementary directions. On the one hand, assets re-issued on-chain (ARO) models digitally reproduce on DLT financial instruments originally issued and maintained within conventional book-entry systems, enabling parallel circulation across both environments. On the other hand, architectures sometimes described by market participants as 'detokenization' or reverse-tokenization models follow the opposite trajectory: assets are issued natively on DLT but, for selected institutional purposes – such as settlement through existing market infrastructures, central bank collateral eligibility, or the provision of traditional post-trade services – their representation is re-established within the book-entry records of a central securities depository (CSD) or another conventional infrastructure. This continuity is most clearly evidenced by the persistence of conventional intermediary roles – custodians, transfer agents, triparty agents, and central securities depositories – which have been integrated into the new operational environment rather than simply substituted by the new technology.

Looking at the current market development, there are several projects that reached a significant scale, for example drawing a non-exhaustive list from the three main areas of development: i) in collateral and repo market management (as J.P. Morgan Kinexys Digital Financing, Broadridge's Distributed Ledger Repo platform, and the HQLA^{x} digital collateral registry); ii) in the issuance of tokenized fixed income instruments (as SIX Digital Exchange in partnership with UBS AG, Euroclear's D-FMI

in the context of the Asian Infrastructure Investment Bank (AIIB) Digitally Native Note, the successive EIB digital bond issuances under Projects Venus,[28] the Hong Kong government's Evergreen initiatives,[29] and Société Générale FORGE's issuances on public Ethereum infrastructure); and iii) the tokenization of investment funds (as Franklin Templeton's FOBXX, BlackRock's BUIDL, Spiko's EU T-Bills Money Market Fund, WisdomTree's tokenized fund suite,[30] and Fidelity International's tokenized money market fund[31]). Even though all these market segments are different by financial nature, they exhibit several operational common patterns.

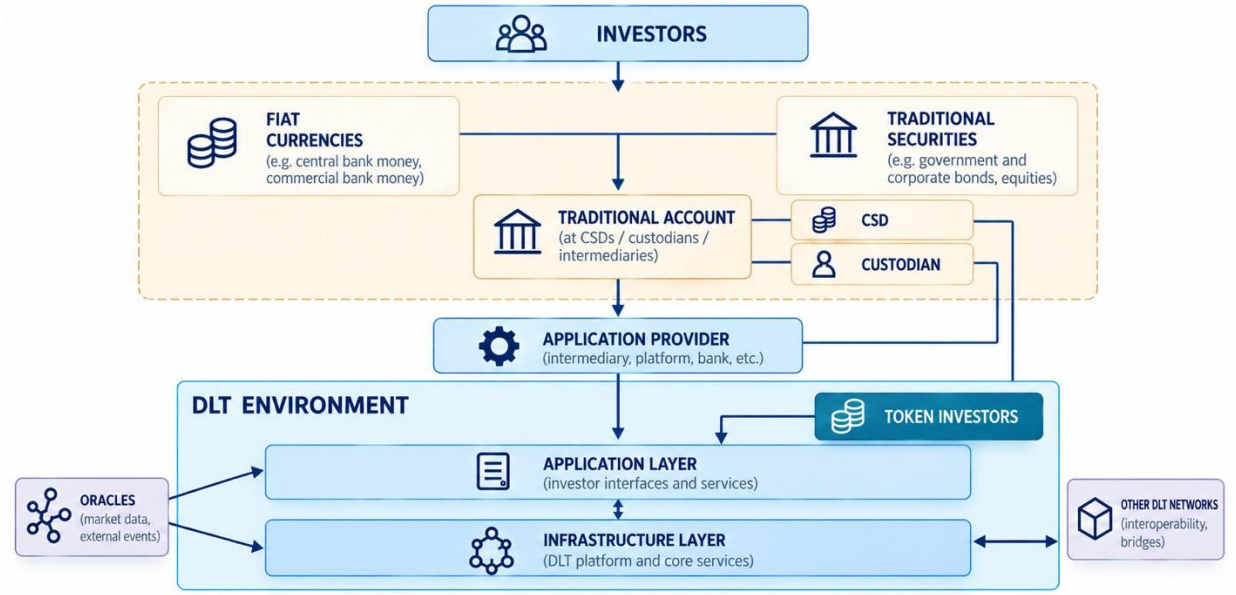
In each case, the core functions of investment management, safekeeping of underlying assets, and fiat currency settlement continue to be performed through conventional financial intermediaries and established payment infrastructure. Custodians such as BNY, CACEIS, and triparty agents retain their role as safekeepers of physical or book-entry securities, while cash movements at the point of subscription, redemption, or repo initiation are executed via established systems such as Fedwire, Single Euro Payments Area (SEPA) transfers, or correspondent banking networks. Crucially, the legal enforceability of transactions continues to rely on existing contractual frameworks – including the Global Master Repurchase Agreement for repo transactions and the Investment Company Act of 1940 for US-registered fund structures – which have been extended or supplemented, rather than replaced, to accommodate the digital format.

What DLT has been strategically deployed to transform is, by contrast, the post-trade settlement and ownership record-keeping layer: the issuance and transfer of tokenized instruments, the atomic exchange of collateral and cash obligations, the maintenance of a single authoritative and real-time record of ownership, and the automation of lifecycle events such as coupon payments, margin calls, and collateral substitutions through smart contracts. The result is a meaningful compression of settlement cycles – from the traditional T+1 or T+2 convention to near-instantaneous or intraday finality – alongside measurable reductions in counterparty exposure, reconciliation costs, and operational fragmentation. This bifurcation between services rendered in traditional form and those delivered natively on-chain reveals a deliberate institutional strategy: rather than displacing the trusted intermediaries and legal frameworks that underpin market confidence and regulatory compliance, practitioners are embedding DLT as a targeted efficiency layer that augments – and in several documented cases substantially accelerates – specific segments of the transaction lifecycle, while preserving continuity with the regulatory, legal, and operational conventions upon which systemic stability ultimately depends (fig. 7).

[28] See EIB (2022).
[29] See HKMA (2024).
[30] See WisdomTree (2025).
[31] See Ledger Insights, *Fidelity's tokenized MMF emerges from stealth mode*.

Figure 7

Example of a general operational scheme for a hybrid system



The emergence of this hybrid operating model may also contribute to reshaping the institutional landscape. Rather than necessarily reducing the need for intermediaries, the allocation of functions between off-chain and on-chain environments could foster the development of a broader ecosystem of specialized service providers. A number of firms are already focusing on functions that have no direct equivalent in traditional post-trade infrastructures, including institutional key management and digital asset infrastructure (e.g. Fireblocks), oracle services (e.g. Chainlink Labs), and enterprise DLT platforms and smart-contract infrastructure (e.g. R3 and Digital Asset). At the same time, incumbent institutions, including custodians and central securities depositories, have also begun to develop DLT capabilities through proprietary platforms, strategic partnerships, and investments in digital asset infrastructure. Initiatives such as Clearstream's D7 platform, Euroclear's Digital Securities Issuance platform, and the digital asset custody services developed by BNY illustrate how established institutions are exploring the integration of these new technological capabilities within their existing service offering. Whether DLT-specific functions will ultimately be internalized by incumbent market infrastructures or performed by specialized technology providers remains an open question. The market may therefore evolve towards different institutional configurations, ranging from vertically integrated models to more modular ecosystems based on partnerships between regulated financial institutions and technology providers.

3.2 Readiness gap and adoption barriers

To provide fresh insights into the actual market trajectory, especially in view of the scarcity and fragmentation of available data, 11 major industry participants actively engaged in financial-asset tokenization, including CSDs, international CSDs (ICSDs), custodian banks, and IT providers, were selected for informal interviews.[32]

[32] The interviews include ICSDs, some European CSDs, two of the top five international custodian banks, a hybrid trading venue active both on traditional and DLT finance, euro area central banks, European and global DLT technology providers focused on institutional clients, financial messaging infrastructure providers.

According to the interviews, distributed ledger technology for custody services is not yet leveraged to its full theoretical potential, as emphasized in the academic literature, which highlights the promise of fully integrated on-chain workflows. In practice, however, the current market initiatives continue to depend heavily on traditional mechanisms and infrastructures, giving rise to hybrid architectures that dilute many of the anticipated efficiency gains associated with DLT-based models.

This gap is partly linked to the hybrid nature of AROs, but more importantly it reflects the limited exploitation of DLT functionalities themselves. Core features such as programmability and the automation of lifecycle events remain only partially implemented, while a significant reliance on off-chain processes persists. Consequently, rather than delivering a truly transformative paradigm, the existing implementations often reproduce conventional workflows within a new technological framework, falling short of achieving fully end-to-end on-chain solutions.

The general opinion is that the slow adoption of new DLT-based custody services is due to several impediments that have to be overcome before specific custody services for tokenized assets can become established. First, **a standardized, integrated ecosystem has not yet materialized**, and most initiatives remain confined to exploratory stages in their own ecosystem. Many projects remain highly tailored to precise use cases, frequently designed to solve institution-specific or asset-specific operational frictions. Their bespoke nature hinders interoperability and limits the potential for scalable network effects. Market participants continue to compete by promoting proprietary technological solutions, and even collaborative initiatives often remain oriented towards the advancement of some platforms rather than being oriented to the development of genuinely shared infrastructures. This competitive dynamic contributes to market fragmentation and limits the emergence of common standards, thereby constraining interoperability and network effects across DLT-based ecosystems.

In response, initial efforts have been undertaken to design dedicated protocols – also DLT-based – to enable interoperability across heterogeneous distributed ledger environments. However, these approaches are still facing significant unresolved challenges, both operational and legal in nature. These include issues related to governance, standardization, liability allocation, and the legal recognition of cross-platform transactions, all of which must be addressed before such interoperability solutions can be deployed at scale.

Second, **liquidity in secondary markets for tokenized instruments remains very limited**. Interviewed market operators widely noted that, without a critical mass of issuers, investors, and intermediaries operating on shared infrastructures, tokenized markets risk remaining a constellation of isolated pilots rather than functioning marketplaces, and this so far results in the lack of a proper business case.

A vicious circle appears to be emerging between limited interoperability and constrained liquidity, whereby market participants postpone meaningful engagement while awaiting the consolidation of a dominant platform or standard. This ‘wait-and-see’ approach reflects a rational but cautious strategy: in the absence of clear standards and interoperable infrastructures, early adoption entails the risk of committing to solutions that may ultimately fail to achieve critical mass. As a result, liquidity remains fragmented across isolated platforms, further reinforcing the lack of interoperability and inhibiting the realization of network effects.

This pervasive uncertainty translates into a still limited level of adoption, which in turn discourages significant upfront investment in new, dedicated custody services built around DLT, thereby slowing the overall pace of transformation in post-trade and custody services.

A further obstacle concerns the demand side. **Risk managers often perceive the potential benefits offered by new custody services offered by distributed ledger technology as non-essential at this stage**, largely because of their confidence in the robustness and reliability of existing traditional solutions. Established custody infrastructures already provide well-understood risk management frameworks, regulatory compliance, and operational resilience, which reduces the perceived urgency to adopt alternative models. At the same time, uncertainty regarding how new DLT-based services may materially differ from, or improve, existing processes further contributes to a cautious stance, as risk managers tend to prioritize predictability, transparency, and proven track records. This is partially due to regulatory requirements which under technological neutrality[33] are similar to those applied to traditional instruments. Other concerns that prevent innovative custody solutions from growing are represented by technology risk, asymmetric information and market barriers for new entrants such as capital requirements and network effects. Multiple market participants observed that a compelling economic rationale strong enough to justify a transition from established services to DLT-based ones is still missing.

This conservative attitude is particularly evident in the context of AROs, where the coexistence of both traditional and DLT-based layers – often referred to as a form of 'dual circulation' – allows existing custody frameworks to remain in place. The persistence of these legacy structures reduces the immediate need to develop new, dedicated infrastructures, as market participants can continue to rely on familiar systems without incurring the complexity and potential risks associated with full migration. The introduction of additional, purpose-built solutions may even be perceived as a source of fragmentation or operational confusion, rather than as a clear improvement, thereby reinforcing the preference for incremental evolution over structural transformation.

Last, **legal and regulatory uncertainty constitutes the structural constraint to the development** and institutionalization of new specific custody services.[34] Empirical evidence gathered through interviews with market participants indicates that unresolved legal questions – particularly those concerning ownership rights, settlement finality, asset segregation, and the juridical status of tokenized instruments – continue to undermine legal certainty, dampen investor confidence, and inhibit the scaling of dedicated custody solutions. These uncertainties are especially salient for institutional actors, whose participation is contingent upon predictable legal outcomes and clearly defined risk allocation frameworks.

A particularly debated issue concerns the proprietary nature of tokenized assets. In several jurisdictions, it remains unclear whether holding a token constitutes a property right enforceable *erga omnes* or merely a contractual entitlement *vis-à-vis* the issuer, platform operator, or custodian. This distinction is not merely theoretical, as it directly affects the treatment of token holders in insolvency proceedings, the applicability of segregation rules, and the prioritization of claims if an intermediary fails.[35]

[33] The principle of technological neutrality guides emerging legislation on tokenized assets by ensuring that regulatory requirements do not privilege specific infrastructures or protocols. It aims to allow innovation to evolve freely while maintaining consistent standards of investor protection, market integrity, and financial stability.

[34] See CCAF (2024).

[35] In the EU, the proposals included in the Market Integration Package (2025) update, among the other measures, the DLT Pilot Regime, extending the authority to provide DLT notary services outside of legacy systems to a specific range of authorized entities:

- Credit institutions (banks): they can obtain specific authorization to act as digital notaries.
- Investment firms: these are included among the entities that can request permission to provide individual core DLT services.
- Regulated markets: they have the option to manage notary services for DLT instruments.

Settlement finality represents a further area of legal ambiguity. Conventional financial market infrastructures rely on well-established legal doctrines that identify a precise point at which transfers become final and irrevocable. By contrast, distributed ledger systems often rely on probabilistic finality, consensus-based confirmations, or layered settlement architectures. Interviewed stakeholders consistently emphasized that, in the absence of explicit statutory or judicial recognition of on-chain finality, the legal enforceability of DLT-based settlement remains uncertain. This lack of clarity discourages the migration of systemically relevant settlement processes to blockchain-based environments, particularly for high-value or time-critical transactions.

Asset segregation in digital custody arrangements poses additional challenges.[36] Traditional custody models rely on account-based segregation mechanisms supported by long-standing legal frameworks and supervisory practices. In contrast, wallet-based segregation on distributed ledgers raises complex questions regarding the attribution of ownership, the enforceability of property claims, and the recoverability of assets in scenarios involving custodian insolvency, operational failure, or cyber incidents.[37] These concerns are further compounded by the reliance on third-party technology providers for wallet infrastructure, private key management, node operation, or smart-contract administration. Such dependencies introduce additional layers of legal and operational risk, triggering the applicability of outsourcing and operational resilience regimes, as for example in Europe the Digital Operational Resilience Act (DORA).

Anti-money laundering and countering the financing of terrorism (AML/CFT) obligations add a further dimension of regulatory complexity. Custodians operating in tokenized markets must ensure that off-chain identity verification processes are effectively linked to on-chain activity, despite the pseudonymous nature of many distributed ledger networks. The use of cross-chain bridges, privacy-enhancing technologies, and programmable transfer functions further complicates transaction traceability and risk assessment. Interviewees highlighted that effective AML/CFT compliance in tokenized environments requires a hybrid approach, combining traditional customer due diligence with sophisticated on-chain analytics, continuous transaction monitoring, and advanced attribution techniques capable of identifying beneficial ownership and behavioural patterns over time.

3.3 Operational implications for traditional custody

As tokenization transforms the mechanisms through which financial assets are issued, transferred, and recorded, custodial functions are required to evolve accordingly. While the fundamental objective

- Traditional central securities depositories (CSDs): they can evolve their business by offering DLT-based services, overcoming the limitations of classic book-entry systems.
- Crypto-asset service providers (CASPs): if authorized to operate a trading platform, they can now request permission to perform notary and central maintenance functions for DLT financial instruments.

Once these actors have obtained specific authorization, they can guarantee the integrity of the digital issuance (DLT Notary function) and the subsequent maintenance of accounts (DLT Account Keeper function), enabling the migration of assets from traditional CSDs to distributed ledger technology infrastructures.

[36] See Zetzsche and Nikolakopoulou (2025).

[37] The distinction lies in the opposability to third parties and the burden of proof regarding ownership. In the event of insolvency, account segregation allows for reliance on a liquidator (or trustee) who verifies entries in a formal ledger. Conversely, with wallet segregation, one may be required to demonstrate that technical control – namely, the possession of the wallet – corresponds to a legal right of ownership. This occurs within a legal framework where traditional personal property laws often struggle to categorize digital assets that are technically segregated yet managed on a collective basis.

of asset safeguarding remains unchanged, the operational scope of custodianship is progressively expanding to encompass a broader set of technological, procedural, and governance-related responsibilities. Interviews confirmed that CSDs and custodians are increasingly expecting to operate within a structurally hybrid environment, in which traditional post-trade functions coexist with new tasks arising from distributed ledger-based asset representations.[38]

In practice, intermediaries will be required to sustain a dual operational architecture. On the one hand, they will be required to continue to deliver the full range of services associated with the underlying off-chain instrument, including safekeeping, settlement coordination, corporate-action processing, reconciliation, and regulatory reporting. On the other hand, tokenized representations introduce additional operational layers, such as private-key governance, smart-contract administration, on-chain reconciliation, and continuous supervision of digital-asset lifecycles, monitoring of the coherence between off-chain ownership records and on-chain token balances. This complexity is further compounded by a fragmented landscape of heterogeneous technological platforms and asset models. Managing these multiple parallel environments – each with distinct technical standards and data structures – generates significant reconciliation burdens and constrains process scalability. Achieving such alignment necessitates specialized reconciliation frameworks capable of preventing double issuance, ensuring entitlement consistency across legal and technical layers, and integrating continuous on-chain activity with off-chain systems that continue to operate on business-day cycles. Therefore, the transition towards a hybrid environment does not generate efficiency gains automatically: while DLT may reduce frictions within specific processes, the coexistence of traditional and digital infrastructures introduces additional operational costs, particularly during the initial phase of adoption.

The operational challenges described above are largely a consequence of the coexistence between traditional and DLT-based infrastructures. A full DLT-based financial market would represent a qualitatively different and more speculative scenario, in which the current distinction between off-chain and on-chain processes would progressively disappear. The consequences of this transformation would depend, first and foremost, on the resulting market structure, forged by regulation and market forces. Currently, there is no universal blockchain standard, as key players are testing different proprietary solutions. In this scenario where multiple blockchains strive to dominate the stage, two are the possible results, largely determined by the regulator's stance: incumbents and newcomers could either compete to establish their technology as the standard or cooperate to foster interoperability between the different solutions. In this second scenario, interoperability can be horizontal, vertical or both. In this process, incumbents may hold significant advantages due to their established market presence, network effects, and substantial scale, whereas newcomers could leverage specialization to deliver innovative services and contest market share with established players. In such an environment, custody services would require a fundamental reassessment, as many activities currently embedded within established market structures could be automated, performed by specialized technology providers or by new categories of intermediaries. The ultimate allocation of responsibilities within such an ecosystem remains an open question, to be shaped by future technological, regulatory, and institutional developments.

The evolution of custodial functions is particularly evident in the management of corporate actions, where the potential for automation must be reconciled with the persistence of traditional legal and operational frameworks. Although smart contracts may automate coupon payments, redemptions, or other lifecycle events at the token level, the legally authoritative source of rights remains the traditional security. Custodians must therefore ensure that off-chain events are accurately reflected

[38] See GDF, ISSA and Deloitte (2023).

on-chain and that token holders receive entitlements strictly consistent with the legal documentation of the underlying instrument. This process introduces dependencies on oracle reliability, smart-contract correctness, and governance mechanisms capable of resolving discrepancies between automated execution and legally binding terms.[39]

Risk-management functions are similarly affected. Whereas custodians in traditional market infrastructures primarily provide periodic reporting on exposures, settlement status, and collateral positions, tokenized environments enable real-time visibility of positions and transactional activity. Programmable ledgers allow risk parameters – such as concentration limits, eligibility criteria, or margin thresholds – to be embedded directly into transactional logic. Interviewees noted that, as a result, custodians are increasingly positioned as operators of integrated risk-data environments that consolidate and contextualize both off-chain and on-chain information streams.

In this context, custodians and CSDs are viewed as coordination nodes capable of mitigating fragmentation through harmonized operational practices and the integration of specialized technology providers. Their unique position, assigned by the regulator, at the intersection of legal ownership records and digital representations allows them to contribute to the development of shared conventions for token formats, corporate-action processing logic, settlement workflows, and identity-management frameworks. More broadly, interviewees emphasized that the maturation of tokenized markets will depend critically on the emergence of common standards – ranging from data models and smart-contract templates to communication protocols and regulatory taxonomies. Historical experience from traditional market infrastructures suggests that such standardization is a necessary precondition for efficiency, scalability, and institutional adoption.

Tokenization introduces new categories of operational risk that extend beyond those encountered in conventional custody models. These include vulnerabilities in smart-contract code, oracle malfunctions, cyber incidents, discrepancies between off-chain and on-chain records, and dependencies on external technology providers. Custodians and CSDs must therefore expand their operational-risk and resilience frameworks to address software-based and decentralized components, ensuring that emerging efficiencies do not come at the expense of robustness, legal certainty, or investor protection.

4. Conclusion

The analysis indicates that asset tokenization still needs some catalyst capable of triggering large-scale market maturation. While experiments and pilots have demonstrated the technological feasibility of distributed ledger technologies (DLT) and their potential to enhance efficiency across issuance, settlement, and record-keeping processes, significant structural barriers continue to constrain institutional adoption. Persistent legal uncertainty, fragmented infrastructures, and the absence of widely accepted standards and the consequent limited secondary-market liquidity, collectively hinder the emergence of integrated and scalable tokenized markets. This immaturity is reflected in the limited development of dedicated custody services, which market participants widely regard as a premature aspect in the absence of a viable business case with sufficient volume of transactions.

According to market operators, once this catalyst is found, the transition to this new financial market is likely to be:

[39] See Doria (2024).

- gradual, as off-chain assets will remain dominant in institutional portfolios,
- hybrid, with tokenized representations coexisting with traditional legal and operational frameworks,
- multi-layered, involving both incumbents and digital-native actors,
- regulation-driven, as legal certainty is essential for institutional adoption, and
- technologically adaptive, relying on increasing interoperability and modularity.

In this perspective, tokenization does not represent an abrupt rupture but rather a phased structural reconfiguration of financial-market functions, progressing through experimentation, standardization, integration into regulated infrastructures, and expansion of the asset and service universe. Although the ecosystem remains in a formative stage, the combined momentum of public-sector initiatives, private-sector experimentation, and growing institutional interest suggests that tokenization is likely to assume an increasingly prominent role in the evolution of global financial markets.

Within this new evolving environment, custodians and central securities depositories (CSDs) may still occupy a central position. As hybrid instruments – such as assets re-issued on distributed ledgers (AROs) – become more widespread, they will be increasingly required to support these new operational architectures. Moreover, their prospective role is expected to extend beyond traditional asset safekeeping towards more complex functions, including the consolidation of risk-related data, the coordination of fragmented market infrastructures, and participation in governance mechanisms that underpin tokenized financial instruments. More fundamentally, tokenization is expected to modify the very nature of custody itself. As control over digital representations increasingly depends on cryptographic credentials rather than solely on account-based records, custodial functions may progressively evolve from the safekeeping of assets towards the governance of access to assets. In this new setting, the ability to securely manage cryptographic keys, authorize transactions, and ensure continuity between legal ownership and digital control becomes a core component of institutional trust.

This hybridization does not diminish the relevance of incumbents. However, in a fully DLT-native financial architecture – a more speculative scenario – the competitive advantage of incumbents may depend less on their control over existing record-keeping infrastructures and more on their capacity to provide governance, interoperability, resilience, and regulatory assurance within digitally native ecosystems. Traditionally perceived as a post-trade intermediary, in tokenized environments the custodian and the CSDs could become a 'node of trust' and an interoperability agent, responsible for:

- governing cryptographic keys using advanced security architectures,
- ensuring the one-to-one correspondence between off-chain assets and their on-chain representations,
- preventing double issuance of tokens,
- safeguarding segregation and property rights,
- managing dual settlement processes in hybrid environments,
- integrating real-time risk-management information into digital custodial workflows, and
- overseeing the technological substrate (multi-party computation, hardware security modules, smart-contract verification, cross-chain reconciliation).

As highlighted by the World Economic Forum (WEF),[40] these traditional intermediaries may evolve into multi-functional digital asset servicing providers, operating precisely at the intersection between off-chain legal frameworks and programmable on-chain infrastructures. Tokenization does not reduce

[40] See WEF (2025).

the need for trusted intermediaries; it redefines the nature of trust and the functions through which it is operationalized.

Custodians are well positioned to become interoperability hubs, linking heterogeneous networks and ensuring the consistency of off-chain and on-chain records. This potential role echoes the historical evolution of traditional post-trade infrastructures, where standardization and interoperability were foundational to integration and cross-border efficiency. Their role will also be to act as a bridge to the emerging DLT environment, where they may either integrate with existing infrastructures or develop proprietary tokenized applications. The evolving DLT ecosystem features increasingly blurred boundaries between application-layer services and infrastructural functions, thereby creating new opportunities for business development and fostering novel forms of interaction among market participants and their respective sectoral specializations.

As tokenized markets develop, new categories of actors and infrastructures may emerge. Beyond traditional custodians and CSDs, the ecosystem may be increasingly populated by:

- token issuance platforms
- digital trading and settlement venues
- decentralized governance entities
- on-chain identity providers
- interoperability providers and network orchestrators
- node operators and smart-contract auditors

These entities complement traditional intermediary services, contributing to a multi-layered and increasingly modular financial supply. In the short term, this evolution is likely to entail a higher degree of fragmentation, as multiple technological solutions, governance models, and service providers coexist. Over time, however, competitive pressures, standard-setting initiatives, and regulatory convergence are expected to drive a gradual process of consolidation, leading to more stable and coherent market structures.

These findings align with recent policy and academic contributions, including work by the OECD[41] and the WEF,[42] which confirm that the frequently invoked notion of 'disintermediation' should be interpreted with caution. Tokenization is expected to reshape the financial ecosystem rather than displacing it. The most significant transformation lies not in eliminating intermediaries' services, but in **reorganizing their objectives within a more digital, automated, and interconnected market architecture.[43]**

Currently, this research has shown that today custody services for tokenized assets are still very similar to their traditional finance equivalent, both because incumbent operators still exhibit limited trust in these new instruments – while continuing to rely on established traditional alternatives – and because the lack of liquidity and standardization discourages market participants from committing investment to them. In the future there is a significant space for innovation: according to market operators **services for tokenized assets will not be a replacement for traditional finance ones but their next evolutionary stage**. The potential of these services to enhance efficiency and transparency through programmability is real, but depends on the maturation of regulatory frameworks, the emergence of interoperable infrastructures, and the redefinition of custodial and post-trade functions.

[41] See OECD (2025).
[42] See WEF (2025).
[43] See Gemini (2019).

A critical prerequisite for the advancement of specialized custody solutions is the creation of broader systemic conditions that enable tokenization to transition from isolated experimentation towards meaningful economies of scale. Interoperability currently represents one of the most significant impediments to the development of standardized services. Evidence from the interviews suggests that current DLT initiatives remain technologically and operationally siloed, constrained by incompatible protocols, settlement logics, data models, and smart-contract frameworks. This pervasive fragmentation ultimately obstructs liquidity formation, heightens operational complexity, and severely restricts the scalability of the broader digital asset ecosystem.

Bridges and wrapping mechanisms offer partial solutions but raise concerns related to legal certainty, auditability, and security – particularly for institutional use. As a result, standardization emerges as the indispensable precondition for efficient tokenized markets. This includes:

- standardized token formats
- harmonized smart-contract templates for corporate actions and settlement
- interoperability protocols across ledgers
- unified identity and anti-money laundering frameworks
- common taxonomies and supervisory expectations

Although current custody service implementations remain largely concentrated on key custody – currently the only genuinely native services that have reached a stable production stage – the underlying technological and operational paradigm points to a far broader frontier of innovation. As the ecosystem matures, it is likely to enable the development of additional service layers that extend well beyond basic safekeeping functions, fostering the emergence of new business models, enhanced forms of intermediation, and more integrated value chains across market infrastructures and service providers.

Annex I: Custody services overview

Asset safekeeping

Asset safekeeping remains a foundational component of custodianship across both traditional and tokenized market infrastructures. In the context of digital assets – and particularly for assets re-issued on-chain (AROs) – the principle of segregation retains its importance, yet it is implemented through distinct operational mechanisms. Whereas traditional custody relies on segregated internal and external accounts to ensure that client assets remain insulated in the event of custodian insolvency, digital custody must achieve a comparable level of protection through wallet architectures and on-chain account structures.

In practice, segregation in digital environments is frequently provided on an aggregated basis, with only a limited number of custodians offering fully segregated, individually identifiable on-chain accounts. This divergence reflects the structural differences between account-based financial systems and wallet-based transaction models, as well as unresolved legal questions surrounding the proprietary status of wallet-held assets under applicable regulatory frameworks. Digital-asset networks face additional challenges in enforcing segregation on a real-time basis, given their continuous, 24/7 operational nature, which complicates the definition of reference points – such as 'end of day' – for reconciliation, reporting, and asset verification.

Asset servicing

Significant distinctions also arise in the domain of asset servicing. In traditional financial infrastructures, the administration of coupon payments, dividend distributions, and principal redemptions typically involves multiple intermediaries – including registrars, custodians, and central securities depositories – and requires extensive manual reconciliation, generating both operational costs and error risks. By contrast, decentralized and programmable ledgers enable lifecycle logic to be embedded directly into smart contracts, integrating the asset's operational rules with the ledger on which it circulates. This internal programmability allows complex operations – such as conditional transfers, automated coupon payments, maturity events, and bundled transactions – to execute deterministically without human intervention. Ownership information is recorded natively on-chain, thereby eliminating the need for separate registrar-based record-keeping, where post-trade processes become increasingly automated and technologically mediated.

For AROs, this transformation takes a distinctly hybrid form. Although their on-chain representation may benefit from programmability and automated lifecycle management, the legal and economic rights associated with the underlying instrument remain situated off-chain, where corporate actions continue to be initiated, validated, and executed within established financial and regulatory frameworks. This duality generates a structural interdependence between the off-chain corporate-action process and its on-chain instantiation.

Custodians must therefore ensure continuous and accurate synchronization between off-chain lifecycle events and their corresponding on-chain expression, so that token holders receive entitlements in accordance with the rights embedded in the underlying asset. This requires maintaining a consistent mapping between off-chain ownership records and on-chain token balances, and preventing any misalignment that could lead to duplicated, missing, or inconsistent entitlements – risks that become particularly acute when AROs circulate across multiple platforms or chains.

For custodians, asset servicing thus evolves from the operational administration of lifecycle events into the broader task of preserving the integrity of cross-layer entitlements, reconciling smart-contract

automation with the authoritative off-chain corporate-action process. While automation reduces manual workloads and enhances scalability, it simultaneously introduces new dependencies on code correctness, oracle reliability, and the operational resilience of the underlying distributed ledger technology (DLT) infrastructure. These technological risks must be managed in parallel with the traditional governance of corporate actions on the off-chain instrument, reinforcing the need for a cohesive servicing model that spans both layers of the asset's lifecycle.

Dual-layer reconciliation

A further function that acquires particular relevance in the context of AROs is dual-layer reconciliation, understood as the continuous alignment between the off-chain register of the underlying asset and the on-chain record of its tokenized representation. Unlike natively digital instruments – whose lifecycle is fully governed by the ledger – AROs remain legally and economically anchored in off-chain infrastructures. Their on-chain tokens represent claims whose validity ultimately depends on the integrity and accuracy of the corresponding off-chain positions. Custodians must therefore maintain a coherent and auditable mapping between the two layers, ensuring that any minting,[44] burning, transfer, or encumbrance of the tokenized asset corresponds to a valid change in the underlying instrument, and vice versa.

This dual-layer configuration introduces reconciliation challenges that differ substantially from those encountered in traditional custody. First, custodians must prevent double issuance, ensuring both that no ARO is minted without an equivalent underlying asset and that the same asset is not represented by multiple tokens across chains or platforms. Second, they must accommodate continuous or near-real-time monitoring processes, insofar as token movements can occur on a 24/7 basis, whereas off-chain systems remain bound by market hours, regulatory deadlines, and operational cut-off times.

Effective dual-layer reconciliation thus becomes a core pillar of ARO custodianship, linking the programmability and transparency of distributed-ledger environments with the legal certainty and governance structures of traditional securities infrastructures. Its reliability directly affects the enforceability of on-chain rights and the degree of institutional trust that tokenized instruments are able to command.

Settlement processes

Settlement processes are similarly redefined. When both cash and securities are represented as tokens on a shared ledger, programmable settlement mechanisms can enforce delivery-versus-payment (DvP) atomically by locking transaction legs until settlement conditions are met – or reverting them otherwise. This substantially reduces counterparty risk and enables settlement immediacy. Programmable ledgers also support transaction bundling, thereby minimizing exposures arising from sequential settlement obligations. Yet automation does not eliminate operational risk: cyberattacks, smart-contract vulnerabilities, oracle failures, and system outages may all disrupt settlement workflows. In permissionless networks, settlement finality becomes more difficult to define, given that transactions move through probabilistic confirmation phases – validation, block inclusion, and eventual finality – rather than a single legally recognized moment, as in traditional clearing and settlement systems.

[44] Minting refers to the process of creating new tokens and adding them to the total supply. These tokens are usually assigned to a specific address (often the caller or a designated recipient).

Permissioned DLTs can mitigate these challenges by embedding governance arrangements that guarantee deterministic finality. For digital securities, however, DvP settlement also requires sufficient liquidity in on-chain cash or cash-equivalent tokens and reliable mechanisms for on-ramping and off-ramping funds. Custodians synchronize off-chain payment obligations with on-chain transactional records, thereby reintroducing a form of operational settlement risk: until the custodian completes its obligations, finality cannot be achieved in legal or economic terms. Smart-contract-based atomic swaps can mitigate part of this risk, but only when both assets reside on the same chain and within a coherent cross-chain governance framework.

AML/CFT

A further dimension of ancillary custody services that acquires heightened relevance in a tokenized environment concerns anti-money laundering and countering the financing of terrorism (AML/CFT) and investor due-diligence processes. Whereas traditional custody relies on established frameworks for identification, verification and transaction monitoring, tokenization introduces additional layers of complexity in tracing beneficial ownership, monitoring transactional behaviour, and interpreting risk signals across both off-chain and on-chain environments. Custodians will be required to integrate on-chain analytics tools capable of detecting anomalous activity, screening wallet addresses against sanctions or high-risk lists, and analysing transactional flows for typologies consistent with money laundering or terrorist financing. These capabilities complement traditional monitoring functions built around client profiles, source-of-funds assessments, and documentary verification.

The use of blockchain oracles, cross-chain bridges, and programmable settlement mechanisms introduces further risks related to data integrity, attribution, and potential obfuscation of transactional activity, all of which must be incorporated into custodians' risk-assessment methodologies. In environments involving public or permissionless ledgers, additional challenges arise concerning wallet attribution: custodians must ensure that the entity controlling a given public address is the verified beneficial owner, and that changes in control over private keys do not enable circumvention of due-diligence obligations.

AML/CFT compliance further requires maintaining accurate ownership mapping across the off-chain and on-chain layers and preventing unauthorized transfers into unverified wallets or the use of wrapped tokens and cross-chain instruments to bypass regulated environments. As tokenized infrastructures evolve, custodians thus become central actors in operationalizing regulatory requirements such as the 'travel rule', ensuring the traceability of asset transfers and maintaining audit-ready records that reconcile investor identity with the full lifecycle of on-chain transactions. In a tokenized market, AML/CFT and know-your-customer obligations become more technologically sophisticated and increasingly intertwined with key-custody, reconciliation, and settlement functions.

Collateral management

Tokenization has the potential to reshape collateral management by enhancing efficiency, mobility, and flexibility. It broadens the range of eligible collateral instruments beyond traditional cash and government securities to encompass less liquid or non-standard assets, such as tokenized money market funds (TMMFs), real estate, and private-market instruments. TMMFs – representing shares in funds that invest in money-market instruments but circulate as tokens on public, permissionless blockchains – can complement conventional collateral pools and unlock new possibilities for margining practices.[45]

[45] See GDF et al. (2025).

Through programmable ownership transfers on distributed ledgers, TMMFs can be posted and settled directly, preserving both yield and eligibility while eliminating the need for redemption into cash, a process that introduces friction, delays, and additional costs in traditional finance. In principle, tokenization could enable investors to rebalance collateral positions continuously, without intermediaries, earning returns for every period during which collateral is posted. In a tokenized ecosystem, money market funds could thus emerge as first-class, high-velocity instruments for flexible and efficient margining, reducing operational costs and improving mobility without compromising legal certainty.

However, significant legal, operational, and infrastructural challenges remain unresolved. Tokenization alters the set of attributes that determine a fund's usability as collateral, raising questions about the enforceability of tokenized interests, the interpretation of their risk profile, and the treatment of investor rights under stress. Interoperability is equally critical: collateral must remain enforceable and readily recoverable in the event of counterparty default, even when circulating across different chains, custodians, or settlement layers. Addressing these issues is essential for realizing the full potential of tokenized collateral in a secure and resilient financial system.

Despite rapid expansion in tokenization, current TMMFs operate within a hybrid market environment. The vast majority of repo transactions continue to occur in traditional money markets, and government securities largely remain under the custody of off-chain intermediaries. In the absence of native tokenized assets and fully developed on-chain money markets, many TMMF functions remain off-chain. For example, the calculation of net asset value (NAV) relies on pricing information typically provided once per business day by off-chain pricing services, which are accessed via blockchain oracles. Similarly, the custody and proof of ownership of the underlying fund investments continue to rely on traditional infrastructures.

Following a slow start, TMMFs have grown rapidly: total value locked (TVL) – equivalent to assets under management – increased from approximately USD 770 million at the end of 2023 to nearly USD 9 billion by October 2025.[46] Yet TMMFs also introduce risks that mirror, and in some cases may amplify, those associated with conventional money market funds and certain categories of stablecoins. Central among these is the liquidity mismatch between the daily redemption capability of tokenized shares and the settlement timelines of the underlying instruments, which remain subject to traditional market cycles. This mismatch can generate acute liquidity pressures during periods of elevated redemption demand in an environment that lacks the financial safety nets typical of traditional finance. In such scenarios, confidence in TMMFs could deteriorate rapidly, exacerbating run dynamics.

Services for risk management

In traditional finance, custodians support risk managers by providing timely information on exposures, collateral positions, settlement status, valuation data, eligibility monitoring, and compliance with investment or collateral schedules. These services rely on structured reporting flows, periodic reconciliation cycles, and standardized operational interactions between custodians and institutional clients.

In a tokenized ecosystem these functions evolve substantially. Programmable ledgers provide real-time transparency over positions and transactional activity, reducing reliance on batch reconciliation

[46] Aquilina M., Lewrick U., Ravenna F., Schonleber L. (2025). 'The rise of tokenised money market funds', *BIS Bulletin* No. 115

processes and enabling continuous monitoring of exposures. Smart contracts can embed risk constraints directly into transaction logic, automatically enforcing eligibility requirements, concentration limits, margin thresholds, or settlement conditions. Tokenized collateral – including TMMFs and other on-chain instruments – can be mobilized with far greater speed, enabling near-instant updates of margin requirements and collateral valuations.

In this environment, the custodian transitions from acting primarily as a provider of periodic reports to functioning as an operator of real-time risk-data interfaces and a validator of the consistency between tokenized claims and the corresponding underlying assets.

Yet the shift towards tokenized risk-management processes introduces a distinct set of operational challenges. Custodians must ensure the accuracy and reliability of oracle-delivered data, verify the correctness of smart-contract-encoded risk rules, and maintain robust cross-chain reconciliation mechanisms when exposures span multiple ledgers. As risk managers increasingly depend on the custodian for real-time accuracy, auditability, and legal reliability of on-chain data, the custodian's role as a risk intermediary not only persists but becomes more technologically demanding.

These operational developments must be interpreted alongside a separate set of legal considerations concerning enforceability, governance arrangements, and risk allocation in tokenized-custody models – issues that determine the ultimate resilience and institutional viability of risk-management processes in a hybrid financial environment.

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