GLOBAL DIGITAL FINANCE

ISDA Safe, Efficient Markets

2026

UNLOCKING CAPITAL WITH U.S TOKENIZED MONEY MARKET FUNDS FOR COLLATERAL MOBILITY

Brown Brothers Harriman

EY

Federated Hermes

Hogan Lovells Cadwalader

OWNERA

Table of Contents

1. Foreword

Amy Caruso
Head of Collateral Initiatives
ISDA

Lawrence Wintermeyer
Chair
GDF

The tokenization wave has now reached the shores of the global capital markets. The deluge of recent announcements launching tokenized digital financial offerings in public, private, and alternative markets across different assets classes including stocks, bonds, commodities, derivatives and real estate are breathtaking, if not at times, a bit dizzying.

This has been aided by the recent favorable regulatory environment in the U.S. with much greater regulatory clarity on tokenized assets, especially with the joint SEC CFTC Digital Asset Taxonomy, and pending legislation with the enacted GENIUS Act and pending CLARITY Act.

Many of us are now witness to this fast-moving era of new digitally driven innovations and the transformation of capital markets, with a keen eye on the urgent need to quickly better understand the use cases and benefits that this evolving technology brings to our markets, customers, and organizations.

A few of us are out in front leading this era of tokenization with new use cases, breaking trail for the pack to harness the benefits of digital transformation to capture new markets, networks, and customers, and enhance the value to our existing customer franchises to keep up with anticipated forward market demand.

To convene this broad industry community and help address some of the challenges of using tokenized money market funds ("TMMF") for collateral mobility in the U.S., Global Digital Finance ("GDF") and the International Swaps and Derivatives Association ("ISDA") collaborated to cosponsor a working group and industry sandbox, following a GDF working group in the European Union ("E.U.") and United Kingdom ("U.K.") in 2025.

The working group assessed the status of the legal, regulatory and operational certainty of using TMMFs for margin in both cleared and non-cleared derivatives in the U.S. along with repo and securities lending and near-production use cases with industry leaders were orchestrated and demonstrated within the GDF Industry Sandbox, powered by Ownera.

Collateral mobility is one of the leading industry use cases for regulated financial institutions with many institutions now seeing the benefits of TMMFs and making the case for moving to use TMMFs as collateral in the near term. By bringing together a broad industry working group, open to firms from TradFi to DeFi, from regulated financial services firms to unregulated digital technology firms, we hope to better establish a "wholistic" understanding of TMMFs and the mobility of collateral in the U.S.

Our aim is to accelerate the material knowledge and emerging best practices of TMMFs in a shared working environment, and to better promote the benefits of open network collaboration, growth and partnerships. We want to equip today's managers with a rational and objective framework to better expedite the (further) assessment of their own TMMF collateral use cases.

We would like to thank the more than 300 participants across an estimated 120 firms for participating in the working group, and the 48 firms involved in the industry sandbox. We would also like to thank the many trade associations and industry firms that provided additional bilateral guidance and insights to the working group.

Lastly, we would like to thank our working group and sandbox co-chairs and secretariat, along with supporting GDF and ISDA team members, for their time and dedication to this material and timely industry report. ■

Working Group and Sandbox Co-Chairs and Secretariat

Sydney Abelow
Secretariat, Digital Asset Product, Operations and Risk Manager
Ernst & Young

Brandon Hammer
LRO Workstream Co-Chair, Partner
Cleary Gottlieb Steen & Hamilton

John Siena
LRO Workstream Co-Chair, Associate General Counsel
BBH

Natasha Benson
Sandbox Workstream Co-Chair
COO, Ownera

Jane Heinrichs
LRO Workstream Co-Chair,
Head of US Regulatory Affairs
Federated Hermes

Edward So
LRO Workstream Co-Chair, Partner
Hogan Lovells

John P Boyle
Secretariat, Partner
Ernst & Young

Seha Islam
Secretariat, Digital Asset Product, Operations and Risk Lead
Ernst & Young

Fabienne van Kleef
Secretariat, Graduate Analyst
GDF

Madeleine Boys
LRO Workstream Co-Chair and Sandbox Co-Chair, Business Development & Client Solutions Lead
Ownera

Justin Kenny
Secretariat, Digital Asset Product, Operations and Risk Senior Manager
Ernst & Young

Also, a big thank you to those individuals who contributed and provided legal and regulatory expertise to the working group co-chairs through bilateral discussions.

Firms Contributing to the Working Group and Industry Sandbox

- 7RIDGE
- AcadiaSoft
- Agant Finance Limited
- AlphaFMC
- AlphaPoint Corporation
- Archax
- Ashurst
- Assoc. Corporate Treasurers
- Bank of America
- Besu
- Brown, Brothers Harriman
- BitGo
- BlackRock
- Bloomberg
- BNP Paribas
- BNY
- Bolder Group
- Broadridge Financial Solutions
- Calastone
- Canton
- Capgemini
- Cara7
- Charles Schwab
- Circle
- Citi
- Cleary Gottlieb
- CloudMargin
- CME Group
- Commonwealth Bank of Australia
- Copper Securities
- Cordial systems
- Crypto Garage
- Crypto.com
- Dechert LLP
- Demand Derivatives Corp.
- DFNS
- Digital Asset
- DLA Piper
- DTI Foundation
- Ethereum
- Eunice
- EY
- Federated Hermes
- Fidelity Investments
- FINOS
- Fireblocks
- Fnality
- Franklin Templeton
- Freddie Mac
- FundConnect
- Futures Industry Association
- GDF
- GK8 by Galaxy
- Goldman Sachs
- Hgraph
- Hashgraph
- Haynes and Boone
- Hedera Foundation
- Hogan Lovells
- Intercontinental Exchange
- Investment Association
- ISLA
- ICMA
- Invesco
- Investment Adviser Assoc.
- Investment Company Inst.
- ioBuilders
- ISDA
- Jones Day
- JP Morgan
- Kaiko
- LayerZero
- LealDinis
- Liberty Group
- Likezero
- Linklaters
- LSEG
- M1X Global
- Macquarie Bank
- Mitsubishi
- Moneta Bridge
- Moody's Ratings
- Morgan Stanley
- Morgan, Lewis & Bockius
- MUFG Bank
- NatWest Markets
- Nomura
- Northern Trust
- OpenZeppelin
- OSTTRA
- Ownera
- Particula
- Patomak Global Partners
- PwC
- QCOMPUTE
- RedStone
- reifi
- Ripple
- S&P Global Ratings
- Schroders
- SEI Investments Company
- Sheppard Mullin
- SIFMA
- SIFMA AMG
- Smartstream Technologies
- Standard Bank
- Standard Chartered
- State Street
- Stellar Development Foundation
- Swift
- Synechron
- Talos
- TD Securities
- Texture Capital
- The Wealthoken
- Tokenovate
- Transcend
- Truist Bank
- U.S. Bank
- UBS
- Unum Group
- Vanguard
- WePoint
- WisdomTree

2. Executive Summary

Real-world assets ("RWA") tokenized assets under management ("AUM") have grown to US$8.4 billion as of May 2026, a 298% increase from 2024, with the tokenization of funds, government securities, and deposits now well afoot. With firms posting and receiving more margin, $1.6 trillion of non-cleared initial margin ("IM") and variation margin ("VM") was collected during year-end 2025.

Increasing cash requirements for cleared VM along with the growing use of cash for uncleared VM have highlighted the need to position the right collateral in the right place, and at the right time. This can result in both operational and liquidity challenges, especially in times of market volatility.

The number of institutions announcing RWA tokenization projects, combined with ongoing liquidity constraints and episodic market volatility events, have fueled regulatory support for digital assets and tokenized collateral in recent months, especially in the U.S.

Survey data by the ValueExchange indicates the near-term adoption of TMMFs with 66% of firms planning to launch TMMFs before the end of 2027 and 44% expecting to accept TMMFs as collateral by the end of 2027, noting that only 33% of firms viewed current MMF processes as efficient.

Using TMMFs as collateral enables collateral to move with greater speed and precision, supporting intraday margining and dynamic re-use across obligations, and have the potential to alleviate many of the constraints within the current collateral ecosystem, such as redeeming fund shares to raise cash for margin and cash sweeps back into an MMF upon redemption.

The growth and the opportunity for collateral mobility with TMMFs in the U.S. (and globally) led to the creation of a co-sponsored working group by GDF and ISDA, the U.S. Tokenized MMF Working Group, to outline the case for further adoption of TMMFs as eligible collateral in the United States.

★ Key takeaway

The working group's key objective was assessing the status of the legal, regulatory and operational certainty of using TMMFs for margin in both cleared and non-cleared derivatives in the U.S., including the requirements for real-time transfer, settlement finality, and, where permitted by regulation, re-use. For the purposes of this report, MMFs are registered under the 1940 Act section 2(a)(7).

Live near-production use cases with leading industry firms were orchestrated and demonstrated in the GDF Industry Sandbox, powered by Ownera.

The working group was structured in two workstreams:

i. Legal, Regulatory and Operations workstream, with working group plenary calls bi-weekly

ii. Sandbox workstream, with regular meetings and work to deliver 3 Sandbox Simulations over Q2 26.

The working group brought together a broad coalition of industry firms across TradFi and DeFi with more than 300 participants across over 120 firms, with 48 firms participating in the Industry Sandbox.

The framework was designed to evaluate whether TMMF shares can meet the core requirements of institutional collateral in the U.S. market, namely whether they are:

- legally recognizable and transferable
- operationally controllable
- acceptable under the relevant regulatory framework
- accessible in a default or insolvency scenario.

The framework assessed TMMFs across three tokenization models, aligned to the SEC CFTC Digital Asset Taxonomy (Page 25):

Importantly, it should be emphasized that "tokenized" assets do not constitute a separate/unique asset class; tokens are the legal record of ownership (under the Digital Native model) or a securities entitlement under the Digital Twin or Custodial models. Tokenizing assets on-chain does not recharacterize or alter the asset, it is merely a method of recording ownership.

1. **Fund Issuer Sponsored** – Digital Native (i.e., digital native): the security issuer or its transfer agent agrees to utilize DLT as the authoritative books and records (i.e., the source of truth) for the purposes of recording ownership of MMF shares

2. **Fund Issuer Sponsored** – Digital Twin (i.e., digital twin): The security issuer or its transfer agent maintains off-chain books and records as the authoritative record of ownership of MMF share ownership, while the on-chain token mirrors that record (i.e., mirror ledger)

3. **Third-Party Sponsored** – Custodial Tokenized Securities (i.e., custodial or intermediated model): a bank, broker, or other securities intermediary agrees to custody the MMF shares for clients, with its books and records reflecting this custodial arrangement either maintained on DLT or updated based on DLT.

The framework assessed the three tokenization models across ten legal and regulatory dimensions for TMMFs (Page 34):

1. Transfer Agent ("TA") recordkeeping on DLT
2. UCC Article 8 characterization (security / entitlement)
3. UCC Article 9 perfection (control / priority)
4. UCC Article 12 reliance
5. Cleared VM
6. Uncleared IM – CFTC
7. Uncleared IM – Prudential regulators
8. Uncleared IM - SEC
9. Uncleared VM (bilateral)
10. Repo & securities lending collateral

A fourth tokenization model, Synthetic Tokenized Securities (SEC CFTC Digital Asset Taxonomy), was also assessed but is considered outside of the scope of TMMFs and this report.

The analysis concluded that favorable regulatory guidance regarding a tokenization model, and/or, that a tokenization model would fit within established legal, contractual or regulatory frameworks:

- for **ALL of the** three tokenization models (Digital Native, Digital Twin, Custodial/Intermediated)
- across **EACH of the** ten legal and regulatory dimensions for TMMFs, except for two of the dimensions:
  - Cleared VM - Explicitly non-eligible as MMFs are excluded for cleared VM. A potentially significant impediment that market participants may wish to consider.
  - Uncleared IM – SEC - There is NO explicit guidance so the assumption is that tokenized securities will be treated the same as non-tokenized securities. Regulatory or legal questions regarding the tokenization model or that potential contractual changes may be required.

Additional considerations were identified across three legal and regulatory domains for TMMFs:

- **Contractual consideration:** Contractual law considerations center on whether collateral documents align with the legal mechanics of collateral transfer, control, perfection and enforcement. Accordingly, CSAs may need to be updated to account for TMMFs to identify what would constitute an effective transfer, when the pledgor's delivery obligation is satisfied, and what evidence the secured party can rely on to show control and enforceability

- **Settlement finality:** Settlement finality has multiple dimensions. In a collateral context, the main consideration is for the party receiving collateral to determine when it has the practical control and legal right to re-use that asset or enforce against it. Settlement finality for tokenized collateral should therefore be analyzed through both legal and operational principles rather than a single criterion and will differ by tokenization model

- **Insolvency and bankruptcy (US):** The "safe harbors" under the major U.S. insolvency and resolution regimes are generally transaction-based rather than technology-based or asset-based. If the relevant arrangement qualifies as a "swap agreement," "repurchase agreement," "margin loan," "loan of securities," or other "qualified financial contract" under these regimes (a "Protected Contract"), the fact that the collateral is tokenized should not, by itself, displace that protected status.

Operational considerations center around how tokenizing MMFs rewires workflows by enabling a model where collateral can be delivered or pledged directly, potentially reducing reliance on repetitive redemptions and cash sweeps across main product dimensions:

- **Uncleared, variation margin and initial margin** - TMMFs may reduce redemption-to cash steps, support faster transfer or pledge, improve visibility into control and encumbrance, and create a clearer audit trail for receipt, release, substitution, and liquidation

- **Cleared initial margin** - TMMFs may support faster collateral substitution at the CCP where MMFs are accepted, clearer receipt confirmation, and more efficient release or redeployment of cash across CCP obligations

- **Repo -** TMMFs may improve substitution speed, reduce manual position checks, and provide shared records of ownership, control, and encumbrance, subject to triparty support and agreed valuation and haircut treatment

- **Securities lending** - TMMFs may streamline collateral receipt, substitution, and return processing, while improving transparency for lenders, borrowers, custodians, and agent lenders through permissioned wallet controls and shared lifecycle records

Tokenized MMFs alter the mechanics of collateral posting, receipt, and redemption and consideration needs to be given to four key areas:

- Record of ownership and transfer agent relationship
- Collateral mobility and settlement speed
- Programmability and automated collateral management
- Collateral segregation and transparency.

Realizing the potential of TMMFs as collateral rests on a set of operational capabilities that extend beyond those used in traditional MMF workflows. Understanding both operational readiness and the structural foundations needed provides the path to industry-wide adoption of TMMFs.

There are several critical operational capabilities firms can develop as they prepare the workflows that will underpin TMMFs as collateral:

- Establishing digital asset wallet and custody capabilities
- Integrated tokenized asset capabilities into existing infrastructure
- Updating internal collateral eligibility and risk frameworks
- Building counterparty onboarding and whitelisting workflows
- Staff training and operational readiness testing.

The current landscape of tokenized asset infrastructure within the U.S. is fragmented, with multiple blockchain networks, custodial platforms, and digital asset systems operating in parallel without standardized connectivity. Key considerations of digital financial market infrastructure to enable adoption and scaling of TMMFs as collateral include:

- Public vs. permissioned chain architecture
- Interoperability
- Digital cash settlement
- Identifying tokenized collateral and the role of Digital Token Identifiers.

The GDF Industry Sandbox, powered by Ownera, is designed to move the analysis of TMMFs as collateral beyond the theoretical and into the demonstrably practical. The sandbox had three principal objectives:

- to validate interoperability across custody environments and router infrastructure
- to test whether near-instantaneous on-chain settlement can be realized within institutional workflows
- and to surface operational gaps that are not apparent from legal or theoretical analysis alone.

The sandbox ran three comprehensive simulations of increasing complexity, each with several scenarios. Each simulation moves from the most established collateral workflow to the most novel, across multiple custodians, data providers and chains.

- Simulation 1: Bilateral uncleared VM - Multi-token and cross-custodial VM pledges, dispute handling, and haircut mechanics

- Simulation 2: Cleared IM (cascade) - CCP-to-FCM-to-client cascade, DvD substitution of cash for TMMFs at the CCP, and intraday cash re-use across two CCPs

- Simulation 3: Uncleared IM (UMR) - Code-enforced third-party segregation via smart contract, and tri-party segregation on tokenized rails.

The sandbox simulations demonstrated tokenization functioned as an efficiency layer over established rails rather than as a replacement for the legal and operational structures that market participants and regulators rely on.

TMMFs can be posted, received, substituted, segregated and returned within the operational frameworks institutions already use, and that this holds across bilateral variation margin, cleared initial margin and UMR-compliant initial margin:

- Settlement completed in minutes rather than over the conventional cycle

- Pledges settled across multiple custody providers and multiple chains within single workflows

- Collateral was optimized and substituted on live market data; cash released through substitution was immediately re-usable across CCP obligations

- Initial margin was segregated through two different models, one enforced in code and one governed by an independent tri-party agent.

In every simulation scenario the existing margin and collateral tooling, including the platforms participants already operate, remained in place. The “router layer” provided interoperability without requiring direct bilateral connections or a common chain, and, in the tri-party model, the roles, approvals and governance of today’s market were preserved.

Four recommendations are outlined for the industry to continue enabling TMMFs as collateral and support increased adoption amongst industry participants:

1. Clarify and confirm legal recognition of TMMFs under U.S. commercial law and collateral documentation

2. Promote interoperable infrastructure that connects tokenized fund records with existing collateral, custody, and margin systems, leveraging industry standards and protocols

3. Facilitate the use of TMMFs within existing U.S. eligible collateral regimes where underlying MMFs are acceptable

4. Support market adoption through controlled production testing, standardized eligibility criteria, and issuer participation.

The findings in this report provide a basis for industry participants to begin assessing how TMMFs could be implemented into their collateral workflows.

The call to action to enable TMMFs as collateral in production includes:

1. Assess where TMMFs could deliver the clearest value within the firm's collateral workflows, including uncleared and cleared derivatives, securities lending, and repo

2. Identify appropriate business owners and internal governance paths for TMMF adoption, spanning collateral, treasury, legal, risk, operations, technology and client-facing teams

3. Engage counterparty priorities, issuers custodians and infrastructure providers to determine where there is sufficient mutual readiness to support first-mover use cases

4. Develop a near-term adoption roadmap that defines the firm's target use cases, required approvals, investment needs, operating model changes, and criteria for moving from testing to production pilots on shared open infrastructure

5. Participate with industry-coordinated advocacy efforts

6. Move the Sandbox activities from near-production off-market simulations to live on-market production.

The findings in this report provide a basis for industry participants to begin assessing how TMMFs could be implemented into their collateral workflows. Firms should now focus on taking the tactical next steps to identify specific workflows, counterparties, documentation changes, and operational controls that can support the first stages of live implementation. ■

3. Introduction and Opportunities Presented by TMMFs for Collateral Mobility

Following years of regulatory activity after the Global Financial Crisis ("GFC"), market participants have been posting and receiving more margin for both uncleared and cleared derivatives. This has resulted in US$1.6 trillion of non-cleared IM and VM collected during year-end 2025 and US$423.5 billion of required IM posted to major central counterparties ("CCPs") for cleared interest rate derivatives and credit default swap transactions[1].

Increasing cash requirements for cleared VM along with the growing use of cash for uncleared VM have highlighted the need to position the right collateral in the right place, and at the right time. This can result in both operational and liquidity challenges, especially in times of market volatility.

With increasing demands for high quality liquid assets ("HQLA"), firms are looking to expand their eligible collateral beyond cash, which is borne out by the 2025 ISDA Margin Survey[2], which concluded: "[T]he share of non-cash collateral grew to 51.7% of total collateral received for non-cleared derivatives exposures, with the share of cash declining to its lowest level of 48.3% at year-end 2025. Non-cash collateral accounted for 89.8% of IM and 32.4% of VM, reflecting a continued shift in the composition of collateral for non-cleared derivatives."

Against this backdrop, RWA tokenized assets under management ("AUM") has grown to US$8.4 billion as of May 2026 — a 298% increase from 2024. The infrastructure to scale tokenized collateral exists but needs to be embedded into mainstream margin and financing workflows[3].

At the time of the 'dash for cash' in March 2020 and the UK Liability Driven Investment ("LDI") Crisis in 2022, market participants were challenged meeting margin calls, especially where credit support documents required cash. In these circumstances, firms had to liquidate securities or money market fund ("MMFs") investments for cash on short notice[4,5].

While the LDI Crisis was not a "U.S." crisis, it demonstrated that a burdensome process requiring liquidating of assets to deliver cash margin during market stress was far from ideal. MMFs are designed as highly liquid instruments, they are not inherently structured for instantaneous use as collateral under traditional frameworks.

An alternative could have been to post securities and MMFs directly as VM, but challenges – especially operational challenges – arise here as well. Tokenized versions of the same assets could provide a solution, making the tokenized collateral use case strong.

★ Key takeaway

Tokenized assets and the near-instantaneous settlement improvements versus traditional settlement can allow for better liquidity management, and a reduction of collateral funding costs.

[1] ISDA-Margin-Survey-Year-end-2025.pdf
[2] ISDA-Margin-Survey-Year-end-2025.pdf
[3] https://www.dtcc.com/-/media/collateral-infrastructure-white-paper.pdf
[4] Key Lessons from the U.K. Gilt Crisis | J.P. Morgan
[5] https://www.chicagofed.org/publications/chicago-fed-letter/2023/480

In addition, the programmability of distributed ledger technology, including, in particular, the ability to use smart contracts, has the potential to improve the ability of market participants to optimize allocations of collateral and limit the risk of erroneous transfers.

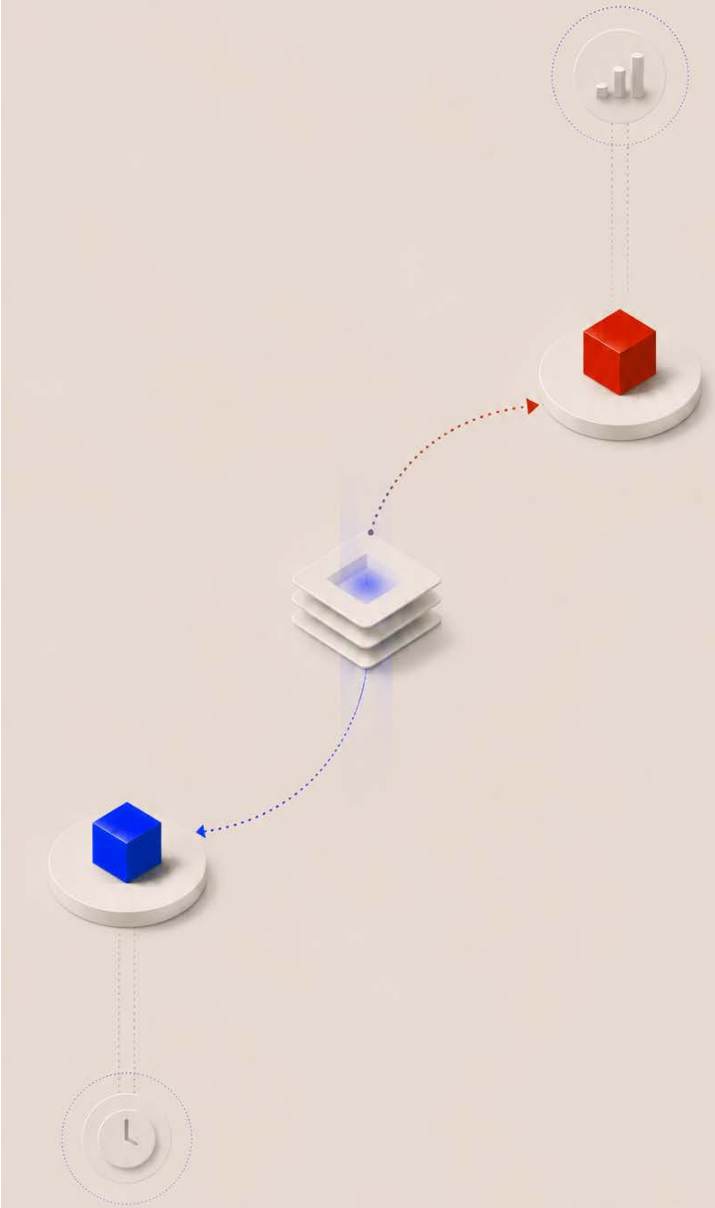
Recent studies back the notion that the market is ready for change and adoption of tokenized assets. In a recent report by the ValueExchange[6], 35% of firms are posting more than half of their collateral overnight, 77% believe that instant Delivery Versus Payment ("DVP") is the key feature of tokenization, and 72% of firms would like to use tokenized money market funds ("TMMFs") as digital money.

Additionally, the report noted that only 33% of firms viewed current MMF processes as efficient, 79% of North American MMF investments were held overnight, and more than 70% of firms identified 24/7, real-time delivery and programmability as key enablers for TMMF collateral eligibility.[7]

As a result of the market need to mitigate operational and liquidity risks with collateral and more favorable digital assets and tokenization regulatory environment, TMMFs have increased in number and AUM. ValueExchange's recent report also indicates near-term adoption, with 66% of firms planning to launch TMMFs before the end of 2027 and 44% expecting to accept TMMFs as collateral by the end of 2027[8].

Within the U.S., there are no regulatory constraints on the types of collateral to be posted for repurchase and securities lending transactions, paving the way for use of MMFs. MMFs are also allowed for cleared IM and non-cleared IM and VM in the United States. However, the operational and recordkeeping challenges mentioned above have prevented these instruments from being used at-scale for collateral management, even though they are a popular liquidity management and cash management tool.

Recent technology advances with distributed ledgers and blockchains, combined with ongoing liquidity constraints and episodic market volatility events, have fueled regulatory support for digital assets and tokenized collateral in recent months, especially in the United States.



Key takeaway

[6] The Case for Collateral Tokenisation: https://thevx.io/wp-content/uploads/2025/11/VX-2025-11-The-case-forcollateral-tokenisation-Key-findings.pdf
[7] The case for Tokenised Money Market Funds – Key Findings (May 2026)
[8] The case for Tokenised Money Market Funds – Key Findings (May 2026)
[9] CFTC Tokenized Collateral Guidance (Dec. 8, 2025) https://www.cftc.gov/csl/25-39/download

In December 2025, the Commodity Futures Trading Commission ("CFTC") released guidance[9] that encouraged market participants proposing to use tokenized assets as eligible collateral to consider legal enforceability, segregation, custody and control arrangements, haircuts and valuation and operational risks.

Also in December 2025, the Depository Trust Company ("DTC") received No-Action Relief from the SEC that permitted DTC participants to elect to have their security entitlements to DTC-held securities recorded using distributed ledger technology ("DLT") as Tokenized Entitlements, rather than only through DTC's existing traditional book-entry ledger.

The U.S. Tokenized MMF Working Group sought to capitalize on the recent market and regulatory momentum and assessed the legal, regulatory and operational feasibility in utilizing MMFs as collateral. The working group was co-sponsored by Global Digital Finance (GDF) and the International Swaps and Derivatives Association (ISDA), with approximately 300 participants representing more than 120 firms. The 2026 report looks to build on the core themes of 2025 E.U./U.K. report sponsored by GDF, covering legal recognition, eligibility, operational feasibility, and market adoption, but anchored to the U.S. legal and market structure.

The working group is concerned with whether tokenized fund structures could operate as institutional collateral within existing U.S. frameworks with legal and regulatory certainty, including treating legal eligibility and operational feasibility as separate but related tests. A structure may be lawful in principle but still must prove it is market-ready and operationally feasible. This includes confirming that collateral does not become trapped in closed custody arrangements, documentation amendments are not too extensive, and liquidation can occur within the timelines expected in a margin default scenario.

a) Why collateral mobility in the United States is ready for digital transformation

Recent regulatory and market developments have accelerated the case for reassessing how MMF exposure moves through U.S. collateral workflows. Collateral mobility in the U.S. remains constrained by timing, process fragmentation, and dependence on cash conversion. Firms can post cash, Treasuries, and selected non-cash assets under established agreements, but the path from ownership to usable collateral is still shaped by cut-off times, intermediated transfers, antiquated recordkeeping, and market-hour limitations.

Operating models work for standard daily cycles, but are less well suited to intraday liquidity demands, cross-time-zone activity, and collateral optimization across large dealer and buy-side books. For the purposes of this report, collateral mobility refers to the ability to transfer, pledge, substitute, and where permitted, re-use eligible collateral with enough legal certainty and operational speed to support institutional funding and margin requirements.

MMFs sit at the center of this constraint. In practice, the use of MMFs as collateral is not efficient because firms must redeem fund shares to raise cash for margin rather than transfer interest in the fund shares themselves. The custodian then typically sweeps the cash back into an MMF.

This redemption-post-sweep pattern adds steps, introduces timing gaps, and can leave balance sheets carrying idle cash buffers that are larger than firms would prefer. This indirect cash conversion pattern is most relevant to

[9] CFTC Tokenized Collateral Guidance (Dec. 8, 2025) https://www.cftc.gov/csl/25-39/download

bilateral margin workflows. Cleared margin, as well as repo and securities lending markets, have different operating rails where frictions may differ from uncleared margin.

Tokenization and DLT are attracting increased attention as a potential solution that can transform the financial services industry, disrupt the current market infrastructure, and re-wire collateral workflows. Recent policy and market developments make a closer examination of TMMFs as collateral a timely objective. U.S. regulators have signaled greater openness to tokenization structures that preserve investor protection and fit within existing legal frameworks.

TMMFs have the potential to alleviate many of the constraints within the current collateral ecosystem. By allowing fund interests to be transferred and pledged directly without the need to convert to cash, which often introduces manual operational complications, TMMFs enable collateral to move with greater speed and precision, supporting intraday margining and dynamic re-use across obligations.

This shift transforms MMFs from a liquidity utility into optimal collateral, reducing friction, operational risk, and excess liquidity buffers that constrain balance sheets while supporting increased yield potential, optimization, and look-through capabilities.

FIGURE 1: Current-state MMF collateral versus tokenized MMF collateral

Dimension	Traditional MMF workflow	Tokenized MMF target state
Primary path to margin use	Redeem shares, receive cash, post cash, often swept back into a fund	Transfer or pledge the fund interest directly, subject to eligibility and control requirements
Timing profile	Fund cut-offs and transfer-agent processing windows shape timing	Potential for intraday or near-realtime 24/7 movement, subject to platform and cash-leg readiness
Operational burden	Higher reliance on manual coordination across custodians agents and systems	More automation possible, but new wallet, governance, and exception processes are required
Stress behavior	Redemption demand may rise when cash is needed quickly	Direct transfer may reduce redemption dependence, but insolvency frameworks still apply
Re-use where permitted	Often limited by servicing frictions, custody silos and lack of transferability	Improved mobility may support reuse where contract, transfer agent and regulations permit

While these developments help pave the way for broader adoption of tokenized collateral use cases, widespread market adoption is also dependent on further qualification and analysis. Tokenization models must provide legal certainty while operational scale is dependent upon custody, settlement documentation, and interoperability.

The policy direction is gaining increased clarity, and the industry now has enough live guidance and market infrastructure activity to assess TMMFs as a serious collateral use case rather than a theoretical concept. The U.S. is well positioned to lead the transformation of collateral management through the tokenization of assets due to its robust financial infrastructure, regulatory framework, and technological innovation spearheaded by key market participants.

Both the regulatory and market adoption factors create an ideal landscape for the widespread adoption of tokenized collateral, positioning the U.S. and its market participants at the forefront of this shift in the global financial market.

This report establishes the legal and regulatory cases for utilizing TMMFs as collateral within the United States with operational considerations and through the use of an industry sandbox, near production use cases of collateral mobility with leading industry firms.

Particular attention is paid to collateral eligibility considerations, legal structuring, and conditions required for market adoption. This report evaluates how TMMFs may function within existing margin frameworks and where regulatory action may be required to enable full effectiveness and broader market adoption.

b) Quantifying the business case

Tokenized collateral may improve regulatory and economic efficiency through three primary channels[10]:

a. First, if tokenized rails reduce wholesale funding exposures by 15% while firms continue to target a 130% Liquidity Coverage Ratio ("LCR"), modeling suggests HQLA needs could decline by roughly 17%.

b. Second, faster-settling collateral can improve Standardized Approach for Counterparty Credit Risk ("SA-CCR") outcomes: moving from a 0.3 to a 0.2 maturity factor may reduce SA-CCR-related exposure by as much as 33% for entities currently assessed at a 100% risk weight.

c. Third, always-on collateral mobility may release a portion of the capital firms currently hold against intraday liquidity needs, with industry analysis indicating that up to 200 basis points could potentially be unlocked.

The economic significance of unlocked collateral mobility is also visible in the size of existing liquidity buffers. The Bank for International Settlements (BIS) data show that U.S. banks held an average Fedwire daylight buffer of $630 billion between 2008 and 2018; the Eurosystem equivalent averaged $443 billion with peaks of $800 billion[11].

[10] Collateral Infrastructure for Tokenized Capital Markets
[11] BIS statistics | BIS Data Portal

JD Risk and UBS estimate the all-in cost of these buffers at approximately US$600 million per year for a top-tier Fedwire participant[12]. Even a modest reduction – DTCC and Finadium suggest daylight overdraft costs alone could be cut by up to half – produces annualized savings in the millions of dollars for a large dealer bank.

The same report outlines a revenue growth scenario, assuming a three-to six-month implementation timeline and 2% conversion of eligible flows, that models a year one outcome of US$150 million in freed capital and US$9 million in incremental revenue for a single large dealer bank. By year three, at 25% adoption, the same model projects US$1.9 billion in freed capital and US$225 million in incremental revenue, with cumulative project revenue reaching US$114 million by year four.

Independent operational data points support this scenario with J.P. Morgan reporting a 56% decrease in operational costs for intraday repos versus traditional funding workflows[13].

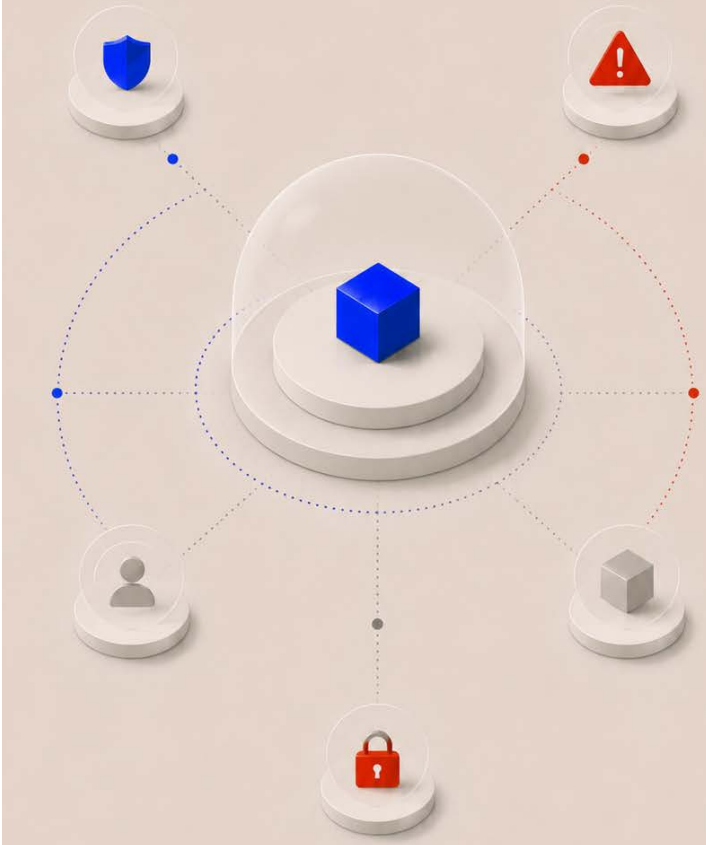
Although not specific to TMMFs, a 2025 study by The ValueExchange noted that "tokenized collateral is expected to deliver immediate savings of US$346 million to tier 1 firms." Their estimate takes into consideration the total value of collateral that is posted in excess and not reused, the average expected increase in mobilization of overnight collateral that is also not reused, and the average expected reduction in excess collateral through tokenization.[14]

c) Opportunity and scope

Utilizing TMMFs as recognized collateral introduces complexities that extend well beyond the challenges of technology integration. While traditional MMFs are permissible as collateral within bilateral arrangements, the process of tokenization reshapes the legal considerations, operational workflow, and regulatory status that determine how funds can be used.

Market participants must also address new risks that arise from the tokenization process itself and evaluate how these could affect the overall practicality and suitability of deploying TMMFs as collateral.

Tokenized collateral must operate reliably within existing legal, operational, and risk frameworks to function as effective collateral within institutional



[12] Optimizing-Intraday-Liquidity-Management---JD-Risk-Solutions-White-Paper.pdf
[13] Kinexys-Digital-Financing_case_study.pdf
[14] The Case for Collateral Tokenisation: VX-2025-11-The-case-for-collateral-tokenisation-Key-findings.pdf

markets. Counterparties require confidence that the asset can be transferred, controlled, and enforced in a way that aligns with established margin practices, including during periods of market stress.

It is one thing to introduce a new and innovative technology that comes with a new language to mainstream industry, in an already technical product, legal, and compliance landscape. It is another thing to confidently confirm the nuance of legal, regulatory, and operational certainty of this new innovative technology, while de-risking its implementation and realizing its espoused benefits to the high standards the financial services sector sets – a great set of challenges.

One of the main challenges in the existing collateral ecosystem is the need for several manual touchpoints and participation by many participants (e.g., clearinghouses, central securities depositories). While DLT and tokenization are expected to streamline operations, posting and receiving collateral in a tokenized ecosystem will still involve custodians, transfer agents, collateral managers, banks, and internal risk and margin platforms, albeit with adjusted roles within the value chain. Without interoperability across custody, ledger and margin systems, tokenization risks shifting operational friction rather than removing it. Section 8: Tokenized Collateral Real Use Cases in the U.S. Sandbox demonstrates how a router-based architecture addresses that risk in practice, providing the means to scale to institutional volumes across asset classes and jurisdictions, with a multi-chain design by default.

Given these challenges, the analysis contained within this report focuses on whether TMMFs can viably function as collateral in an end-to-end U.S. market context. This includes assessing how different tokenization models behave under U.S. law and whether TMMFs can be recognized, transferred, and enforced as collateral under standard collateral documentation.

Operational considerations, such as eligibility checks, valuation, settlement timing, exception handling, among others, are treated as equally important to legal form and eligibility. Several items fall outside the core scope of this report. The report does not attempt to resolve the prudential capital treatment of tokenization models but instead flags recent capital rule guidance and rules that may influence future treatment. It also does not address tax treatment, accounting treatment, or the treatment of cross-border conflicts of law.

d) Background on Traditional MMFs

Traditional MMFs are widely used cash-management vehicles that provide daily liquidity, emphasize principal stability, and generate yields linked to short-term interest rates. They play a critical financing role in the U.S. economy by investing in high-quality, short-term instruments such as U.S. Treasury bills, repo, commercial paper, and municipal obligations, depending on whether the fund is structured as a government, prime, or tax-exempt MMF.

All MMFs are registered investment companies under the Investment Company Act of 1940 and subject to Rule 2a-7, which imposes requirements around portfolio quality, maturity, and diversification, making MMFs generally lower-risk, regulated investment products, albeit with correspondingly lower expected returns. Any assessment of TMMFs should be grounded in how traditional MMFs are actually used in today's collateral ecosystem. While MMFs serve as important liquidity-management tools for institutional investors, dealers, and asset managers, their direct use as collateral remains narrow in practice.

Under United States Prudential Regulators and CFTC eligible collateral rules, only MMFs that include government securities are permitted for both IM and VM for uncleared derivatives. However, regulators also include asset-transfer

Key takeaway

restrictions that exclude MMFs that use securities lending, repo, reverse repo, and similar arrangements, materially narrowing the universe of eligible U.S. MMFs. Industry participants have been advocating for the removal of asset transfer restrictions from eligible MMFs since 2019[15], [16]. The CFTC noted in 2026 that it will seek to finalize proposals to amend these requirements.

The core case for TMMFs centers on their potential to improve the transferability, control, and recognition of fund interests within collateral workflows, as well as compelling economic benefits. Tokenization may reduce operational frictions by enabling direct movement of fund interests, programmable transfer restrictions, clearer records of encumbrance and release, and potentially atomic or near-simultaneous collateral and cash movement, provided that the receiving party accepts the asset, the custody and control model is legally robust, and the redemption or liquidation path works on the required margin timeline.

e) The Working Group and Sandbox

The U.S. Working Group has adopted the same structure as last year's E.U./U.K. working group and industry sandbox, adapting the frameworks and use cases for U.S. law, U.S. margin rules, and U.S. market structure, and where necessary, introduced new frameworks.

Two coordinated workstreams support the effort:

- A Legal, Regulatory, and Operations workstream that evaluates tokenization models and tests whether those models can fit within established market practices

- An Industry Sandbox workstream that simulates end-to-end workflows and highlights where legal analysis meets operational design.

Legal, Regulatory, and Operations Workstream

Building on frameworks developed during the E.U. U.K. working group, this stream aims to establish an analytical foundation by mapping potential tokenization structures, including digitally native, digital twin, and custodial or intermediated models, based on existing market frameworks and use cases. It then assesses the structures against regulatory and legal considerations, including Uniform Commercial Code ("UCC") considerations and contractual considerations.

The approach involves legal analysis, validation of findings with working group participants, and coordination with Sandbox simulations to ensure alignment between legal and operational analyses. The dual-track approach ensures that concepts are rigorously tested in practice, enabling the working group to advance the conversation around tokenized collateral in the U.S. market.

The dual-track workstream design aims to recognize where the law may already support adoption, where documentation will need to change, and where technology still must mature. The working group structure supports that outcome by keeping the legal and operational tracks in dialogue rather than treating them as separate exercises.

[15] ISDA-Letter-to-US-Regulators-Cash-and-Money-Market-Funds-as-Initial-Margin-8.1.19.pdf
[16] ISDA-Letter-Reiterating-Support-for-CFTC-Margin-Proposal-with-Comment-Letter-041426.pdf

Sandbox Workstream

Building on the simulations conducted during the E.U. U.K. working group[17], this stream translates theory into practice by simulating real-world workflows, including collateral posting, variation margin calls, substitutions, on-chain settlements, insolvency scenarios, and redemptions, all within a controlled production environment.

The GDF Industry Sandbox, powered by Ownera, utilizes an AWS-hosted testbed integrated via the FinP2P protocol to simulate all technical components of trade flows across multiple DLT platforms.

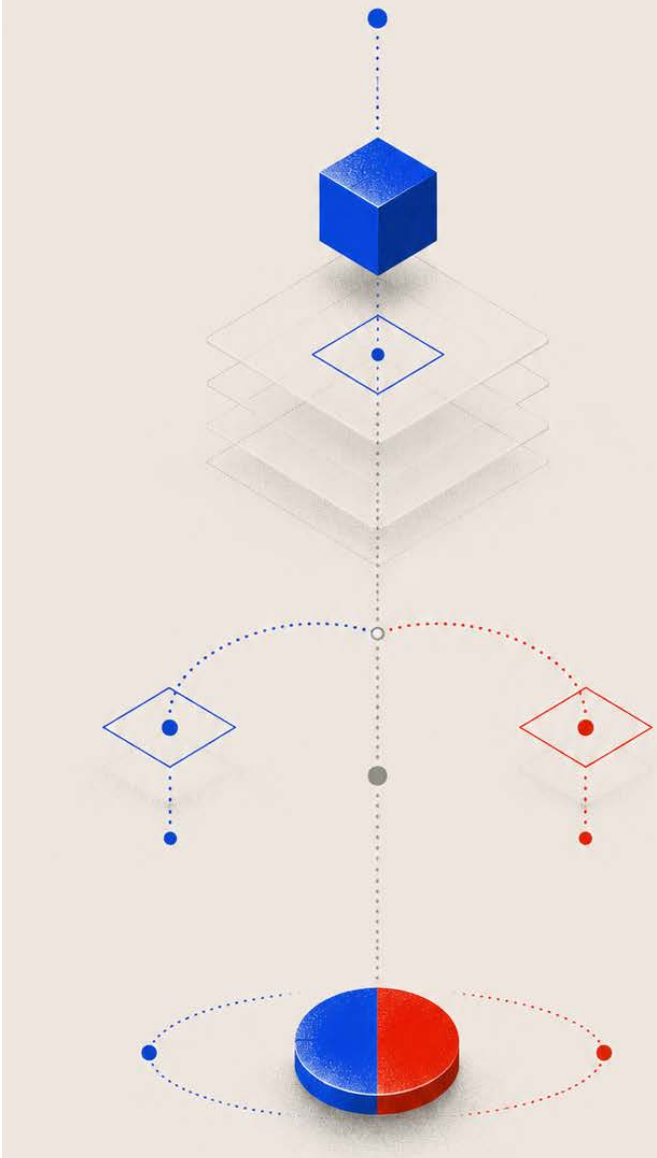
Use cases were selected based on identified pain points (e.g., settlement speed, collateral lockup), taking into considerations what was proven in the E.U. and U.K. sandbox to not repeat all simulation factors.

This included a de-peg simulation, where a real-time NAV shock triggered an automated, onchain substitution of the deteriorating collateral via atomic delivery-versus-delivery (DvD) swaps, replacing the affected asset within seconds and without interrupting trading or requiring the manual margin calls today's systems would demand, demonstrating a model of intraday risk management the legacy collateral chain cannot match.

Similarly, a default simulation stresstested enforceability: under a counterparty default, the TMMFs were seized and redeemed unilaterally by the collateral taker, without the defaulter's consent and with clear audit trails, confirming that English-law title transfer holds in a tokenized environment to the settlementfinality and insolvency standards regulators and custodians require. A repo use case extended this further to tri-party funding, showing that intraday liquidity could be mobilized in minutes while the posted collateral continued to accrue yield.

Underpinning these flows, the Common Domain Model (CDM) was used to define and align the terms of the underlying agreements, so that margin calls generated from CDM-based analytics fed directly into DLT actions, giving the simulations a standardized, machine-readable data layer that bridged participants' legacy risk engines and on-chain collateral workflows.

The outcome created a live testing environment to demonstrate feasibility, identify edge-case risk issues (e.g., DLT finality, re-use considerations), and validate the legal risk scoring from the Legal, Operations and Regulatory stream, all feeding back into the analytical framework to ensure findings are not merely theoretical but proof-tested. ■



[17] https://www.gdf.io/wp-content/uploads/2020/12/GDF_-UKEU_TMMF-report-1.pdf

4. Tokenized Collateral Legal and Regulatory Assessment in the U.S.

The core question for U.S. market participants is whether TMMF shares can perform like institutional collateral. That means they must be legally recognizable and transferable, operationally controllable, acceptable under the relevant regulatory framework, and accessible in a default or insolvency scenario. A token that moves quickly but cannot be subject to a perfected security interest, re-used when permitted, or liquidated promptly upon a default would be of little use.

a) Framework for assessing tokenized collateral in the U.S.

The U.S. working group adapted the 2025 E.U. U.K. assessment framework and assessed TMMFs across three primary tokenization models:

- **Fund Issuer Sponsored – Digital Native (i.e., digital native):** the security issuer or its transfer agent agrees to utilize DLT as the authoritative books and records (i.e., the source of truth) for the purposes of recording ownership of MMF shares. The SEC staff has confirmed the suitability of this model in FAQs issued by the Division of Trading and Markets in May 15, 2025 (updated Feb. 19, 2026), noting that transfer agents may utilize DLT as the master securityholder file.[18],[19] Minting of the fund share token can be facilitated either by the fund issuer or by a third-party tokenization platform on behalf of the issuer

- **Fund Issuer Sponsored – Digital Twin (i.e., digital twin):** The security issuer or its transfer agent maintains off-chain books and records as the authoritative record of ownership of MMF share ownership, while the on-chain token mirrors that record (i.e., mirror ledger). The security issuer or transfer agent agrees to update its off-chain books and records immediately, at specified intervals, or on-demand based on the transfers recorded on DLT

- **Third-Party Sponsored – Custodial Tokenized Securities (i.e., custodial or intermediated model):** a bank, broker, or other securities intermediary agrees to custody the MMF shares for clients, with its books and records reflecting this custodial arrangement either maintained on DLT or updated based on DLT. The custodian/ intermediary does not act as an agent on behalf of the issuer in the same manner as a transfer agent. This model is indifferent as to how the transfer agent records ownership, whether under a digitally-native or digital twin model or under a traditional, non-DLT model.

The three main fund models listed above were assessed in accordance with the SEC's Statement on Tokenized Securities. In addition to these three models, the SEC digital asset taxonomy includes details on Synthetic Tokenized Securities, which was not considered in-scope for this working group assessment as synthetic tokens do not grant investors rights as

[18] https://www.sec.gov/rules-regulations/staff-guidance/trading-markets-frequently-asked-questions/frequentlyasked-questions-relating-crypto-asset-activities-distributed-ledger-technology
[19] SEC.gov | Statement on Tokenized Securities

shareholders or beneficial owners and are merely contractual claims against the token minter. The working group concluded that such tokens would present such regulatory, legal and commercial challenges to limit their suitability as institutional collateral, at least in the short term. Additional details on each fund model can be found in Section 9: Appendices.

An additional model that was not in-scope of this report is the custodian receipt (i.e., "wrapped asset") model. Under this model, the token constitutes a receipt for a security, similar to an American Depository Receipt or a warehouse receipt. Considering that receipts for securities are generally treated as separate securities under U.S. securities laws but not necessarily as securities for U.S. commercial law purposes, the working group found that this model would likely present regulatory, commercial law, and other challenges that would limit its suitability as institutional collateral.

Regardless of the tokenization model, the working group's analysis concluded that, to achieve the goals outlined above, it would be optimal to structure the TMMF in a way that it qualifies as either a "security" or "security entitlement" under Article 8 of the UCC.

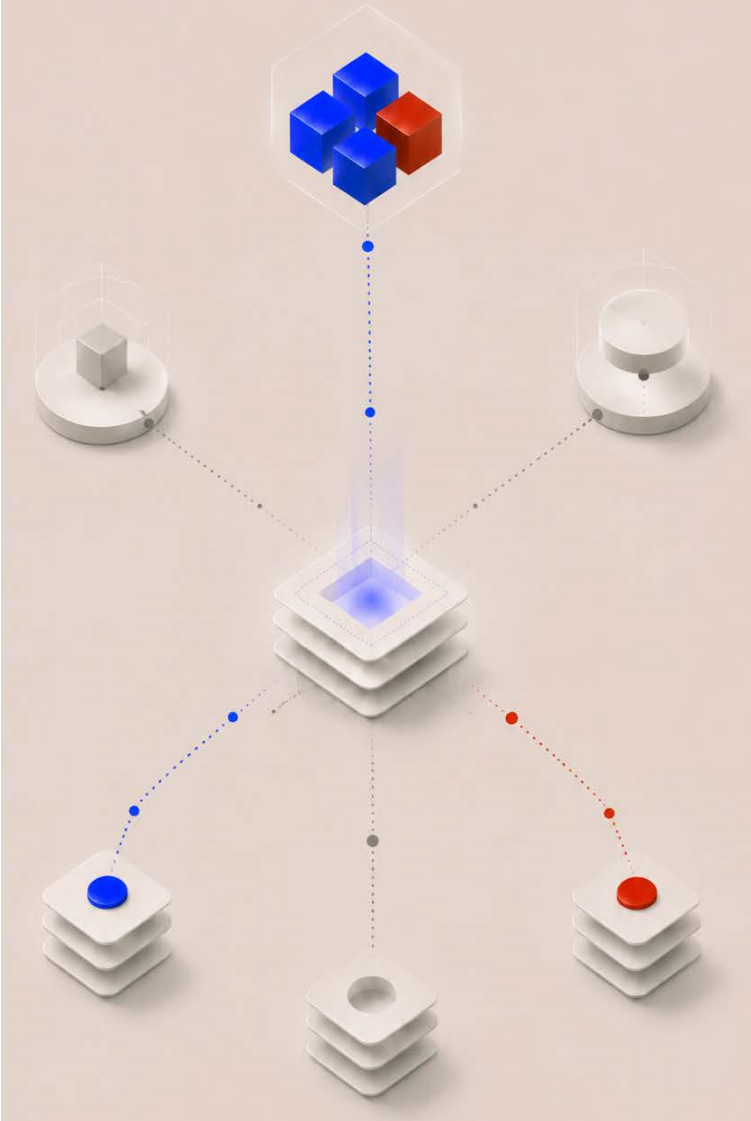
While the analysis concluded that each of the three models can provide legal and regulatory certainty under existing U.S. laws and regulatory frameworks, they should be viewed as points along an evolving spectrum of operating maturity, rather than as a fixed hierarchy or near-term ranking.

The digitally native model is evolving rapidly as on-chain transfer agency, control frameworks, programmable compliance, and operational governance mature, native issuance is becoming increasingly viable as a primary collateral pathway alongside the digital twin and custodial or intermediated models.

Regardless of which model is chosen, the decisive question is whether the issuer and its transfer agent (or, in the custodial case, the responsible intermediary) have the operational controls, monitoring, and resilience required to manage the blockchain risk and comply with legal (e.g., UCC) and regulatory (e.g., SEC) requirements.

So long as these requirements are met, any of the three models can support institutional collateral use in a manner that secured parties, CCPs, and opinion providers will accept.

The operational requirements that issuers and transfer agents must satisfy to support TMMFs as collateral, particularly under digitally native and digital twin structures, should also be set at a standard consistent with regulatory expectations and international norms regarding operational resilience adopted in financial services.



Key takeaway

FIGURE 2: Overview of Universal Commercial Code (UCC) Section 8, 9 and 12

The U.S. UCC is the key in enabling TMMFs as collateral as it provides the legal framework for establishing a perfected security interest in financial assets, including digital representations of fund shares. TMMFs must be recognized, pledged, and enforced as collateral with clear priority rights in the event of default, aligning with existing collateral markets and frameworks.

UCC Section	Overview	Why it's important to TMMFs
Article 8 – Investment Securities	Governs the issuance, ownership, transfer, and control of securities held directly or through intermediaries, including the concept of "security entitlements" in the indirect holding system.	Provides the legal foundation for treatment of tokenized MMF shares as "securities" when recorded on the books and records of an issuer or its TA – either as a "native" token or on a "twin ledger" - and as "security entitlements" when holding is intermediated (i.e., "held in custody") and enables clear rules around ownership, transfer and investor protections.
Article 9 – Secured Transactions	Establishes the framework for creating, perfecting, and enforcing security interests in personal property, including investment property.	Critical for enabling tokenized MMF shares to be used as collateral in repo, margin arrangements and financing transactions, clarifying how lenders obtain and perfect security interests – and re-use these as assets move across wallets, platforms or protocols.
Article 12 – Controllable Electronic Records	Introduces a new legal regime for "controllable electronic records" ("CERs"), and – through revised UCC Article 9 - provides that control is sufficient to perfect a security interest in, and benefit from take-free rules in relation to, rights in certain digital assets.	Can provide legal certainty for digitally native representations of MMF ownership for certain rights but generally provides less certainty than Article 8.

The goal in structuring TMMFs as "securities" or "security entitlements" is to ensure two things:

- that a secured party can establish its interest in the TMMF simply by taking control of the token
- that well-established "take-free" rules apply, providing settlement finality and limiting the risk that another party later claims ownership of the same tokenized assets. Treating TMMF shares as a "security" or "security entitlement" under Article 8 allows them to be treated as "investment property" under Article 9[20].

This, in turn, creates the framework for "perfection," which is the necessary legal step ensuring a security interest is enforceable against a third party (or the pledgor itself in its bankruptcy). In addition, this enables the application of the UCC's "take-free" rule protections that facilitate collateral re-use [21],[22].

Note that if the TMMF does not constitute a security or security entitlement under Article 8, it would likely constitute a "general intangible." Although newly created Article 12 may provide perfection and take-free rules applicable to a general intangible recorded using DLT, these protections may be limited in the context of tokenized representations of TMMF shares and may not extend to any "linked" or "tethered" rights, depending on the application of other law[23].

Moreover, a third of the states in the U.S. have not adopted Article 12, and it is not generally feasible to force courts in States that have not adopted Article 12 to apply that legislation. Additionally, under a digital twin model or any model where the record of ownership is separate from the asset, Article 12 may not be relevant and provides much less certainty than Article 8.

In the context of shares or other instruments that are not represented through paper certificates, the UCC's definition of "security" requires that transfers of the instrument "be registered on books maintained for that purpose by or on behalf of the issuer."[24],[25]

The "security entitlement" definition is more flexible, as it can generally be satisfied where a securities intermediary, including an entity that maintains securities accounts for others in the ordinary course of its business, undertakes to treat a person (known as an "entitlement holder") as entitled to exercise the rights concerning a security or other financial asset.

Notably, unlike in the context of "securities," the UCC does not appear to specify how a securities intermediary must record or evidence that a person is an entitlement holder[25],[26].

[20] https://www.law.cornell.edu/ucc/9/9-102

[21] https://www.law.cornell.edu/ucc/8/8-303

[22] https://www.law.cornell.edu/ucc/8/8-502

[23] Uniform Commercial Code Amendments (2022) Final Act with Comments; Page 243

[24] While UCC Section 8-103(c) clarifies that an investment company security is a security under the UCC, the official comments make clear that such provision is meant to address the fact that investment company securities are often redeemed rather than traded. It is not premised on a notion that investment company securities would be recorded in a different manner than other securities. Moreover, other provisions of Article 8 are premised on the idea that issuer has its own books and records or books and records maintained for the issuer.

[25] https://www.law.cornell.edu/ucc/8/8-102

[26] https://www.law.cornell.edu/ucc/8/8-501

Considering the above, digital twin models that clearly involve the transfer of securities on the issuer's or transfer agent's books and records as well as custodial or intermediated structures under which the intermediary agrees to act as a securities intermediary under the UCC provide strong legal and regulatory certainty for institutional collateral use.

Digitally native models that rely on permissioned ledgers, or on public ledgers with sufficient internal recordkeeping by the issuer or transfer agent to constitute registration of transfers, provide equivalent legal protections.

One consideration of the digital twin model is that it introduces reconciliation complexity. Institutions must be able to demonstrate, at any point in time, that on-chain token positions, fund entitlements, and collateral system records are aligned, particularly during margin calls or default scenarios.

This process is especially important for regulatory reporting and audit requirements. Certain institutions have elected to utilize the digital native model on public chains but first were required to implement adequate risk and control frameworks and operational resilience of such record keeping.

TMMFs as collateral have been evaluated under six critical considerations that matter to market participants and regulators. These categories are rehypothecation and re-use, UCC applicability, regulatory requirements, contractual considerations, settlement finality, and insolvency to explain which model is most likely to support production collateral activity in the U.S, which risks still need to be addressed, and what facts are driving that conclusion.

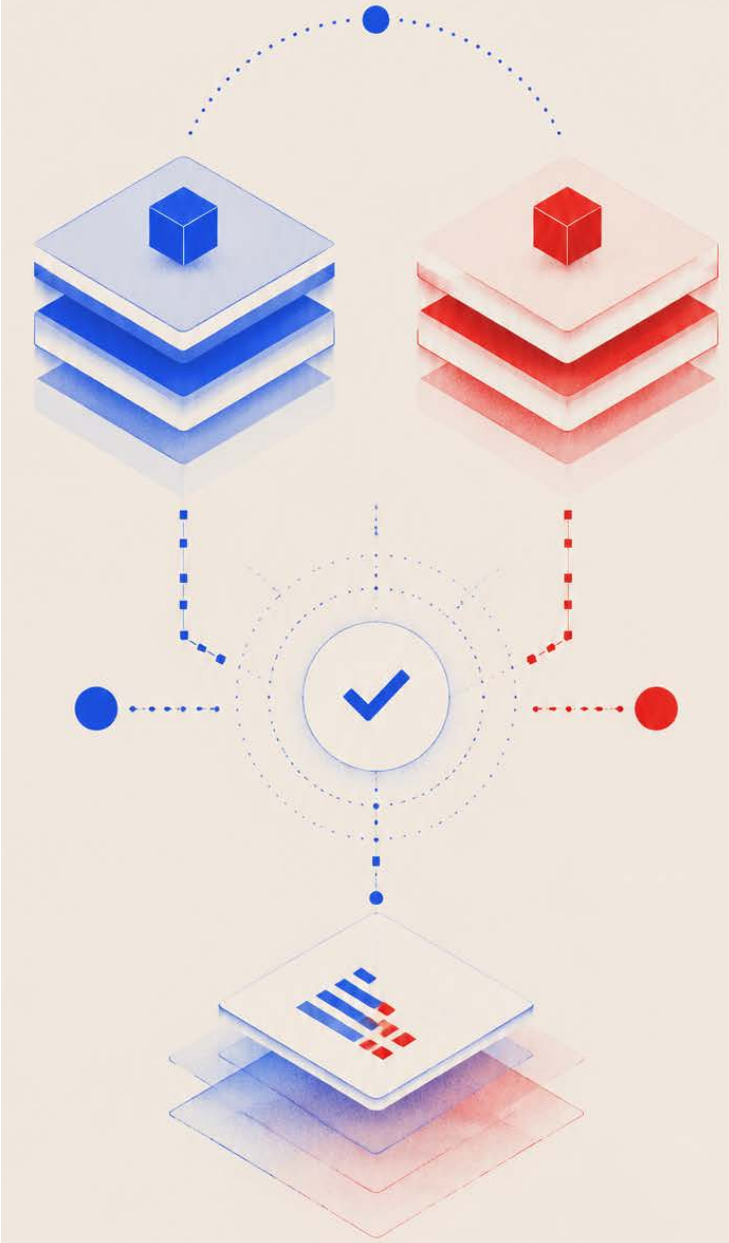


FIGURE 3: Feasibility view across the three primary tokenized MMF models

Model	Near-term feasibility view	What forms that view
Digital native	Acceptable and market adopted, but higher proof burden	Offers the strongest mobility and programmability, but UCC analysis depends on how the issuer or its agent refers to the tokenized asset on the blockchain to comply with the definition of "security," whether transfers are registered on books maintained by or on behalf of the issuer, whether the control framework is robust, and whether market participants accept the ledger (as maintained by the issuer or its agent) as the operative record for collateral purposes.
Digital twin	Low barriers to entry as it leans on existing infrastructure (legal, regulatory, and operational)	Preserves the transfer agent or issuer off-chain register as the legal source of truth for recording ownership, fits more cleanly within UCC definition of "security," and reduces novelty in perfection and control analysis. Counterparties, custodians, and regulators will already be familiar with the structure because it mimics today's workflows, roles and responsibilities.
Custodial or intermediated	Currently operational but limited buy-in from clients due to potential operational friction from onboarding and intercustodian arrangements	Uses the existing "securities intermediary" framework under the UCC, which is the same framework that currently governs most securities in the US today and which provides legal certainty on perfection and control. Users will need to assess the counterparty risk associated with these structures as it may change the rating of the asset.

TMMFs are not a single, uniform legal product. Legal permissibility depends on the structure of the vehicle. In the U.S. market, the strongest near-term pathway is a model that keeps an issuer, transfer agent, or intermediary as the recognized party responsible for maintaining authoritative books and records for recording ownership of shares, whether utilizing off-chain or on-chain books and records, while delivering transfer speed and control to improve collateral mobility.

State law implications are also critical in assessing legal certainty. Massachusetts and Delaware are highly relevant to this analysis because many MMFs and custodians are domiciled in these states. New York is also highly relevant as it is typically chosen as the governing law for key transaction documents (e.g., Credit Support Annexes).

Differences across Massachusetts, Delaware, and New York are less material for vehicles that fit within the security and security entitlement definitions of Articles 8 and 9. Article 12 has not been fully adopted across all States, causing a practical constraint for reliance on Article 12. Of particular note, Massachusetts has not adopted Article 12.

b) Rehypothecation and re-use considerations

Re-use eligibility is critical in offering meaningful collateral utility. A collateral asset that can only be held passively may reduce some transfer friction, but it does little to improve balance sheet efficiency for the receiving side. By contrast, an asset that can be re-used or redeployed, where the relevant transaction structure and regulatory framework permit that outcome, provides clear funding value to the recipient. The legal and commercial analysis must distinguish between markets in which re-use is permitted and those in which it is restricted by design.

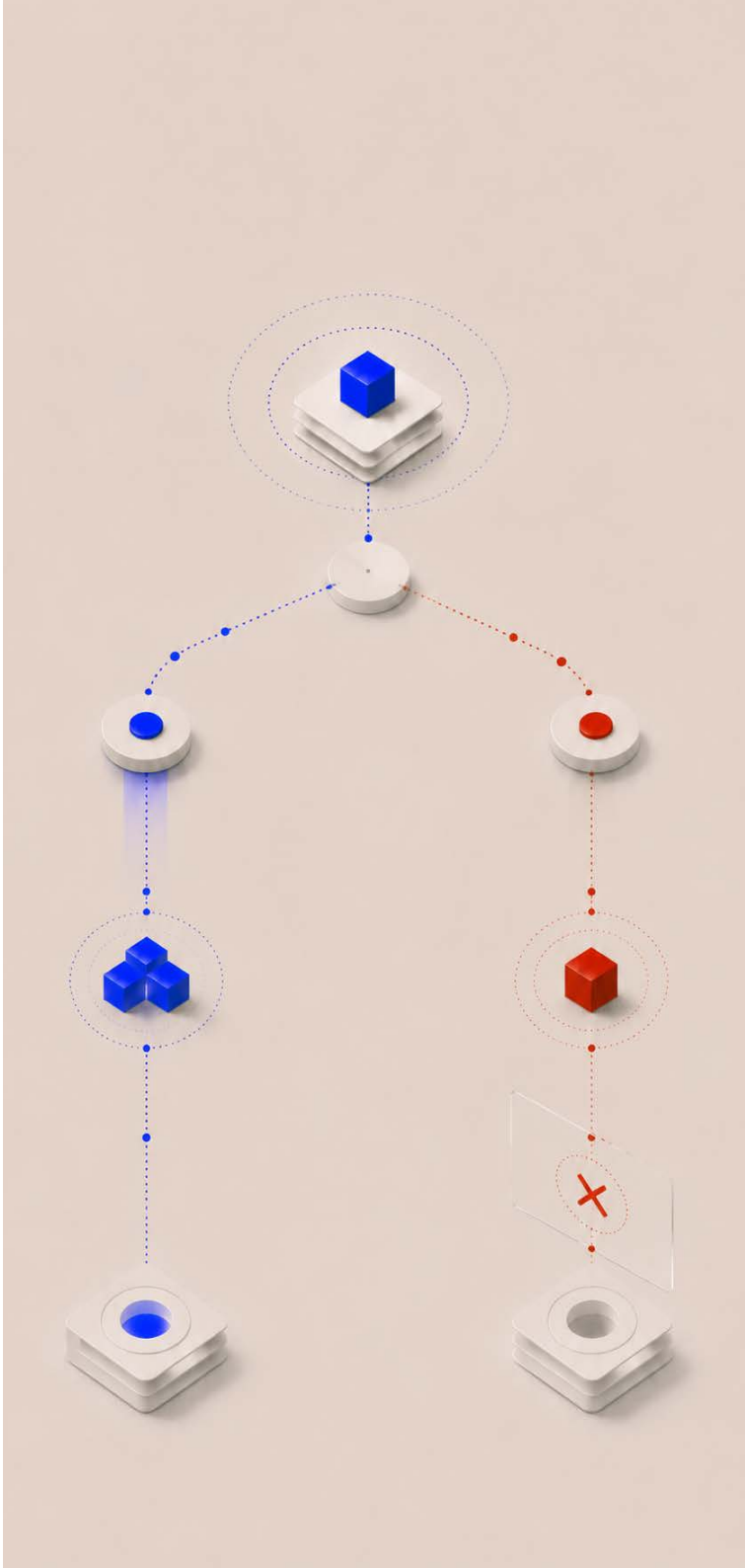


FIGURE 4: Key derivatives terms

Derivatives term	Near-term feasibility view
Regulatory initial margin (IM)	IM is a form of collateral required by regulation to minimize current and potential risk exposure. IM is based on the theoretical losses a party might suffer in the event of another party defaulting, but only due to mark-to-market movements from the date of the last variation margin posting, therefore covering potential future exposure and not current exposure. IM is intended to serve as a buffer throughout the transaction lifecycle and protecting one party against the default of the other party. IM requirements differ across regulatory regimes, primarily in their scope of products and entities covered, the counterparties that must exchange IM, the thresholds and exemptions that apply, and the prescribed approaches to eligible collateral, segregation, and calculation methodologies.
Variation margin (VM)	Primarily used as a risk management tool, VM is the amount of collateral exchanged (often daily or intraday) between counterparties to reflect gains or losses on cleared or uncleared derivatives positions due to price movement, ensuring that exposures remain fully collateralized as market prices fluctuate.
Rehypothecation (re-use)	The practice whereby a collateral receiver is permitted to repledge or otherwise re-use posted collateral for its own funding, investment, or transaction purposes, subject to contractual terms and applicable regulatory restrictions. Rehypothecation occurs when banks, brokers, or other financial institutions re-use assets posted as collateral by clients to secure their own borrowings or transactions.

Under current U.S. CFTC and prudential regulator rules, regulatory IM remains subject to strict segregation and limited re-use. Regardless of the regime, tokenization does not alter these provisions, and in the case of the CFTC and prudential regulator rules, the tokenized asset does not create a new right to rehypothecate.

For VM, repurchase agreements, and securities lending, the picture is different. Those markets generally can support title transfer or other forms of re-use subject to the contract and the applicable rules.

Under SEC rules governing 1940 Act Funds, all collateral posted by a 1940 Act Fund is similarly subject to segregation and re-use restrictions, irrespective of whether the underlying transaction is subject to UMR.

The SEC's IM rules for security-based swaps within its scope do not impose the same re-use restrictions. Tokenization may materially improve the mechanics of re-use if the structure supports a clear control framework and if the receiving market participant accepts the tokenized form as functionally usable collateral. In either the digital native or digital twin models, the party receiving the repledge will need to be onboarded to the transfer agent and pass all applicable Anti Money Laundering

(AML), Know Your Customer (KYC), and compliance checks. Similarly, in the case of the custodial model, the party receiving the repledge will need to be onboarded to the custodian and sign a custody agreement.

A digitally native model can offer, in practice, the greatest re-use value because the token can move directly between approved holders with fewer manual custody steps. This may also be applicable to the custodial or intermediated model, though onboarding and inter-custodian arrangements would need to be assessed on a case by case basis. Additionally, the Digital Native model allows a counterparty to assess the risk associated with the token issuing fund itself, rather than an unaffiliated intermediary issuing the record of ownership in the Digital Twin model intra day.

Within a digital twin model, the token can still support rapid transfer, while the off-chain register preserves a clear path for control, recognition, and remediation.

The discussion above should not be read as a ranking of the three models for re-use purposes. In each case, the practical re-use pathway depends on the operational controls applied at the relevant issuer, transfer agent, custodian, or intermediary layer, and on the contractual re-use perimeter agreed with the secured party.

The digitally native model can support equivalent re-use outcomes to the custodial or intermediated model where the issuer and transfer agent maintain wallet allow-listing, transfer controls, AML/KYC processes, and operational resilience consistent with material outsourcing and digital operational risk standards.

The selection of model should be focused on the parties' commercial and operational use case and preferences for the specific transaction, not on a default preference for any particular structure.

c) Uniform Commercial Code (UCC) considerations

Building on the UCC framework outlined above, the analysis for TMMFs depends on whether the tokenized fund interest can be structured as a "security" or "security entitlement" under Article 8. This determination is critical because it enables treatment as "investment property" under Article 9, allowing secured parties to rely on established control-based perfection and priority mechanics. The definitions of both a "security" and "security entitlement" under the UCC must be considered:

- **"Security,"** except as otherwise provided in Section 8-103[27], means an obligation of an issuer or a share, participation, or other interest in an issuer or in property or an enterprise of an issuer:

  (i) which is represented by a security certificate in bearer or registered form, or the transfer of which may be registered upon books maintained for that purpose by or on behalf of the issuer

  (ii) which is one of a class or series or by its terms is divisible into a class or series of shares, participations, interests, or obligations

  (iii) which:
  (A) is, or is of a type, dealt in or traded on securities exchanges or securities markets; or
  (B) is a medium for investment and by its terms expressly provides that it is a security governed by this Article

[27] https://www.law.cornell.edu/ucc/8/8-103

- **"Security entitlement"** means the rights and property interest of an entitlement holder with respect to a financial asset specified in Part 5, which outlines the requirements and conditions for obtaining a security entitlement for persons with a securities account, as defined by Article 8. "Entitlement holder" means a person identified in the records of a securities intermediary as the person having a security entitlement against the securities intermediary. If a person acquires a security entitlement by virtue of Section 8-501(b)(2) or (3), that person is the entitlement holder[28]. As defined by Section 8-501(a), "securities account" means an account to which a financial asset is or may be credited in accordance with an agreement under which the person maintaining the account undertakes to treat the person for whom the account is maintained as entitled to exercise the rights that comprise the financial asset[29].

If a TMMF cannot be characterized within these definitions, it will generally fall outside the Article 8 framework, limiting its effectiveness as collateral in institutional markets.

Against this backdrop, each tokenization model can be assessed based on how it satisfies Article 8 requirements:

- **Digitally native structures** can meet the Article 8 framework but require clarity as to what constitutes the issuer's (or its transfer agent's) authoritative books and records and whether such books and records are maintained "by or on behalf of the issuer." Where this linkage is clearly established, the same control-based perfection framework can apply; where it is not, additional legal uncertainty may arise. Firms have sought to demonstrate that the DLT is maintained "by or on behalf of the issuer" by ensuring robust KYC measures and that ownership and transfer of funds are only permissible amongst whitelisted wallet addresses

- **Digital twin structures** maintain the transfer agent or issuer's off-chain register as the authoritative record of ownership, with movement of fund share tokens serving as synchronized representations that trigger updates to that register. Because ownership and transfer continue to be reflected on recognized books and records, these structures align cleanly with the definition of a "security," and control is achieved when the secured party is recorded as the owner

- **Custodial or intermediated structures** operate within the established securities intermediary framework. A custodian agrees to treat token holders as entitlement holders, creating a securities account relationship that fits squarely within the Article 8 framework. This approach is largely indifferent to the underlying technology used to record ownership and preserve familiar control mechanics though introduces an intermediary layer – a trade-offs to weigh against the directness of a native or twin structure (see concentration risk in the risk and controls section).

In contrast, structures that do not meet Article 8's definitions may be treated as general intangibles, which introduces materially different requirements. In those cases, perfection typically requires filing a financing statement, priority depends on timing of filings, and clear take-free protections are not available, making such structures less suitable for high volume collateral use.

[28] https://www.law.cornell.edu/ucc/8/8-102
[29] https://www.law.cornell.edu/ucc/8/8-501

While Article 12 provides an alternative framework for certain digital assets, it is generally viewed as a secondary path in this context. For a digitally native model that does not fall under the "security" definition within Article 8, the TMMF would fall into the general intangible and controllable electronic record under Article 12.

Within the digital twin and custodial or intermediated models, Article 12 is not helpful as it gives rights to the token (i.e., lines of code) and not the underlying asset. These considerations, in conjunction with its partial adoption across States within the U.S. and more limited market familiarity, reflect that Article 12 does not currently offer the same level of legal certainty as structuring within Article 8 where feasible.

In practice, each model aligns with existing UCC constructs through a different mechanism. Digital twin and custodial or intermediated models map onto the secured-party diligence patterns market participants already know. Digitally native models achieve the same control-based perfection where the issuer or its transfer agent's authoritative books and records are clearly identified - a determination that is increasingly well established as on-chain transfer agency matures. In either model, a consistent approach from the industry to treat tokens or other digital representations of ownership recorded onchain as the asset itself, rather than a separate asset class, is critical to widespread adoption.

d) Regulatory requirements & considerations

While U.S. regulators have signaled an increased openness towards tokenized collateral, they have not created any tokenization exemptions from existing collateral rules. The CFTC's December 2025 Tokenized Collateral Guidance is explicit on this point. The guidance states that tokenization need not change the fundamental characteristics of an asset and that market participants should analyze tokenized collateral within existing frameworks for eligible assets, legal enforceability, segregation and custody, haircuts, and operational risk.

That position is constructive because it confirms that the issue is not whether tokenization is allowed in the abstract; the issue is whether the specific tokenized asset and structure satisfy the same requirements that would apply to the underlying asset in traditional form. There have not been similar actions by the USPRs nor the SEC regarding eligible collateral in tokenized form.

This technology-neutral view benefits all three models, but in different ways. The rights associated with a digital twin or custodial or intermediated structure look more familiar. Parties can determine whether the tokenized form is functionally equivalent to the traditional fund interest with less interpretive stress. However, a digital twin model can create additional complexity under the CFTC's guidance due to the dependency on the issuer or its TA to update the off-chain ownership books and records to reflect transfers reflected on DLT.

While there are existing regulations that govern the maintenance of master securityholder files by a transfer agent, there has not been updated guidance, rules, or standards released that mandate the frequency or cadence in which the transfer agent must reconcile the transfers reflected on DLT to the off-chain ownership books and records.

Issuers and TAs will need to consider the optimal reconciliation frequency when designing their operating models and resilience frameworks, while ensuring they continue to adhere to regulatory expectations. A digitally native structure also fits within the CFTC's guidance, but may generate follow-up questions on legal enforceability, settlement finality, documentation, and eligible custody arrangements.

The follow-up questions associated with a digitally native structure are not legal-framework objections. They are diligence questions about the issuer's and transfer agent's on-

chain operating environment: how the ledger is recognized as the authoritative books and records, how transfer controls are enforced at the wallet layer, how settlement finality is defined for the relevant chain, how custody and key management are structured, and how the issuer and transfer agent satisfy the digital operational resilience expectations described earlier in this Section. Some or all of these considerations may also be relevant with the other models.

It is also notable that, when the Sandbox tested these models end-to-end, participating issuers elected to issue natively precisely to evidence the control and resilience available under that structure. The diligence questions that the digitally native model raises in principle - how the ledger is recognized as the authoritative books and records, how transfer controls are enforced at the wallet layer, and how settlement finality and key management are governed - were not left open but answered in practice, with native TMMFs pledged, substituted, enforced, and settled across multiple chains and custodians without recourse to the off-chain reconciliation that the digital twin model depends on.

Where these are answered, the digitally native structure fits within the CFTC's technologyneutral guidance on the same basis as the other two models. The diligence focus differs across models, but the regulatory acceptability does not.

SEC frameworks also matter. Tokenization does not remove the underlying fund from the Investment Company Act of 1940, Rule 2a-7, or transfer-agent obligations. The SEC's January 2026 Statement on Tokenized Securities confirms that "the format in which a security is issued or the methods by which holders are recorded (e.g., on-chain vs. off-chain) does not affect application of the federal securities laws." Tokenized securities and their issuers are subject to the same securities laws requirements as the traditional, non-tokenized securities.

The Investment Company Act of 1940 also introduces important considerations regarding secondary market activity and transferability, including Section 22(d) and Rule 22c-1. Section 22(d) generally prohibits a mutual fund, principal underwriter, or dealer from selling redeemable fund shares to the public except at the current public offering price described in the fund's prospectus, while Rule 22c-1 generally requires sales, redemptions and repurchases of redeemable securities by a fund, principal underwriter, dealer, or other designated person to occur at a price based on the fund's next calculated net asset value ("NAV").

These provisions were designed to prevent dilution, preferential treatment, and disorderly distribution practices in mutual fund shares. This is crucially important as tokenized shares can move peer-to-peer at any time, including outside of normal fund dealing hours.

Generally, peer-to-peer transfers between investors should remain permissible, provided that the transaction does not involve a principal underwriter or dealer acting in that capacity and the fund's transfer restrictions, whitelisting, AML/KYC, tax, and shareholder-servicing requirements are satisfied. Section 22(d) applies to principal underwriters and dealers, not all investors or brokers, and the SEC has recognized the distinction between a dealer acting for its own account and a broker acting as agent.

A party that makes a market, buys and sells from inventory, or otherwise may be acting as a dealer, may consider pursuing exemptive relief, which may be needed as reflected by the SEC's 2026 notice relating to tokenized government money market funds, which would permit affiliated and unaffiliated dealers to transact in fund shares at a fixed US$1.00 price, without waiting for the next NAV calculation.

Although outside the scope of this paper, cross-border equivalence is another issue market participants will need to monitor. The working group noted that U.S., E.U., and U.K. rules do not treat MMF collateral identically, and that substituted compliance or equivalence determinations remain relevant for cross-border derivatives relationships.[30],[31].

Tokenization does not remove those differences. Participants that plan to use TMMFs in crossborder portfolios may therefore need to assess both the token structure and the jurisdictional perimeter in which that structure is expected to operate.

e) Capital and balance sheet considerations of TMMFs

The capital and balance sheet analyses must start with traditional MMFs rather than their tokenized form. In March 2026, the banking agencies released a statement that confirmed that tokenized securities should receive the same regulatory capital treatment as their non-tokenized counterparts.

The main capital-related issue for MMFs is how the receiving institution records and uses the asset once it is posted. For banks, that treatment can differ materially depending on whether the position sits within the trading book or the banking book.

If an MMF is held in the trading book, capital requirements are generally driven by market-risk measures. Given the low-volatility profile of government MMFs, the resulting charge is generally expected to be modest. Banking book treatment differs and has potentially significant implications for those holding these securities.

If MMFs are held in the banking book, MMFs may be treated as equity exposures to investment funds and carry a minimum 20% risk-weight under current approaches, even where the underlying fund profile is short-duration and highly liquid. These impacts are likely to be most prevalent for bank treasury functions and smaller banking organizations that may not maintain an active trading book. As a result, these firms may be less willing to receive MMFs as collateral if the asset is likely to remain on balance sheet and consume capital costs that are perceived as out of proportion to its economic risk.

In practice, banks may seek to re-use, finance, or repo out received TMMFs rather than hold them as inventory and incur these charges, and the operational mobility created by tokenization may make that strategy more prevalent. While this strategy would not remove the banking book capital issue, it may reduce the time the MMF sits on balance sheet and would improve collateral and liquidity efficiency.

Looking ahead, this points to a policy question as to whether current capital treatment properly reflects the risk profile and liquidity behavior of MMFs used as collateral, and regulatory advocacy may be needed to adjust these risk-weightings accordingly.

[30] ISDA-Letter-to-US-Regulators-Cash-and-Money-Market-Funds-as-Initial-Margin-8.1.19.pdf

[31] ISDA-Letter-to-EU-policy-makers-Money-Market-Funds-9.30.19.pdf

f) Legal and regulatory assessment of tokenized funds models for TMMFs

★ Key takeaway

The findings below are a synthesis of the legal and regulatory considerations for tokenized money market fund in the U.S. The synthesis is intended as guide for thought leadership and it does not constitute legal, regulatory, tax, accounting, investment or financial advice.

Managers seeking to implement TMMFs in the U.S. should obtain their own independent professional advice and should not rely solely on the report for structuring, legal analysis, regulatory conclusions, or commercial decisions.

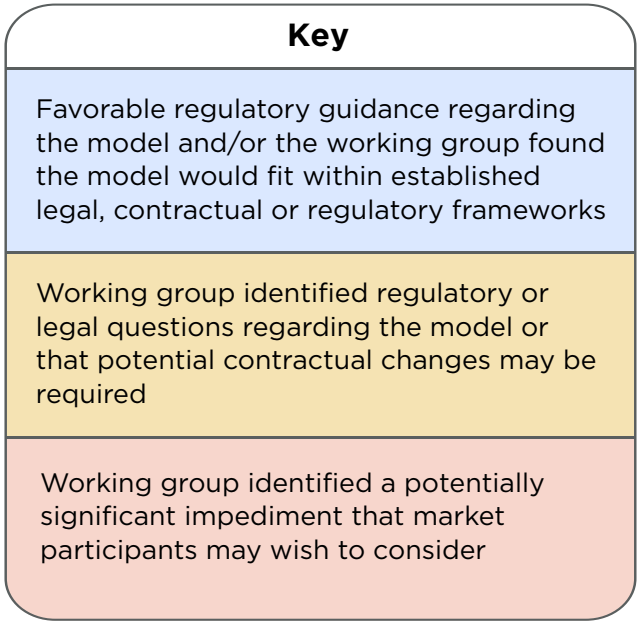
Findings may need to be reassessed as U.S. digital asset, collateral, securities, custody, insolvency and regulations continue to develop, and at pace. Additionally, the report's findings reflect working group outputs and contributions but should not be assumed to represent the position of any participating institution, legal adviser, technology provider, or market participant.

The framework assessed the three tokenization models across ten legal and regulatory dimensions for TMMFs:

1. TA recordkeeping on DLT
2. UCC Article 8 characterization (security / entitlement)
3. UCC Article 9 perfection (control / priority)
4. UCC Article 12 reliance
5. Cleared VM
6. Uncleared IM – CFTC
7. Uncleared IM – Prudential regulators
8. Uncleared IM - SEC
9. Uncleared VM (bilateral)
10. Repo & securities lending collateral

A fourth tokenization model, Synthetic Tokenized Securities (SEC CFTC Digital Asset Taxonomy), was also assessed but is considered outside of the scope of TMMFs and this report.

FIGURE 5: Legal and regulatory assessment of tokenized fund models



	Issuance Models			
	Fund Issuer Driven		Third-Party Driven	
Legal or Reg. Issue Area	**Digitally Native**	**Digital Twin**	**Custodial/ Intermediate[32]**	**Synthetic Tokenized Securities[33]**
TA recordkeeping on DLT	Favorable clarifying guidance provided (TA may use DLT as master file)	Favorable clarifying guidance provided (Off-chain TA register remains authoritative)	No explicit guidance required (intermediary wrapper)	No explicit guidance required (intermediary wrapper)
UCC Article 8 characterization (security / entitlement)	Can be structured to constitute a security under Article 8	Can be structured to constitute a security under Article 8	Can be structured to constitute a security within Article 8	May not clearly fit within Article 8 framework, depending on structure
UCC Article 9 perfection (control / priority)	Perfection by control, priority, and take-free rules available if structured as a security	Perfection by control, priority and take-free rules available if structured as a security	Perfection by control, priority, and take-free rules available if structured as a security entitlement	Ability to perfect by control or benefit from take-free rules uncertain, depending on structure
UCC Article 12 reliance	Not relevant if structured as a security	Not relevant if structured as a security	Not relevant if structured as a security entitlement	Perfection and take-free rules under Article 12 may be available depending on structure
Cleared VM	Explicitly non-eligible (MMF excluded for cleared VM)	Explicitly non-eligible (MMFs excluded for cleared VM)	Explicitly non-eligible (MMFs excluded for cleared VM)	Explicitly non-eligible (MMFs excluded for cleared VM)

[32] Scope includes scenarios in which token holders have been onboarded to the custodian. Analysis does not cover "wrapped" or other similar custodial receipt variations.
[33] Includes custodial receipts

Cleared IM	Favorable clarifying guidance provided (only if MMF meets eligibility; token doesn't bypass eligibility requirements)	Favorable clarifying guidance provided (only if MMF meets eligibility; token doesn't bypass eligibility requirements)	Favorable clarifying guidance provided (only if MMF meets eligibility; token doesn't bypass eligibility requirements)	Explicitly non-eligible (synthetic token not MMF share/entitlement)
Uncleared VM and IM – CFTC	Favorable clarifying guidance provided (only if MMF meets eligibility; token doesn't bypass eligibility requirements)	Favorable clarifying guidance provided (only if MMF meets eligibility; token doesn't bypass eligibility requirements)	Favorable clarifying guidance provided (only if MMF meets eligibility; token doesn't bypass eligibility requirements)	Explicitly non-eligible (synthetic token not MMF share/entitlement)
Uncleared VM and IM – Prudential regulators	Favorable clarifying guidance provided (subject to segregation/ transfer constraints)[34]	Favorable clarifying guidance provided (subject to segregation/transfer constraints)	Favorable clarifying guidance provided (subject to segregation/transfer constraints)	Explicitly non-eligible (synthetic token not eligible collateral)
Uncleared VM and IM - SEC	No explicit guidance (tokenized treated same as non-tokenized)	No explicit guidance (tokenized treated same as non-tokenized)	No explicit guidance (tokenized treated same as non-tokenized)	No explicit guidance (tokenized treated same as non-tokenized)
Repo & securities lending collateral	No major impediments identified	No major impediments identified	No major impediments identified	No major impediments identified
Collateral documentation (CSA / tokenized collateral provisions)	Use of standard documentation is feasible, though parties may wish to clarify when transfer occurs	Use of standard documentation is feasible, though parties may wish to clarify when transfer occurs	Use of standard documentation is feasible, though parties may wish to clarify when transfer occurs	Amendments from standard contractual provisions may be necessary to accommodate unique asset type
Investment Company Act of 1940	Peer-to-peer transfers generally permissible; dealer market-making may require relief	Peer-to-peer transfers generally permissible; dealer market-making may require relief	Peer-to-peer transfers generally permissible; dealer market-making may require relief	Not fund shares; treatment depends on synthetic structure

[34] March 5, 2026: Capital Treatment of Tokenized Securities FAQs issued by the Office of the Comptroller of the Currency, the Board of Governors of the Federal Reserve System, and the Federal Deposit Insurance Corporation

Additional details on the simulations in the GDF Industry Sandbox, powered by Ownera, can be found within the "Tokenized Collateral Real Use Cases in the U.S. Sandbox" and "Sandbox Findings" sections.

g) Contractual considerations

Contractual law considerations center on whether collateral documents align with the legal mechanics of collateral transfer, control, perfection and enforcement. In practice, the 1994 New York law ISDA Credit Support Annex ("CSA") remains the standard security-interest form for many U.S. collateral relationships. Accordingly, CSAs may need to be updated to account for TMMFs to identify what would constitute an effective transfer, when the pledgor's delivery obligation is satisfied, and what evidence the secured party can rely on to show control and enforceability.

ISDA has been active in providing guidance for incorporating tokenization into existing documentation provisions. ISDA's Tokenized Collateral Model Provisions point to an additional transfer provision for DLT securities and other property transferred by DLT.

Updating documentation requires careful balance and consideration to ensure provisions remain accurate, without being too prescriptive in that updated provisions lose relevance as the market matures and progresses. For this reason, the most useful documentation updates are likely to be targeted rather than wholesale changes. Counterparties may need to calibrate the definition of "transfer," related conditions precedent, relevant representations, eligibility schedules, and any operational annexes that describe evidence of delivery, control, release, substitution, and error handling. It is also important not to create additional legal uncertainty in drafting updated provisions.

Adding blockchain-specific terms such as wallet, private key, or blockchain into core collateral clauses may not improve certainty if the same result can be reached through technology-neutral concepts tied to books and records and legally effective transfers. The better course for near-term adoption is to amend only where the structure truly requires it and to rely on implementation guidance where existing CSA provisions are already applicable.

Separately, fund terms, transfer-agent procedures, and any platform rules need to state with enough precision where legal ownership changes, whether that occurs on an update to DLT or off-chain books and records, transfer agent recognition, and stated confirmation threshold.

Clearly defined events and thresholds are critical as transfers on-chain can create scenarios in which the transferor has initiated the movement, but the transferee does not yet view the asset as usable, posing implications for settlement finality and perfection. In the case of the custodial or intermediated model, additional documentation may be required as ownership, and transfers are governed by specific rule books of the entity creating the tokenization wrapper of the fund.

h) Settlement finality and transfer effectiveness

Settlement finality has multiple dimensions. In a collateral context, the main consideration is for the party receiving collateral to determine when it has the practical control and legal right to reuse that asset or enforce against it. In the context of tokenized collateral, an additional question compared to traditional settlement is whether the party's receipt of the asset is subject to chain reorganization risk. This new risk should be understood in the context of the shorter time needed to transfer the tokenized collateral, and the legal agreement that requires the collateral to be posted.

Settlement finality for tokenized collateral should therefore be analyzed through both legal and operational principles rather than a single criterion. For swaps, repos, securities finance, and other covered transactions, the Bankruptcy Code safe harbors remain central as they protect close-out, collateral realization, and anti-avoidance outcomes based on the nature of the transaction. The tokenized form of the asset should not displace those protections.

The moment of settlement finality may be outside the full control of the parties. A pledgor may have taken all steps within its power to transfer the asset, but the secured party may need a third party to take an action or need greater assurance that chain reorganization risk has been sufficiently reduced before it treats the asset as received and reusable. As outlined in Section 4.e. above, the CSA and related collateral documents will need to outline what constitutes an effective transfer for purposes of discharging the pledgor's delivery obligation.

Settlement finality will differ by the tokenization structure. In a custodial or intermediated model, finality from a legal/registrar standpoint is typically treated as when the relevant depository, custodian, or securities intermediary updates its books and records.

In a digital twin model, the same logic may apply if the transfer agent or issuer updates its offchain books and records. For a digital native model, the parties to the transaction may need to determine whether finality is confirmed as soon as the DLT reflects the transfer, transfer-agent recognizes the on-chain transfer, or if a stated confirmation threshold is met - a standard the parties define once in documentation, comparable to the intermediary book-update standard used in the other models.

These distinctions have direct consequences for credit risk and default analyses. If the pledgor is not recognized as fulfilling its obligations until the secured party is willing to recognize the asset as final, the parties can end up in an intermediate state where the pledgor is not able to take any further action after submitting the transfer, but the transfer is still recognized as invalid. However, the period of time for which this state persists may well be shorter than today's settlement timeframes.

Conversely, if the documents deem a transfer to be complete too early, the secured party may be left with an asset that appears delivered but is still subject to blockchain risks (e.g., reorganization), delayed recognition by the transfer agent, or mismatch between wallet state and the official record of ownership.

Key takeaway

i) Access on insolvency under U.S. bankruptcy and securities laws

Insolvency is an area in which the market's appetite for novelty often ends. While firms may be willing to adopt a new operating model if day-to-day transfers work effectively, they are less likely to rely on it at scale if they do not believe the secured party can access and realize the collateral in distress.

The working group discussions and analyses pointed towards the same theme: The "safe harbors" under the major U.S. insolvency and resolution regimes are generally transaction-based rather than technology-based or asset-based. If the relevant arrangement qualifies as a "swap agreement," "repurchase agreement," "margin loan," "loan of securities," or other "qualified financial contract" under these regimes (a "Protected Contract"), the fact that the collateral is tokenized should not, by itself, displace that protected status.

Notably, the major U.S. insolvency regimes, including the Bankruptcy Code, the Securities Investor Protection Act ("SIPA"), the Federal Deposit Insurance Act, and Title II (the Orderly Liquidation Authority Title) of the Dodd-Frank Act all contain, or incorporate by reference, substantially similar definitions of the Protected Contracts.

In addition, a number of other U.S. insolvency regimes, including many state insurance insolvency statutes, the New York Banking Law, the statute applicable to a government sponsored enterprise insolvency, and the Federal Credit Union Act, also use substantially similar definitions for these contracts.

As a result, the use of tokenized collateral should not generally interfere with the ability of parties facing the vast bulk of U.S. counterparty types to take comfort that they will be able to exercise remedies promptly upon a bankruptcy or other insolvency proceeding.

Furthermore, the fact that an issuer, transfer agent, or securities intermediary uses DLT to record interests in an asset should not affect the analysis of the rights of token holders in the entity's insolvency.

Shareholders of an insolvent issuer should still have claims against the issuer even when the issuer or the transfer agent is insolvent, and the UCC rule concerning the distribution of assets that apply in a custodian bankruptcy, namely UCC Section 8-503, should apply regardless of whether the custodian using DLT to record ownership.

That said, the secured party still needs an enforceable and perfected security interest and a practical means of exercising its rights., as outlined within the "Uniform Commercial Code ("UCC") considerations" Section 4.c. above.

Insolvency considerations for the digitally native model are more concentrated on the issuer's and transfer agent's operational control environment. Where the issuer and its transfer agent recognize the ledger as the authoritative books and records, operate wallet-level transfer restrictions consistently, maintain documented incident response and recovery procedures, and otherwise meet the operational risk and resilience expectations described elsewhere in this Section, the secured party can demonstrate ownership, perfection, and the path to realization with the same level of confidence as under a digital twin or custodial or intermediated structure.

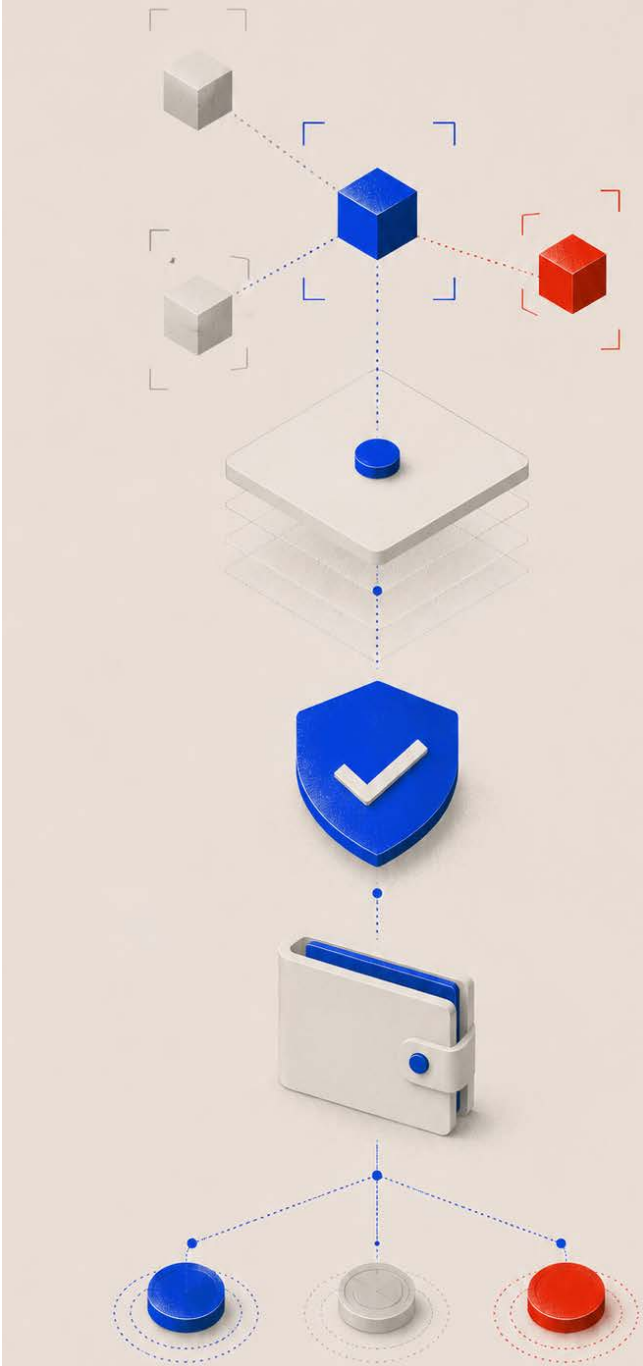
The point is not that the digitally native model may be less suitable for insolvency purposes, but that the diligence focus shifts from intermediary-level mechanics to issuer- and transfer-agentlevel operational controls.

Indeed, the digitally native model can offer a distinct operational advantage at the point of enforcement. Because the secured party holds control of the token directly at the wallet level, it can realize the collateral - transferring or redeeming the fund shares - unilaterally and nearinstantly upon default, without depending on the cooperation of an insolvent or uncooperative counterparty, custodian, or other intermediary, and with a complete on-chain audit trail.

The default-scenario simulation in the E.U./U.K. Sandbox demonstrated that digitally native TMMFs could be seized and redeemed by the collateral taker without the defaulter's consent, evidencing effective access to the asset on insolvency[35].

Similarly, in Simulation 3 of the US Sandbox, where collateral is segregated under code-enforced control, the secured party's ability to realize the asset is defined in the contract logic and does not depend on the cooperation of an intermediary, including where assets sit across multiple ledgers. The same enforceability analysis applies with the operational path to realization evidenced on-chain.

The insolvency discussion leads to a balanced conclusion. The use of tokenized MMFs in lieu of traditional MMFs should not affect the application of the safe harbors that protect close-out netting and collateral rights or the applicable distributional rules. ■



Key takeaway

[35] https://www.gdf.io/wp-content/uploads/2020/12/GDF_-UKEU_TMMF-report-1.pdf

5. Operational Considerations to Enable TMMF as Collateral

a) How tokenization rewires MMF collateral flows

Tokenizing MMFs rewires workflows by enabling a model where collateral can be delivered or pledged directly, potentially reducing reliance on repetitive redemptions and cash sweeps. This results in near instant settlement and a change in how control, encumbrance, and releases are evidenced and documented. Where legacy flows rely on account structures and agent-mediated controls, tokenized flows rely on wallet governance, permissioning, and synchronization between the on-chain state and off-chain records.

Importantly, tokenization does not eliminate the need for tri-party or agent-based services. Instead, it reshapes their role, while also allowing some transfers to settle directly between approved holders where the parties prefer a more direct model. Tri-party agents, custodians, or collateral service providers may continue to perform eligibility checks, valuation support, substitution, and reporting, but with token movement and restriction replacing traditional book-entry delivery.

The operational challenge for the market is to preserve the predictability and risk outcomes of existing collateral frameworks while allowing tokenized instruments to integrate without introducing ambiguity around control or timing. Repo and securities lending raise a different set of operational considerations. These markets already support collateral movement through bilateral and triparty structures, but the acceptance of TMMFs would depend on collateral schedules, valuation, agent workflows, transfer-agent or custodian recognition, and the ability to liquidate or transfer the asset during a recall, substitution or default.

The Sandbox showcased how the same rails that move TMMFs as VM in Simulation 1 can be used to mobilize collateral on an intraday basis - the use case industry research now identifies as a near-term P&L opportunity. The Federal Reserve's daylight overdraft cost floor stands at 50 basis points, while intraday repo against high-quality collateral is currently priced at 30 to 40 basis points.

The Bank for International Settlements reports that U.S. banks held an aggregate Fedwire buffer averaging US$630 billion between 2008 and 2018, with the largest participants carrying buffers that cost approximately US$600 million per year. Simulation 2 demonstrates that the cascade and substitution flows needed to release a meaningful share of that buffer are operationally feasible today.[36]

For cleared IM, the current process is generally more standardized than bilateral uncleared margin. Certain CCPs, custodians, and collateral agents already support defined call, pledge, and substitution of MMFs. In these instances, TMMFs would need to plug into established operating rails rather than replace them. While the operational benefit in these instances may not be as pronounced as uncleared margin, the benefits would come from faster substitution, better visibility into encumbrance, and more efficient movement of collateral across CCP relationships.

In general, MMF collateral workflow considerations differ across products. Uncleared margin, cleared IM, repo, and securities each possess varying degrees of friction.

Key takeaway

[36] https://www.dtcc.com/-/media/collateral-infrastructure-white-paper.pdf

FIGURE 6: Product-specific workflow consideration

Product context	Overview of current workflow	How TMMFs alleviate workflow frictions
Uncleared margin, variation margin and initial margin	Posting and receipt are driven by bilateral documentation, eligible collateral schedules, custodian or transfer-agent instructions, control evidence, segregation where required, valuation, and dispute handling. Frictions are highest here due to redeem-post-sweep mechanics and asset-transfer restrictions for regulatory IM.	TMMFs may reduce redemption-to-cash steps, support faster transfer or pledge, improve visibility into control and encumbrance, and create a clearer audit trail for receipt, release, substitution, and liquidation.
Cleared initial margin	Collateral moves through the client to CCP under CCP rulebooks (where accepted), which the custodian or triparty processes. The workflow is more standardized than uncleared margin, with frictions centered on CCP acceptance, substitution approvals, and settlement confirmation.	TMMFs may support faster collateral substitution at the CCP where MMFs are accepted, clearer receipt confirmation, and more efficient release or redeployment of cash across CCP obligations.
Repo	Collateral is posted bilaterally or through triparty agents against cash, with established processes for eligibility, allocation, valuation, margin maintenance, substitution, and close-out. Frictions arise if TMMFs are not recognized in collateral schedules, triparty system, valuation feeds, or liquidation procedures.	TMMFs may improve substitution speed, reduce manual position checks, and provide shared records of ownership, control, and encumbrance, subject to triparty support and agreed valuation and haircut treatment.
Securities lending	Borrowers post collateral to lenders, custodians, agent lenders, or triparty platforms, with ongoing marks, substitutions, recalls, returns, income handling, and collateral reinvestment requirements. Frictions are tied to collateral schedule acceptance, beneficial-owner restrictions, borrower onboarding, and recall or return timing.	TMMFs may streamline collateral receipt, substitution, and return processing, while improving transparency for lenders, borrowers, custodians, and agent lenders through permissioned wallet controls and shared lifecycle records.

Assessing how settlement finality is treated from an operational perspective is also critical. Firms will need a shared understanding of when a transfer is treated as final from an operational perspective, including which network-level indicators (such as the defined number of confirmations) are required before downstream systems treat the asset as available.

Tokenized MMFs alter the mechanics of collateral posting, receipt, and redemption:

Record of ownership and transfer agent relationship

- Under the current MMF structure, the transfer agent serves as the authoritative system of record for share ownership. The use of MMFs as collateral either requires the redemption – post-sweep process mentioned previously within this report – or the transfer of ownership through the transfer agent and custodian, a slow and manual process with multiple intermediary touchpoints. Tokenization of MMFs allows the ownership to shift onto a distributed ledger, where the token itself represents shares in the fund and ownership is determined by the blockchain (i.e., digital native) or mirrored on the blockchain but maintained in a transfer agent's off-chain books and records (i.e., digital twin)

- The SEC's Division of Trading and Markets released FAQs in May 15, 2025 (updated Feb. 19, 2026) that confirm that transfer agents are able to use blockchain and DLT as the authoritative books and records for share ownership, paving the way for funds to move on-chain at scale. While the SEC's stance is accommodative of blockchain serving as the authoritative source for fund ownership, firms may elect to incrementally transition their recordkeeping and transfer agency relationships via the digital twin model as the operating and governance models surrounding tokenized funds are further developed within the industry

- Also, a number of issuers are choosing to operate digitally native funds today, with the distributed ledger serving as the authoritative books and records and the transfer agent operating directly on-chain. The choice between an incremental digital twin transition and a directly native operating model should be understood as an issuer-level decision driven by cost, operational readiness, the maturity of the issuer's and transfer agent's control environment, and the strategic priorities of the fund complex- The sandbox simulations described in Section 7 used native issuance at the request of participating issuers, who selected the native pathway to demonstrate the controls and resilience available under that structure and remove potential associated with the digital twin and custodial models

- In practice, near-term adoption is likely to involve multiple recordkeeping models rather than a single end-state architecture, which aligns to the current examples we see in the market today. Some issuers may prefer to maintain on-chain books and records, while some may prefer digital twin models in which off-chain books and records serve as the authoritative register while tokens facilitate mobility and automation in transfer rights;

Collateral mobility and settlement speed

- TMMFs have the technical capacity to settle on a near-instantaneous or intraday basis on-chain, which would represent a fundamental improvement in collateral mobility generally. In principle, this could reduce the need for over-collateralization, improve intraday liquidity management, and support more responsive collateral substitution. However, the realization of this benefit depends on broader infrastructure being in place, including on-chain cash or payment rails capable of supporting delivery-versus-payment

(DvP) settlement (in the context of repo and cash collateralized securities lending), and connectivity between the tokenized collateral platform and the downstream systems of counterparties, custodians, and collateral agents

- Target state architectures should include tightly integrated processes from exposure calculation through margin call issuance, collateral selection, bilateral and custodian/CCP agreements, settlement instruction, and transfer confirmation. Sandbox simulation testing proves that a bilateral variation margin flow could complete without manual re-keying and with settlement in less than two minutes, which further emphasizes the feasibility in TMMF as collateral from an operational perspective. It also highlights the need for firms to enable tight orchestration between margin platforms, custodians, and settlement layers to ensure these gains are repeatable in production;

Programmability and automated collateral management

- One of the more distinctive operational features introduced by TMMFs is the ability to embed programmable logic directly into collateral arrangements through smart contracts. In a tokenized collateral framework, margin calls, substitutions, and releases can be automated based on pre-agreed criteria, reducing reliance on manual instruction and confirmation workflows that require coordination across multiple operational teams and market participants

- The potential efficiency gains are meaningful, particularly for high-volume or time-sensitive collateral workflows where manual processing introduces both settlement and operational risk. However, the deployment of smart contract automation in a regulated collateral context raises important questions about governance and exception handling. Collateral disputes, erroneous triggers, and edge cases in complex legal agreements are not easily accommodated by deterministic on-chain logic, and the consequences of an incorrectly executed smart contract in a margin or default scenario could be significant

- Any implementation would need to define clearly where smart contracts are appropriate, where human oversight remains necessary, and how on-chain actions map to off-chain legal obligations. In 2024, GDF and the Global Financial Markets Association ("GFMA") published "The Smart Contract Primer: An Initial Overview of Smart Contract Implementation within Financial Services & Regulatory Solutions for Risk Management," which provides guidance and recommendations for firms implementing and scaling smart contracts, including how to apply existing legal and regulatory frameworks to help mitigate risks posed by this technology

- To further support the adoption of smart contracts and workflow automation across the collateral management ecosystem with integration between legacy systems and traditional workflows, the industry should continue to build out the capabilities of the Common Domain Model to establish a standardized approach to data collection, movement, and straight through processing, which will decrease operational friction, encourage resiliency among technology and infrastructure providers, and reduce counterparty risk related to data-driven disputes and fails;

Collateral segregation and transparency

- The ability to identify, segregate, and verify collateral positions accurately and in near-real time is a foundational operational requirement and becomes increasingly important in stress scenarios. In the current environment, MMF collateral positions are

distributed across transfer agent records, custodian books, and triparty systems, with no single consolidated view available to all parties simultaneously

- TMMFs shares held in on-chain wallets can offer real-time visibility into ownership and encumbrance status to all authorized parties, with a tamper-resistant audit trail covering the full collateral lifecycle. This is a meaningful improvement over current practice in terms of both operational transparency and the ability to respond rapidly to collateral shortfalls or disputes. The extent to which this benefit is realized in practice will depend on access controls, data standards, and whether the networks on which TMMFs are held are designed to support the kind of cross-party visibility that makes transparency operationally useful (e.g., permissioning constraints)

- Treatment of collateral inventory is also crucial. TMMF positions need to be visible in collateral systems as usable inventory to be able to optimize and redeploy positions that today sit in long-cash portfolios as passive investments. This requires collateral engines, treasury functions, and custody records to recognize tokenized fund positions as available collateral, subject to the relevant eligibility, haircut, and control rules. The sandbox has demonstrated how this is achieved through permissioning and controls with the collateral system not having to substantially change their technology stack

- Tokenizing MMFs alone does not resolve the operational limitations that exist within the current MMF collateral environment. Operational roles, responsibilities and operating models must be deliberately redesigned to enable efficiency gains that tokenization offers without increasing risk.

b) Operational readiness and enablers to full adoption

Market participants and infrastructure providers alike stand to benefit from the shift to a tokenized collateral operating model. The case for TMMFs as collateral is operationally feasible, and firms can extend existing operational practices and technology stacks.

Realizing the potential of TMMFs as collateral rests on a set of operational capabilities that extend beyond those used in traditional MMF workflows. These capabilities warrant focused analysis and targeted investment from industry participants. Meaningful progress is already underway – firms are actively implementing blockchain and DLT-related infrastructure, and a clear set of enablers will support broader adoption at scale.

Understanding both operational readiness and the structural foundations needed provides the path to industry-wide adoption of TMMFs. Below are the critical operational capabilities firms can develop as they prepare the workflows that will underpin TMMFs as collateral.

Establishing digital asset wallet and custody capabilities

For TMMFs to be operationally viable, digital asset custodians will need to build and offer wallet infrastructure that meets the security and operational standards expected of institutional digital asset custody while also satisfying the legal standard for "control" under UCC Articles 8 and 9. While further regulatory clarity is expected regarding digital asset custody, New York Department of Financial Services ("NYDFS") maintains stringent requirements for those wishing to offer custody services and the Office of the Comptroller of the Currency ("OCC") has issued guidance for nationally-chartered banks offering custody services[37].

[37] https://www.occ.gov/news-issuances/bulletins/2025/bulletin-2025-17.html

Digital asset custodians holding TMMFs as collateral must ensure they have established robust key management practices, clear asset segregation procedures at the wallet level, and well-documented recovery and business continuity procedures specific to digital assets. Custodians underpinning collateral workflows will also need to amend account control agreements and required documentation to account for the enhanced remit of tokenized collateral.

Digital asset custodians are actively building the capabilities required to support this operating model. Regulated digital asset custody is already offered by both established global custodians and specialist providers, and several support tokenized fund instruments today. Continued expansion – particularly the maturation of TMMF support delivered as a scalable, regulated service – will give collateral participants a clear path to holding and pledging TMMFs at scale.

Integrating tokenized asset capabilities into existing infrastructure

Firms will need to assess the connectivity gap between on-chain tokenized collateral environments and traditional collateral management systems, margin engines, and back-office infrastructure. This includes collaborating with internal technology teams and external vendors to develop the integration points necessary for TMMF collateral positions to be recognized, valued, margined, and reported within existing workflows.

The Sandbox initiative, detailed in Section 8, has provided a solid foundation for firms to build on and deploy to production as it works with existing systems and processes. Firms should conduct gap assessments to understand which systems require updates, what data standards and messaging formats are needed, and where tactical manual workarounds may be necessary in the interim while strategic, longer-term integration work is completed.

The integration strategy must be sound to enable scaling and adoption. Early adoption is more likely to succeed where firms extend current margin, collateral, treasury and messaging environments rather than attempt full replacements of existing infrastructures. That includes supporting multiple communication methods, such as APIs, SWIFT, and flat files, with middleware and industry-developed data standards, such as the Common Domain Model, normalizing them so tokenized collateral does not create a new manual side channel.

Updating internal collateral eligibility and risk frameworks

Firms involved in the exchange of TMMFs as collateral will need to explicitly incorporate TMMFs into their internal collateral eligibility schedules, counterparty credit policies, and haircut frameworks. This requires legal, risk, and operating functions to align on how TMMFs are classified, how their liquidity and risk characteristics are assessed relative to traditional MMFs, and what conditions TMMFs must meet to qualify as acceptance collateral under the firm's own standards. Secured parties would need to consider how they would manage and liquidate TMMFs in a default scenario, and whether current default management procedures are fit for purpose in a blockchain environment.

Building counterparty onboarding and whitelisting workflows

Due to the anonymity of wallet addresses on blockchain networks, firms will need to develop updated operational workflows for onboarding counterparties into tokenized collateral, including the KYC, AML and enhanced due diligence required before a counterparty's wallet address can be approved and added to the firm's whitelist. This process should be repeatable and documented to enable an onboarding workflow

Key takeaway

that can be executed efficiently and consistently as tokenization adoption increases. Legal documentation for TMMF collateral exchanges, including the account control agreement updates to account for TMMFs, should be developed and pre-agreed with counsel so that counterparty onboarding does not become a bottleneck when the firm is ready to transact and execute collateral exchanges.

Staff training and operational readiness testing

Utilizing TMMFs as collateral introduces new concepts, tools, and exceptions that existing collateral operations teams may not be familiar with. Firms will need to invest in training across legal, operations, risk and technology functions to ensure that staff understand how TMMFs as collateral will work, inherent risks within the process and in a blockchain environment, and how to best respond to exception or network events. Fireblocks released a study in April 2026 that outlined key findings on the criticality of upskilling and hiring to scale digital assets. According to the study, 42% of financial institutions surveyed noted that skill gaps are a primary obstacle to expanding the use of digital asset products and services.

Encouragingly, the Sandbox simulations demonstrated that existing collateral and margin teams were able to execute tokenized collateral workflows utilizing existing platforms without requiring upskilling. Establishing interoperability with existing collateral platforms and workflows is critical to ensure teams are ready to execute scalable tokenized collateral workflows without significant retraining.

Equally important is the end-to-end operational testing. Firms should execute dry runs of the full tokenized collateral lifecycle in test environments before going live, including simulating margin calls, substitutions, and default scenarios to identify gaps in procedures or system capabilities before they arise in production. For additional information on tests and simulations run by the Sandbox Workstream of this workgroup group, please refer to Section 8: Tokenized Collateral Real Use Cases in the U.S. Sandbox.

c) Technology, integration and market infrastructure dependencies

Industry use cases and the Sandbox simulations have demonstrated that TMMFs as collateral are highly feasible and are tightly coupled with technology integration across the financial ecosystem. Collateral management platforms, margin engines, risk systems, compliance tooling, and reporting infrastructure were largely designed for traditional securities and cash instruments. Tokenized collateral must therefore integrate cleanly into existing workflows rather than operate as a parallel, bespoke process. The current landscape of tokenized asset infrastructure within the U.S. is fragmented, with multiple blockchain networks, custodial platforms, and digital asset systems operating in parallel without standardized connectivity.

The Sandbox has demonstrated, however, that these fragmented systems can be managed through an interoperability solution built on open-source standards and protocols, and API connectivity to traditional collateral management and optimization systems. TMMFs that can only be recognized and transferred within a single proprietary platform provides limited incremental value over existing arrangements, and the efficiency gains of tokenization depend substantially on network adoption and interoperability - a dependency the Sandbox shows is already met through open source API-driven interoperability protocols rather than one the market is still waiting to resolve.

Further scaling will be supported by continued convergence around standards for messaging, identification of tokenized fund interests, and interfaces between traditional and DLT environments. The sandbox showed that interoperability does not have to wait for

that convergence: open protocols and shared identifiers such as DTIs already allow tokenized funds to move across chains and custodians today.

Below is an overview of market infrastructure considerations to enable adoption and scaling of TMMFs as collateral.

Public vs. permissioned chain architecture

Issuers and their agents continue to refine the governance, permissioning and privacy controls required to operate tokenized products at institutional scale, with the market to date having primarily converged on public chains with permissioning and privacy controls embedded at the application layer. A common set of industry standards in this area would further support adoption. The sandbox findings in Section 8 indicate, however, that interoperability across public and permissioned environments is achievable today through router-based architectures, so the architectural choice need not be resolved before TMMFs can scale as collateral.

Interoperability

A significant consideration in the adoption of tokenized collateral is enabling interoperability. A common assumption in the design of tokenized collateral platforms is that participants must transact on a single chain - that for the lifecycle to settle, assets must be migrated, bridged, or re-issued as wrapped derivatives onto whichever ledger the trading venue runs on. This assumption is operationally and commercially unsustainable, and any production-grade operational model for the use of TMMF as collateral must support multi-chain custody, cross-CSD settlement and multi-issuer participation by design.

No single chain is emerging as the universal venue. Tokenized securities are being issued today on multiple distinct ledgers - issuer-native chains, custodian-operated permissioned networks, central bank pilots, and public-permissioned environments – each chosen for reasons specific to the asset, the issuer, the jurisdiction, and the regulatory regime under which it sits.

The need for a structured industry approach to interoperability is now explicitly recognized at the financial market infrastructure ("FMI") level. In their March 2026 joint white paper, DTCC, Clearstream and Euroclear set out five foundational building blocks for digital asset securities interoperability – assets and liabilities, ownership recognition, asset lifecycle and movement protocols, ledgers, and legal and regulatory compliance – and called for industry-wide alignment on data standardization, process harmonization, and clear roles and accountability for novel actors such as bridges and oracles. For TMMFs, these foundations map directly onto the practical requirements identified in this report and architected in the Sandbox: shared identifiers for fund interests, agreed messaging standards, consistent treatment of lifecycle events across chains, and well-defined operational responsibility at each layer of the collateral chain.

Sandbox simulations demonstrated that tokenized funds could move effectively across various DLT, payment rails, and legacy collateral systems, creating a credible model for large-scale adoption of tokenized settlement. The Sandbox also demonstrated that gradual implementation, which has been expressed as the preferred approach among the industry rather than a "rip-and-replace" model, is feasible.

Interoperability is also a liquidity consideration as much as a technology one. If TMMFs become trapped within a single chain, protocol, or custody environment, the market risks recreating the fragmentation and trapping collateral that tokenization is meant to reduce. A durable operating model is one in which the same fund

Key takeaway

interest can settle across multiple rails while preserving a coherent control and recordkeeping framework. Data standards and messaging protocols will be necessary to support a resilient tokenized assets ecosystem.

Digital cash settlement

Realizing the full efficiency of TMMF collateral requires an on-chain cash equivalent, such as tokenized bank deposits or stablecoins, capable of supporting DvP settlement. In the U.S., this infrastructure has made significant progress due to the passage of the GENIUS Act. The OCC, Federal Deposit Insurance Corporation ("FDIC"), Financial Crimes Enforcement Network ("FinCEN"), and Office of Foreign Assets Control ("OFAC") have all issued notices of proposed rulemaking, with final rules required by mid-2026 and the Act taking effect by January 2027. As this framework is finalized, regulated payment stablecoins and tokenized deposits are positioned to move from pilot deployments into broader institutional use, enabling atomic on-chain subscription and redemption of TMMF shares.

Identifying tokenized collateral: the role of Digital Token Identifiers

A practical pre-condition for using tokenized MMFs as collateral at scale is the ability to identify, at the level of the specific token, which digital asset is being posted, recalled or substituted. The same underlying fund – uniquely identified for traditional purposes by its International Securities Identification Number ("ISIN") – can be tokenized multiple times across multiple ledgers, with each instance representing the same beneficial entitlement but constituting a distinct digital asset for settlement, custody and risk purposes.

Two tokens issued against the same MMF on different chains are not natively fungible, may settle with different finality characteristics, and route through different wallet, smart-contract and bridge infrastructures. A collateral framework that identifies eligible assets only at the fund level cannot distinguish between them, and cannot apply chain-specific haircuts, eligibility rules or settlement instructions.

ISO 24165 - the Digital Token Identifier (DTI) standard - provides the missing layer. A DTI is a nine-character alphanumeric code issued by the DTI Foundation (the ISO-appointed Registration Authority) that uniquely identifies a digital token by reference to its distributed ledger, technical implementation and issuance characteristics. DTIs are designed to sit alongside, not replace, ISIN, Classification of Financial Instruments ("CFI") and Financial Instrument Short Name ("FISN"): the ISIN continues to identify the underlying fund, while the DTI identifies the specific tokenized instance on a given ledger. The standard has been adopted in EU regulatory reporting under the Markets in Crypto-Assets Regulation ("MiCA"), and EMIR Refit, under consultation for Markets in Financial Instruments Regulation ("MiFIR"), and is referenced by the US Office of Financial Research as the emerging digital-asset identifier of record.

For tokenized MMFs posted as collateral, embedding DTIs in collateral schedules, eligibility tables and margin call messages allows counterparties, custodians and collateral managers to unambiguously identify what has been delivered, applied to which margin requirement, on which ledger – a prerequisite for both operational reliability and regulatory reporting.

d) Managing, risk, controls, and compliance in a tokenized collateral model

Shifting to a tokenized collateral environment introduces novel risks and control environments that differ meaningfully from traditional collateral models. Tokenization compresses and automates much of the traditional collateral lifecycle, which improves efficiency but also removes natural control points that firms currently rely on. Current control environments must be subject

Key takeaway

to robust gap assessments to determine where deliberate redesigns are required as opposed to minor enhancements or adaptations. Likely enhancements to control environments center around smart contract failures, KYC, AML, and enhanced due diligence processes, network risk monitoring, and the handling of exceptions.

Control frameworks should also address finality thresholds and exception escalation. Firms will need explicit rules for when a tokenized transfer is considered available for margin purpose, when a failed or delayed confirmation triggers escalation, and how counterparties reconcile differences between ledger status, custodian records, and collateral system books.

These questions are especially crucial in default management scenarios, where mobility and the timing of transfers is important and legal rights must be matched by operational certainty.

While compliance obligations do not change because the collateral is tokenized, the mechanisms for meeting them must be enhanced to account for novel digital assets and tokenization considerations. KYC, AML, and enhanced due diligence must be enforced through whitelisting and permissioning to attribute anonymous wallet addresses to accepted institutional participants.

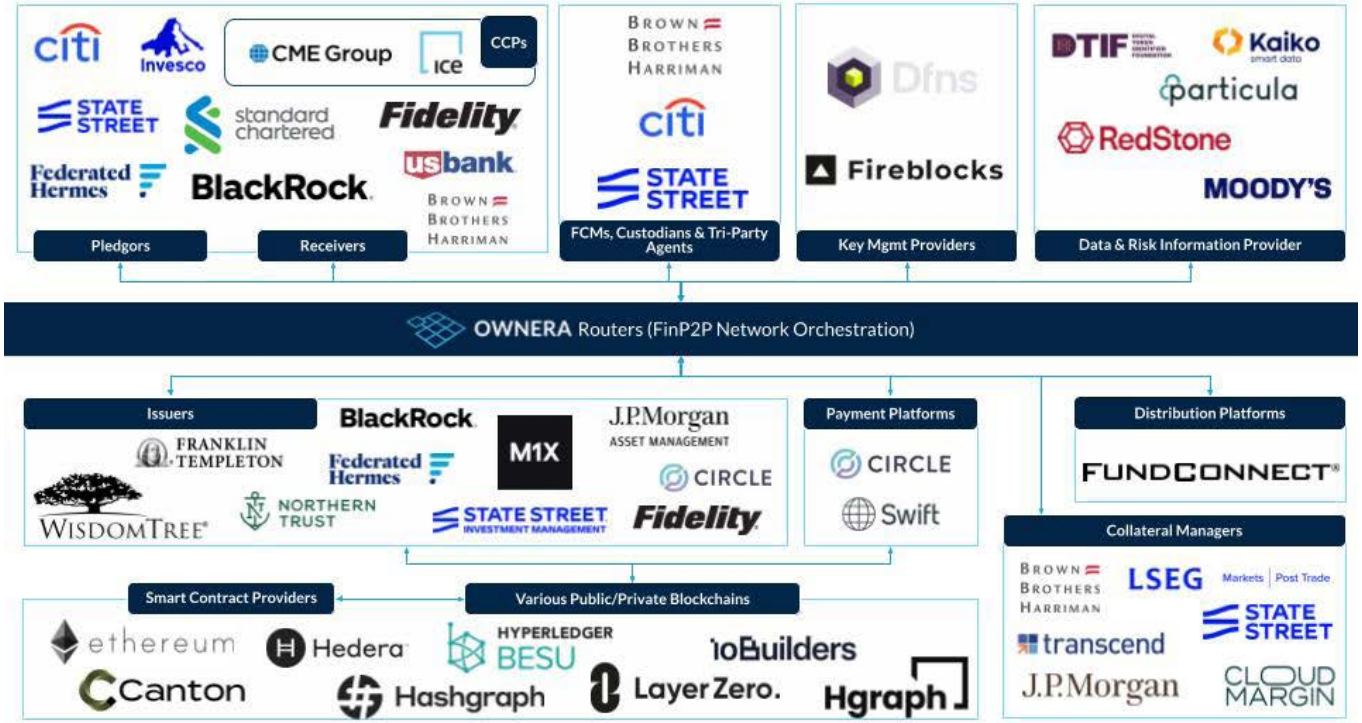
Additionally, on-chain activity will need to be accurately captured and integrated into reporting frameworks designed around traditional assets to ensure accuracy in regulatory reporting. Until reporting standards for tokenized collateral are clarified by regulators, firms will need to bridge that gap through interpretive judgments and consensus through internal governance forums.

Concentration risk also matters. Early tokenized collateral markets may depend on a small number of wallet providers, tokenization platforms, transfer agents, or interoperability solutions. A firm may therefore face new single-point-of-failure exposures even if the underlying fund is low risk. The degree of exposure depends as much on how a given component is architected as on how many providers exist. Designs that concentrate activity within a single operator's environment, or that require assets to be held or moved only within one platform, tend to raise concentration risk; designs that are distributed across participants, that keep assets on their native ledgers, and that allow providers to be substituted tend to reduce it. Firms should assess each component, including custodians, tokenization platforms and interoperability solutions, against the same criteria: operational resilience, substitutability, and the extent to which the design avoids a dependence that cannot readily be diversified.

Additionally, interoperability layers can reduce that concentration by enabling firms to transact across multiple custodians, chains and platforms through a single network connection, broadening optionality rather than narrowing it. The provider landscape is broadening as more custodians, tokenization platforms, and interoperability layers come to market, giving firms greater flexibility to diversify these dependencies over time.

Control frameworks for TMMFs should extend existing vendor risk practices to this context, incorporating due diligence, service resilience testing, fallback procedures, incident response plans, and governance forums that assess whether a concentration profile is becoming too dependent on a single platform or provider. ■

6. Tokenized Collateral Real Use Cases in the U.S. Sandbox



The GDF Industry Sandbox, powered by Ownera, is designed to move the analysis of TMMFs as collateral beyond the theoretical and into the demonstrably practical. Its central purpose is to test whether TMMF collateral can function within the real operational frameworks that institutional market participants depend on – existing margin call systems, established custody infrastructure, and standard bilateral documentation – without requiring those frameworks to be rebuilt from scratch.

Sandbox scope, objectives, and assumptions

The sandbox has three principal objectives:

- To validate interoperability across custody environments and router infrastructure
- To test whether near-instantaneous on-chain settlement can be realized within institutional workflows, and
- To surface operational gaps that are not apparent from legal or theoretical analysis alone.

The simulations are sequenced to build in complexity, beginning with bilateral uncleared VM before progressing to cleared margin scenarios involving CCPs and Futures Commission Merchants ("FCMs"), substitution and liquidations, and even market stress scenarios. Building on the E.U./U.K. Sandbox simulations, care was taken to not repeat already-proven workflows and technology, such as margin calculations, leveraging the Common Domain Model, and intraday repo.

The following key assumptions apply across all simulations:

- All instruments used are test assets only
- No real fund interests are transferred, and no legal obligations are created
- Assets are priced at one dollar per token unit, with a standard haircut applied across all instruments
- The eligible asset list is treated as pre-agreed between pledgor and receiver

- For variation margin, settlement is structured as a pledge of security interest under New York law, consistent with how VM is executed in the bilateral derivatives market, with ownership changes reflected on the blockchain as controlled by the transfer agent
- For IM, the asset is locked at the receiver's custodian or the CCP's custodian in the case of cleared markets, and the record of ownership is updated accordingly.

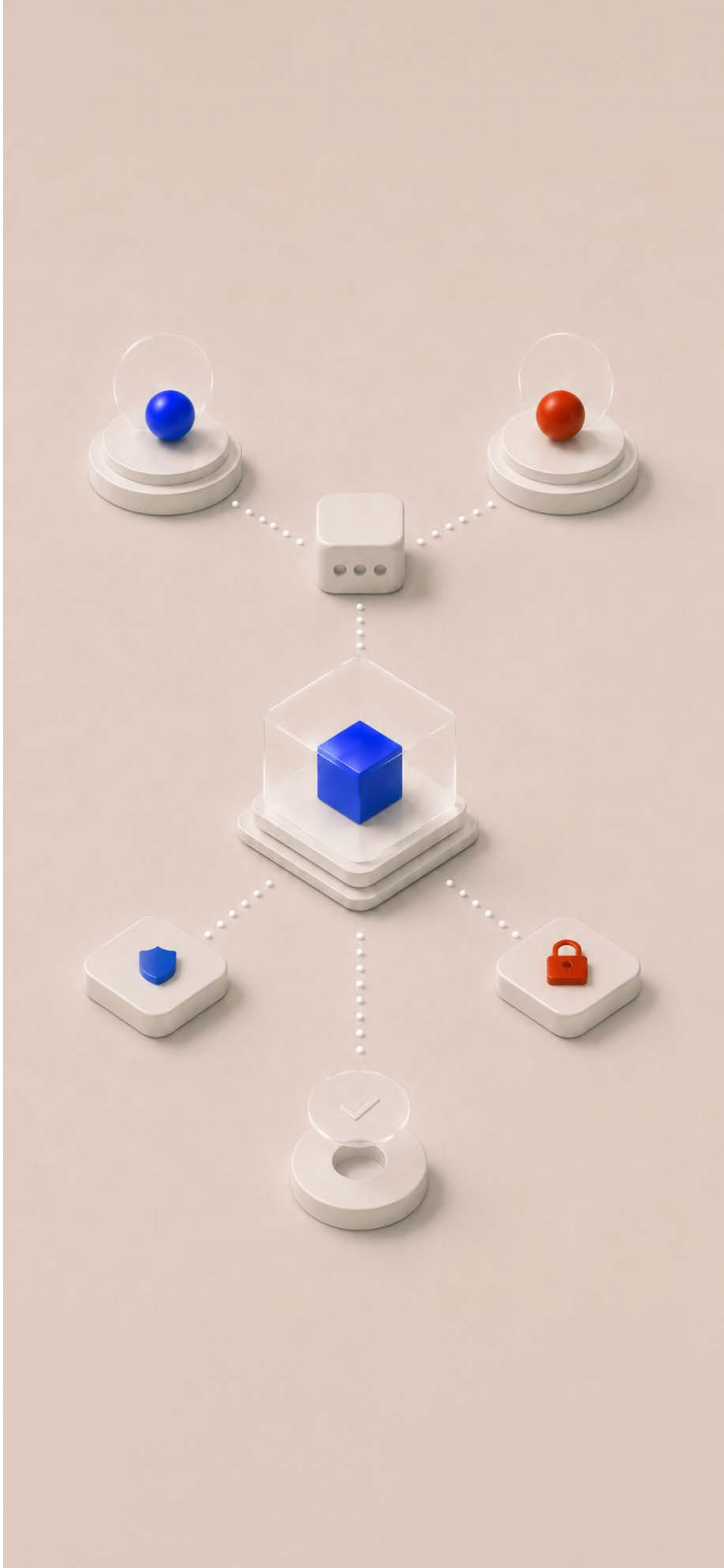
Sandbox architecture

The GDF Industry Sandbox operates on an AWS-hosted test environment powered by Ownera's FinP2P protocol, which provides the blockchain agnostic application layer connecting institutional participants, their custody providers, margin management systems, and the various blockchains on which the test tokens are issued.

Each participant connects to the FinP2P protocolthrough a router that sits between their internal systems and the broader router ecosystem. This means that participants do not need direct bilateral technical connections, nor do they need to operate on the same blockchain or within the same custody environment. The router layer provides the abstraction that enables a pledgor holding tokens in a wallet managed by one digital asset custody provider to transfer those tokens to a receiver using another custody solution, without either party modifying their internal infrastructure beyond the router integration.

The margin management layer uses LSEG PTS (Acadia) for call issuance, affirmation, and instruction generation, with Cloud Margin and Colline providing collateral management for individual participants.

These systems receive inventory information from pledgor routers, optimize and match the agreed call amount against available eligible assets, and generate movement instructions that are transmitted directly to the router layer for on-chain execution — without manual re-entry or additional messaging from either counterparty.



Issuer Name	Asset Name	Ticker	DTI (on Ethereum or specified otherwise)
J.P. Morgan Asset Management	Test JPMorgan OnChain Liquidity Money Market Fund	TJLTXX	DTIA0020X
J.P. Morgan Asset Management	My OnChain Net Yield Fund Test	MONY	B9BL0JLRT
Franklin Templeton	Franklin OnChain U.S. Government Money Fund	FOBXX	LTZB13WH0
BlackRock	Mock BlackRock Liquidity Funds T-Fund	MOCKTSTXX	DTIA0017X
WisdomTree	WisdomTree Government Money Market Digital Fund	WTGXX	8G2G3K4TC
State Street Global Advisors	State Street Institutional US Government MMF	GVMXX	DTIA0012X
State Street Global Advisors	State Street Institutional Treasury Plus Money Market Fund	TPIXX	DTIA0019X
Circle Internet Group	USD Coin (USDC)	NA	CK9PW1MFH
Federated Hermes	Federated Hermes Tokenized Treasury Test Fund	FHTTFXX	DTIA0013X
Federated Hermes	Federated Hermes Tokenized Treasury Test Fund	FHTTFXX	Hedera DTI: DTIA0014X
Fidelity Management & Research Company	Fidelity Treasury Digital Fund	FYOXX	DTIA0015X
Fidelity Management & Research Company	Fidelity Treasury Digital Fund	FYOXX	Hedera DTI: DTIA0016X
Northern Trust Investments, Inc.	MOCK Northern Institutional U.S. Government Portfolio	MBNGXX	Besu DTI: DTIA0018X

Tokenized funds tested in the sandbox

The instruments selected for the sandbox represent interests in U.S. government money market funds operating under SEC Rule 2a-7, providing a consistent regulatory baseline against which the generic haircut and eligibility assumptions can be assessed as commercially realistic. Although the legal and regulatory analysis was focused on 2a-7 funds, this analysis may be relevant to private placement funds, as well.

All tokens were pre-agreed as eligible assets between participating pledgors and receivers, and all were priced and haircut on a uniform basis for Simulation 1. The instruments span both digitally native and digital twin structures and sit on different chains (both public and private).

Overview of Sandbox Simulations & Assets in Sandbox

The sandbox ran three simulations of increasing complexity, each building on workflows already proven in the E.U./U.K. sandbox rather than repeating them. They move from the most established collateral workflow to the most novel, across multiple custodians, data providers and chains. ■

Simulation	Margin type	What is tested
1	Bilateral uncleared VM	Multi-token and cross-custodial VM pledges, dispute handling, and haircut mechanics
2	Cleared IM (cascade)	CCP-to-FCM-to-client cascade, DvD substitution of cash for TMMFs at the CCP, and intraday cash re-use across two CCPs
3	Uncleared IM (UMR)	Code-enforced third-party segregation via smart contract, and triparty segregation on tokenized rails

7. Sandbox Findings

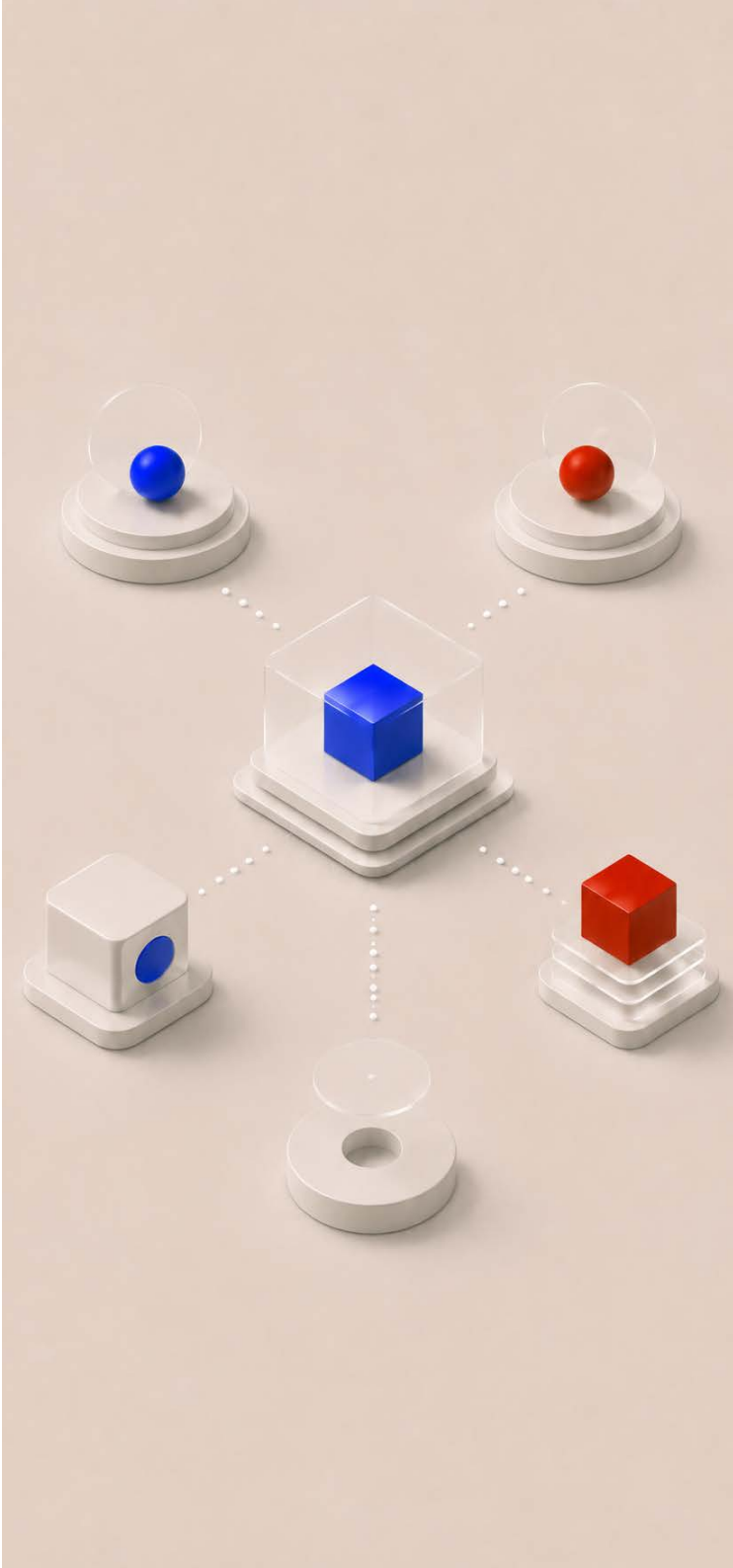
This section sets out what the GDF Industry Sandbox demonstrated in practice. Across three simulations, the working group moved progressively from the most established collateral workflow to the most novel: bilateral variation margin in Simulation 1, a full cleared initial margin cascade with substitution and collateral re-use in Simulation 2, and UMR-compliant initial margin segregation using two distinct operating models in Simulation 3.

Each simulation was designed to test whether TMMFs can function within the operational frameworks institutions already rely on, rather than requiring those frameworks to be rebuilt. Every simulation ran on test assets and synthetic tokens, with no real fund interests transferred and no legal obligations created, and with eligible-asset lists, haircuts and valuation treated as pre-agreed between the parties. The purpose was not to prove a single platform but to surface where the law already supports adoption and that the technology is ready to be deployed, working readily with existing systems.

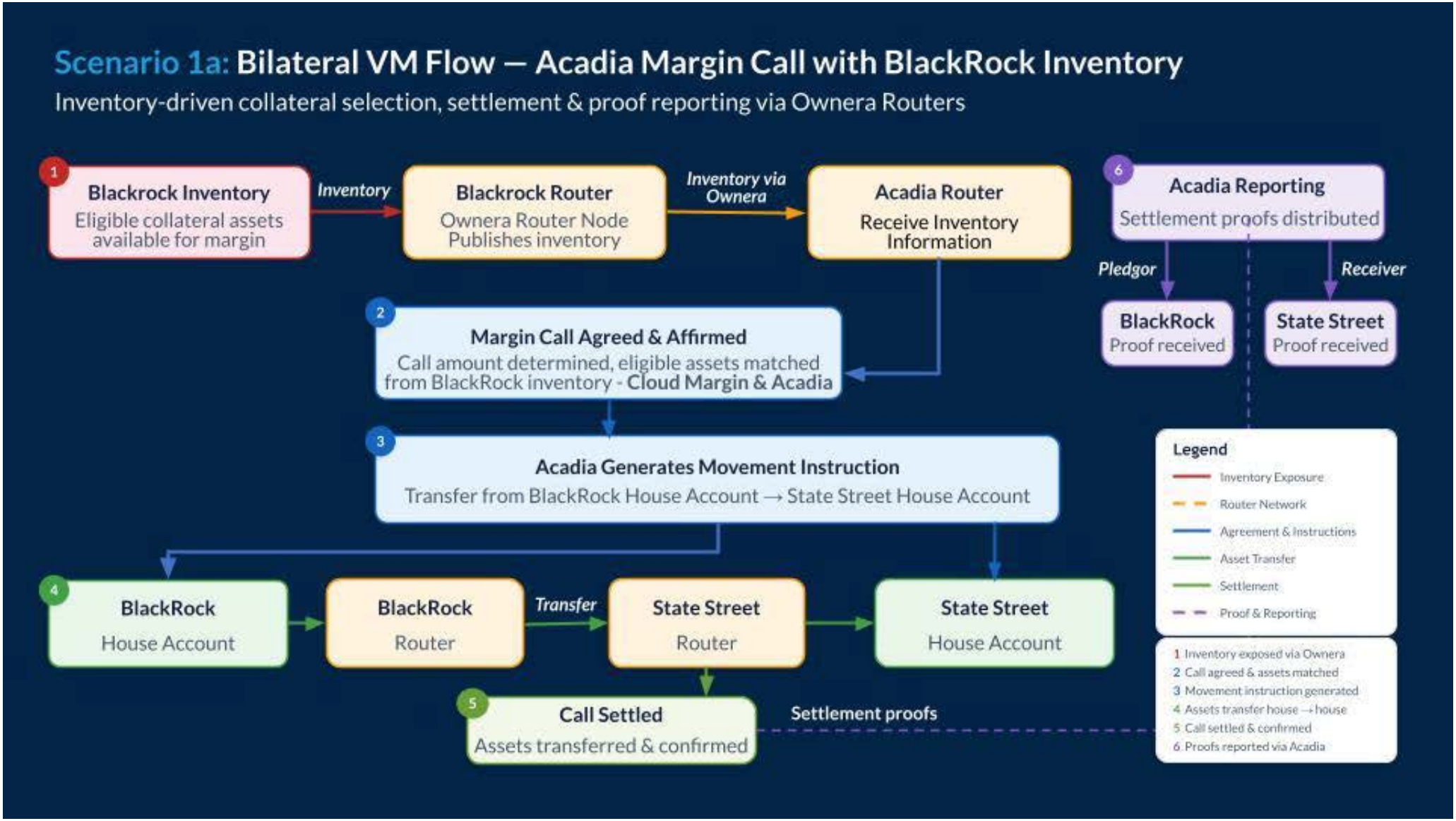
Each scenario is presented in a consistent format: what it does, its key features, and why it matters for production adoption. Taken together, the simulations provide an operational counterpart to the legal and regulatory analysis set out earlier in this report, and the observations they generate feed directly into the industry recommendations that follow.

Simulation 1

The three scenarios in Simulation 1 support a qualified and substantive conclusion: TMMFs can be pledged as bilateral VM within existing institutional infrastructure, with settlement completing in under two minutes in each case, and without requiring modification to the core margin management systems on which counterparties already depend. The recording for Simulation 1 is available here.



Scenario 1a: Partial Dispute — State Street / BlackRock



What it does

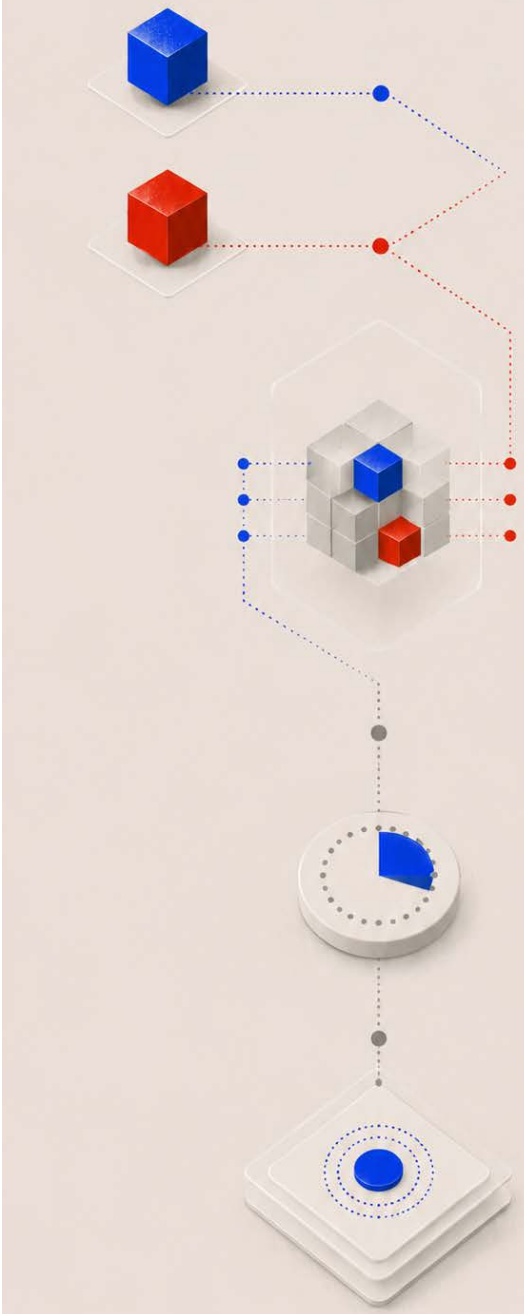
State Street Bank and Trust Company (“State Street”) issued a margin call of $4,000,000 to BlackRock Inc. (“BlackRock”) under agreement 123456789. BlackRock agreed to $3,000,000 of the call, disputing the remaining US$1,000,000. The agreed portion was pledged using three tokenized instruments — the BlackRock BLF Treasury Trust Fund, the WisdomTree Treasury Money Market Digital Fund (WTGXX), and the State Street Institutional US Government MMF – routed via Ownera FinP2P and settled via Fireblocks wallet custody on Ethereum.

Key features

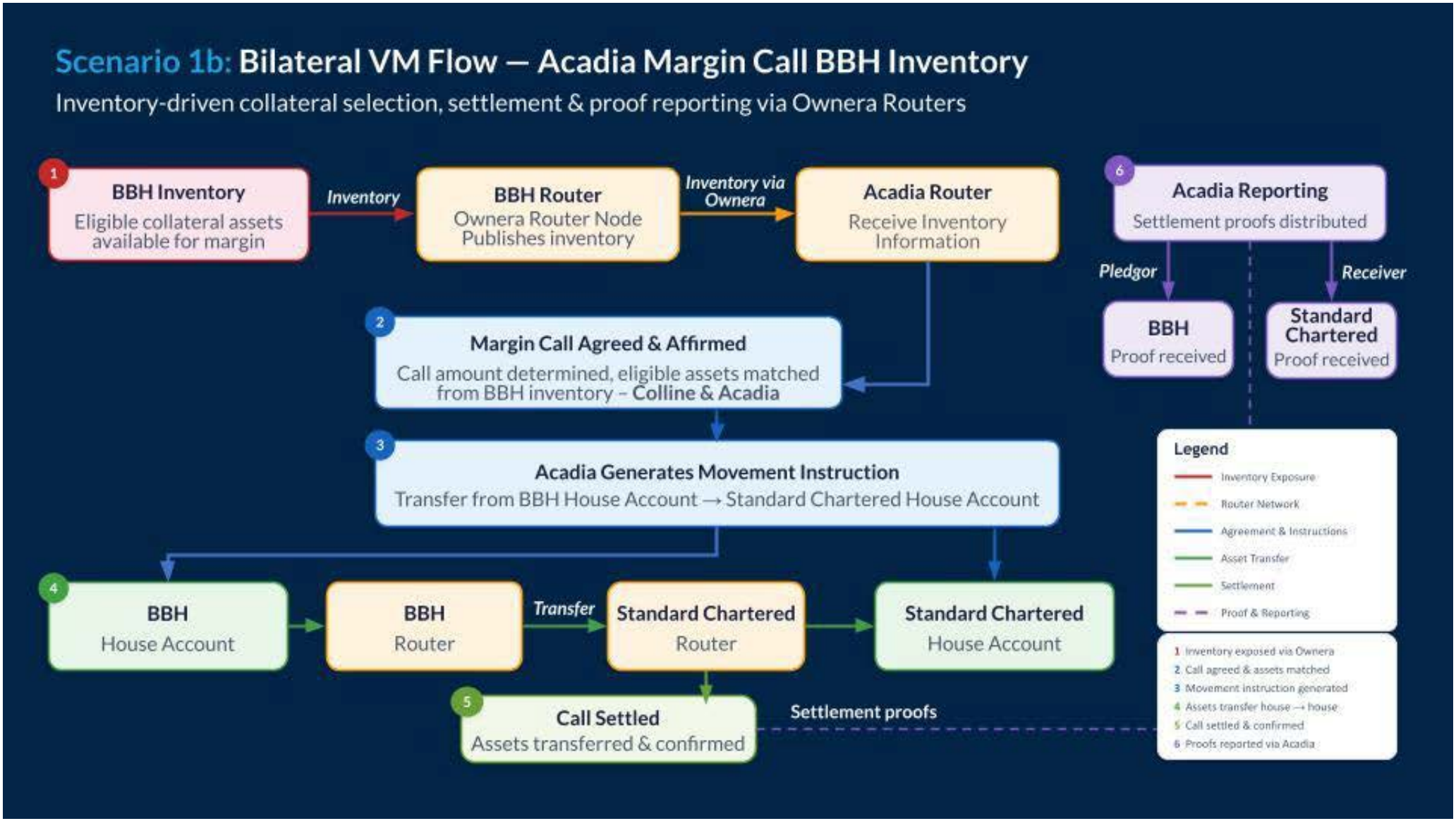
The US$3,000,000 pledge was executed using three tokens of equal value across three issuers. The disputed US$1,000,000 was cleanly flagged and excluded from the pledge cycle without impeding settlement of the agreed amount. Acadia generated the movement instruction from the margin match, which was transmitted directly through the router layer to Fireblocks for on-chain execution. Settlement was confirmed by both parties without manual re-entry or additional messaging.

Why it matters

This scenario confirmed that dispute handling is operationally separable from pledge execution — a critical requirement in live bilateral workflows where parties frequently settle the undisputed portion of a call while the remainder is managed separately. It also validated that multi-token pledging across different issuers functions correctly within a single movement instruction and demonstrated end-to-end settlement in under two minutes from margin match to confirmed on-chain transfer.



Scenario 1b: Full Agreement, Two-Token Pledge — Standard Chartered / BBH



What it does

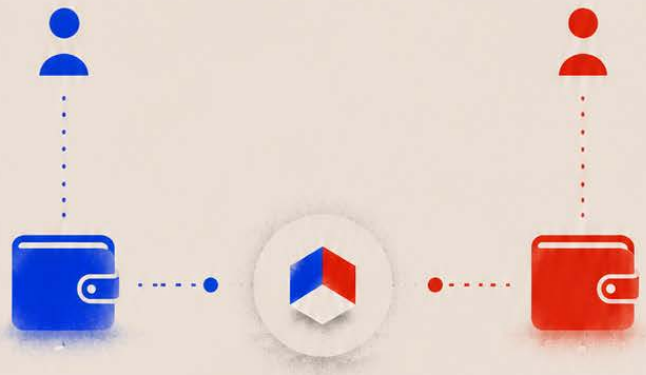
Standard Chartered Bank issued a margin call of US$2,000,000 to Brown Brothers Harriman and Co. (“BBH”) under agreement 987654321. The pledge was executed using two tokens — the WisdomTree Fund and the State Street Institutional US Government MMF (GVMXX) — settled using Dfns wallet custody on Ethereum.

Key features

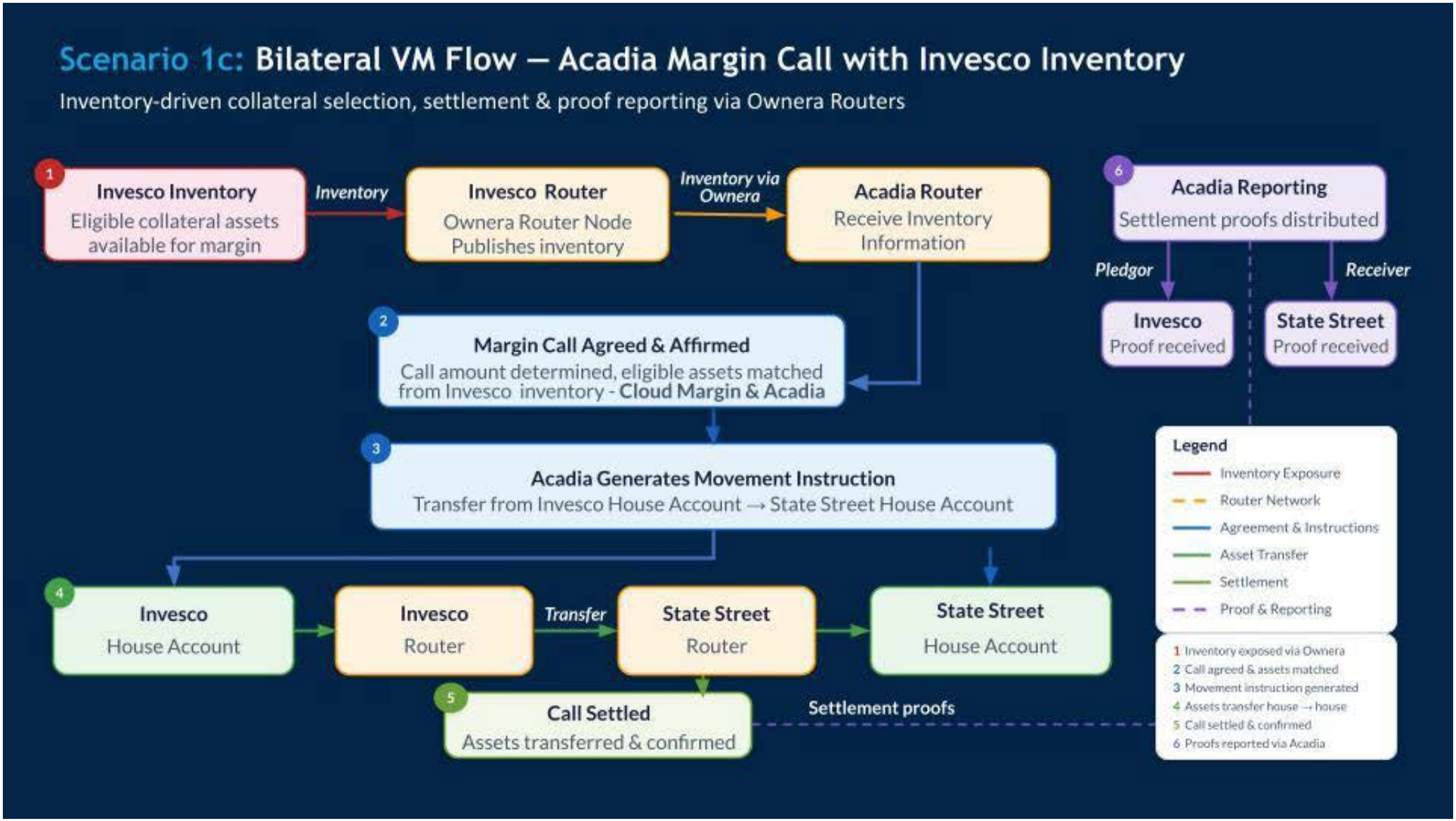
This scenario operated across two different custody providers: Standard Chartered used Dfns and BBH used Fireblocks. Colline and Acadia were used for collateral management and call affirmation respectively. The FinP2P router layer orchestrated the on-chain transfer between wallets managed by different custody providers, without either party establishing a direct technical connection to the other's custodian.

Why it matters

Scenario 1b demonstrated cross-custodial interoperability in a live workflow. Without this capability, the practical reach of TMMF pledging would be limited to counterparty pairs sharing the same custody infrastructure — a significant constraint on adoption. The scenario confirmed that the router-based architecture resolves this constraint, allowing firms to transfer tokenized assets to counterparties using different wallet providers through a single network connection.



Scenario 1c: Full Agreement, Single-Token Pledge — State Street / Invesco



What it does

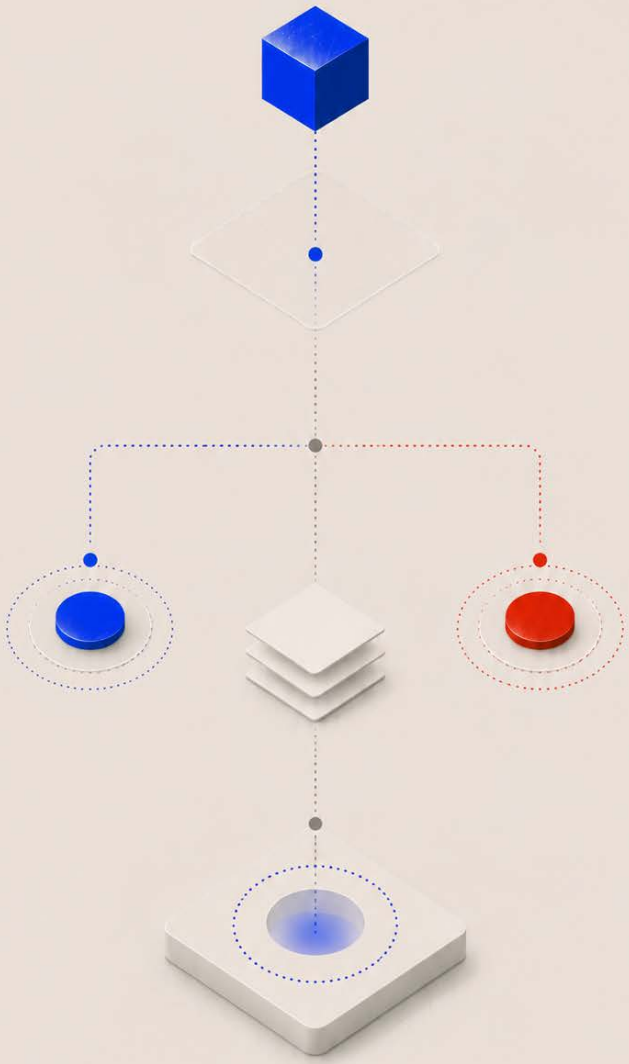
State Street issued a margin call of US$5,000,000 to Invesco Advisers, Inc. (“Invesco”) under agreement 192837456. Invesco agreed in full. The pledge was executed using a single WisdomTree WTGXX token at US$5,750,000, reflecting the 15% haircut, routed via Ownera FinP2P and settled via Fireblocks wallet custody on Ethereum.

Key features

The full pledged amount, grossed up to account for the haircut, was transferred as a single onchain transaction from Invesco's house account to State Street’s house account. Acadia and CloudMargin managed the margin call and affirmation, with the movement instruction generated automatically from the margin match. Settlement proofs were distributed to both parties via Acadia on completion.

Why it matters

This scenario illustrated that haircut mechanics are correctly embedded in the instruction generation and transmitted faithfully through to settlement without manual adjustment at the custody layer. It also confirmed that large-notional single-token pledges settle with the same speed and reliability as multi-token scenarios, and that the settlement proof and reporting layer functions correctly across all three scenario types.



Simulation 2

The five scenarios in Simulation 2 extend the test scope from bilateral VM to a full cleared IM cascade: an initial margin call cascading from a CCP to its FCM, the FCM in turn calling three buy-side clients, an optimized delivery-versus-delivery substitution of digital cash for TMMFs at the CCP, and the re-use of the freed cash to a second CCP call. Settlement completed in each leg within the same operational window and across different chains, without requiring direct technical connections between the FCM, clients, custodians or CCP custody beyond their respective FinP2P routers. The recording for Simulation 2 is available here.

Scenario 2a: Independent-UI Subscription — BBH / Fund Connect

What it does

In a preparation step ahead of the cascade, BBH (acting in its client capacity) subscribed via Fund Connect, State Street's client-facing subscription user interface ("UI"), for US$25,000,000 (post-haircut) of TMMF positions across three issuers: US$4,000,000 of the BlackRock MOCKTSTXX, US$3,000,000 of the State Street GVMXX, and US$18,000,000 of the State Street TPIXX. Trade instructions were transmitted from Fund Connect to the Ownera FinP2P router for orchestration.

Key features

Subscription was placed through an independent client UI rather than through a router-native interface, with Fund Connect's investor dashboard showing live position updates and Ownera displayed in parallel to evidence the routing handoff. The three resulting positions were tagged within the eligible-collateral bucket on the BBH wallet and made available for downstream pledging in the cascade.

Why it matters

This scenario confirmed that TMMF subscription can be initiated from existing distributor-facing UIs, with no requirement for the subscribing investor to interact directly with the router or the underlying chain. It also validated that subscription and custody can be orchestrated through a single integrated workflow - a precondition for institutional adoption, where the buy-side typically transacts through established fund-portal infrastructure rather than crypto-native and disparate interfaces.

Scenario 2b: Cash-Leg Pledged from FCM to CCP - Citi / ICE

What it does

Intercontinental Exchange ("ICE") issued a US$25,000,000 initial margin call to Citi in its FCM capacity. Citi met the call in full by transferring US$25,000,000 USDC on Ethereum Sepolia from its Fireblocks-managed wallet to a CCP wallet custodied by BBH and managed using Dfns key infrastructure. No haircut was applied to the USDC leg.

Key features

The pledge was executed entirely in stablecoins. Settlement was confirmed end-to-end through the FinP2P router, with the CCP wallet at BBH showing the $25,000,000 USDC inflow and CCP exposure to Citi fully covered before any client-leg calls were initiated.

Why it matters

This scenario established a credible baseline for the cleared-margin cash leg, using a GENIUS-regulated digital cash instrument settled on the same router infrastructure as the TMMF legs that follow. It also created the operational precondition for the substitution scenario described below – the CCP could not accept

TMMF collateral in place of cash unless cash was already posted and available to be released back to the FCM.

Scenario 2c: FCM-to-Client Cascade with Collateral Optimisation — Citi / Fidelity, BBH, Invesco

What it does

With its CCP exposure covered, Citi cascaded the call down to three buy-side clients in sequence: Fidelity Capital Markets ("Fidelity") for US$10,000,000, BBH (FX desk) for US$25,000,000, and Invesco for US$15,000,000. Each call was orchestrated through Cloud Margin, with BBH's leg additionally optimized through their internal tool Colline. A generic 8% haircut was applied uniformly to all TMMFs. Settlement spanned Ethereum Sepolia and Hedera within a single workflow.

Key features

Optimization was performed live for each leg.

For Fidelity, Cloud Margin selected the Fidelity FYOXX token (US$3,000,000), the J.P. Morgan Asset Management TMONY token (US$4,000,000) and WisdomTree WTGXX (US$3,000,000) with tokens moving from Dfns-managed wallets at Fidelity to Citi's Fireblocks wallet on Ethereum Sepolia.

For BBH, Colline selected the BlackRock MOCKTSTXX ($4,000,000), State Street GVMXX (US$3,000,000) and the State Street TPIXX ($18,000,000).

For Invesco, Cloud Margin selected the Federated Hermes FHTTFXX (US$5,000,000) and Franklin Templeton FOBXX (US$10,000,000) with settlements spanning Hedera and Ethereum Sepolia.

By close of the cascade, Citi's FCM wallet held the full US$50,000,000 post-haircut composition - across eight distinct TMMFs.

Why it matters

This scenario validated two properties of the FCM-to-client leg in a live workflow. First, that the margin workflow tooling already used by FCMs and their clients (Cloud Margin, Colline) integrates with FinP2P routers without bespoke connectivity. The FCM and each client operated through their existing collateral platforms, leveraging the FinP2P routers to orchestrate the transaction, as opposed to having to bilaterally integrate manually with each of them.

Second, settlement is chain-agnostic from the participant's perspective: tokens moving across Ethereum Sepolia and Hedera in different legs of the same cascade settled without manual reconciliation between them.

Scenario 2d: DvD Substitution at the CCP - Citi / ICE (USDC TMMFs)

What it does

Once Citi held the post-cascade collateral composition in its FCM wallet, Transcend, acting on behalf of Citi, proposed a delivery-versus-delivery (DvD) substitution at ICE: $25,000,000 USDC out, and the five TMMFs received from clients in (MOCKTSTXX US$4M, GVMXX US$3M, FYOXX US$3M, FHTTFXX US$5M, FOBXX US$10M, totalling US$25,000,000 post-haircut).

The CCP affirmed, BBH (as CCP custodian) signed the inbound TMMF basket – approving each release of funds on Dfns – and the two legs settled atomically: USDC returned from BBH to Citi's Fireblocks wallet on Sepolia; the five-asset TMMF basket moved from Citi to BBH custodying on behalf of the CCP.

Key features

Transcend, connected via the FinP2P routers, filtered the FCM wallet using NAV and reference data sourced via the Ownera router's integration with Kaiko and the DTIs, and identified the optimal TMMF basket for substitution on a data-driven cheapest-to-deliver basis. The other half of the TMMFs remained at the FCM as proprietary collateral, locked under the agreement-level re-use restriction. The substitution executed as a single coordinated DvD operation rather than a sequenced pair of unilateral movements.

Why it matters

This scenario tested two of the more commercially important capabilities of the architecture in a single step. It confirmed that an FCM can use intraday CCP substitution to replace cash instruments with TMMF collateral once eligible client collateral has been collected, releasing the cash for redeployment elsewhere.

This is one of the central commercial arguments for posting TMMFs into the cleared margin chain. It also confirmed that the substitution can be optimized on live market data and that the underlying CCP-eligibility flag is enforced at the substitution layer rather than at the agreement layer, allowing the same TMMF universe to be pledged into bilateral and cleared workflows under different eligibility scopes.

Scenario 2e: Recycling of Returned USDC to a Second CCP Call — Citi / CME

What it does

To close the cascade, Chicago Mercantile Exchange ("CME") issued a separate US$25,000,000 IM call to Citi. Citi met the call in full using the $25,000,000 USDC just returned from the ICE substitution in Scenario 2d, transferring it on Ethereum Sepolia from its Fireblocks wallet to a CME wallet custodied by BBH.

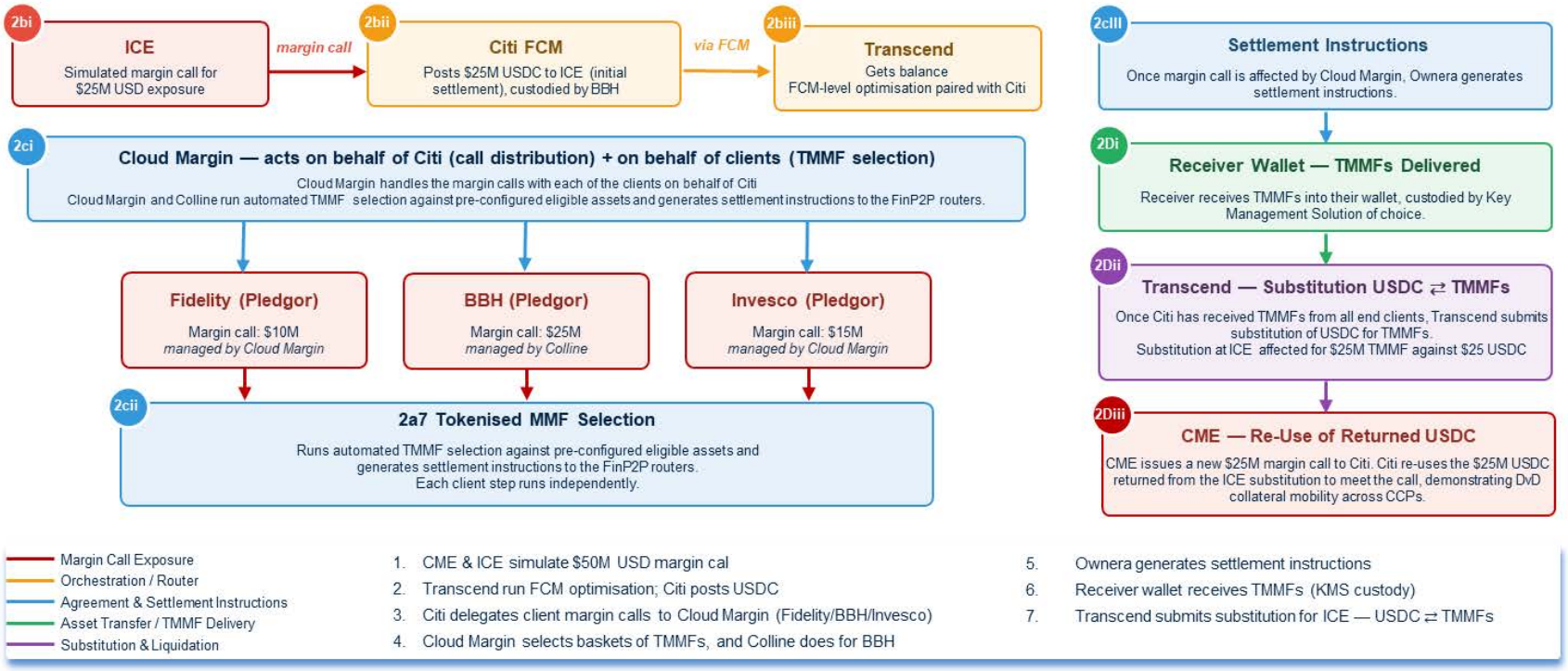
Key features

The same $25,000,000 of USDC served two separate CCP exposures within a single operational window - first at ICE, then released back to Citi via DvD substitution, then redeployed to CME. No bridging, conversion or off-router redemption was required between the two posts. Any digital cash solution, or fiat with the SWIFT integrations provided in the FinP2P routers could be leveraged for this instance.

Why it matters

This scenario closed the loop on the cascade by demonstrating cash mobility at the FCM level. The substitution mechanism in Scenario 2d is only commercially attractive if the cash it releases is genuinely fungible across the FCM's CCP relationships and can be redeployed without operational delay. Scenario 2e confirmed that the freed cash is immediately available for re-use and that intraday liquidity management across multiple CCPs is supported within the same router orchestration plans.

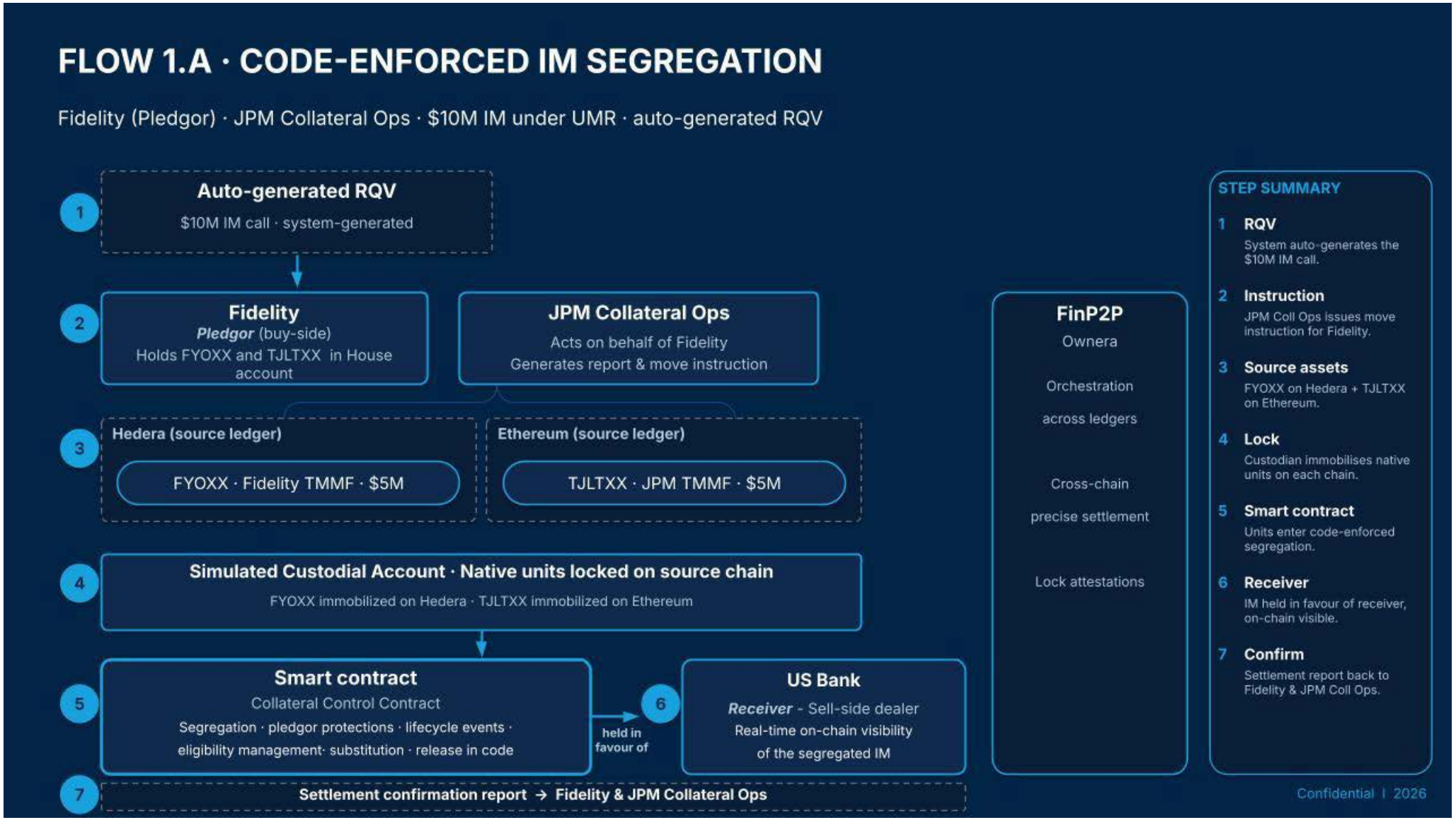
FIGURE 7: CCP Margin Cascade



Simulation 3

Simulation 3 extended the test scope from variation margin and cleared initial margin to UMR-compliant initial margin segregation, using TMMFs as collateral. It demonstrated two distinct but complementary operating models on the same tokenized infrastructure: code-enforced thirdparty segregation through the Ownera Collateral Control Contract (Flow 1, run as two parallel pledgor legs), and institutional tri-party governance on tokenized rails with State Street acting as independent tri-party agent (Flow 2). In both models the initial margin was held segregated and bankruptcy-remote, and was not rehypothecated, consistent with UMR requirements. FinP2P provided the common orchestration layer across Ethereum, Hedera, Ethereum Sepolia and Besu, settling each leg in a single end-to-end workflow with no manual reconciliation between legs, while independent ratings data from Moody's and pricing data from Kaiko and Redstone fed the eligibility and haircut logic. The recording for Simulation 3 is available here.

Scenario 1.A: Code-Enforced Third-Party Segregation, Pledgor Leg - Fidelity / JPM Collateral Ops to US Bank



What it does

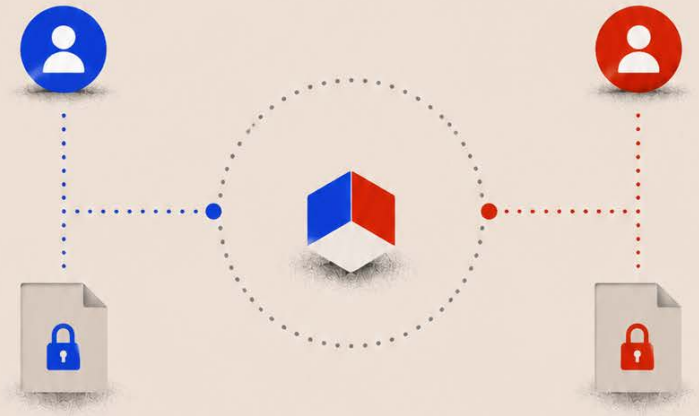
In Flow 1A, JPM Collateral Ops, acting on behalf of Fidelity Capital Markets, pledged US$10,000,000 of initial margin to US Bank as receiver. The pledge was composed of two TMMFs on different chains: the J.P. Morgan Asset Management TJLTXX (US$5,000,000 on Ethereum) and the Fidelity FYOXX (US$5,000,000 on Hedera). The simulated custodian immobilized the native units on their source ledgers, and the Ownera Collateral Control Contract held the segregated position in favour of US Bank. A settlement confirmation was returned to Fidelity and JPM Collateral Ops to close the loop.

Key features

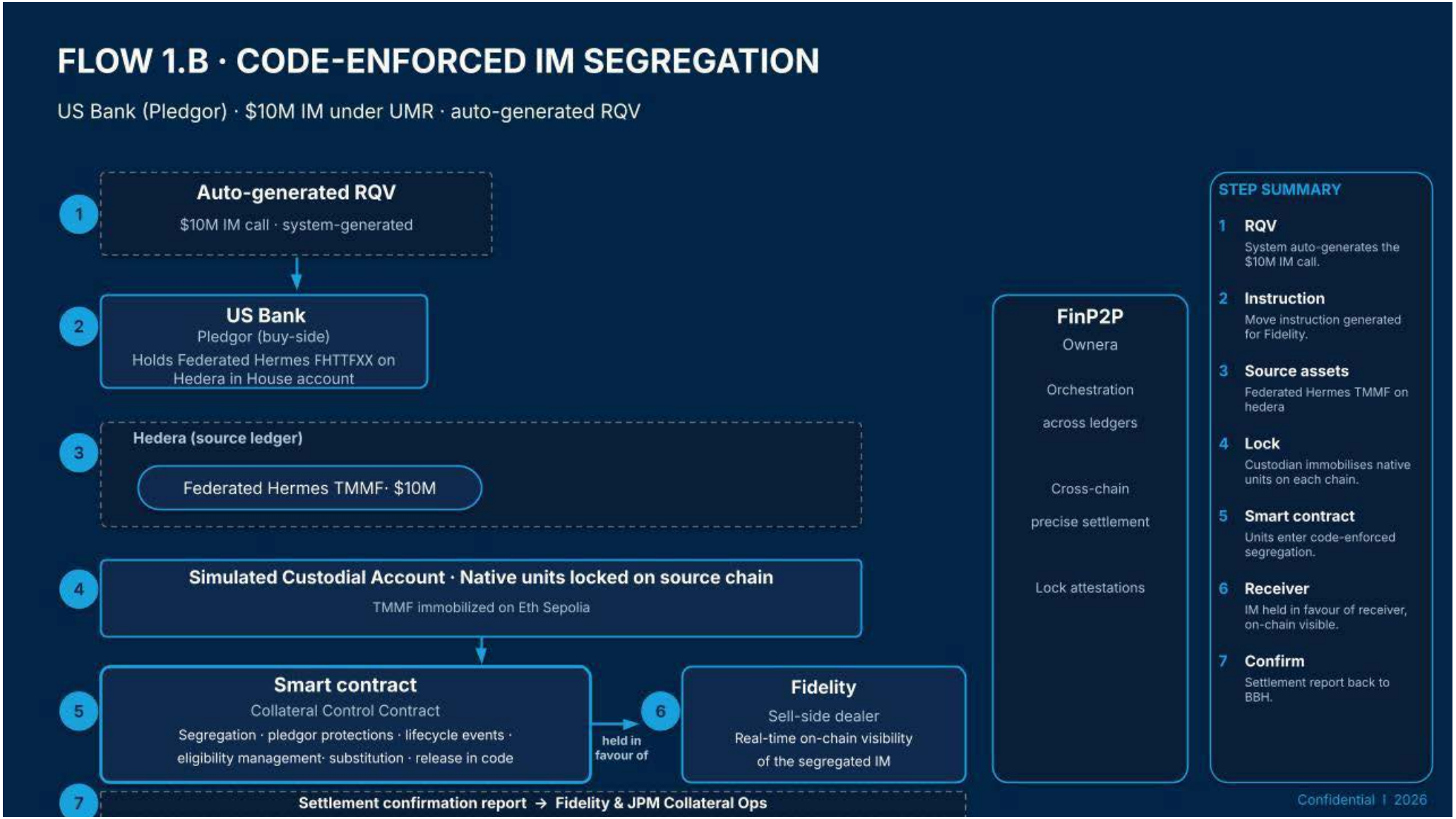
Segregation, pledgor protections, coupon and dividend routing, substitution and release were enforced in code by the Collateral Control Contract rather than through manual instruction. US Bank obtained real-time, on-chain visibility of the segregated position but could not unilaterally seize it: release was governed by the contract logic, not by manual action at the custody layer. The two component assets settled across Ethereum and Hedera within a single workflow, with FinP2P orchestrating across both chains.

Why it matters

This scenario demonstrated that UMR third-party segregation can be delivered through code, providing an alternative to a traditional tri-party arrangement while preserving the core protections UMR requires: assets held for the receiver, bankruptcy-remoteness, no rehypothecation, and release that neither party can force unilaterally. Embedding these controls in the contract, rather than in operational procedure, reduces the manual touchpoints and reconciliation the legacy initial margin chain depends on, while keeping the pledgor's economic entitlement to dividends intact as well as ensuring that collateral remains protected if either counterparty defaults.



Scenario 1.B: Code-Enforced Third-Party Segregation, Reverse Leg - US Bank to Fidelity



What it does

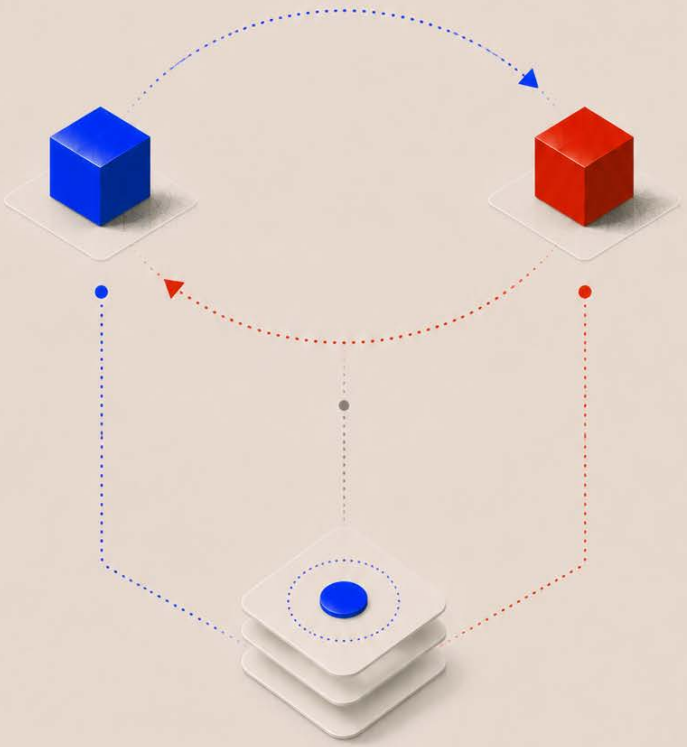
Flow 1B was the reverse of Flow 1A: US Bank acted as pledgor and Fidelity as receiver, for a US$10,000,000 initial margin pledge using the Federated Hermes token on Hedera. Because there was no separate collateral operations team on this leg, Ownera produced the report and issued the move instruction on behalf of US Bank. The simulated custodian immobilized the FHTTFXX units on Hedera, and the Ownera Collateral Control Contract held the segregated position in favor of Fidelity, with a settlement confirmation returned to US Bank.

Key features

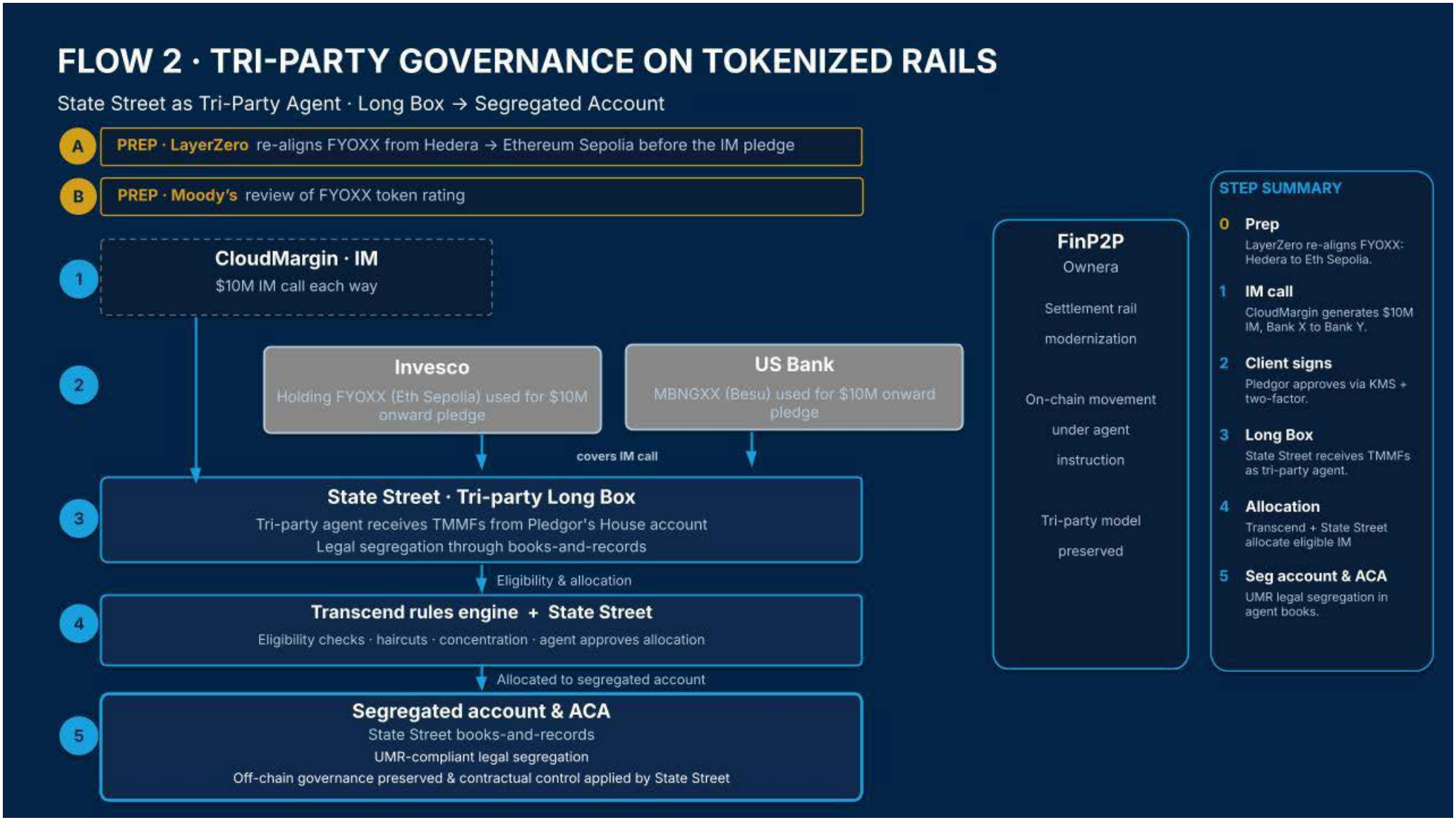
The Collateral Control Contract again enforced segregation, pledgor protections, lifecycle events, substitution and release in code, with Fidelity obtaining real-time on-chain visibility and release remaining code-governed. Running this leg as the mirror image of Flow 1A, on a single asset and a single chain, isolated the return path and showed the model operating symmetrically regardless of which counterparty is pledging.

Why it matters

This scenario confirmed two practical points. First, the code-enforced segregation model is bidirectional: the same contract logic governs the pledge and its reverse without bespoke build for each direction. Second, the report-and-instruction step can be performed by the orchestration layer where a counterparty has no dedicated collateral operations function, which lowers the operational barrier for smaller or less digitally staffed participants to take part in tokenized initial margin workflows.



Scenario 2: State Street Tri-Party Governance on Tokenized Rails - Invesco & US Bank



What it does

Flow 2 reproduced today's UMR tri-party initial margin operating model, with State Street acting as independent tri-party agent and the digital asset rails modernizing the settlement rails rather than the governance. CloudMargin generated a US$10,000,000 initial margin call to Invesco, State Street and US Bank. Invesco delivered US$10,000,000 of the Fidelity FYOXX and US Bank delivered US$10,000,000 of the Northern Trust MBNGXX from their respective House accounts into the State Street tri-party Long Box. State Street, using the Collateral+ interface and Transcend's rules engine, applied the eligibility logic and allocated eligible TMMFs from the Long Box into a Segregated account to cover the call, with FinP2P orchestrating the on-chain movement under agent instruction.

Key features

Ahead of the pledge, a preparatory step used LayerZero to re-align the FYOXX token from Hedera onto Ethereum Sepolia. This ensured consistency with the supported chains of the tri-party agent. The FYOXX token was also rated by Moody's, with live data feeds embedded into the FinP2P routers, feeding the eligibility logic to be used in the onward flow.

Legal segregation was delivered through State Street's books and records, which satisfies UMR initial margin segregation requirements today; wallet-to-wallet segregation was treated as a future, exploratory concept and was not what this simulation set out to validate. FinP2P did not move assets autonomously: every movement required the same client instructions, approvals and tri-party agent oversight present in today's UMR setup, and eligibility, disputes, substitutions and exception handling remained off-chain under State Street's control. Transcend ran the eligibility, haircut and concentration checks, with NAV sourced through the router's integration with Kaiko and Redstone.

Why it matters

This scenario is the counterpoint to Flow 1: it shows that tokenization can be introduced into UMR initial margin without disturbing the established tri-party model or the allocation of roles and responsibilities among client, agent and optimisation provider. State Street remained the independent tri-party agent, governance stayed off-chain, and legal segregation continued to rest on agent books and records, while tokenization and FinP2P acted purely as an efficiency layer over the settlement rails. For institutions that rely on tri-party arrangements for initial margin, this is the lower-risk adoption path, because it preserves the legal and operational model regulators and custodians already accept while still capturing the speed, cross-chain reach and data integration that tokenization enables.

What the Sandbox Demonstrated

Across the three simulations, the sandbox showed that TMMFs can be posted, received, substituted, segregated and returned within the operational frameworks institutions already use, and that this holds across bilateral variation margin, cleared initial margin and UMR-compliant initial margin.

Settlement completed in minutes rather than over the conventional cycle; pldeges settled across multiple custody providers and multiple chains within single workflows; collateral was optimized and substituted on live market data; cash released through substitution was immediately re-usable across CCP obligations; and initial margin was segregated through two different models, one enforced in code and one governed by an independent tri-party agent.

Equally important is what did not change. In every scenario the existing margin and collateral tooling, including the platforms participants already operate, remained in place; the router layer provided interoperability without requiring direct bilateral connections or a common chain; and, in the tri-party model, the roles, approvals and governance of today's market were preserved. Tokenization functioned as an efficiency layer over established rails rather than as a replacement for the legal and operational structures that market participants and regulators rely on. ■

Key takeaway

8. Industry Recommendations and Call to Action

Momentum behind distributed ledger-based market infrastructure is increasing in the United States. The current administration has expressed a clear intent to increase competition in capital markets by enabling crypto-native firms to engage in activities comparable to those of regulated financial institutions, with the possibility of skinny Federal Reserve master accounts under active consideration.

The SEC and CFTC are taking an innovative first approach. In this context, firms that defer engagement with tokenized collateral infrastructure risk a steeper transition curve and weaker competitive positioning when the model becomes standard.

First movers may see material advantages in cost of capital management, enabling more competitive client pricing, improved capital allocation, and increased profitability. The work documented in this report is intended to give U.S. market participants a basis for engaging now, while the costs of building optionality may be comparatively lower compared to implementing in the future.

a) Industry Recommendations

Based on the working group's findings, below are four recommendations for the industry to continue enabling TMMFs as collateral and support increased adoption amongst industry participants:

1. **Clarify and confirm legal recognition of TMMFs under U.S. commercial law and collateral documentation:** In the current legal framework, market participants should consider structuring TMMFs, where feasible, as "securities" or "security entitlements" under Uniform Commercial Code ("UCC") Article 8, enabling treatment as "investment property" under Article 9 and supporting familiar control, perfection, priority and enforcement mechanics. This approach gives secured parties, CCPs, custodians, etc. a stronger basis to evaluate tokenized fund interests within existing collateral frameworks. Near-term industry efforts should focus on clarifying when transfers are legally effective, how control is evidenced, how transfer-agent or intermediary records align with ledger activity, and how standard collateral documentation, including Credit Support Annex ("CSAs") and operational annexes, should recognize TMMFs without over-prescribing blockchain-specific mechanics.

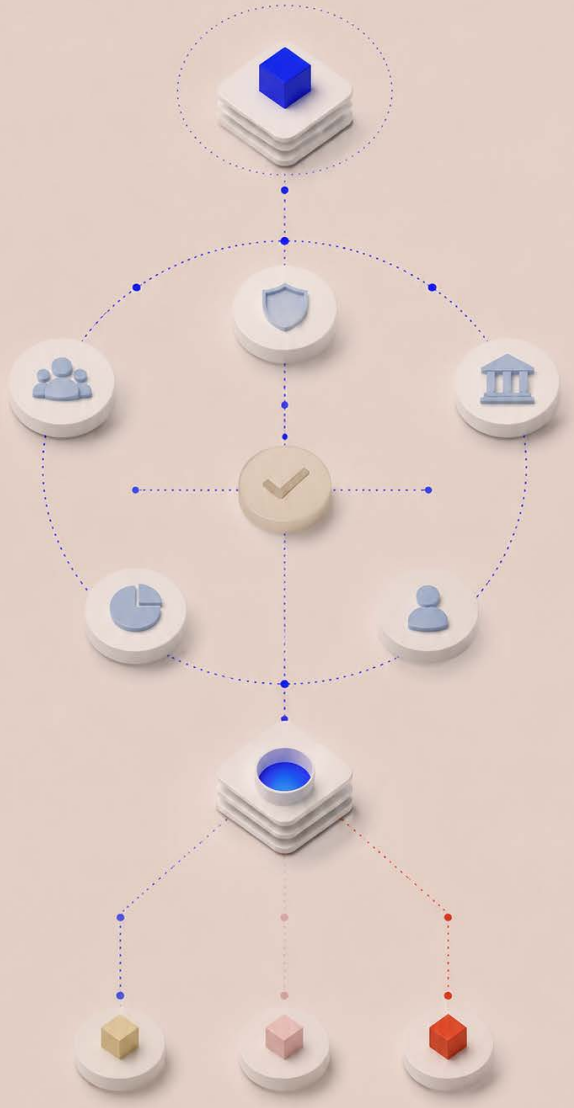
2. **Promote interoperable infrastructure that connects tokenized fund records with existing collateral, custody, and margin systems:** The U.S. market should prioritize operating models that allow TMMFs to move across custodians, CSDs, issuers, wallets, collateral platforms, transfer agents, CCPs, and triparty environments without forcing participants into a single chain, platform, or custody provider. The working group's sandbox demonstrated that tokenized collateral workflows can operate through existing margin and collateral tools, including current collateral management platforms, while using router-based infrastructure to coordinate movement across different custody providers and distributed ledgers. Industry adoption will depend on shared identifiers for tokenized fund interests, common messaging standards, agreed

Key takeaway

rules for settlement confirmation and exception handling, and clear allocation of responsibility across issuers, transfer agents, custodians, interoperability providers, and collateral receivers. The objective should be to extend existing operating rails rather than create a parallel collateral process that reintroduces fragmentation. When possible, industry standards should be deployed, such as the FinP2P protocol and the Common Domain Model[38] in an effort to encourage interoperability and resiliency, both of which are explained in further detail within this report. As this work moves from controlled testing toward production, the same principle should guide deployment: building on a shared, open network that any participant can connect to on common terms, rather than a closed or single-provider environment, is what allows interoperability and resiliency to hold at scale.

3. **Facilitate the use of TMMFs within existing U.S. eligible collateral regimes where underlying MMFs are acceptable:** Regulators and market participants should assess TMMFs based on the legal and economic characteristics of the underlying MMF, rather than treating tokenization as a separate basis for exclusion. The U.S. report finds that tokenization does not bypass existing eligibility, segregation, custody, haircut, valuation, or re-use rules, but it can make compliant collateral movement faster and more transparent. In uncleared margin, further action is needed to address asset-transfer restrictions that narrow the universe of MMFs eligible for regulatory initial margin and variation margin, including the CFTC's proposed amendments and parallel considerations for USPR rules. In cleared initial margin, as well as repo and securities lending contexts, the focus should be on productlevel acceptance, including CCP rulebooks, triparty eligibility schedules, agent-lender workflows, valuation treatment, and default liquidation.

4. **Support market adoption through controlled production testing, standardized eligibility criteria, and issuer participation:** Broader adoption will require coordinated testing across issuers, transfer agents, custodians, CCPs, asset managers, dealers, triparty agents, technology providers,



[38] https://www.isda.org/isda-solutions-infohub/cdm/

and legal advisers. The sandbox results indicate that TMMFs can be posted, substituted, and confirmed through existing institutional workflows, including bilateral variation margin and cleared initial margin scenarios, but production use will require clear eligibility standards, agreed haircut and valuation processes, wallet onboarding, whitelisting, operational resilience controls, and default management procedures. Industry forums should continue to define product-specific eligibility criteria for uncleared margin, cleared initial margin, repo, and securities lending, while encouraging fund issuers and transfer agents to support both digitally native and digital twin models where governance, reconciliation, and investor protection standards are satisfied. This will help move TMMFs from pilot activity into scalable collateral use across U.S. market infrastructure.

b) Call to Action

The call to action to enable TMMFs as collateral in production includes:

1. Assess where TMMFs could deliver the clearest value within the firm's collateral workflows, including uncleared and cleared derivatives, securities lending, and repo

2. Identify appropriate business owners and internal governance paths for TMMF adoption, spanning collateral, treasury, legal, risk, operations, technology and client-facing teams

3. Engage counterparty priorities, issuers custodians and infrastructure providers to determine where there is sufficient mutual readiness to support first-mover use cases

4. Develop a near-term adoption roadmap that defines the firm's target use cases, required approvals, investment needs, operating model changes, and criteria for moving from testing to production pilots on shared open infrastructure

5. Participate with industry-coordinated advocacy efforts

6. Move the Sandbox activities from near-production off-market simulations to live onmarket production.

Together, these steps describe a path from controlled sandbox testing to live production. The working group's view is that this transition is best served by moving onto an open: shared, interoperable infrastructure that connects issuers, transfer agents, custodians, collateral platforms, CCPs and tri-party agents across chains and venues on common standards, so that no participant is locked into a single chain, platform or provider.

The sandbox has shown the workflows are feasible; building them out on open rails, rather than fragmented or proprietary ones, is what will allow the efficiencies demonstrated here to scale across U.S. market infrastructure. The opportunity now is for firms to move to production.

The findings in this report provide a basis for industry participants to begin assessing how TMMFs could be implemented into their collateral workflows. Firms should now focus on taking the tactical next steps to identify specific workflows, counterparties, documentation changes, and operational controls that can support the first stages of live implementation. ■

9. Appendices

a) Fund Model Taxonomy Cross-Reference

Tokenization Sponsor	Fund Model	Description	Token Minting	Cross-referenced terms (e.g., alias)	Source(s)
Bilateral uncleared VM	Digital Native	An issuance model in which the blockchain record is the issuer's/ transfer agent's official master securityholder file, with no parallel offchain authoritative ledger. Ownership and transfer occur natively onchain.	Fund share tokens are minted directly by the fund issuer or by a third-party tokenization platform on behalf of the issuer	• GMAC: Digital Native • SEC: Issuer-Sponsored (onchain master holder file)	• CFTC GMAC Digital Asset Taxonomy (Mar. 6, 2024) • SEC Staff Statement on Tokenized Securities (Jan. 28, 2026) • SEC Division of Trading and Markets: Frequently Asked Questions Relating to Crypto Asset Activities and Distributed Ledger Technology, May 15, 2025 (updated Feb. 19, 2026)
Fund Issuer Sponsored	Digital Twin	An issuance model in which on-chain tokens are used to facilitate transfers in ownership rights, but the issuer or TA on behalf of the issuer agrees elects to update the off-chain	Fund share tokens are minted directly by the fund issuer or by a third-party tokenization platform on behalf of the issuer	• GMAC: Digital Twin • SEC: Issuer Sponsored (offchain master holder file); Duplicate or "digital twin" of master securityholder file	• CFTC GMAC Digital Asset Taxonomy (Mar. 6, 2024) • SEC Staff Statement on Tokenized Securities (Jan. 28, 2026)

Tokenization Sponsor	Fund Model	Description	Token Minting	Cross-referenced terms (e.g., alias)	Source(s)
		authoritative books and records to mirror the transfers on the DLT. The off-chain ledger remains controlling in the event of conflict			• SEC Division of Trading and Markets: Frequently Asked Questions Relating to Crypto Asset Activities and Distributed Ledger Technology, May 15, 2025 (updated Feb. 19, 2026)
Third-Party Sponsored	Custodial Tokenized Securities	A model in which a securities intermediary holds the underlying fund shares for customers and issues an onchain token representing a customer's security entitlement to such shares. Investors' rights run against the intermediary under UCC Article 8 rather than the issuer directly.	Fund share tokens are minted by third parties unaffiliated with the issuer of the fund. Such third parties may be the securities intermediary or a different party.	• SEC: Third-Party Sponsored — Custodial (Tokenized Security Entitlement); Custodial Tokenized Security; Synthetic Tokenized Security • UCC Article 8:m Securities intermediary	• SEC Staff Statement on Tokenized Securities (Jan. 28, 2026) • UCC Article 8 (Investment Securities) (Jan. 28, 2026)
Third-Party Sponsored	Synthetic Tokenized Securities (not inscope	A third-party model in which a third-party, unaffiliated with the fund issuer, mints a token that provides synthetic exposure to the fund share but	Tokens are minted by third parties unaffiliated with the issuer of the fund.	• SEC: Third-Party Sponsored —Custodial (Tokenized Security Entitlement); Custodial Tokenized Security; Synthetic Tokenized Security	• SEC Staff Statement on Tokenized Securities (Jan. 28, 2026) • Securities Exchange Act of 1934 §3(a)(68) • Commodity Exchange Act §1a

Tokenization Sponsor	Fund Model	Description	Token Minting	Cross-referenced terms (e.g., alias)	Source(s)
	orassessed in U.S. TMMF Working Group)	is not issued by the fund and does not convey direct ownership, voting, redemption, or other rights against the fund issuer. The instrument may be structured as a linked security (e.g., a note or exchangeable security) or as a securitybased swap referencing the value of the fund share or issuer-related events. Synthetic tokens do not grant investor property rights under UCC Article 8 and are merely contractual claims against the token minter		• Exchange Act §3(a)(68): Securitybased swap • Commodity Exchange Act §1a: Swap exclusions relevant to characterization	

b) Select Money Market Funds and Private Liquidity Funds in the Market

Fund Name	Issuer	Structure & Operational Notes
BlackRock USD Institutional Digital Liquidity Fund (BUIDL)	BlackRock / Securitize	$1.00 rebasing token; pays monthly yield directly to wallets; institutional only.
BlackRock Select Treasury Based Liquidity Fund (BSTBL)	BlackRock	Digital share class of an existing BlackRock Treasury liquidity fund; tokenized shares expected to be available on Ethereum and operate alongside traditional share classes.
BlackRock Daily Reinvestment Stablecoin Reserve Vehicle (BRSRV)	BlackRock	Newly created tokenized money market fund designed for stablecoin issuers and cryptowallet- based investors; expected to launch across multiple blockchains.
Circle U.S. Dollar Yield Token (USYC)	Circle / Hashnote	Yield-accumulating token; token price increases to reflect interest earned.
Federated Hermes Money Market	Federated Hermes	Seeks to provide current income consistent with stability of principle by investing in a
Management Digital Treasury Fund		portfolio of U.S. dollar cash and U.S. Treasury investments and repurchase agreements fully collateralized by U.S. Treasury securities.
Fidelity Treasury Digital Fund – OnChain Class (FYHXX//FYOXX)	Fidelity	Institutional-grade tMMF that primarily invests in cash and U.S. Treasury securities while recording secondary ownership and transactions on the public Ethereum blockchain
Franklin OnChain U.S. Government Money Fund (BENJI / FOBXX)	Franklin Templeton	$1.00 rebasing token; native SEC-registered mutual fund on public chains.
WisdomTree Government Money Market Digital Fund (WTGXX)	WisdomTree	SEC-regulated 40-Act fund; designed for retail users via mobile app.
My OnChain Net Yield Fund ("MONY")	J.P. Morgan Asset Management	506(c) private placement fund providing qualified investors the opportunity to earn U.S. dollar yields.
JPMorgan OnChain Liquidity Token Money Market Fund ("JLTXX")	J.P. Morgan Asset Management	U.S. registered government money market fund designed to invest in a manner to support stablecoin issuers under the GENIUS Act

This list is includes both MMFs as well as private liquidity funds (not registered under 1940 Act section 2(a)(7)).

Fund Name	Issuer	Structure & Operational Notes
Ondo Short-Term US Government Treasuries (OUSG)	Ondo Finance	Tokenized wrapper of BlackRock's BUIDL; built for DeFi utility and collateral.
Ondo Yield Co-Op (USDY)	Ondo Finance	Bearer-instrument structure; structured as a tokenized bank note; global non-US retail.
Superstate Short-Term Government Bond Fund (USTB)	Superstate	Yield-bearing ERC-20 token; combines onchain tracking with traditional fund registry.
OpenEden T-Bill Fund (TBILL)	OpenEden	On-chain vault structure; token price tracks the net asset value (NAV) of underlying T-bills.
NIF Treasury Instruments Portfolio	Northern Trust Asset Management	The tokenized share class represents a digital mirror record of the fund's institutional share class using blockchain technology.
Northern Trust Digital Enabled Shares (NDEXX)	Northern Trust Asset Management	Tokenized share class representing a digital mirror record of the fund's institutional share class using blockchain technology.
State Street Galaxy Onchain Liquidity Sweep Fund (SWEEP)	State Street Investment Management & Galaxy Asset Management	Tokenized private liquidity fund; utilizes stablecoins (PYUSD) for subscriptions and redemptions; qualified purchasers only.
UBS USD Money Market Investment Fund Token (uMINT)	UBS AM	Money Market investment built on Ethereum distributed ledger technology; provides access to institutional-grade cash management solutions underpinned by high-quality money market instruments.
VanEck Treasury Fund Ltd. (VBILL)	VanEck	Tokenized U.S. Treasury fund offering onchain exposure to short-term U.S. Treasuries; launched across Avalanche, BNB Chain, Ethereum, and Solana for qualified investors
Western Asset Institutional U.S. Treasury Reserves (DIGXX)	Franklin Templeton / Western Asset Management	Digital institutional share class designed for distribution through approved tokenized platforms; blockchain technology is used to maintain a mirror record of share ownership via the fund's transfer agent, while the fund does not invest in cryptocurrencies or digital assets.

c) References and Reading list

Selected references

• Global Digital Finance, The Case for Collateral Mobility in Europe & the UK Using Tokenized Money Market Funds, 2025. https://www.gdf.io/wpcontent/uploads/2020/12/GDF_-UKEU_TMMF-report-1.pdf
• International Swaps and Derivatives Association, ISDA Margin Survey Year-end 2025, April 2026. https://www.isda.org/
• Depository Trust & Clearing Corporation, The Great Collateral Experiment: A New Digital Infrastructure to Mobilise Collateral, 2024. https://www.dtcc.com/-/media collateralinfrastructure-white-paper.pdf
• Commodity Futures Trading Commission, CFTC Letter No. 25-39, Tokenized Collateral Guidance, December 8, 2025. https://www.cftc.gov/csl/25-39/download
• Commodity Futures Trading Commission, Margin Requirements for Uncleared Swaps for Swap Dealers and Major Swap Participants, Proposed Rule, 88 Fed. Reg. 53409, August 8, 2023. https://www.federalregister.gov/documents/2023/08/08/2023-16572/marginrequirements-for-uncleared-swaps-for-swap-dealers-and-major-swap-participants
• Securities and Exchange Commission, Division of Trading and Markets Frequently Asked Questions Relating to Crypto Asset Activities and Distributed Ledger Technology, May 15, 2025 (updated Feb. 19, 2026). https://www.sec.gov/rules-regulations/staff-guidance/trading-markets-frequentlyasked-questions/frequently-asked-questions-relating-crypto-asset-activities-distributedledger-technology
• Securities and Exchange Commission, Statement on Tokenized Securities, January 28, 2026. https://www.sec.gov/newsroom/speeches-statements/corp-fin-statement-tokenized-securities-012826-statement-tokenized-securities
• Board of Governors of the Federal Reserve System, Federal Deposit Insurance Corporation, and Office of the Comptroller of the Currency, Capital Treatment of Tokenized Securities Frequently Asked Questions, March 5, 2026. https://www.federalreserve.gov/newsevents/pressreleases/bcreg20260305a.htm
• Depository Trust & Clearing Corporation, Clearstream, Euroclear, and Boston Consulting Group, Building the Path Towards Digital Asset Securities Interoperability, March 2026. https://www.dtcc.com/news/2026/march/04/mapping-the-course-to-interoperability
• Global Financial Markets Association and Global Digital Finance, The Smart Contract Primer: An Initial Overview of Smart Contract Implementation within Financial Services & Regulatory Solutions for Risk Management, October 2024. https://www.gfma.org/wpcontent/uploads/2024/10/gfma-gdf-smart-contract-primer-report-2024.pdf
• International Swaps and Derivatives Association, Tokenized Collateral Model Provisions for ISDA 2016 Credit Support Annexes for Variation Margin, December 2023. https://www.isda.org/book/tokenized-collateral-model-provisions-for-vm-csa/
• J.P. Morgan, Key Lessons from the U.K. Gilt Crisis, May 2023. https://www.jpmorgan.com/insights/securities-services/trading-services/uk-gilt-crisiscollateral
• Bank for International Settlements, The Rise of Tokenised Money Market Funds, BIS Bulletin No. 115, November 2025. https://www.bis.org/publ/bisbull115.htm

Additional reading

• The ValueExchange and Nasdaq, Making the Case for Tokenized Collateral, 2026. https://thevx.io/wp-content/uploads/2026/02/Case-for-Tokenised-Collateral_Survey-Report_-Nasdaq-and-The-ValueExchange.pdf
• CFTC Global Markets Advisory Committee, Digital Asset Markets Subcommittee, Digital Asset Taxonomy, March 2024. https://www.cftc.gov/media/10321/CFTC_GMAC_DAM_Classification_Approach_and_Taxonomy_for_%20Digital_Assets_030624/download
• Uniform Law Commission, Uniform Commercial Code Articles 8, 9, and 12. https://www.uniformlaws.org/

BROWN BROTHERS HARRIMAN

EY

Federated Hermes

HOGAN LOVELLS CADWALADER

OWNERA