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GDF GLOBAL DIGITAL FINANCE

2025 | TMMF REPORT

THE CASE FOR COLLATERAL MOBILITY IN EUROPE & THE UK USING TOKENIZED MONEY MARKET FUNDS

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Foreword

Lawrence Wintermeyer
GDF Members Board Chair

In recent years, the capital markets have witnessed a growing interest in how DLT and tokenization are modernizing traditional financial infrastructure. From payments to post-trade processing, this technology is increasingly viewed as an innovation that delivers greater capital efficiency and transparency across financial systems.

One of the most compelling and emerging applications of this technological innovation lies in the mobility of collateral. Against the backdrop of more demanding margining regimes, constrained liquidity, and increasingly complex market infrastructures, the need to enhance collateral mobility has never been more urgent.

The Liability-Driven Investment (LDI) crisis in the UK in the autumn of 2022 is a sobering reminder that in times of great market stress, the reliance on cash collateral can exacerbate systemic risk. Liquidity stress across short-term funding markets contributed to broader market volatility – Money Market Fund (MMF) investors needing cash reserves for margin calls redeemed MMF shares, posted cash, and then the receiving custodian subscribed to the same or a different MMF via a daily sweep.

The current multi-step redemption and subscription workflow is fraught with operational risks that can negatively impact liquidity strains.

Amidst these challenges, Tokenized Money Market Funds (TMMFs) have emerged as a promising solution. As traditional MMFs issued on DLT, they combine the regulatory familiarity and liquidity of MMFs with the settlement speed, programmability, and transparency enabled by this innovative technology.

TMMFs can be posted atomically, preserve yield, eliminate the need for redemption into cash, and bypass many of the frictions that plague today's collateral ecosystem. In practice, however, translating this promise into a legally enforceable, operationally viable, and regulatorily acceptable solution requires careful analysis and industry-wide collaboration.

To accelerate these developments, Global Digital Finance (GDF) convened the TMMF Working Group (WG) to bring together over 70 organizations from across the financial services sector – spanning banks, asset managers, custodians, technology providers, and legal experts – to examine the feasibility of using TMMFs as eligible collateral in derivatives markets in Europe.

What makes this body of work distinctive is its dual-track methodology: A market and legal research and assessment was undertaken in parallel with the testing of real-life tokenized collateral use cases in the GDF Industry Sandbox to prove TMMFs can deliver in production, today.

GDF extends its sincere thanks to the co-chairs, the secretariat, the industry contributors, and sandbox firms and participants who made this WG a great success. We look forward to kicking off the US leg of this WG in January 2026.

We believe that the insights in the report will serve as a foundation for further industry engagement, market development, and policy dialogue. ■

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- Ownera
- Particula
- Platonic
- Quant Network
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- S&P
- Schroders
- Solidus Labs
- Standard Chartered Bank
- State Street
- State Street Global Advisors
- Stellar
- Taurus
- Tokenovate
- UBS
- UBS Asset Management
- ZeroBeta
- Zodia Custody
- Investment Association
- Institutional Money Market Funds Association

Layer 1s

- Besu
- Canton Network
- Corda
- Ethereum
- Hedera
- Polygon
- Stellar

2. EXECUTIVE SUMMARY

Tokenization is taking hold – the forecast of tokenized real-world assets (RWAs) has climbed to US $18 billion by early-2025, up 80% year-on-year, with tokenized treasuries and MMFs among the fastest-growing segments.

As financial markets continue to evolve with the adoption of DLT and tokenization, new opportunities arise for enhancing efficiency and liquidity in collateral management.

GDF, the leading global industry association of member firms advocating and accelerating the adoption of best practices for digital assets, convened a WG, open to industry participants, to explore this opportunity further.

Ownera, a leading GDF member firm who operates the FinP2P routers that implement the open FinP2P standard, hosted the GDF Industry Sandbox used in the TMMF WG, and separately hosts the GDF FIX FinP2P Interoperability Alliance.

The TMMF WG comprised two streams of work and assessed the feasibility, requirements, and potential benefits of using tokenized collateral with legal certainty for industry:

- **Research and Assessment Stream** – examining the use cases, define eligibility criteria, and assess the benefits and risks across legal, regulatory and operational considerations

- **Sandbox Stream** – establishing a collaborative sandbox to pilot real-world transactions and define operational workflows involving key industry participants including issuers, collateral providers, receiving banks, custodians, tokenization providers, etc.

The WG brought together a broad coalition of over 70 global firms, from traditional financial institutions to digital asset custodians, infrastructure providers, associations, and legal experts and delivered a positively comprehensive set of findings.

TMMFs represent a significant leap forward for collateral efficiency in both buy-side and sell-side market operations. By leveraging DLT to digitize traditional MMF units, both financial and operational inefficiencies are addressed, helping to transform the landscape of collateral management and liquidity for derivatives and repo markets.

Major financial institutions are now adopting TMMFs as a solution for enhancing collateral liquidity and offering compelling benefits as Bank of New York (BNY) and Goldman Sachs recently announced.[1]

Tokenized versions of constant and low volatility net asset value (NAV) MMFs provide an opportunity to behave like cash collateral, allowing them to be transferred outside of the normal valuation cycles[2]. Leveraging DLT, TMMFs blend the yield, safety, and familiarity of traditional MMFs with new levels of operational efficiency and real-time usability.

Ireland and Luxembourg host more than 80% of the MMFs and cross-border funds in Europe and English law governs the Credit Support Annex (CSA) published by the International Swaps and Derivatives Association, Inc. (ISDA).

There is relative legal certainty for derivative counterparties operating within these selected European jurisdictions, with a focus on the application of TMMFs in bilateral Variation Margin transactions under:

- ISDA title transfer CSA governed by English law; and
- TMMFs issued in England and Wales.

In any cross-border transaction, some complexity arises with respect to conflicts of laws due to the need to consider the interaction between the laws of different jurisdictions related to digitally native shares.

[1] *https://www.goldmansachs.com/pressroom/press-releases/2025/bny-goldman-sachs-launch-tokenized-money-market-funds-solution*

[2] *Under the European Market Infrastructure Regulation (EU) No 648/2012 (EMIR) and its UK equivalent, certain MMFs can be used as eligible collateral for initial margin in non-centrally cleared OTC derivative trades, subject to several conditions including that they are highly liquid and subject to certain concentration limits, with UCITS-compliant MMFs generally accepted. MMFs are not currently used as collateral for cleared derivative trades*

There is relative legal certainty of TMMFs located in Luxembourg in a digitally native or registered form due to the availability of statutory frameworks to govern such transactions.

Longstanding historical legal interaction between Luxembourg and the UK in respect of financial and investment contractual arrangements, including CSAs, also makes this an attractive place to establish a TMMF where the tokens will be posted as collateral under an English-law governed CSA.

There is not yet express statutory or judicial authority in Ireland specifically addressing tokenized shares or TMMFs. Legal certainty in respect of ownership and treatment of tokenized shares under Irish law therefore requires an analogy to traditional shares and electronic contracts, rather than being directly established.

It is reasonable to conclude that Irish courts would treat digitally native TMMF shares in a manner consistent with traditional shares. This alignment reinforces the view that TMMF shares can be accommodated within existing property law principles in Ireland, supporting their recognition and enforceability under Irish legal standards.

Where an MMF is tokenized using a digitally native TMMF and is located in the UK, there is a low degree of legal uncertainty concerning the legal treatment of ownership and a similarly low level of uncertainty concerning the replication of rights for market participants between the traditional MMF and a digitally native TMMF.

It is anticipated that further certainty will be available in the UK if the Property (Digital Assets etc.) Bill is enacted and common law precedent is developed as to the implications of the "third category" of property.

With no fundamental barriers identified across legal, operational, or regulatory dimensions, the sandbox demonstrated that TMMFs can transition from theoretical use cases to a production-ready collateral instrument.

Over 30 firms came together in The Sandbox Stream and "piloted" the findings from the Research and Assessment Stream in real-life uses cases, across six simulations to demonstrate that the features and functions of most TMMF scenarios can be delivered in production, now:

- **Simulation 1:** Simple Bilateral Transfer – Manual Margining of TMMFs
- **Simulation 2:** Integrated Margin Calls – Automated Posting via Third-Party Systems
- **Simulation 3:** Depeg Event and Substitution – Dynamic Portfolio Management
- **Simulation 4:** Default Scenario – Enforcement and Recovery in Insolvency
- **Simulation 5:** Funding of TMMF in Triparty
- **Simulation 6:** From SWIFT to Collateral Settlement in Seconds.

The sandbox simulation findings demonstrated:

- **Operational Feasibility and Efficiency:** The simulations orchestrated in the sandbox demonstrated that posting a TMMF as margin can work end-to-end under current legal and operational frameworks under UK and EU law. There were no settlement failures or ambiguous title issues – each token transfer resulted in a legal title change recorded by the TA, satisfying custody requirements.

- **Risk Management and Resilience:** The automated substitution workflow triggered by a real-time depeg scenario showcased how tokenized collateral can adjust dynamically, without interrupting trading or requiring manual margin calls as they would today in traditional systems.

- **Legal and Regulatory Alignment:** By simulating a default scenario in a proof-of-concept environment, it demonstrated that enforcement and recovery are possible on-chain in a way that is in line with English law principles for title transfer collateral. The TMMFs were enforced without ambiguity: the fund shares could be redeemed by the collateral taker without the defaulter's consent, and with clear audit trails.

- **Interoperability of Legacy and Digital Infrastructure:** The sandbox dispelled this fear by showing how TMMFs can integrate into

current architecture, leveraging Ownera's FinP2P routers, which provides a low-risk environment for the system transformation needed to capitalize on the benefits of tokenized assets.

- **Collateral Value Proposition - Yield and Liquidity:** TMMFs offer qualities that are hard to replicate with other kinds of assets in the collateral use case (e.g., cash and stablecoins). Unlike cash, they accrue yield making them a more attractive form of posted collateral, particularly in a high-interest rate environment.

- **Market Momentum and Alignment - TMMFs in Live Market Environments:** The outcomes from the sandbox dovetail with developments in the market. TMMFs are no longer a concept they are being used in real trades.

The WG set out four recommendations, each underpinned by a group of actions, to further support firms exploring similar solutions, and providing a reference point for policymakers.

Recommendation 1. Clarify and Confirm Legal Recognition of Digitally Native Transfers under Existing Frameworks

Action 1.1: Create Standardized Legal Documentation
Action 1.2: Produce a Cross-Border Legal Guide
Action 1.3: Secure Formal Legal Opinions

Recommendation 2. Encourage Interoperability with Existing Collateral and Custody Systems

Action 2.1: Leverage industry-developed data standards and models
Action 2.2: Leverage Connectivity Through Proven APIs
Action 2.3: Adopt a Standardized Cross-Chain Communication Framework

Recommendation 3. Facilitate the Use of TMMFs under Existing Eligible Collateral Regimes

Action 3.1: Seek Formal Regulatory Guidance
Action 3.2: Align with Supervisory Reporting Requirements
Action 3.3: Develop Standardized Operational Playbooks

Recommendation 4. Encourage market adoption and scalability across Firms

Action 4.1: Incentivize Issuers of Digitally Native MMFs
Action 4.2: Develop Harmonized Eligibility Criteria
Action 4.3: Establish an Industry Testbed

The recommendations and actions, supported by legal and regulatory analysis throughout the report, are further expanded upon in Section 5b. Policy recommendations and actions. ■

"As a co-chair of this working group, I have been impressed with the collaborative and effective working engagement across traditional financial institutions, and fintechs as well as legal and professional services contributors and their firms. The combination of research and assessment findings and the practical sandbox execution of production use cases made this working group a very special and successful achievement."

– Armin Peter
GDF Executive in Residence, former Global Head of Debt Syndicate EMEA at UBS, former GFMA Board Member

3. INTRODUCTION AND PROBLEM STATEMENT

a) Why collateral mobility needs a rethink

Broader adoption of TMMFs can transform collateral management from a slow, siloed, and resource-intensive process into a real-time, interoperable, and yield-optimized digital asset. The result is dramatically higher efficiency, lower systemic risk, and a level playing field that empowers both large and small institutions to maximize capital productivity.

This shift is not just incremental, it recasts the foundations of liquidity, risk management, and competitive dynamics in global markets. This is especially relevant as the global transition to T+1 will drive an increased need for intraday collateral and intraday liquidity.

Collateral in bilateral OTC derivatives must be legally enforceable, operationally efficient, and regulatorily compliant. Yet the current model, anchored to cash and traditional securities, is showing its limits.

Cash remains the dominant form of VM, according to the ISDA Margin Survey, making up approximately 68% of received VM collateral, with government securities accounting for almost 18% and other securities at almost 14%.

While MMFs are eligible under ISDA CSAs, they are not widely used directly as collateral. Instead, they are typically deployed as cash-management tools and redeemed to meet margin calls, with the proceeds then posted as cash and then swept from a custodian account back into an MMF. This indirect use introduces settlement lag, additional operational steps, and liquidity inefficiencies (such as pro-cyclical shock amplification when converting MMFs to cash for use as margin).

The systemic impact of these frictions became clear during the UK's LDI crisis in 2022. The sharp trigger in gilt yields led to significant margin calls on pension funds, which forced pension funds to sell gilts and convert other assets, including MMFs, into cash to post as collateral. As gilt prices collapsed, the delays and rigidity in current collateral processes exacerbated the need for fire sales, prompting emergency intervention by the Bank of England.

Although this was a significant event that resulted in risks to financial stability, breakdowns in collateral mobility are not isolated events. According to market estimates, inefficiencies in current systems contribute to over $15–20 billion in annual operational cost[3], while trillions of dollars in collateral can sit idle or be trapped intraday.[4]

[3] https://www.gfma.org/wp-content/uploads/2023/05/impact-of-dlt-on-global-capital-markets-full-report.pdf?utm_source=chatgpt.com
[4] https://finadium.com/collateral-market-tops-e25-trillion-expanding-the-argument-for-dlt-solutions/?utm_source=chatgpt.com

The global financial crisis reforms established margin and collateral requirements to reduce counterparty risk. Yet, in turn, these gave rise to surges in liquidity demands during periods of heightened market stress, as seen, for example, during the 2022 LDI crisis.

As pension funds scrambled to meet margin requirements against their gilt exposures at that time, they were forced to redeem holdings in MMFs in order to source cash, causing money fund managers to be forced sellers into a stressed market, depressing gilt prices even further and contributing to a negative spiral.

By enabling programmable ownership transfer on distributed ledgers, TMMFs would have allowed the money fund units to be posted to the collateral receiver quickly and efficiently and most importantly, would have avoided the need for redemption into cash and the associated frictions and stress that would thus be introduced into the market.

TMMFs allow for more efficient collateral management allowing capital to be freed up, reserve requirements reduced and existing inventories used more effectively.

This is an all round win-win for collateral managers, money managers, investors and regulators.

– **Kim Hochfeld**
Global Head of Cash and Digital, State Street Investment Management

This challenge is paving the way for digital transformation through the tokenization of collateral.

Multiple studies have highlighted the potential for DLT infrastructure, digital assets and tokenization to improve collateral efficiency at scale. According to a recent industry report, DLT solutions could free up $100 billion of trapped collateral and reduce industry costs by $20 billion annually[5]. Tokenization is already taking hold - the market value forecast of tokenized real-world assets (RWAs) has climbed to ~ US $18 billion by early-2025, up 80% year-on-year, with tokenized treasuries and MMFs among the fastest-growing segments[6].

This transformation can be compared to the latest wave of innovation in securitization. Markets have moved from paper-based instruments to dematerialized digital records, and are now progressing to programmable, on-chain assets.

TMMFs are a prime example use case for this evolution. By enabling direct, programmable ownership transfer on distributed ledgers, TMMFs can enable funds to be posted and settled, preserving yield and eligibility, while eliminating the need for redemption into cash and the associated frictions that introduce into the financial system. Instead of being a step removed from the collateral process, MMFs have the opportunity to become a first-class instrument for efficient and flexible margining, reducing cost and unlocking mobility without sacrificing legal certainty.

This reframing lies at the heart of the WG objectives: to better understand whether TMMFs can transition from an indirect cash-management tool to a digitally native, legally enforceable, and operationally viable form of collateral in its own right.

[5] https://www.gfma.org/wp-content/uploads/2023/05/impact-of-dlt-on-global-capital-markets-full-report.pdf
[6] ainvest.com, investax.io

Firms offering digital Financial Market Infrastructure (dFMI) have been focused on delivering viable commercial solutions to showcase the operational, and arguably more importantly, the commercial value of collateral tokenization.

This report brings to the forefront the business case and commercial blueprint to leverage TMMFs by setting out the market potential and legal considerations and certainty for collateral eligibility for MMFs and other tokenized assets being used as collateral in major European jurisdictions.

> *"Using tokens representing the value of shares of Money Market Funds on GS DAP® would enable us to unlock their utility as a form of collateral and open up more seamless transferability in the future"*[7]
>
> **– Mathew McDermott**
> Global Head of Digital Assets at Goldman Sachs, on the recent BNY/Goldman Sachs launch

b) Problem statement and scope

As tokenization gains traction in capital markets, the industry is beginning to shift from proof-of-concept pilots to production-grade implementation at scale. TMMFs stand out as a promising use case due to their liquidity, regulatory familiarity, and viability in short-term financing strategies.

Deploying TMMFs as eligible collateral in derivatives markets, however, introduces a range of challenges that go beyond the initial technological considerations.

The issue is not whether MMFs are acceptable forms of collateral in a bilateral agreement - they can be. Rather, the question is how tokenization changes the legal, operational, and regulatory properties that determine a fund's usability in this context and how market participants interpret the risks that may arise in the tokenization process and how these risks affect the commercial viability of TMMFs as a form of collateral.

For tokenized assets to function effectively as collateral, they need to do more than simply replicate the economic exposure of the underlying asset - they must carry the appropriate enforceable legal rights, function effectively within existing market plumbing, and be recognized by counterparties and regulators as fit for purpose under normal market conditions and stress conditions.

A central challenge identified by the market lies in infrastructure interoperability. While TMMFs are typically issued on a specific distributed ledger or platform, collateral movements often require interaction across multiple systems including custodians, clearing agents, fund administrators, banks and other counterparty risk systems. Many of these systems are built on legacy technology, which can raise additional challenges.

Without interoperable infrastructure, the process of posting and receiving tokenized collateral risks reintroducing the same fragmentation and latency that tokenization aims to solve.

The WG approach has explicitly sought to demonstrate cross-platform and cross-functionality interoperability, not only between token issuance platforms and collateral management systems, but across the layers of legal enforceability, fund administration, and real-time settlement.

Solving collateral mobility in a digitalized format is not just a technical problem, it is a systems integration challenge that cuts across legal constructs, custody networks, and risk management practices.

[7] https://www.goldmansachs.com/pressroom/press-releases/2025/bny-goldman-sachs-launch-tokenized-money-market-funds-solution

In order to test whether TMMFs can meet these challenges, it was necessary to identify specific models of tokenization, and analyze their behavior under the laws of specific jurisdictions.

Ireland and Luxembourg were selected as the two jurisdictions for WG focus as they constitute over 80% of the domiciled MMFs in Europe[8] and are the leading jurisdictions for global cross-border funds in the European market.

England was selected as a jurisdiction for WG focus because English law governs the CSA facilitating collateral management between parties in over-the-counter (OTC) derivatives transactions governed by the ISDA Master Agreement.

Unlike a New York law CSA, England uses a title transfer mechanism, where the collateral taker becomes the outright owner of the posted collateral - cash or securities. This approach is used to mitigate counterparty credit risk by ensuring collateral is readily available in the event of default.

The WG focused on building a framework capable of testing whether TMMFs issued under English, Irish or Luxembourg law[9] can be recognized, transferred, and enforced as collateral under existing bilateral CSA structures governed by English law.

Beyond the legal considerations, the WG evaluated operational considerations, but excluded considerations related to the possible impact of the use of TMMFs on accounting policies or regulatory capital of the entities in the ecosystem. The resulting accounting and/or regulatory capital treatment may also impact local tax treatment in the various jurisdictions which would also need to be considered as the entities in the sandbox continue to progress with their plans.

The aim of the analysis was not to advocate for a particular tokenization model or jurisdiction, but to establish where legal certainty exists, where operational friction remains, and what practical paths might support wider industry adoption on a truly interoperable capital markets network.

c) The GDF Working Group and sandbox

Recognizing the potential of tokenizing collateral while acknowledging the barriers to adoption, GDF convened the WG in Q1-2025 under the aegis of the GDF Tokenization Forum – a forum open to all industry firms.

The initiative brought together over 70 organizations spanning:

1) Sell-side firms: Investment banks, broker-dealers, and liquidity providers,
2) Buy-side institutions: Asset managers, hedge funds, pension funds, and insurance companies,
3) Central counterparties (CCPs): Clearing houses and exchanges,

[8] *ALFI's "The Market of Money Market Funds (1) — DECEMBER 2024"*
[9] Please refer to footnote 2.

4) Technology providers: DLT and tokenization solution providers, and
5) Industry associations: Leading digitalization advocacy associations with relevant experience in TMMF adoption.

Given the relative novelty of the asset structure and the need for commercial evidence, the WG was deliberately structured around two parallel yet interlinked streams:

1) Research & Assessment Stream

- **Purpose:** Build a robust analytical foundation by mapping potential tokenization structures - digitally native, digital twin and digital representations - evaluating seven legal structure variants, and scoring each against three bank-prioritized criteria:
  - **a.** legal certainty,
  - **b.** collateral access in the event of insolvency, and
  - **c.** receiving party eligibility criteria (including regulatory drivers, firm-level risk drivers, and commercial / operational drivers).

- **Approach:** Conduct detailed legal analysis, bilateral interviews with receiving parties involved in the sandbox, and develop a decision-tree logic model to organize and standardize, and evaluate assessments

- **Outcome:** Produce a detailed analysis demonstrating legal and operational viability, designed to inform both sandbox architecture and industry recommendations.

2) Sandbox Stream

- **Purpose:** Translate theory into practice by simulating real-world workflows including collateral posting, VM calls, substitutions, on-chain settlements, an insolvency scenario and redemptions, all within a controlled production simulated environment.

- **Approach:** The GDF Industry Sandbox utilized an AWS-hosted testbed integrated via FinP2P to simulate all technical components of trade flows across multiple DLT platforms. Sandbox use cases were selected directly from research-identified pain-points (e.g., lack of settlement speed, collateral lock-up).

- **Outcome:** Create a live testing environment to demonstrate feasibility, raise edge-case risk issues (e.g., DLT finality, insolvency triggers), and validate the legal risk scoring from the research stream - all feeding back into the analytical framework to ensure findings are not just theoretical but proof-tested.

This twin-track approach ensured the theory was pressure-tested in practice and the WG was able to:

- Adapt research hypotheses based on observable sandbox behaviors and receiving party criteria
- Prioritize use cases with measurable business impact, and
- Build technical design (CDM integration, transfer agent (TA) wallet flows) that connect directly to legal and operational findings, technologically orchestrated by the FinP2P routers. ■

4. TOKENIZED COLLATERAL RESEARCH AND ASSESSMENT

TMMFs represent a significant leap forward for collateral efficiency in both buy-side and sell-side market operations. By leveraging DLT to digitize traditional MMF units, both operational and financial inefficiencies are addressed, potentially transforming the landscape of collateral management and liquidity for derivatives and repo markets.

> *"Tokenization removes key operational constraints … It offers a real-time, on-chain representation of assets, making the funds verifiable, trackable, and easier to mobilize."*
>
> – **Anna Matson**
> Head of Digital Assets & Innovation,
> EMEA Northern Trust

Table 1. Features of Traditional MMF vs TMMF Collateral

Key Feature	Traditional MMF Collateral	TMMF Collateral
Settlement time	1–3 days[10]	Seconds
Hours of operation	Business hours	24/7/365
Collateral mobility	Low (manual, batch process)	High (real-time, programmable)
Yield retention on collateral	No (yield lost when liquidated)	Yes
Interoperability	Limited	Broad, cross-platform
Operational friction	High	Low (automated, on-chain)

[10] As explained above, typically today this involves redeeming an MMF holding, posting the resulting cash as collateral, and the receiving party subscribing in the same or a different MMF.

a. A framework for assessing tokenized collateral

The TMMF as collateral value proposition for both the buy-side and sell-side set out in Table 2 illustrates compelling benefits to industry players. This report offers a tokenized collateral framework for industry, policymakers, and regulators with the aim of delivering the compelling benefits of the TMMF as Collateral Value Proposition.

This was achieved through a cross-discipline collaboration fostering innovation, harnessing efficiencies, and ensuring legal certainly and regulatory compliance for the accelerated adoption of TMMF in derivatives markets.

The framework was developed collaboratively with legal, operational, and regulatory experts within the WG. The framework consists of three constituent frameworks:

1. A framework for tokenization structure to legal form
2. A framework for certainty of digitally native digital tokens
3. A framework for legal certainty of TMMFs.

Appendix A contains further insights into the development of the framework.

Table 2. TMMF as Collateral Value Proposition

Value Driver	Buy-Side	Sell-Side
Liquidity access	Immediate collateral posting, no asset fire-sales	Frequent margin/repo re-use; instant settlement
Collateral yield	Earnings maintained until collateralized	Reduces cost pressures from holding HQLA in reserve
Settlement time	From days to minutes	Intraday, T+0; supports deadlines and global cutoffs. Reduced use of end of day and intraday capital buffers.
Regulatory compliance	Digital audit trails & data feeds	Satisfies evolving EMIR/SFTR standards
Operational cost	Less reconciliation, automation reduces manual processes	Smaller back office, reduced settlement failures
Risk reduction	Mitigates counterparty/ settlement risk	Improved crisis resilience and risk offsets

"There is relative legal certainty of TMMFs located in Luxembourg in a digitally native or registered form, where both Ireland and the UK have a low degree of uncertainty as the courts are likely to treat digitally native TMMF shares in a manner consistent with traditional shares. The cross discipline collaboration involved in this work has been outstanding and it is a credit to the industry participants,"

– Sharon Lewis
Lead Partner for Future of Finance and Co-Chair of Digital Asset & Blockchain Practice, Hogan Lovells.

A framework for tokenization structures to legal structures

Understanding the link between tokenization structures and legal structures is crucial for assessing whether a TMMF can be eligible collateral. Figure 1 breaks down these key considerations in a comprehensive decision tree.

Tokens can be digitally native, a digital twin, or asset backed, and given the potential for structural variations of these digital tokens including how fund units are recorded, how the register is maintained, how legal title is transferred, and what that title pertains to (including the rights that the token confers on the holder in respect of the fund interest) - parties will need to ascertain the nature of their entitlement.

These structural features directly influence the legal nature of the token and therefore its enforceability, operational treatment, and recognition under existing collateral frameworks.

When each tokenization structure is mapped to one or more candidate legal structure(s), it reflects how the TMMF would be treated under law. This mapping also outlines seven distinct legal structures, each of which carries specific implications for collateral eligibility.

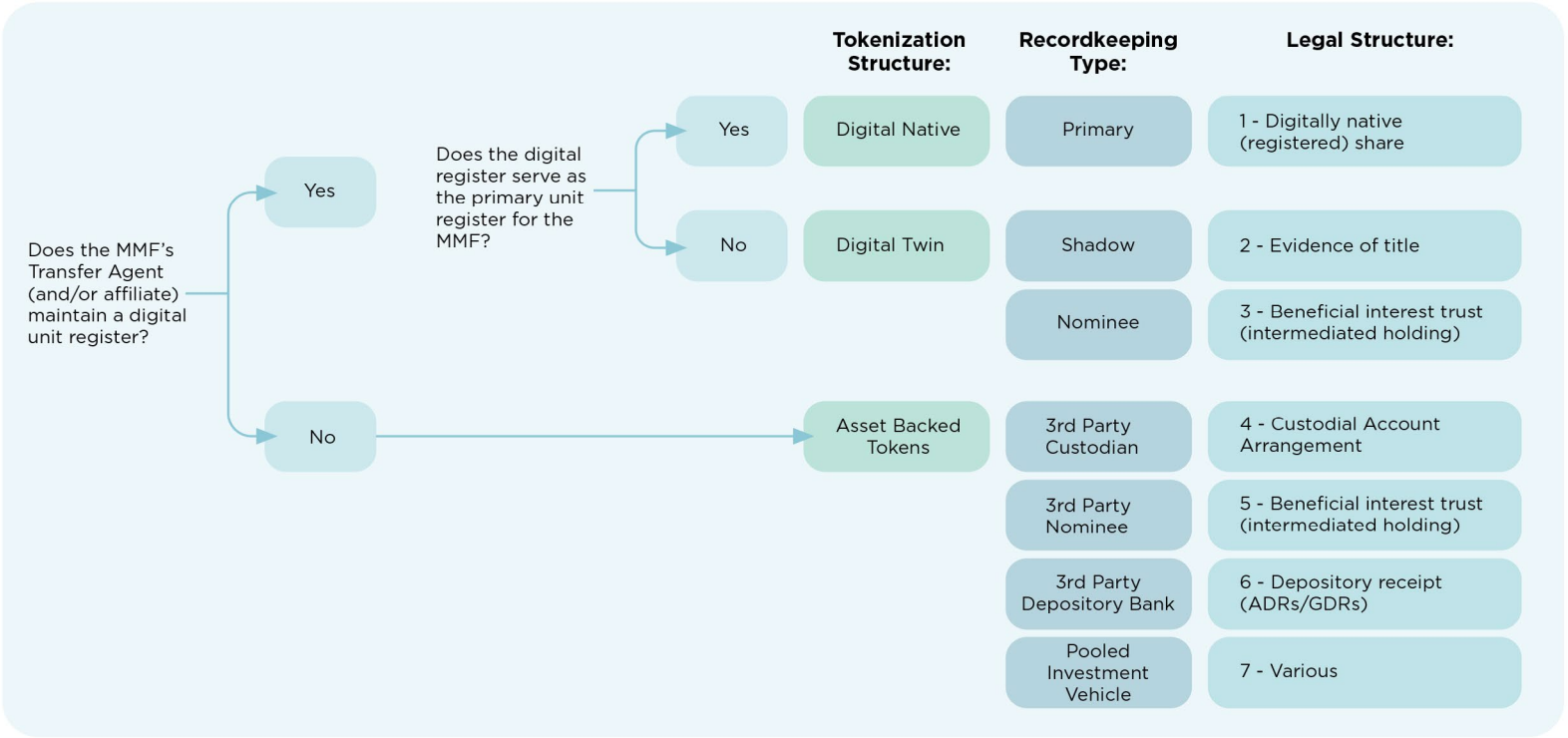

Figure 1 - MMF Token Structure and Legal Structure Decision Tree

The extensive framework for analyzing tokenized collateral is set out in Appendix A.

A framework for certainty of digitally native tokens

While a traditional MMF may already satisfy many of these requirements, the tokenization process introduces new considerations that must be evaluated on a case-by-case basis.

When considering the operation of an English law governed CSA taking effect in respect of digitally native TMMFs being used as collateral that are themselves located in the UK, Luxembourg and Ireland, the way in which different legal considerations are interrelated is illustrated in Figure 2.

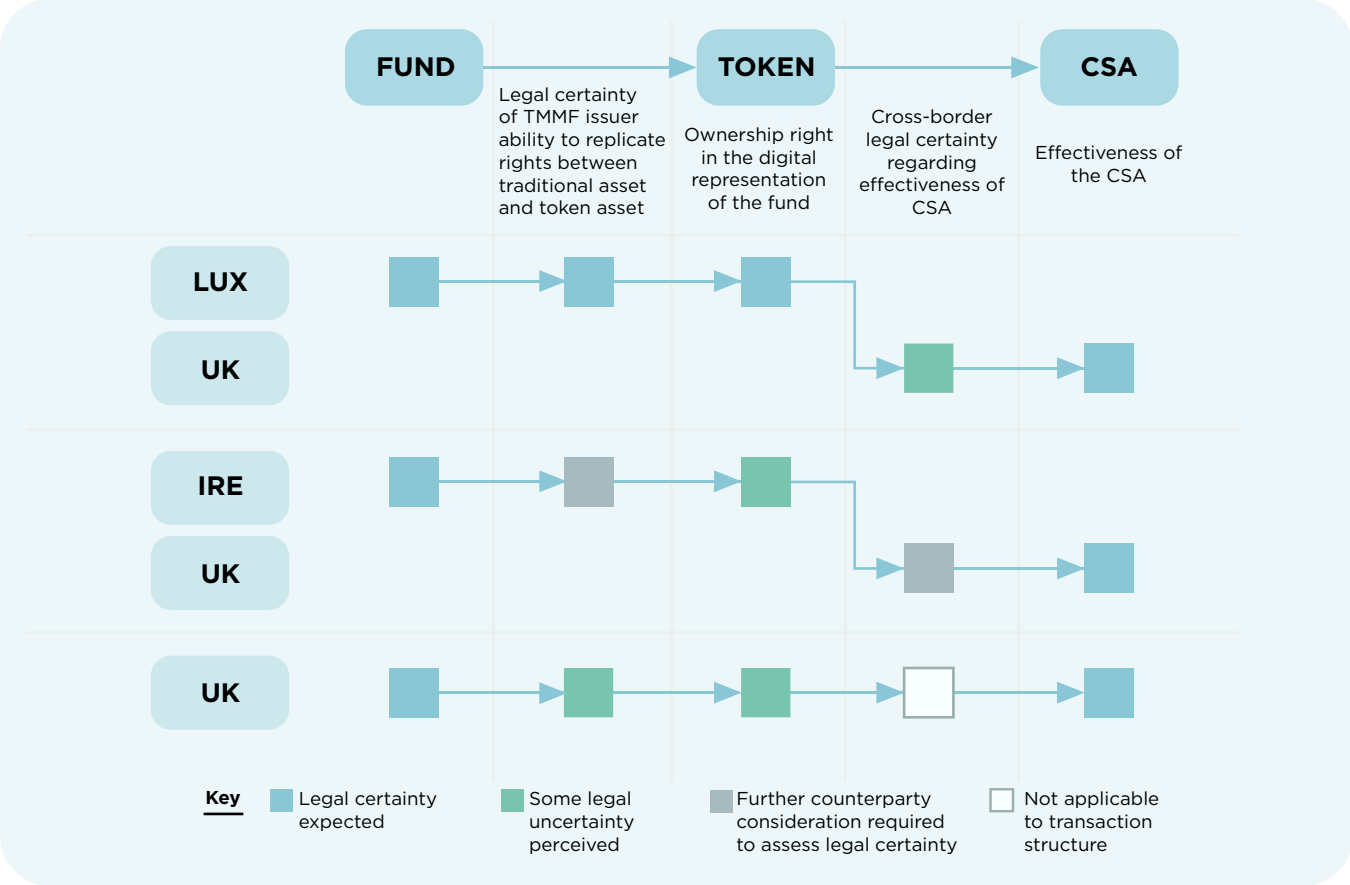

Figure 2 - Legal Certainty Analysis for Digitally Native Tokens

A framework for eligibility of TMMFs as collateral

The framework, central to the analysis, has been developed around three core dimensions deemed critical to determining whether a TMMF could be accepted in practice by receiving parties:

- **Legal Considerations including Legal Certainty:** Could legal title to the fund interest or a right to the fund interest be established, transferred, used as collateral, and enforced with clarity across jurisdictions?
- **Access on Insolvency:** Will the collateral taker have reliable access to the fund interest in the event of default, insolvency/ administration of the collateral provider, an intermediary (if applicable) or the MMF (or the issuer of the MMF, if the MMF itself does not have separate legal personality)?
- **Receiving Party Eligibility Criteria:** Do these TMMFs meet the commercial and regulatory criteria set out by parties in the CSA agreement?

Factors that currently limit adoption or require further clarity in each of the jurisdictions across the three core dimensions of the framework are highlighted below for consideration.

"Rather than selling shares of a money market fund and then sending the cash as collateral to meet a margin call, a financial institution can transfer ownership of tokens representing shares of the money market fund. That reduces the time for settlement and increases the speed."

– **Sandeep Sasikumar**
Director, Derivative Operations, Clearing & Collateral Management, Blackrock[11]

b. Legal considerations including legal certainty

In carrying out the legal considerations analysis there is a general focus on the TMMF structure labelled digitally native tokens. Where particular legal features of other TMMF structures are discussed, this is specifically mentioned.

An introduction to legal considerations

The legal considerations for a digitally native TMMF around title and property rights, transferability, enforceability of rights that have been established within a given structure and the certainty of legal treatment (for example in the event of a dispute) and anticipated access to assets on insolvency, were key to this segment of the analysis.

In order to determine whether the necessary legal certainty exists in a specific scenario, it is necessary to determine which legal regime applies to a particular transaction and the assets involved, and what the outcome is under that regime. Different regimes may apply to different aspects of the collateral arrangement.

For the purpose of this framework, it was important to determine the nature of a TMMF holder's legal title, transferability of the asset, eligibility for use as collateral and accessibility during insolvency. The latter, however, was deemed as its own key consideration by receiving parties in the sandbox so it has been addressed separately in the next section of this report (although there remains some overlap on this subject in this section).

All the tokenization legal structures contemplate having in place an English-law governed title transfer CSA for transferring the TMMF from the collateral provider to the collateral taker. However, the law that governs the legal effectiveness of a transfer of the TMMF may be different. A key factor in determining which law will apply for this purpose is likely to be the location[12] of the TMMF itself as well as the TMMF fund issuer, together with any intermediary where that is relevant to a particular tokenization legal structure, which may be located in a different jurisdiction.

For purposes of this paper, we have made some simplifying assumptions about the location of the fund, token issuer and the parties, so we can focus on the key issues for TMMFs. However some conflicts of laws analysis is still required, in particular for consideration of the cross-border transactions involving digitally native TMMFs located in Luxembourg and Ireland.

i. Conflicts of laws English law: governing law of the CSA

Digitally native (registered) share

In any cross-border transaction, some complexity arises with respect to conflicts of laws due to the need to consider the interaction between the laws of different jurisdictions. Identifying the law that will determine the legal effectiveness of transfer of a TMMF in practice can be complex, as it will depend on where the parties assume any dispute would be litigated, and then on the analysis of the private international law rules of that jurisdiction[13]. This is the case for traditional assets as well as their tokenized versions.

[11] *https://www.fia.org/marketvoice/articles/analysis-enthusiasm-builds-tokenisation-collateral-management*
[12] As discussed further below, the "location" (or deemed location) of an intangible asset such as a TMMF is a legal question determined by applying the relevant conflicts of law rules.
[13] In practice, ISDA maintains a library of collateral opinions that consider how these conflicts of law rules would be applied in several different jurisdictions, for a range of assets that could be held as collateral.

Transactions in Figure 2 both involve these features, and in practice a large number of transactions involving TMMFs posted as collateral under a CSA are expected to be structured such that conflicts of laws assessment is necessary.

It is no doubt important to market participants to ensure that the tokenization legal structure adopted for a TMMF introduces no greater uncertainty than that pre-existing in the traditional MMF market and private international law plays a significant role in this respect.

The following existing private international law principles are important in this context:

- **Contractual governing law:** The Rome regulation on the law applicable to contractual obligations ((EC) No 593/2008) ("Rome I") which applies to all EU member states except Denmark, and forms part of English law by virtue of the European Union (Withdrawal) Act 2018 (as amended)[14]. Hence, in this scenario, the contractual obligations of the collateral provider and the collateral taker relating to the transfer of the interests in the TMMF under the CSA, and any disputes between the collateral taker and the collateral provider relating to obligations under the CSA, are governed by English law, in accordance with the English choice of law clause in the CSA[15].

- **Property governing law:** The general rule in private international law across legal jurisdictions is that disputes relating to property rights (i.e. disputes as to entitlement to the relevant property) are determined according to the law of the place where the object is located (i.e. the lex situs). Here, therefore, it is location of the TMMF which is determinative. How that "location" is determined, including the location of what, exactly – for example fund issuer, its registrar, a token (and in respect of a token, what constitutes its situs in fact) will depend on a number of structural features and consequently the lex situs of the TMMF may be impacted by the structure being used[16].

Certain key features of the CSA transaction under consideration have been identified for further legal certainty analysis, including the effectiveness of provisions relating to transfer of the collateral and the effectiveness of contractual netting (see column 4 in Figure 2).

[14] Article 3 of Rome I provides that "a contract shall be governed by the law chosen by the parties".
[15] This is subject to the requirement to give effect to the overriding mandatory provisions of the law of the country where contractual obligations have to be or have been performed, if those provisions render the performance of the contract unlawful, as per Article 9(3) of Rome I. However, this exception is generally unlikely to be relevant in the context being discussed.
[16] We use the word "location" throughout this paper to refer to the jurisdiction and governing law that will apply to the TMMF from a property law perspective but note that "location" for these purposes is a matter that requires an in depth legal assessment, the nature of which may vary depending on the structure being used. For example, depending on the precise legal structure, the TMMF may constitute financial collateral for the purposes of the Financial Collateral Arrangements (No. 2) Regulations 2003 (and its equivalent in the EU) which will have consequences for the determination of lex situs and if the TMMF comprises book entry securities as collateral, this will also impact the analysis. There are further notes on this topic in *Appendix D – Determining the Lex situs.*

Under the type of CSA considered, "transfer" of collateral is intended to take effect from a contractual perspective. However, although the CSA provides for the transfer of title to the collateral and sets out the parties' obligations towards each other under English law, it is not necessarily conclusive in determining whether title has actually been transferred. Whilst in practice it is expected that parties will also seek to replicate the correct title under the relevant local law records of the TMMF, circumstances may be envisaged where change of ownership has not been appropriately concluded from the perspective of the relevant lex situs jurisdiction of the TMMF.

The third-party effects of the transfer will (in many cases) depend on the law of the lex situs of the TMMF. It is crucial therefore for legal certainty that the lex situs of the TMMF would recognize the English-law governed CSA (including an English court's decision[17] in respect of its effects) as effective to transfer ownership of the TMMF interest from the collateral provider to the collateral taker and that the transfer of the TMMF is effective as a matter of the governing law applicable to the TMMF[18].

It is also important that the lex situs of the TMMF recognizes that the TMMF can form part of a collateral arrangement and be the subject of property rights and that the transfer of the TMMF is effective and recognized as sufficient to transfer the collateral provider's rights relating to the TMMF, such that no third-party may claim an interest, right or entitlement to the TMMF[19].

As mentioned above, legal conflicts could arise in respect of an English court's decisions made in respect of the effect of a CSA, and the need for this to be recognized (including against third parties) in a different jurisdiction (including outcomes that do not reflect local law ownership records in the location of the TMMF). How certain the parties can be that the contractual arrangements that have been implemented between them will be legally reflected in a cross-border TMMF location and enforceable locally in relevant circumstances is reflected in column 4 of Figure 2 (with additional reasoning provided below in the relevant local law sections).

It is noted as a general point that at present, the full set of legal opinions which support traditional transactions concluded under market standard documents are not yet available in respect of tokenized collateral and precedent transactions (and disputes which give rise to judgments containing relevant legal analysis and precedent on these matters) are limited in number.

ii. English law: governing law of the CSA

All the transactions in Figure 2 involve an English law governed CSA. As mentioned above, by virtue of Rome I, all the contractual obligations of the collateral provider and the collateral taker under the CSA will be governed by the law chosen by them - here, English law.

English law has long-standing and clear legal precedent for enforcing relevant contractual obligations under CSAs and although the contractual provisions which enable tokenized collateral to be posted under CSAs are relatively new, there is substantial legal confidence as to their enforceability in accordance with the intentions of the parties. As a result, all the boxes in column 5 in Figure 2 reflect that legal certainty is expected.

If an English law governed CSA needs to be litigated or enforced in the English courts, the fact that the English courts have already had to deal with the concept of cryptoassets in a number of fraud and other cases is also helpful to establish the anticipated certainty of legal treatment[20].

More information on the proprietary legal status of digital assets under English law appears below under *iii. Legal Considerations – English law: situs of the TMMF.*

[17] Note that for these purposes, it is also assumed that the CSA contain a jurisdiction clause which allows disputes to be brought in the English courts..
[18] Achieving effective transfer may entail completing additional formalities in the jurisdiction of the location of the TMMF, as to which see further details provided in the Luxembourg law and Irish law sections below.
[19] It is noted that the lex situs (*see Appendix D*) is also likely to be the applicable law for disputes concerning the third party and proprietary aspects of the transfer (including disputes concerning competing claims to the TMMF or the assignability of the TMMF)
[20] See for example AA v Persons Unknown [2019] EWHC 3556 (Comm) and D'Aloia v Persons Unknown [2022] EWHC 1723 (Ch)

iii. English law: situs of the TMMF

The third row of Figure 2 reflects a transaction where the TMMF itself is located in the UK[21]. As noted above, the fact that the English courts have already dealt with the concept of cryptoassets is helpful to establish the anticipated certainty of legal treatment for a UK TMMF. In addition, the Property (Digital Assets etc) Bill, which is currently going through Parliament in the UK, aims to clarify further the legal status of digital assets by recognizing them in legislation as a new third category of personal property.

The Bill deliberately does not define the characteristics of this third category of "thing" but leaves this to the development by English common law, which is helpful as it will allow for a flexible approach which is not possible to achieve in legislation. We note for completeness that further work may be needed to address the application of common forms of English law governed security interests to this third category of property.[22]

Having an MMF established in the UK raises no concerns from a legal certainty perspective and the third row in column 1 of Figure 2 reflects this. Where the MMF is tokenized using a digitally native TMMF which is located in the UK, there is a low degree of legal uncertainty concerning the legal treatment of ownership as reflected in the third row in column 3 of Figure 2 and, connected with that, a similar low level of uncertainty concerning the replication of rights for market participants between the traditional MMF and a digitally native TMMF as set out in the third row in column 2 of Figure 2.

As explained above, it is anticipated that further certainty will be available if the Property (Digital Assets etc) Bill is enacted and common law precedent is developed as to the implications of the "third category" of property. Establishment of more structures and development of market practice through trading activity (including through initiatives like the sandbox) are also clearly helpful in the meantime, together with input from the Law Commission[23] and other legally authoritative guidance, the work of industry bodies[24] and transactional legal work which is focused on establishing consistency and improving legal certainty of outcomes.

iv. Luxembourg law: situs of TMMF

Many traditional MMFs have been established in Luxembourg and there is no legal uncertainty as to the availability of this model under Luxembourg law as reflected in the first row, column 1 of Figure 2. In addition, where a TMMF is located in Luxembourg there is also relative legal certainty due to the availability of statutory frameworks to govern such transactions. **From a legal perspective Luxembourg does not differentiate between the available "dematerialized" and "registered" forms.**

This makes Luxembourg an attractive jurisdiction from the perspective of establishment of a TMMF.

Longstanding historical legal interaction between Luxembourg and the UK in respect of financial and investment contractual arrangements, including CSAs, also makes this an attractive place to establish a TMMF where the tokens will be posted as collateral under an English law governed CSA.

There are two main potential legal constructs under Luxembourg law that may be used for a tokenized legal structure of the type labelled "Digitally Native" in Figure 1 – fund units in dematerialized form, or fund units in registered form. These are both considered below.

[21] To date, there have been few MMFs located in the UK and no TMMFs.
[22] We note that consideration of CSA collateral structures which require "taking security" over TMMFs as opposed to "title transfer" models were out of scope for this WG, but further legal work is likely to be required on this aspect in the future.
[23] See for example the Law Commission's work here: Digital assets – Law Commission
[24] See for examples the following ISDA publications: Guidance for memorandum of law examining the validity and enforceability of collateral arrangements using the ISDA model provisions for tokenized collateral
Navigating Bankruptcy in Digital Asset Markets: Digital Asset Intermediaries and Customer Asset Protection
Navigating Bankruptcy in Digital Asset Markets: Netting and Collateral Enforceability
Contractual Standards for Digital Asset Derivatives

1. Fund units in dematerialized form

Luxembourg laws provide for explicit recognition to use DLT for securities governed by Luxembourg law and which are in dematerialized form. The relevant Luxembourg law dated 6 April 2013 on dematerialized securities (the Law on Dematerialised Securities) was amended for the second time at the end of 2024 to cover equity securities in addition to debt instruments and investment fund units/shares amongst other developments (Blockchain law IV), so it is feasible that a TMMF located in Luxembourg will be structured to fall within this law.

The Law on Dematerialised Securities requires a settlement organization/CSD, central account keeper or control agent to carry out roles including (i) holding the securities issuance account, which is the account in which securities are created; (ii) supervising the custody chain at account holder, investor level; and (iii) ensuring that the number of securities issued by the issuer and via the securities issuance account is identical to the total number of securities registered with the securities accounts of the account holders as recorded using the relevant DLT.

This framework together with the Luxembourg law of 1 August 2001 on the circulation of securities (Law on the Circulation of Securities) provides for rules for digitally native securities including as to transfer and settlement. For foreign law governed securities which are located in a securities account in Luxembourg the Law on the Circulation of Securities has also recognized DLT for use in respect of the securities accounts.

The transfer of Luxembourg law governed digitally native TMMF interests which are structured to fall within this dematerialized securities framework would be effected by "book-entry" recording from one securities account to another (by direct reference to entries made on the DLT records without additional formalities, for example, without interaction with any non-DLT register or other off-chain activity being required).

The legal certainty with which parties can establish ownership in a Luxembourg digitally native TMMF, and the fact that the rights which parties obtain are relevantly replicated between a traditional MMF and a TMMF, are therefore reflected as relatively legally certain in the first and second columns of the first row in Figure 2.

2. Fund units in registered form

An alternative form which can also be chosen for investment fund units subject to Luxembourg law, is the registered form. There is no explicit recognition for DLT in this legislation, however the laws do not prevent parties from using DLT technology to maintain the register and in particular the rules concerning the form of the unit/share register leave room for flexibility.

As a result, such registers could either be held on-chain or off-chain, or the information required for the register could be obtained from an on chain process and records, whilst the primary register was held off-chain. Either way, it is easy to see how use of DLT could still ensure that the legal requirements for the register maintained by the issuer or its transfer agent or registrar were met.

The most relevant Luxembourg corporate form used for MMFs (mainly UCITS) is the form of an SA, where the ownership of registered shares is evidenced by the entry of the holder and associated information in the register.

> The main rules in respect of ownership registration requirements derive from the Luxembourg Law of 10 August 1915 on Commercial Companies, as amended (Luxembourg Companies Law). Under the Luxembourg Companies Law a transfer of registered shares of a SA is performed by way of declaration of transfer in the register, "dated and signed" by the transferor and the transferee or by their duly authorized representatives in accordance with the rules on the assignment of claims set out in Article 1690 of the Luxembourg Civil Code. Such assignment can be implemented by way of an electronic transaction.

There is precedent in the Luxembourg market (also prior to Blockchain Law IV) for issuance of fund units in the "registered form" model, where the register is being operated on chain or off chain by the transfer agent so there is relatively longstanding experience with using this structure in the Luxembourg market and that is helpful from a legal certainty perspective.

Depending on the form of the fund unit, the transfers are recorded in registers or securities accounts to reflect the ownership, however, if a dispute arose between parties under an English law CSA in the English courts there is relative certainty that any transfer of the TMMF would have been effective as a matter of the governing law applicable to the TMMF (due to the clarity of legal provision in Luxembourg for these structures) and that any outcome requiring an adjustment to DLT records in Luxembourg could be implemented (including that, in principle, the English law judgment would be enforced in Luxembourg).

This supports the determination, in line with the fourth column in the first row of Figure 2, that a cross-border transaction will maintain relative legal certainty for parties in respect of the interaction between the contractual agreements reached on collateral under the CSA, and the Luxembourg law perspective.

For a structure such as the 'dematerialized' or 'registered form' digitally native TMMF, the appropriate lex situs for purposes of determining transfer rules or creation of rights in rem will depend on the form and also on whether the securities are directly held or via an intermediary.

Lex situs may be determined to be where the register is located with certain exemptions (for securities in the registered form), or where the relevant securities account is located (for securities in book-entry form), or where the securities are registered, or where the issuer or a depository or clearing system (mainly relevant for the dematerialized form) is located or, in case of securities deposited with an account keeper, lex situs may be determined by reference to the location of the account keeper.

Ultimately, these scenarios generally mean that the correct legal framework is tied to the jurisdiction where the securities account is maintained or the issuer, register or intermediary is located. From a Luxembourg perspective, this offers helpful clarity for parties involved in cross-border transactions.

As a final note on Luxembourg law in this area, the Luxembourg Collateral Law was amended in 2023 to expressly cover financial instruments in various forms including those issued and transferred using DLT, therefore including securities that will be issued by a Luxembourg TMMF. This ensures that digitally native TMMFs may form part of a relevant financial collateral arrangement (which can include a pledge agreement, a title transfer collateral arrangement, a repurchase agreement and/or a fiduciary transfer arrangement).

The Luxembourg Collateral Law also assists in respect of certain provisions on treatment of financial collateral arrangements in the event of a counterparty insolvency which are covered in more detail below.

v. Irish law: situs of TMMF

Similar to the situation in Luxembourg, many traditional MMFs have been established in Ireland and there is no legal uncertainty as to the availability of this model under Irish law as reflected in the second row, column 1 of Figure 2. A common structure for the traditional MMF in Ireland entails the issuance of shares to investors by a corporate vehicle, a plc or ICAV, and it is envisaged that would be the base structure for an Irish TMMF in this section.

Under Irish law, shares are classified as choses in action, which are intangible property rights enforceable through legal proceedings. The Irish Companies Act 2014 and the ICAV Act 2015 (the Acts) provide a broad and flexible statutory framework for the issuance, transfer, and registration of shares.

Both Acts do not prohibit the issuance of shares in digital or tokenized form, and the definition of "share" is sufficiently broad to encompass digital formats, provided the company or ICAV's constitution and prospectus so permit. The Electronic Commerce Act 2000 and the eIDAS Regulation (EU 910/2014) underpin the legal

validity of electronic contracts and e-signatures in Ireland, supporting the enforceability of tokenized shares which are issued and transferred via DLT.

The Irish European Union (Markets in Financial Instruments) Regulations 2017 were updated on 23 March 2023 to provide that "financial instruments" under that regulation, and related EU law, includes financial instruments, such as transferable securities and units in a collective investment undertaking, issued by means of distributed ledger technology. Without specifically referencing tokenized shares, the Irish High Court has previously ruled that electronic shares should be treated in the same manner as certificated shares.

When the structure under consideration is a digitally native TMMF[25], the on-chain tokenized share register is the authoritative legal record of the legal owner of shares. There is no explicit recognition for DLT in corporate law, however the laws do not prevent parties from using DLT technology to maintain the register. Legal certainty in respect of ownership and treatment of tokenized shares under Irish law is therefore the same as traditional shares underpinned by electronic contracts, rather than being directly established by but this is easily done where the primary register is on-chain.

It is then reasonable to conclude that Irish courts would treat digitally native TMMF shares in a manner consistent with traditional shares. This alignment reinforces the view that TMMF shares can be accommodated within existing property law principles in Ireland, supporting their recognition and enforceability under Irish legal standards.
In respect of this outcome, it is noted that a moderate level of legal certainty exists for establishment of ownership rights in a Digitally Native Irish TMMF but that the TMMF issuer's ability to replicate rights of holders between a traditional MMF and a TMMF will be dependent upon whether the on-chain register and use of DLT can be facilitated implemented under and in accordance with current laws.

While the law allows for registers to be kept in electronic form, and for authentication by electronic means, the use of DLT as the sole and authoritative register requires the DLT-based register to be maintained in accordance with applicable laws. It is a matter for the TMMF to ensure that the DLT-based register is maintained accordingly and therefore Digital Twin models may prove popular (an option which may be relevant for the tokenization legal structure labelled "Digital Twin" in Figure 1).

Where a Digital Twin TMMF is established in Ireland, the information required for the register could be obtained from an on-chain process and records, whilst the primary register was held off-chain (an option which may be relevant for the tokenization legal structure labelled "Digital Twin" in Figure 1). Legal certainty of a Digital Twin model requires further counterparty assessment to establish the exact nature of the tokens, what rights they represent and whether they are a distinct financial instrument or digital representation of the shares.

It is noted that a degree of legal uncertainty exists for establishment of ownership rights in a Digital Twin Irish TMMF and the relevant replication of rights between a traditional MMF and a TMMF.

In respect of effecting a transfer in a TMMF, it is noted that transfer of shares in Ireland is governed by the Acts, which require that a proper instrument of transfer be delivered to the company or ICAV. Both Acts are sufficiently flexible to permit electronic instruments of transfer, and the Electronic Commerce Act 2000 confirms that "electronic modes of representing words in visible form" satisfy statutory requirements for "writing" and "signature".

There is also a requirement for certification of transfers (e.g., "certificate lodged" and signature by an authorised person) which may present operational issues for DLT-based processes (though these may be addressed by appropriate technical solutions and director approval). For legal title to pass, the register of members must be updated. It is noted that the directors of an Irish company or ICAV may approve forms of transfer other than the traditional written instrument, potentially including DLT-based instructions, provided the formalities for execution and delivery are met.

[25] i.e. One that is offering tokenized shares to investors – note that the use of "tokenized" terminology in this section is not intended to denote a "Digital Twin" structure.

In a traditional scenario, the stock transfer form would be the instrument of transfer, and this would be signed and delivered to the TMMF, fulfilling execution and delivery.

In a DLT instruction model, the transferor would "sign" the instruction by using their private key, which would constitute an electronic signature under the Electronic Commerce Act 2000, with the smart contract governing the transaction defining the rules of execution.

Completion would differ slightly between digitally native and digital twin structures. In a digital twin structure, submission of the DLT instruction (signed transaction to the ledger or the registrar's DLT) would constitute delivery. However, legal title would only transfer once the off-chain TMMF register is updated to reflect the change, with the ledger acting as operational infrastructure.

In a digitally native model, delivery occurs upon submission to the ledger, when the TMMF's DLT receives and validates the transaction. Once the smart contract confirms the transaction and updates the ledger, the register of members is updated and this would represent transfer of legal title.

As a final note on relevant Irish law, it is noted that the Irish Financial Collateral Arrangements Regulations 2010 (the Irish Collateral Regulations) govern the use of financial collateral in Ireland (including netting). Unlike the position in the UK, where amendments have been suggested to the equivalent FCARs to ensure that they are broad enough to cover digital assets, the existing definitions of "financial collateral" and "financial instruments" under the Irish Collateral Regulations are sufficiently broad to capture tokenized shares, tokenized units in a fund and any claims relating to, or rights in or in respect of such shares or instruments.

This ensures that digitally native TMMFs may form part of a collateral arrangement under the Collateral Regulations and for structures which do fall within the Irish Collateral Regulations, parties will have the benefit of additional legal certainty on the Irish 'lex situs' of the TMMF as well as provisions on treatment of collateral in the event of a counterparty insolvency which are covered in more detail below.

c. Access on insolvency

Understanding how TMMFs behave in insolvency scenarios is critical to assessing their suitability as collateral. While many of the same principles apply as for traditional MMFs, tokenization introduces new legal and operational variables that can affect an investor's ability to claim, enforce, and recover collateral through the insolvency waterfall.

Insolvency can affect a TMMF used as collateral under a bilateral title transfer CSA in a number of ways including:

1. The insolvency of the collateral taker,
2. The insolvency of the collateral provider, and
3. The insolvency of the issuer.

The potential consequences arising as a result of insolvency of the collateral provider have been assessed. In this scenario, the collateral taker is the beneficiary of a flow of rights - from the fund to the token, through the contractual arrangements that govern the collateral into the hands of the collateral taker.

How a collateral taker is protected (or may experience uncertainty) in enforcing its rights when a collateral provider becomes insolvent depends on a range of features of the contractual terms and the structure from which the assets it is holding have been issued.

There are some key aspects for assessment. In the event of the insolvency of the collateral provider, it is key that the TMMF would not form part of the collateral provider's estate. This entails that title to the TMMF has been effectively transferred, with legal certainty (including through any legal challenge which may come to be decided by a court as a result of the insolvency process) to the collateral taker.

It is important therefore that the transfer of title of the TMMF to the collateral taker is effective and that it cannot be clawed back or recharacterized as a security interest and that the close-out netting

mechanism under the ISDA Master Agreement is enforceable against the collateral provider in its insolvency.

Legal certainty for a collateral taker in a scenario where the TMMF is located in Luxembourg is generally considered strong in this area. Luxembourg law provides for relative certainty in terms of a collateral taker's establishment of proprietary rights to the TMMF[26], and also contain certain key protections on insolvency matters, including the Luxembourg Law on Dematerialized Securities which provides that the securities in the creating securities issuance account shall not be subject to winding up proceedings and in principle these securities creating issuance accounts shall also not be subject to attachments (with exceptions).

This is protection for the framework as such, and since the dematerialized securities are to be recorded in the relevant securities account of the relevant account holder who ultimately "owns" the securities.

When it comes to collateral, it is also noted that the Luxembourg Collateral Law explicitly captures tokenized securities, including tokenized fund interests such as digitally native TMMFs.

As a result, TMMFs which are in dematerialized form under Luxembourg law (or in fact which constitute foreign law securities held in securities accounts that have been established using DLT) can constitute "financial collateral" under the Luxembourg Collateral Law. This law provides for robust insolvency protection on the part of the collateral taker against insolvency of a Luxembourg collateral provider.

The insolvency protection is broad covering hardening periods as well. In addition, the Luxembourg Collateral Law also provides protection for foreign law governed financial collateral arrangements where the collateral provider is located in Luxembourg.

Also to note that Article 8 of the EU Insolvency Regulation (Recast) (Regulation (EU) 2015/848), provides for an insolvency protection of security interests over assets located in a different member state.

Similar to Luxembourg, the Irish position on legal certainty in respect of insolvency of a collateral provider is also supported by the existence and breadth of the Irish Collateral Regulations, which are broad enough to cover TMMF shares.

The Irish Collateral Regulations ensure that if a collateral taker's valid legal title has been established (including via a valid legal transfer, if applicable[27]) to TMMF shares under Irish law, the collateral taker's rights in the event of insolvency would be protected under Irish insolvency law and the Collateral Regulations.

The Collateral Regulations also include additional protections whereby EU Member States cannot declare a financial collateral arrangement invalid or void on the basis of timing or a lack of awareness on the part of the collateral taker.

d. Receiving party eligibility criteria

The two previous sub-sections set out whether a TMMF can be accepted as eligible collateral from a legal perspective. Beyond this eligibility, there are also considerations as to whether firms are able to accept TMMF as collateral in practice.

Based on the feedback of firms acting as receiving parties in the sandbox, receiving party criteria sit at the intersection of three thematic drivers:

a. Legal and regulatory drivers,
b. Firm-level risk policy drivers, and
c. Commercial / operational drivers.

Key characteristics for each of these drivers are outlined in Figure 3.

[26] See notes above in Section V(i)(E) for further information on these aspects of Luxembourg law
[27] See notes above in Section V(i)(F) for further information on these aspects of Irish law

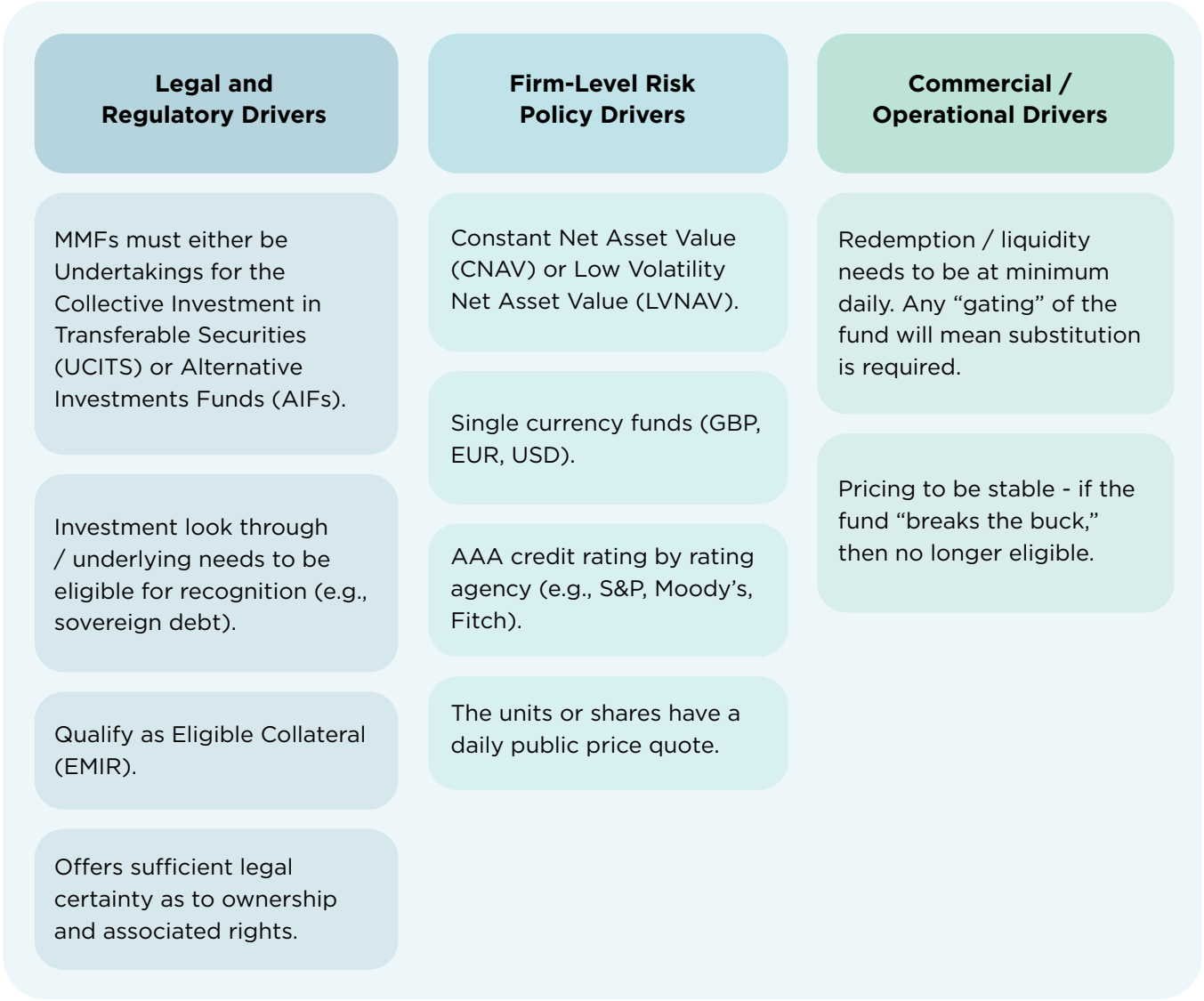

Figure 3 – Receiving Party Collateral Eligibility Drivers

To prioritize the scope of this research, a focus specifically on the new touchpoints where tokenization might influence any of these drivers and the resulting eligibility of the TMMF for collateral use were examined.

The analysis centered around key eligibility questions raised by receiving parties in the sandbox. These questions were used to isolate how tokenization may introduce new legal, regulatory, operational or risk-related frictions compared to traditional MMFs.

While interdependent, these considerations could be logically grouped into three distinct layers:

- **The fund layer** - where eligibility is influenced by the fund's legal structure, domicile, and whether the token affects risk attribution or regulatory look-through
- **The token layer** - where eligibility depends on the rights embedded in the token, its link to the official unit register, and the ability to trace liquidity and valuation
- **The CSA layer** - where eligibility turns on how the token behaves under collateral substitution, enforcement, and netting scenarios.

The breakdown using some key receiving party questions as anchor points in the distinction across these layers is illustrated below.

Table 3. Eligibility Considerations for Receiving Parties at Layer Level

Example Eligibility Questions	Layer	Example Considerations
Is the underlying fund type eligible under existing collateral schedules?	Fund	• Does the MMF qualify as a UCITS or AIF? Is it a CNAV or LVNAV structure? Is it a single-currency fund (GBP, EUR, USD)? • Is the fund comprised of securities that are allowed, per regulatory parameters and/or collateral schedule?
Does the wrapper change the fund's rating or look-through treatment?	Token	• How is the rating of the fund impacted when tokenized? • How could the legal structures with the wrapper change the risk profile of the token and expose the holder to a third-party? Does it impact regulatory look-through?[28]
Can we verify daily NAV & liquidity on chain and via the TA?	Token	• Does the token link back to the fund's official register? • Are data feeds timely and reliable? • Can pricing/lifecycle events be verified on-chain or off?
What happens if the fund 'gates' or breaks the buck?	CSA	• Can the CSA support same-day substitution? • Is there a mechanism for replacing the asset with another eligible fund? • Is pricing continuity preserved?

This layered analysis helped distinguish where legal and regulatory, firm-level risk policy, or commercial and operational considerations arise - and enables the identification of which factors are most impactful to the receiving party's overall assessment of a TMMF as eligible collateral.

Feedback from receiving parties participating in the sandbox underscored how TMMFs meet collateral eligibility standards under most configurations, although there remains some variance depending on how the product is structured. In particular, firms indicated that fund level and CSA level considerations remained the most consistent.

At the token level, firms noted – and as evidenced in the sandbox - that digitally native and twin structures show the greatest potential to meet regulatory and operational requirements, provided that they meet the legal certainty requirements including access on insolvency considerations.

Indeed, banks participating in the sandbox were aligned in commenting that many eligibility checks (LVNAV/CNAV status, currency, UCITS/AIF status) remain fund centric and therefore agnostic to the tokenization process unless the wrapper introduces extra credit or liquidity frictions. In contrast, asset backed token models with nominee structures tend to raise concerns around credit rating, liquidity and valuation reliability. ■

[28] The digital assets ratings firm Particula has been leveraged in this sandbox to give a rating on one of the funds using in the sandbox (see Particula rating assessment and methodology in Appendix B)

5. TOKENIZED COLLATERAL REAL USE CASES IN THE INDUSTRY SANDBOX

The GDF Industry Sandbox is the pivotal bridge between theoretical analysis and live market readiness. Over 30 organizations – spanning sell-side banks, buy-side asset managers, custodians, fintech providers, and industry bodies – participated across six core simulations.

To translate the framework into practice, a dedicated sandbox environment was established to pilot real-world collateral workflows using TMMFs. The GDF Industry Sandbox is AWS-hosted and powered by Ownera, integrated with its FinP2P digital asset network, which simulated all key technical components and participants across multiple DLT platforms.

The sandbox simulations:

- Address specific real-world use cases and stress conditions identified as pain points in collateral management and involved a representative range of TMMFs were aligned to the tokenization and legal frameworks developed

- Enable industry, policymakers, and infrastructure providers to participate in real-world collateral workflow pilots using TMMFs including margin calls, market volatility, substitutions, cross-chain settlement, and default events

- Demonstrate that the future of collateral mobility is not hypothetical but achievable today by validating TMMFs as a production-ready collateral instrument, combining the yield and familiarity of regulated MMFs with the instant settlement, programmability, and transparency of distributed ledgers.

> *This groundbreaking initiative proves that digital assets can be used in regulated financial markets under existing legal frameworks here in the UK. It's a major step forward in demonstrating how tokenization can enhance collateral efficiency, reduce friction, and unlock new trading opportunities*
>
> **– Peter Left**
> Head of Digital Finance at Lloyds Banking Group

a. Sandbox overview

The sandbox was conceived as a production simulation environment - it is the pivotal bridge between theoretical analysis and live market readiness. By running 6 progressively complex simulations[29], the sandbox demonstrated not only that TMMFs can operate as enforceable collateral today, but also how they unlock efficiencies, resilience, and interoperability that traditional systems cannot match.

Across these simulations, the sandbox pressure-tested every critical dimension of tokenized collateral:

- **Operational Feasibility and Scale** – From the first bilateral token transfer to automated, API-driven margin calls, the experiments showed that TMMFs can be integrated directly into existing collateral management systems without "rip-and-replace." Simulation 2's fully automated posting cycle proved that smart-contract settlement and industry data standards can cut margining timelines from days to minutes.

- **Programmable Margin Management** – In simulation 2, the Common Domain Model (CDM) was introduced and used to define the terms of the swap agreement between parties. This standardization of definition was critical to ensure that the terms of the margin agreement were aligned.

- **Real-Time Risk Management** – In Simulation 3, a simulated NAV shock triggered an instantaneous, on-chain substitution of collateral using atomic delivery-versus-delivery (DvD) swaps. This showcased a new paradigm for intraday risk management, where deteriorating assets can be replaced within seconds, something impossible in the legacy collateral chain.

[29] Part V of the report lays out the detailed analysis of each simulation.

- **Legal Enforceability Under Stress** – Simulation 5 provided the ultimate test: a counterparty default. Here, TMMFs were seized and redeemed unilaterally by the collateral taker, validating that English-law title transfer works seamlessly in a tokenized environment and satisfying the highest standards for settlement finality and insolvency protection by regulators and custodians.

- **Interoperability Across Markets and Ledgers** – By orchestrating cross-platform settlements that touched Ethereum, Canton, Polygon, Hedera, Stellar, Besu, and institutional cash networks such as Fnality, the sandbox proved that tokenized funds could move fluidly across heterogeneous DLTs and new payment rails. Simulation 6 extended this to tri-party repo funding, showing that intraday liquidity can be mobilized in minutes while retaining yield.

- **Liquidity and Yield Advantages** – Throughout the tests, TMMFs retained their core money-market characteristics-regulated structure, stable NAV, and ongoing yield-while gaining 24/7 transferability.

- **Market Readiness and Policy Alignment** – Each simulation fed directly into the legal and operational frameworks, offering regulators concrete evidence that TMMFs meet existing requirements under EMIR, UKEMIR, and ISDA CSAs. The demonstrations have already influenced live market initiatives from proving the sandbox's relevance beyond the test environment.

The sandbox validated TMMFs as a production-ready collateral instrument, combining the yield and familiarity of regulated MMFs with the instant settlement, programmability, and transparency of distributed ledgers.

The sandbox and simulations provide industry, policymakers, and infrastructure providers with a working blueprint for scalable adoption - showing that the future of collateral mobility is not hypothetical but achievable today.

> *"The GDF project proves out the benefits of DLT in enabling use of MMFs in collateral markets. We hope this will be a catalyst for the emergence of more tokenized MMFs, as well as the review of regulation and market participants' collateral management frameworks to allow for greater use of MMFs"*
>
> **– Reyer Kooy**
> Global Head of Digital Operations, Apex Group (and former Chair of IMMFA

Figure 4 depicts the flow of collateral being used against derivatives margin for IM and VM with Party A acting as the pledgor (or the entity posting collateral) and Party B as the secured party (or the entity receiving collateral) whereby:

1. Secured Party will send a collateral call via API connections
2. Margin System will issue the margin call instruction to Pledgor and their custodian
3. The Pledgor Custodian will verify and sign the move instruction and then approve the execution plan with the SP Custodian.
4. The execution plan will move the Digital Shares to either the SP Custodian or natively to the Secured Party with an update at the TA
5. There is legal transfer of title (at source) on the tokenized asset.. The Transfer Agent at all times will maintain the ledger of holders.
6. Collateral call closed with confirmation to both parties

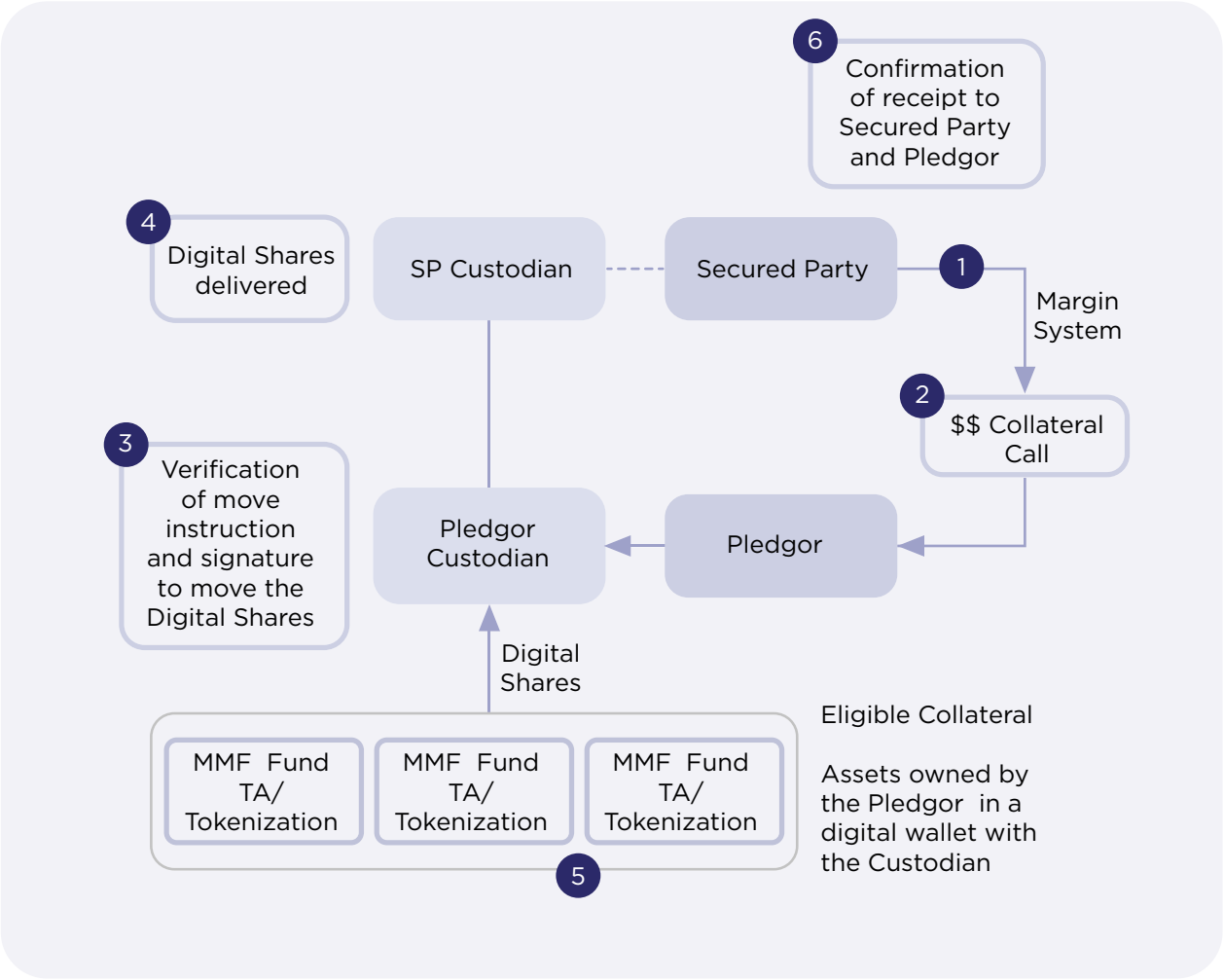

Figure 4 – Illustrative Margin Call Workflow using Tokenized MMFs

b. Sandbox architecture

Crucially, the sandbox included integration with third-party systems (e.g. ZeroBeta and Tokenovate margin engines, Particula for ratings[30], and Kaiko price oracles) and multiple blockchains (such as Ethereum, Canton, Polygon, Hedera) to reflect a realistic heterogeneity of platform, software and repo systems (Fnality, Adhara and State Street Triparty).

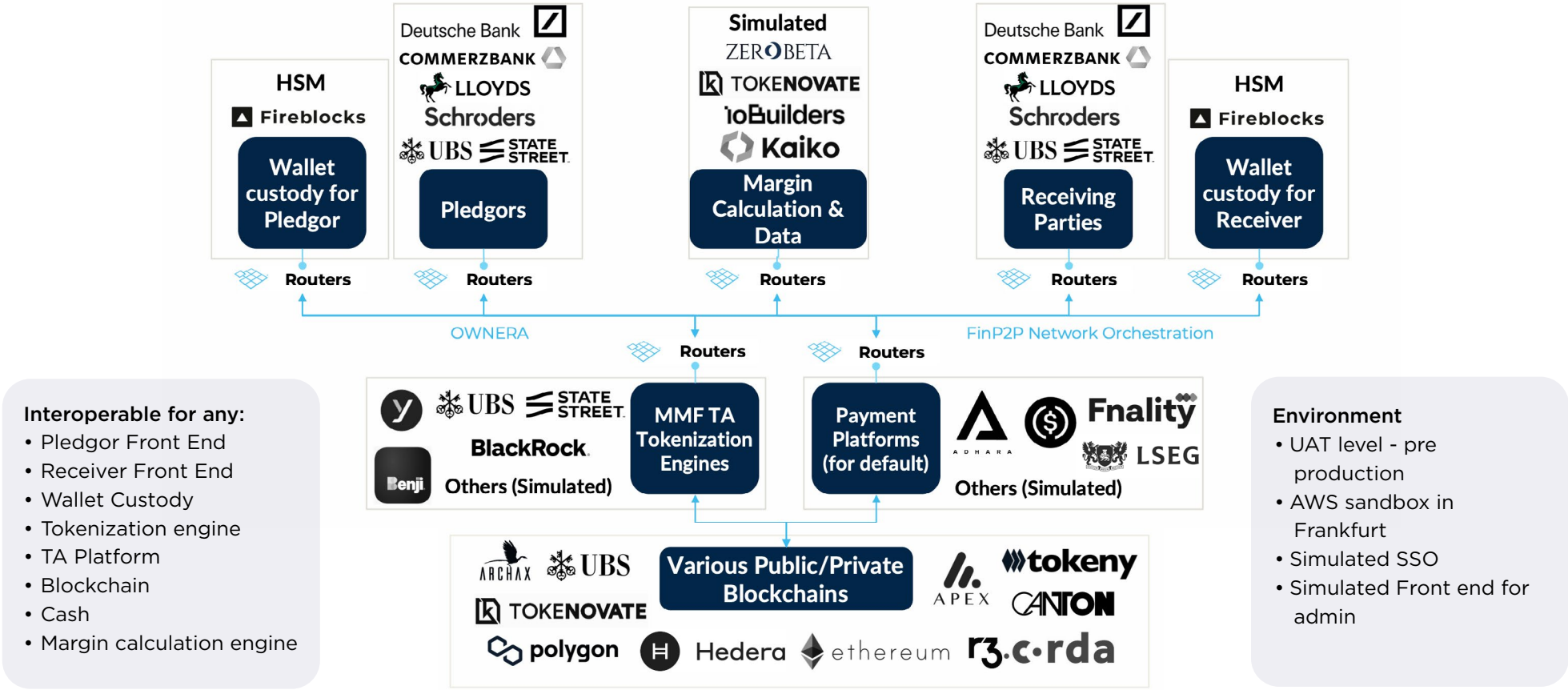

Figure 5 - GDF Industry Sandbox – High-Level Architecture

[30] See APPENDIX B for insights into Particula's TMMF ratings

As illustrated in Figure 5, firms spanning sell-side banks, buy-side asset managers, custodians, fintech providers, and industry bodies participated in various roles within the sandbox, providing a broad perspective on operational and legal considerations.

Figure 5 also illustrates the high-level sandbox architecture, in which modular “routers” represent each participant's function: investor and bank custodial wallets, margin call engine, TAs, cash payment rails, etc. The design ensured that every step from margin call initiation to token transfer and fund register update could be orchestrated and observed in a controlled setting.

The sandbox environment leveraged Ownera’s FinP2P network to connect participants’ systems, illustrated below. Key router components included an Investor Router for the collateral provider (initiating token transfers), a Bank Router for the collateral receiver (monitoring incoming assets), a Margin Router (generating margin calls/IOIs based on market data), a TA application (updating official shareholder registers), and a Cash Router for handling fiat or tokenized cash movements.

This setup enabled end-to-end testing of tokenized collateral flows – from Initial Margin (IM) posting and VM calls to substitutions and redemptions – all within a unified framework.

Building on this architecture, the sandbox also tested the operational lifecycle of a margin call using TMMFs as collateral. When a secured party initiates a collateral call via its margin system, the instruction is sent to the pledgor and its custodian through API connections, as illustrated below.

The pledgor custodian verifies and signs the move instruction, coordinating with the secured party’s custodian to approve the execution plan. Once confirmed, the digital shares representing the TMMFs are transferred to the secured party or its custodian, while the TA updates the definitive register of holders.

This ensures that legal title is transferred at source on-chain, with both parties receiving confirmation of completion. The process demonstrates that margin calls can be executed seamlessly in a tokenized environment while preserving enforceability and operational certainty.

c. Sandbox scope and assumptions

To ensure that the sandbox could operate as a credible testing environment, a defined a set of scope parameters and practical assumptions was made. These conditions provided a common foundation for participants, allowed for efficient coordination, and ensured that testing outcomes could be translated into real-world applicability.

First, a couple TMMFs were created specifically for the sandbox. These funds were structured in alignment with the legal and technical frameworks ensuring consistency with emerging best practices for tokenization.

Participants agreed to assume Luxembourg or Ireland as the domicile of these funds, recognizing it as the most commercially viable jurisdiction for early-stage execution and cross-border adoption.

The funds developed for the sandbox were not intended as purely theoretical constructs. Each was designed with a commercial pathway in mind, serving both as proof of concept and as a foundation that could be refined and deployed in production environments. This approach allowed the sandbox to test not only technical interoperability but also operational and legal enforceability within realistic market structures.

d. Tokenized funds included in the sandbox

A representative range of TMMFs were contributed by buy-side asset managers and aligned with domiciles most relevant to market participants for deployment in the sandbox. Each fund was modelled against the tokenization and legal frameworks established in earlier research, ensuring comparability across different structures - see figure 6.

By testing this diverse set of TMMFs in practice, the sandbox could assess which configurations offered the strongest commercial viability to date, while also identifying areas requiring further refinement before full-scale deployment.

> *"The over 30 TradFi and Fintech firms participating in the sandbox have demonstrated that collateral mobility for TMMFs has arrived. This is an exciting next step in the continued uplift to the future market's infrastructure, leveraging digital assets to bring real-world benefit to investors and financial institutions around the globe,"*
>
> – **Amarjit Singh**
> UK Digital Assets Leader, EY

#	Issuer	Fund Name	TA or Trust or Custodian	Blockchain	Fund Domicile	Tokenization Structure	Legal Structure
1	Benji by Franklin Templeton	• CNAV US Government Money Fund (Franklin OnChain U.S. Government Money Fund)	BNY	Stellar	Luxembourg	1- Digital Native	1- Digitally native (registered) share
2	UBS - GDF Digital Money Market Fund	• UBS - GDF Digital Money Market Fund CNAV Treasury Fund	UBS	UBS Tokenize (on Ethereum)	Ireland	1- Digital Native	1- Digitally native (registered) share
3	State Street -ETH Replica	• State Street ETH GBP Government Liquidity Fund	State Street	Ethereum	Ireland	1- Digital Native	1- Digitally native (registered) share
4	State Street Global Advisors Europe Limited	• State Street USD Liquidity LVNAV Fund • State Street GBP Liquidity LVNAV Fund • State Street EUR Liquidity LVNAV Fund • State Street USD Treasury Liquidity Fund • State Street GBP Government Liquidity Fund • State Street EUR Government Liquidity Fund	Archax	Hedera	Ireland	3- Asset Backed Tokens	5- Beneficial interest trust (intermediated holding)
5	BlackRock Asset Management Ireland Ltd	• BlackRock ICS US Dollar Liquidity Fund • BlackRock ICS Sterling Liquidity Fund • BlackRock ICS Euro Liquidity Fund • BlackRock ICS US Treasury Liquidity Fund • BlackRock ICS Sterling Government Liquidity Fund • BlackRock ICS Euro Government Liquidity Fund	Archax	Hedera	Ireland	3- Asset Backed Tokens	5- Beneficial interest trust (intermediated holding)

Figure 6 – Tokenization Structure and Legal Structure of TMMFs used within the sandbox

e. Overview of sandbox simulations

The sandbox orchestrations were structured as a series of six core simulations, each designed to address specific real-world use cases and stress conditions identified as pain points in collateral management. These scenarios incrementally increased in complexity and demonstrated how TMMFs could handle margin calls, market volatility, substitutions, cross-chain settlement, and default events.

What it does – Simulation 1 tested the basic posting and return of a TMMF as IM and VM collateral under a bilateral CSA, using manual processes. Two counterparties set up digital wallets (via Fireblocks) and execute a simple token transfer of an eligible MMF token between them. Haircut and valuation were applied manually by the collateral provider.

Key features - This simulation showcased a direct peer-to-peer token transfer orchestrated by the Ownera Routers - the MMF token was pre-approved by the receiver (e.g. only government bond-backed funds used); a fixed haircut (e.g. 2-5%) was applied to simulate over-collateralization.

Why it matters - This simulation established the foundational process and operational comfort for handling tokenized funds. It proved that legal title transfer and settlement finality can be achieved on-chain within the existing CSA framework.

As the first simulation, it helped prove that the legal and operational structures support basic bilateral use of TMMFs as collateral, while familiarizing banks with wallet management (e.g. key management via Fireblocks) in a low-risk setting.

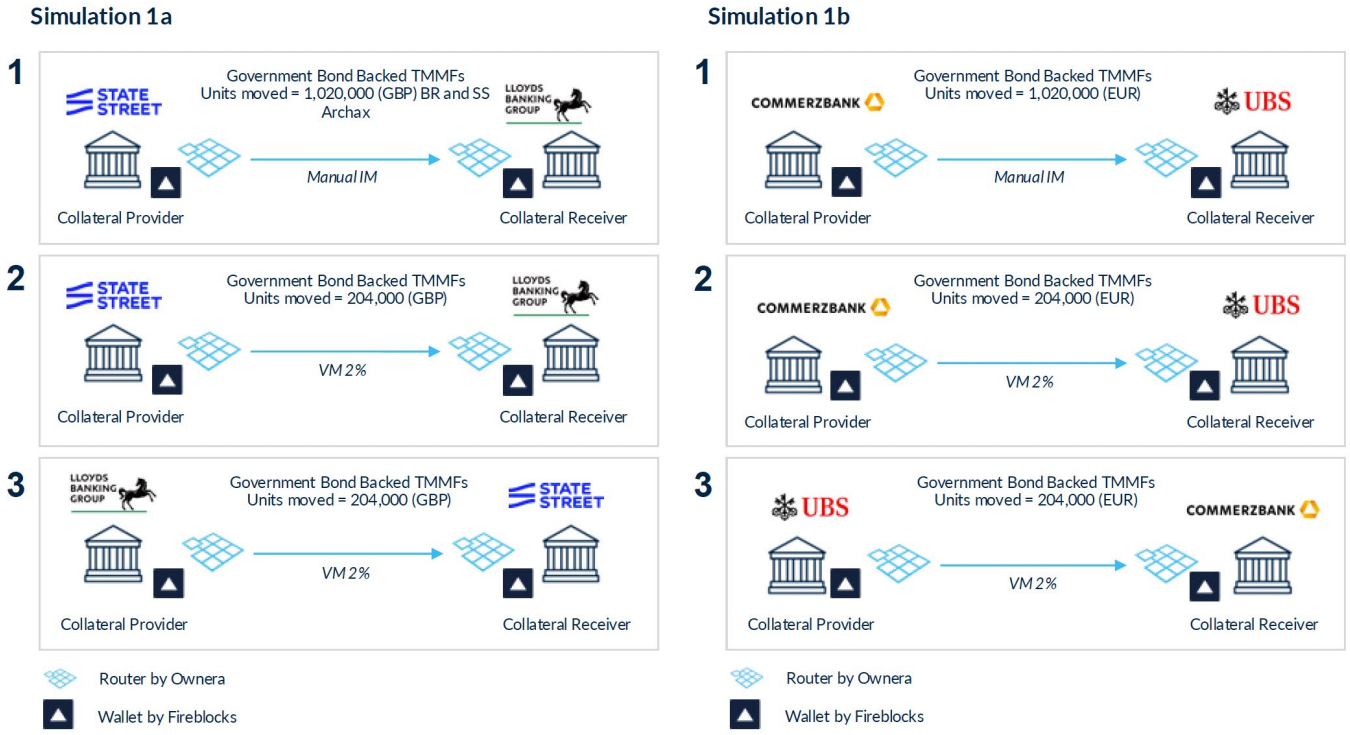

Figure 7 - Simulation 1: Simple Bilateral Transfer: Manual Margining of TMMFs.

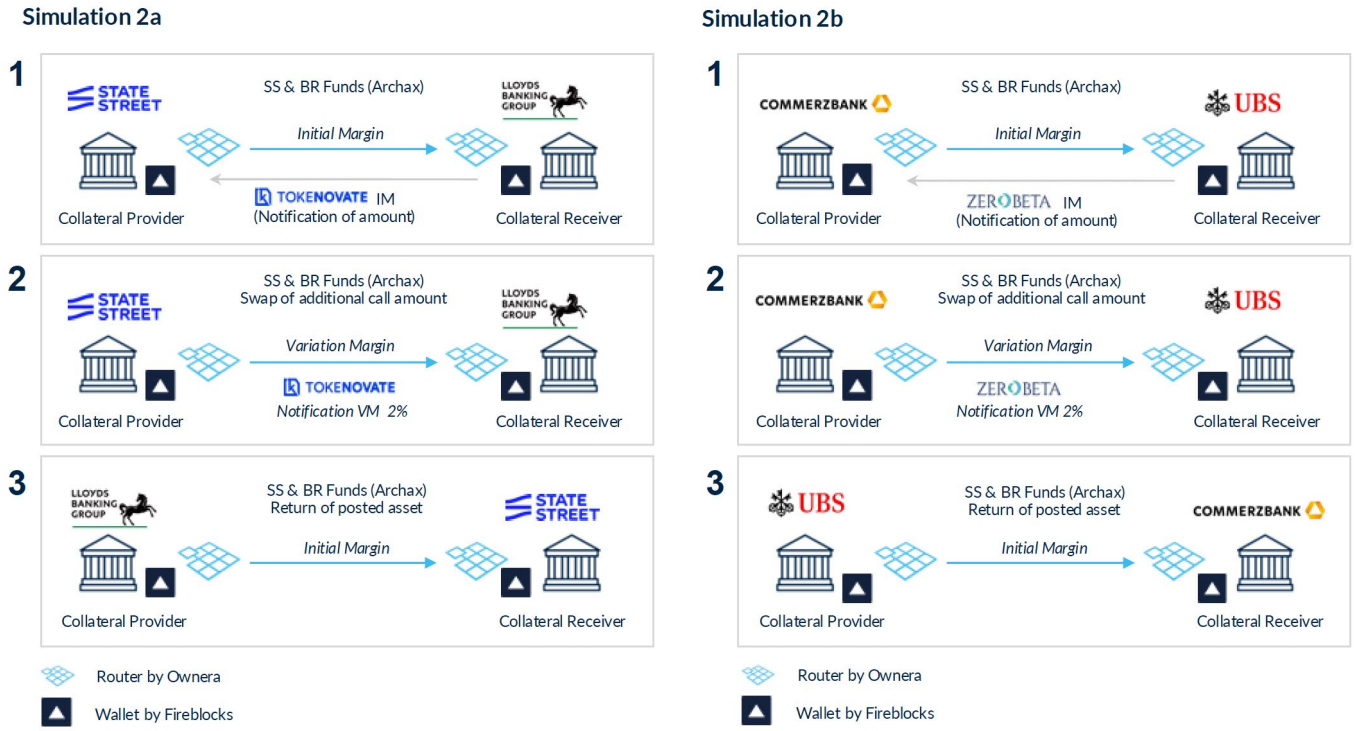

Figure 8 - Simulation 2: Integrated Margin Calls: Automated Posting via Third-Party Systems

What it does – Simulation 2 demonstrated an automated margin call workflow using third-party collateral management systems (Tokenovate and ZeroBeta) to calculate IM and VM requirements and trigger token transfers.

This simulation integrated the sandbox with a margin engine generating calls based on daily Mark-to-Market.

Key features - Fully automated margin call notifications and collateral movements – the system calculates exposure and instructs token transfers without manual intervention. External price feeds and margin calculators determine haircuts and the number of MMF units to post, eliminating manual coordination. APIs were used to automatically move tokens upon call issuance.

Why it matters - This simulation showed that tokenized collateral can be seamlessly integrated into existing collateral management infrastructure, bridging the gap between digital asset networks and traditional margining flows. It is a critical step toward full straight-through processing and scalability in using TMMFs for day-to-day margin calls.

By removing manual frictions, tokenization allows near-instant settlement of margin – avoiding delays from fund liquidation or wire transfers.

As an industry analysis noted, "collateral mobility is one of the killer use cases for institutional DLT", and integrating TMMFs with current systems validates that potential.[31]

[31] https://www.ledgerinsights.com/state-street-working-on-tokenizing-money-market-funds-as-collateral/

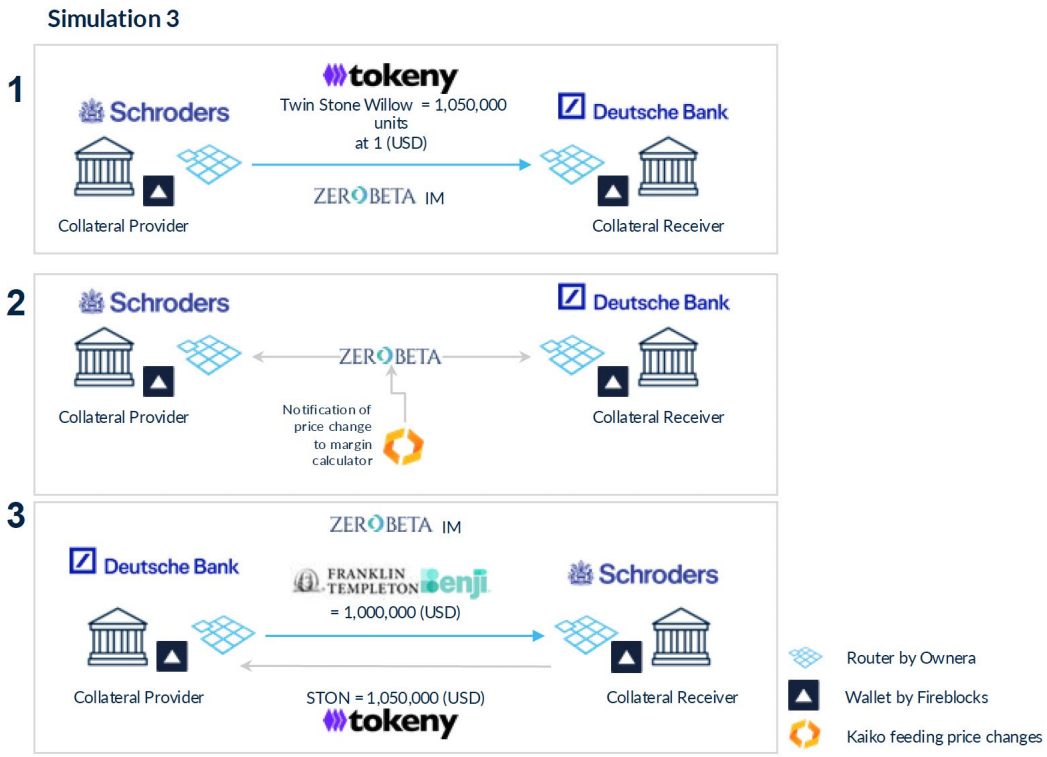

Figure 9 - Simulation 3: Depeg Event and Substitution: Dynamic Portfolio Management

What it does – Simulation 3 enacted a stress event wherein one posted MMF token "de-pegs" or drops in value (e.g. due to a market disruption in the underlying fund). In the test, a price feed from Kaiko was used to introduce a mock NAV drop for the token, causing its value to breach the haircut threshold. This triggered an automated substitution - the impaired fund is replaced with another eligible TMMF via a DvD atomic swap orchestrated by Ownera routers between wallets.

Key features - Real-time price oracle integration (Kaiko) to detect the NAV drop and alert the collateral receiver of a required top-up. Upon trigger, a DvD swap facilitated an exchange of the de-pegged fund tokens for a new fund across the two parties' all in one atomic transaction. The margin engine (ZeroBeta) generated an immediate report and new instructions for the substitution.

Why it matters - This scenario demonstrated the resilience and responsiveness of a tokenized collateral workflow to market events. In a traditional setup, such a fund value drop might require urgent calls and manual collateral substitution or cash funding; here it was handled automatically on-chain.

The test proved the operational feasibility of using DvD contracts for collateral substitution in a live environment, an essential mechanism to protect both parties' exposure. It also showcased practical interoperability between decentralized components (price oracles, smart contracts) and institutions' collateral processes, indicating that even complex margin events can be managed with minimal human intervention.

"We face many challenges in Europe with our fragmented settlement infrastructure to make T+1 happen. Solutions like this demonstrate that we could solve the need for cash on-ledger and help overcome some of these barriers across 22 CSDs and our currently prohibitively high intra-day liquidity demands. These experiments show that tMMFs deliver a highly liquid alternative that can be used as collateral for margin payments. Thus combining the interest payable benefits from MMFs with the ability to be used in-lieu of cash."

– **Andreas Biewald**
Managing Director, Senior Advisor Cash and Collateral, Treasury Department, Commerzbank

Simulation 4: Default Scenario – Enforcement and Recovery in Insolvency

What it does – Simulation 4 orchestrated a counterparty default during which the collateral provider fails to meet a margin call, allowing the collateral taker to enforce its rights on posted collateral. In the test, an Independent Collateral Custodian Platform (ICCP) was used to mimic an intermediary holding the pledgor's assets. The pledgor (Party A) is assumed to default on variation margin payment. The secured party (Party B) then unilaterally redeems the posted TMMF tokens to cover the exposure. Two variant methods were tested:

4a) Redemption into fiat (through normal fund processes), and
4b) Redemption into tokenized cash using a settlement token (in this case, USD cash tokens issued by Adhara/UBS, akin to a commercial bank digital currency prototype).

Key features - The default trigger caused an automatic freeze/close-out instruction via the margin router when the margin call wasn't met. The TA was notified to transfer legal title of the pledged MMF tokens fully to the secured party. In variant 4a, the secured party then redeemed the fund shares through the TA for cash proceeds (simulating a manual redemption request).

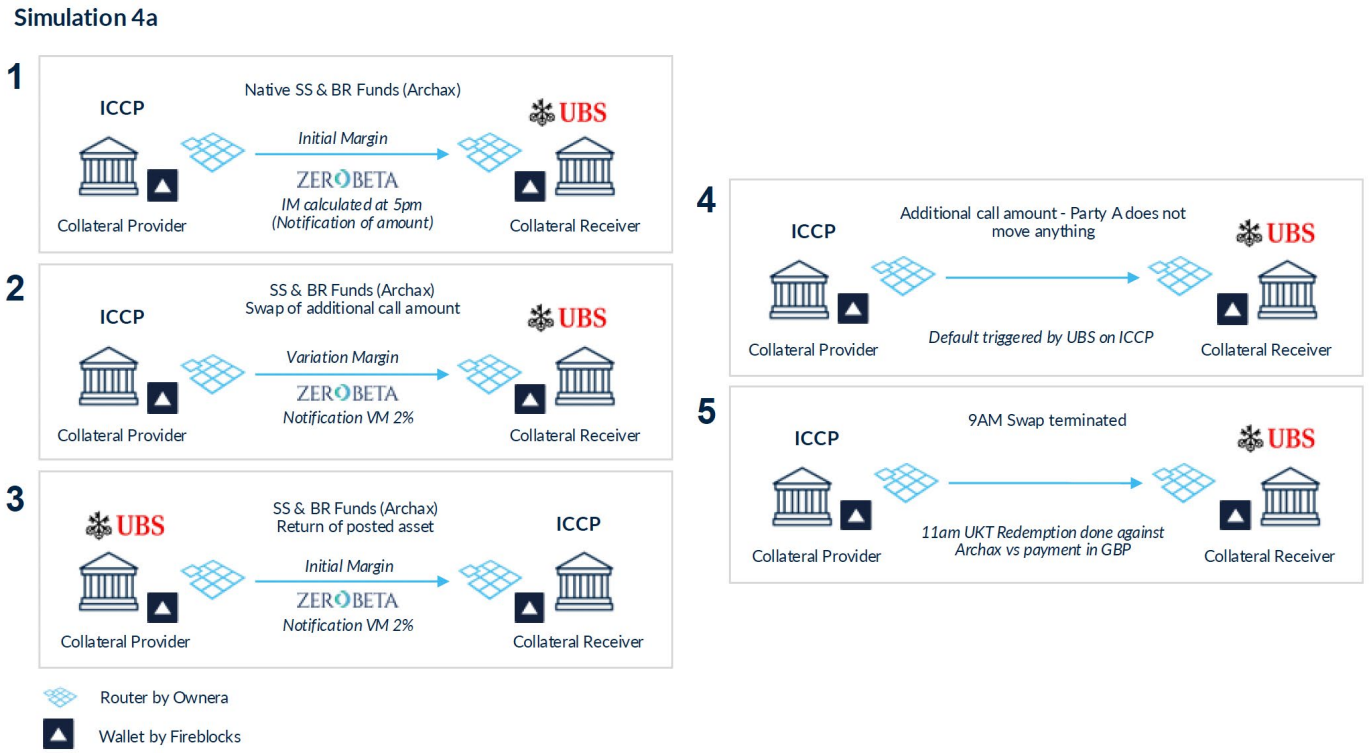

Figure 10 - Simulation 4a: Default Scenario: Enforcement and Recovery in Insolvency with Redemption into Fiat

In variant 4b, the fund platform interacted with the UBS deposit token network from Adhara to pay out redemption proceeds in tokenized bank money (which was received in Party B's wallet).

Why it matters - This was the most critical test from a legal enforceability standpoint. It demonstrated that a tokenized fund can be effectively seized and liquidated by a collateral taker even if the counterparty is insolvent or uncooperative. The successful unilateral redemption of the MMF tokens by the receiver proved the concept of "access on insolvency," one of the key legal hurdles identified by the framework.

Additionally, using a tokenized cash instrument (as shown in Figure 10) showed how settlement finality could be achieved on-chain with minimal friction. In essence, the sandbox default scenario gave practitioners and regulators comfort that enforcement mechanics in a DLT environment can mirror, or even improve upon, traditional methods, the process was instantaneous and transparent, with all actions auditable on the ledger.

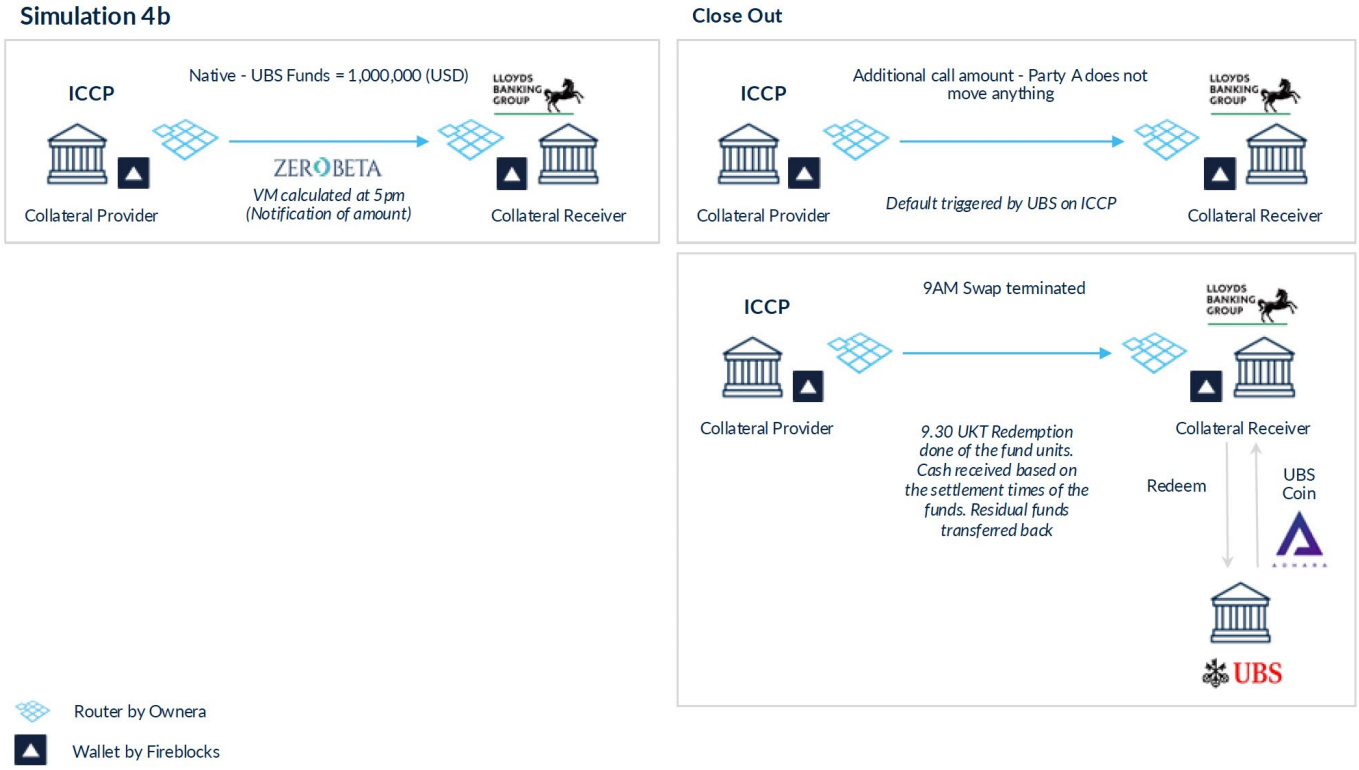

Figure 11 - Simulation 4b: Default Scenario: Enforcement and Recovery in Insolvency with Redemption into Tokenized Cash

Simulation 5: Funding of TMMF in Triparty

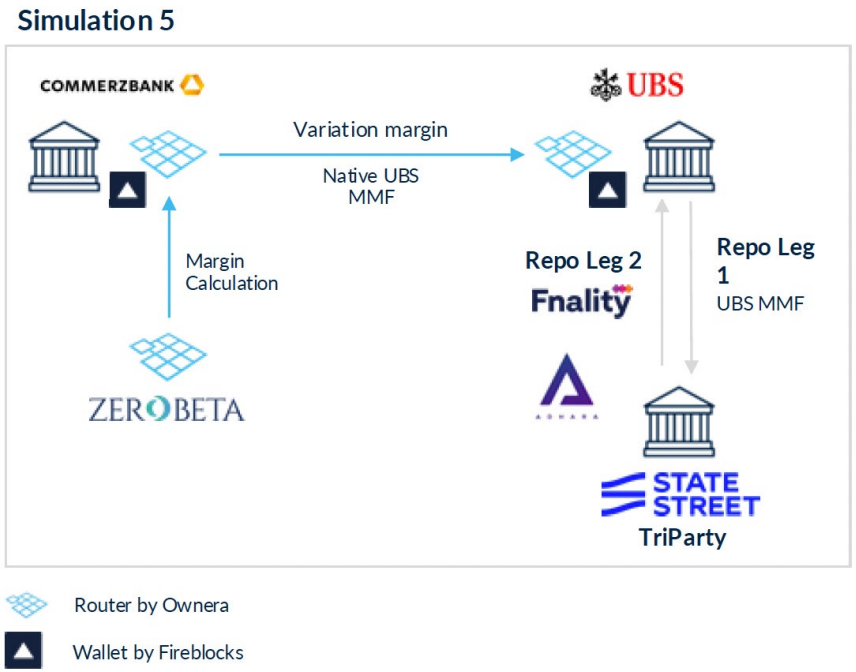

Figure 12 - Simulation 5: Funding of TMMF in Triparty

What it does - Simulation 5 tested the use of TMMFs within a tri-party repo structure. Commerzbank (Party A) posted variation margin to UBS (Party B). UBS then funded the MMFs through an intraday repo with State Street (Party C) for 10 minutes, using the USD Fnality Payment System ("USD FnPS" testnet) as the cash settlement leg utilizing funds held at a central bank account.

The repo was subsequently unwound (leg 2), returning the funds held in the USD FnPS testnet and reversing the financing. This demonstrated how TMMFs can be mobilized across both bilateral margin flows and tri-party repo infrastructure in real time.

Key features - The collateral provider was Commerzbank, with UBS acting as the collateral receiver and State Street serving as the tri-party agent. The workflow used Fireblocks wallets for secure custody and Ownera routers to orchestrate the token flows, while ZeroBeta performed daily margin calculations. Settlement was carried out using a USD FnPS testnet from Adhara as the cash settlement leg.

The collateral consisted of a Digitally Native UBS Money Market Fund with a 2% haircut, under fixed-to-floating swap terms, with margin calculated each day at 9am. The repo cycle involved UBS funding the MMFs in an intraday repo with State Street for ten minutes, before reversing the transaction and returning the tokens. The entire process combined bilateral variation margin, tri-party repo funding, and tokenized settlement into a fully integrated flow.

Why it matters - This simulation extended beyond bilateral collateral transfer to demonstrate integration with repo market infrastructure. It proved that TMMFs can be funded via intraday repos leveraging Fnality Funds fully backed by funds held at the central bank, which both preserves yield and enables liquidity without the need to redeem to cash. Settlement was compressed to minutes, showing the potential of tokenization to support real-time, 24/7 collateral flows.

By linking bilateral margining, triparty repo, and tokenized settlement rails, this test provided a blueprint for scalable, interoperable liquidity management. It also addressed systemic lessons from past crises by illustrating how tokenized assets could enhance resilience under stress while remaining compatible with existing tri-party repo frameworks.

Simulation 6: From SWIFT to Collateral Settlement in Seconds

What it does - This variation extended the infrastructure to link to legacy SWIFT based messages for margin management and FIX trading messages for Repo into the collateral movements. This showed how systems can evolve by using interoperability routers to connect old and new systems together.

This Simulation also linked in LSEG's Digital Settlement House (DiSH) infrastructure, provided on a dedicated Adhara test network, as the cash leg. Commerzbank executed various collateral movements with UBS using the Franklin Templeton and UBS Native funds and the Asset Backed Tokens from Archax on the Blackrock USD Funds.

Following this movement UBS and State Street then executed a real-time repo financing transaction of the pledged collateral using commercial-bank money tokenized on the DiSH ledger, which represents cash held in trust at participating commercial banks.

The workflow demonstrated that a TMMF can move from bilateral margin posting to triparty repo funding and settle in under one minute, even when

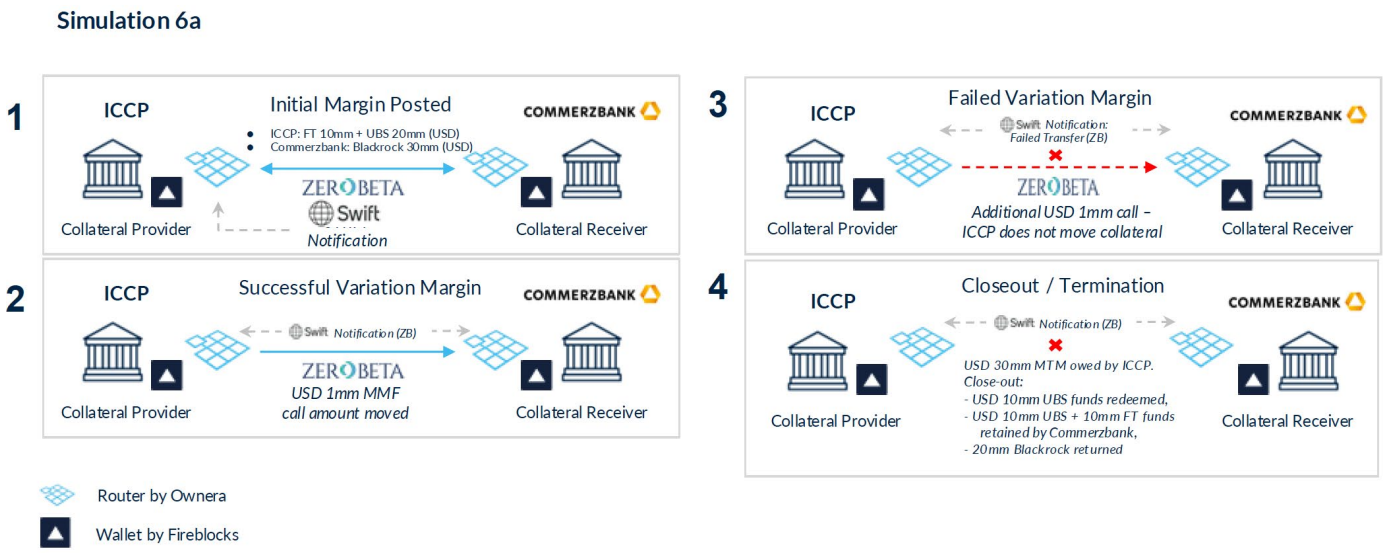

Figure 13 – Simulation 6a: From SWIFT Message to Collateral Settlement in under 1 minute

Simulation 6b

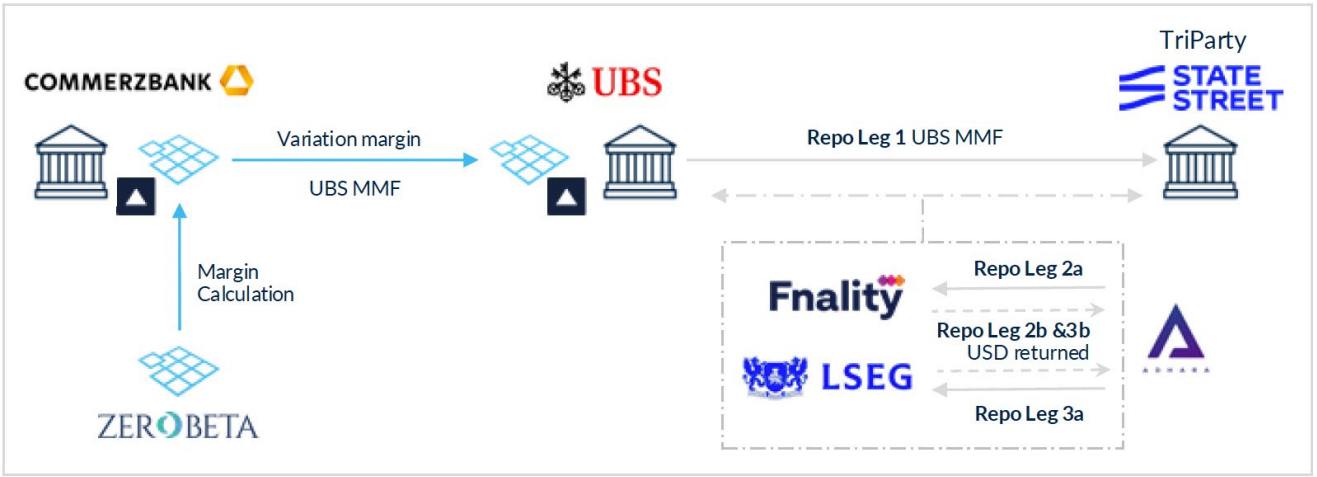

Figure 13 – Simulation 6b: The Future of Finance using Tokenized Cash against Tokenized Assets

the cash leg is digital commercial-bank money rather than central-bank reserves.

Key features - This simulation highlighted:

- **Legacy integration:** Initiated from a standard collateral management system and routed via Ownera's FinP2P network, proving compatibility with existing back-office processes
- **Digital cash settlement:** Utilized the DiSH ledger as a live proxy for LSEG-sponsored commercial-bank money, allowing instant, final settlement between UBS and State Street
- **Full repo lifecycle:** Included intraday funding, automated unwind, and return of collateral, all recorded on-chain with full auditability
- **Real-time orchestration:** End-to-end settlement completed in seconds, compared with the hours typical of current triparty workflows.

Why it matters - This test showed that tokenized collateral and digital commercial-bank money can interoperate with legacy collateral systems, creating a credible model for large-scale adoption of tokenized settlement.

It demonstrated how high-quality liquid assets, such as TMMFs, can be mobilized intraday without redemption to cash, cutting operational timelines from hours to minutes and reducing settlement-fail risk.

In the context of T+1 settlement pressures and rising intraday liquidity costs, this approach highlights a practical path for lower funding costs, reduced counterparty risk, and 24/7 liquidity, all within a regulatory framework familiar to global market participants. ■

> *"Hosting the GDF Industry Sandbox was a monumental collaborative effort, bringing together some of the best-in-class market participants, custodians, and technology providers from across the industry. The results highlight what's truly possible when we apply FinP2P and its DLT interoperability layer to collateral mobility and optimization. This isn't just about faster settlement; it's about enabling entirely new business models built on real-time liquidity and balance sheet efficiency. Incumbents should take notice of what's been achieved here, and we welcome the proactive steps some CCPs are already taking toward adoption."*
>
> – **Natasha Benson**
> COO & CFO, Ownera

6. SANDBOX FINDINGS AND POLICY RECOMMENDATIONS

a. Sandbox findings

Across six real-world simulations, the sandbox successfully demonstrated that TMMFs can function as effective, enforceable, and operationally integrated forms of collateral in bilateral derivatives transactions. Each simulation stress-tested different legal, operational, and commercial dimensions of tokenized collateral, yielding clear insights and areas for further refinement. These are summarized across six verticals outlined below.

- ***Operational Feasibility and Efficiency***

The simulations orchestrated in the sandbox demonstrated that posting a TMMF as margin can work end-to-end under current legal and operational frameworks under UK and EU law. There were no settlement failures or ambiguous title issues – each token transfer resulted in a legal title change recorded by the TA, satisfying custody requirements.

This result also highlighted the significant efficiency gains of using TMMF as collateral. Tasks that once might have involved faxes, emails, or manual entries (like substitution or recall of collateral) were handled through smart contracts and API calls, signaling the potential for wider industry adoption and benefits to be realized across operational processes and cost saving.

Simulation 2 highlighted that integrating DLT-based assets with existing collateral systems is achievable with minimal friction, paving the way for gradual adoption within current infrastructure thereby improving ROI profile for adopters.

- ***Risk Management and Resilience***

Sandbox participants raised concern with how tokenized collateral may behave in stress scenarios. Simulation 3 tested the system's ability to respond to this very kind of adverse market event.

The automated substitution workflow triggered by a real-time depeg scenario showcased how tokenized collateral can adjust dynamically, without interrupting trading or requiring manual margin calls as they would today in traditional systems.

By integrating price oracles and margin triggers, smart contracts enabled rapid - within minutes if not seconds - swap-outs of deteriorating collateral. This dynamic functionality introduces a new paradigm for real-time collateral risk management, fulfilling the promise that collateral mobility enables swaps of high-quality liquid assets amongst banks to maintain regulatory ratios.[32]

- ***Legal and Regulatory Alignment***

One of the most pressing questions in tokenized markets is whether novel digital assets can comply with longstanding legal frameworks. Simulation 5 tackled this directly by simulating a default scenario in a proof-of-concept environment, demonstrating that enforcement and recovery are possible on-chain in a way that is in line with English law principles for title transfer collateral.

The TMMFs were enforced without ambiguity: the fund shares could be seized and redeemed without the defaulter's consent, and with clear audit trails.

The simulation provided tangible evidence that, when the fund register is properly maintained and the token is well-structured, TMMFs can behave like any other title-transfer asset - satisfying the standards regulators, custodians, and insolvency courts require. This reinforces that tokenization need not introduce new legal risks if the structures those already in use and the property rights underpinning the assets in question.

- ***Interoperability of Legacy and Digital Infrastructure***

A recurring concern in the adoption of tokenized assets is the fear of "rip-and-replace." Market participants are understandably hesitant to abandon complex infrastructure built over decades. The sandbox dispelled this fear by showing how TMMFs can integrate into current architecture, leveraging Ownera's FinP2P routers, which provides a low-risk environment for the system transformation needed to capitalize on the benefits of tokenized assets.

[32] https://www.ledgerinsights.com/state-street-working-on-tokenizing-money-market-funds-as-collateral/

For example, margin calls were generated from ISDA CDM-based analytics and fed into DLT actions, whilst, fund administration platforms cooperated with on-chain token contracts. Moreover, the project demonstrated that a gradual integration model is workable – e.g. a bank's existing collateral management system can plug into a token network via APIs, and a TA can update records via a node on a blockchain.

As such, the sandbox has successfully provided a blueprint illustrating how legacy systems (custodians, payment networks, etc.) can co-exist and interoperate with tokenized assets and systems. Rather than fragment operations or introduce parallel workflows, digital assets can plug into the established plumbing, preserving oversight, auditability, and process integrity.

- ***Collateral Value Proposition: Yield and Liquidity***

TMMFs offer qualities that are hard to replicate with other kinds of assets in the collateral use case (e.g. cash and stablecoins). They accrue higher yield making them a more attractive form of posted collateral, particularly in a high-interest rate environment.

Compared to stablecoins, MMFs are regulated and well understood fund structures and therefore arguably more suitable candidates in capital markets use cases, as indicated in a recent Standard Chartered article noting that TMMFs are "more attractive to hold for long periods than stablecoins, and a better form of collateral because they actively generate income".[33]

For risk committees and operations teams, this familiarity makes adoption easier as it's not a new asset class, it's a new format for a trusted one. In traditional workflows, MMFs often need to be redeemed to meet liquidity needs, which incurs delays and potential pricing risk.

In tokenized form, however, they can be settled instantly while continuing to accrue value. These dual benefits - yield and liquidity - are especially attractive to collateral takers, enabling more efficient balance sheet management and potentially reducing reliance on costly repo or cash-only margining solutions.

- ***Market Momentum and Alignment: TMMFs in Live Market Environments***

The outcomes from the sandbox dovetail with developments in the market. TMMFs are no longer a concept they are being used in real trades.

JPMorgan's Kinexys platform piloted the use of a BlackRock TMMF as collateral in a derivatives transaction with Barclays.[34] Most recently, Goldman Sachs and BNY announced the launch of a TMMF solution allowing BNY to maintain a record of customer's ownership of select MMFs leveraging Goldmans Sachs' Digital Asset Platform.[35]

In April 2024, Archax executed the first multi-million-pound transaction in tokenized BlackRock MMF shares using Ownera's FinP2P network and demonstrating that the infrastructure tested in the sandbox is already in production.

Elsewhere, crypto-native platforms such as Deribit has begun accepting TMMFs as collateral, reflecting demand from a different segment of the market.

These examples reinforce that tokenized funds can deliver the best of both worlds. They retain the trust and stability of traditional assets while unlocking the transferability, transparency, and automation of digital infrastructure.

The sandbox has been able to help bring that claim to life across a broader pool of market participants with real-world evidence, offering a viable blueprint for how the market can scale developed in a structured test environment that supports these live efforts with the legal, operational, and regulatory rigor to help advocate for use case at scale.

[33] https://www.sc.com/en/news/corporate-investment-banking/tokenized-money-market-funds/#:~:text=But%2C%20as%20with%20stablecoins%E2%80%99%20stability%2Ca%20higher%20interest%20rate%20environment

[34] https://www.ledgerinsights.com/state-street-working-on-tokenizing-money-market-funds-as-collateral/

[35] https://www.goldmansachs.com/pressroom/press-releases/2025/bny-goldman-sachs-launch-tokenized-money-market-funds-solution

b. Policy recommendations

With no fundamental blockers identified across legal, operational, or regulatory dimensions, the sandbox has demonstrated that TMMFs can transition from a theoretical use case to a production-ready collateral instrument. Alongside these findings, a series of recommendations is offered to better support firms exploring similar solutions and a reference point for policymakers:

1. Clarify and Confirm Legal Recognition of Digitally Native Transfers under Existing Frameworks

Regulators and policymakers should consider issuing guidance to confirm that digitally native tokenized fund units, when properly structured and recorded through a TA or authorized register, can meet the legal standards of title transfer, settlement finality, and custody under existing regimes.

Particular emphasis should be placed on the role of the TA or registrar in establishing legal continuity between on-chain transfers and fund ownership records. This clarification would provide market participants with the confidence needed to scale adoption while ensuring alignment with established legal principles.

- **Action 1.1: Create Standardized Legal Documentation.** In collaboration with industry bodies such as ISDA, develop standardized, robust legal documentation and templates for title transfer and security interests for TMMFs. This will streamline legal due diligence and reduce the bespoke, bilateral legal work currently required for each new tokenization pilot, making the process repeatable and scalable.

- **Action 1.2: Produce a Cross-Border Legal guide.** The industry should collaborate to improve market confidence in cross-border legal treatment of TMMFs across key jurisdictions, with an aim to produce a cross-border guide. This would clarify the legal status of tokens as commonly recognized financial instruments, provide guidance on lex situs and the governing law for digitally native tokenized fund units (including in the context of current ongoing conflicts of laws legal consultations) and cross-border treatment on insolvency.

- **Action 1.3: Secure Formal Legal Opinions.** The industry should, in collaboration with national and regional regulators and private law firms, obtain explicit legal opinions and confirmations. This would affirm that the transfer of a token, representing a beneficial interest in an MMF, constitutes a valid and legally binding transfer of the underlying asset without altering its legal character.

2. Encourage Interoperability with Existing Collateral and Custody Systems

Tokenization initiatives should prioritize integration with existing infrastructure rather than full system replacement. The sandbox has demonstrated that TMMFs can plug into current collateral management systems, risk engines, and fund administration tools through API-based connectors and smart contract integrations. Implementing an industry-developed digital data standard, such as the Common Domain Model, will help firms bridge their current legacy systems and workflows to new natively digital streamlined systems.

- **Action 2.1: Leverage industry-developed data standards and models.** Encourage the widespread adoption of industry-developed and agreed data standards and models. For instance, the CDM for on-chain collateral workflows can be leveraged. It is a standardized data model ensures that collateral data - including valuation, haircuts, and eligibility - is machine-readable and interoperable across different DLT platforms, legacy systems, and participants' internal risk engines.

ISO standards for asset, token, and entity identification with ISINs, DTIs, and LEIs respectively can also be utilized. While ISINs and LEIs have long supported the exchange of asset and entity information in traditional collateral flows, the DTI enhances precision by providing unambiguous token identification linked to a specific asset and issuing entity.

- **Action 2.2: Leverage Connectivity Through Proven APIs.** The GDF Industry Sandbox (powered by FinP2P, the interoperability layer of the sandbox) has demonstrated that seamless, secure, and standardized connectivity between legacy systems, custodians, and distributed ledgers is achievable today. Institutions can connect existing collateral management and risk systems to multiple DLT networks through a single, interoperable API layer.

Rather than developing fragmented, bespoke integrations, market participants should now focus on cross chain interoperability layers that allow tokenized collateral data to flow in real time, enabling continuous intraday risk management, reporting, and settlement. This approach builds on what has already been proven in the sandbox - instant collateral movement, SWIFT-to-DLT integration, and multi-institution orchestration - and provides a scalable path to production adoption.

- **Action 2.3: Adopt a Standardized Cross-Chain Communication Framework.** The sandbox simulations have demonstrated that cross-chain asset movement and collateral substitution are viable today through interoperability layers such as FinP2P. This framework enables a TMMF issued on one ledger to be used seamlessly as collateral or funding on another - connecting Ethereum, permissioned ledgers, and custodian environments under a single protocol.

To ensure this capability can be scaled consistently across markets, the industry should now move toward formalizing a standardized interoperability layer - building on proven frameworks like FinP2P - as the foundation for tokenized collateral and liquidity management.

Establishing this standard would ensure that collateral mobility is not confined to a single technological ecosystem, but instead operates across DLTs, custodians, and settlement networks, realizing the promise of a truly connected digital market infrastructure.

3. Facilitate the Use of TMMFs under Existing Eligible Collateral Regimes

Further clarification which would enable tokenized versions of UCITS - and LVNAV/CNAV-compliant MMFs - where the token does not materially alter the risk profile - to be treated as eligible collateral under existing regulatory frameworks (e.g., EMIR, CRR), would be welcomed by industry. This would reduce uncertainty for receiving parties and prevent the fund tokenization process from unintentionally triggering higher haircuts or risking poor rating assessments.

- **Action 3.1: Seek Formal Regulatory Guidance.** Engage with regulators to secure a formal statement or guidance that the act of tokenization, in itself, does not change the eligibility of an asset for use as collateral under existing regulatory frameworks. This is a critical step in providing confidence to market participants that they can leverage TMMFs without regulatory friction.

- **Action 3.2: Align with Supervisory Reporting Requirements.** Ensure that any TMMF framework facilitates and streamlines compliance with existing supervisory reporting requirements. This could include demonstrating how the transparent, auditable nature of DLT can be used to improve supervisory reporting by providing regulators with a more accurate and timely view of systemic risk, reducing the burden on firms to provide manual, end-of-day reports.

- **Action 3.3: Develop Standardized Operational Playbooks.** Establish clear, shared governance protocols for DLT-based collateral systems. This includes creating standardized playbooks for key operational scenarios, including margin calls, collateral substitution, and default management. These playbooks should detail the automated and manual steps required, ensuring that all participants can respond to market events in a predictable and coordinated manner.

4. Encourage Market Adoption and Scalability across Firms

The ability to achieve broad adoption across issuers, collateral pledgers and receivers is critical. Current market capacity is limited by the number of TMMFs and the lack of harmonized collateral eligibility standards. Overcoming these constraints is essential to develop a scalable, liquid and interoperable market for TMMFs as collateral.

- **Action 4.1: Incentivize Issuers of Digitally Native MMFs.** Encourage a broader range of fund managers to issue digitally native MMFs. This can be achieved by highlighting the operational and capital efficiencies of the on-chain model, providing a clear legal and regulatory roadmap, and establishing a collaborative environment where legal and technical questions can be addressed.

- **Action 4.2: Develop Harmonized Eligibility Criteria.** Industry participants, led by major collateral takers, should collaborate to develop a set of harmonized eligibility criteria for TMMFs. This would go beyond legal and regulatory requirements to include operational and technical standards. A standardized approach would provide certainty to all market participants, increase the pool of eligible collateral, and improve market liquidity.

- **Action 4.3: Establish an Industry Testbed.** Building on the success of the GDF Industry TMMF Sandbox, establish a permanent, collaborative, multi-platform testing environment. This testbed would allow market participants to stress-test new TMMFs and workflows in a controlled, neutral environment before moving to production. This will facilitate the development of shared operational frameworks, risk management practices, and technical standards, leading to broader adoption.

These recommendations reflect the practical insights gained through the research and analysis, and the sandbox live testing, and are intended to inform both policy dialogue and industry implementation.

As the digital asset ecosystem evolves, TMMFs represent a tangible, near-term opportunity to modernize collateral markets without compromising on regulatory certainty or operational resilience. The stage is now set for further innovation and continued collaboration between regulators, fund managers, and infrastructure providers will be essential to translate this proof of concept into scalable, production-ready models. ■

> *"Testing the legal certainty of digital assets and demonstrating real production use cases is a time that has arrived for the global securities industry. This outstanding working group demonstrated it could engage the world's best TradFi and digital Financial Market Infrastructure (dMFI) firms to collaborate and demonstrate to the whole of the industry and its regulators that digital finance has truly arrived,"*
>
> – **Lawrence Wintermeyer**
> GDF Members Board Chair

APPENDICES

APPENDIX A - Building a framework for analyzing tokenized collateral

a. Scope and assumptions

The WG set out to create a framework to enable the evaluation as to whether TMMFs could meet the legal and collateral eligibility requirements set out by receiving parties in a sandbox environment where real life use cases could be piloted.

This analysis focused on the application of TMMFs as variation margin collateral in bilateral derivatives transactions, where collateral is located[36] in England & Wales, Ireland or Luxembourg and exchanged pursuant to ISDA title transfer CSAs governed by English law.

The central question was not whether the underlying fund was eligible in principle - as certain firms already accept MMFs under current CSA frameworks - but whether and how tokenization affects that eligibility in practice.

The objective was to test whether tokenization changes the collateral's legal, regulatory, or operational treatment in a way that could impair its eligibility or create uncertainty. In particular, the analysis is framed around three dimensions critical to adoption:

- **Legal considerations (including legal certainty):** whether the legal structure underpinning a TMMF provides for certainty of legal treatment and allows for the valid issue and recognition of the tokens (including the rights intended to be associated with them), enables transfer, taking security and realization of rights under insolvency scenarios and cross-jurisdictional conditions

- **Access on insolvency:** whether a TMMF can provide a legally recognized interest in the MMF and ensure the rights of the parties (including crucially, the collateral taker) are certain, enforceable and cannot be contested in an insolvency scenario

- **Receiving party eligibility criteria:** whether TMMFs can be reliably issued, transferred, redeemed, and settled across market infrastructure, including custody, clearing and collateral management platforms, meeting market participants' commercial and regulatory requirements.

To maintain focus and ensure comparability across use cases beyond MMFs, the following key assumptions were adopted:

- MMF listed as eligible collateral within a CSA between two counterparties if it meets predetermined requirements
- The fund is structured as a UCITS-compliant short-term MMF, typically LVNAV or CNAV, domiciled in the UK or a European jurisdiction (e.g., Ireland or Luxembourg)
- The analysis is limited to title transfer variation margin (VM) posted in bilateral uncleared transactions, rather than initial margin (IM) or cleared margining, (and does not cover "taking security" over tokenized collateral)
- Only tokens representing interests in open-ended funds (i.e., redeemable at NAV) are considered.

This scope intentionally excludes broader questions around token issuance mechanics, investor onboarding (e.g., KYC/AML), and fund distribution, except where directly relevant to legal certainty and enforceability, or eligibility in a collateral context.

The scope of this initiative was also limited to title transfer VM based on current practice in the UK and issues related to control signaled from banks participating in the sandbox. Concern was raised around the additional complexity associated with both IM and security (where a number of other considerations would have to be taken into account), likely increasing the barrier to entry for many participants.

[36] This refers to both the issuer of the TMMF and the TMMF itself.

b. A working definition of tokenization

Tokenization, in the context of MMFs, refers to the issuance of a digital representation of a redeemable interest in a fund on a distributed ledger. Regardless of the technical implementation, an MMF within the scope of this paper remains a regulated UCITS fund.

This means that, under current legal and regulatory frameworks in respect of the jurisdictions in scope of this project, its official register of ownership must be maintained by a regulated entity, typically a transfer agent (TA) or registrar.

Thus, the transfer of legal title to fund units is not necessarily conferred by token ownership alone, unless the register is updated to reflect the transfer of the token representing the fund unit. Tokenized models must therefore ensure that register maintenance, legal recognition, and regulatory compliance are preserved - even as the infrastructure evolves.

To help navigate the diversity of tokenization models observed in the market and the sandbox, the decision tree in Figure 8 below distinguishes TMMF structures based on the role of the TA.

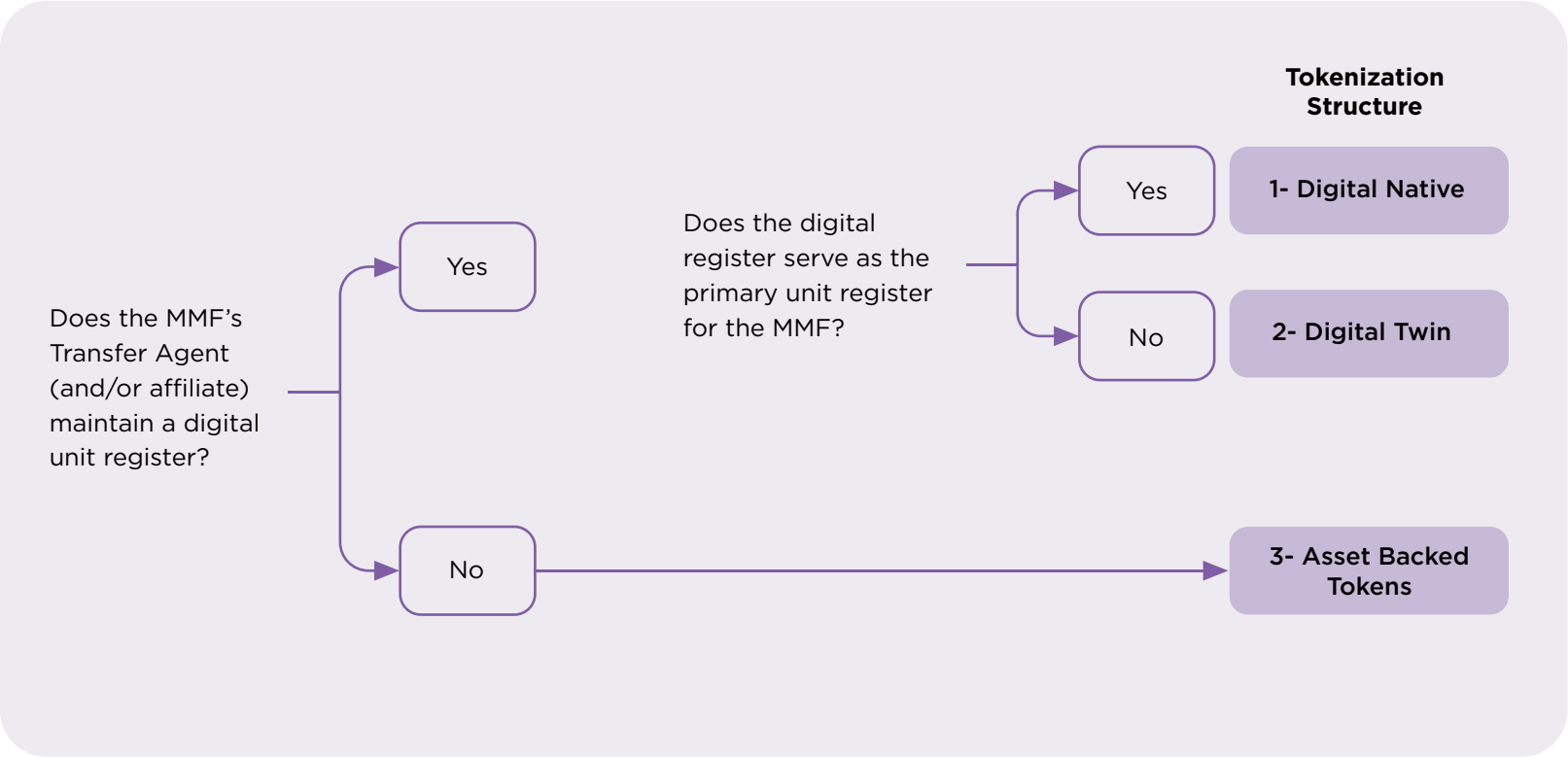

Figure 7 - MMF Tokenization Structure Decision Tree

The first decision point outlined in Figure 1 considers whether the TA (or an affiliate within its group) maintains a digital unit register and the logic follows as such:

1. **If the TA does maintain such a register, is this register serving as the primary unit register for the TMMF:**
   a. If yes, the model falls within the "digitally native" category.
   b. If no, it is categorized as a "digital twin."

2. **If the TA does not maintain a digital register at all, the structure is considered an "asset backed token."**

This decision tree process has served as the base for understanding the three viable tokenization structures to be utilized in the sandbox.

These structures are present in the sandbox, examples of which can be found in the market today, illustrated below. The three tokenization structures, each have unique properties with respective legal, regulatory and operational considerations which are analyzed in the following sections.

Table 4. Tokenization Structures Characteristic Overview

Tokenization Type	Key Characteristics	Examples in the Market
Digitally Native	• Fully dematerialized issuance, no traditional underlying or connected asset. • TA's on-chain register is the primary legal record (noting that the concept of primacy is key, even if it would be anticipated that off-chain data is also required to be maintained). • All ownership and rights are on-chain.	• Franklin Templeton's Franklin OnChain US Government Money Fund (FOBXX), which is represented by BENJI tokens. ISIN: LU2900381208, DTI: 160MQCRQ4 represents Franklin OnChain US Government Money Fund on Stellar.
Digital Twin	• Uses traditional underlying fund interests / shares (could be certificated / uncertificated, with traditional register / TA). • Nominee becomes a shareholder entered on the traditional register and that nominee layers on a DLT interest-holder register, to record holders of tokenized shares. • Mirrored service providers, terms and rights that apply to trad and tokenized versions, as much as possible.	• Calastone
Asset Backed Tokens	• Uses traditional underlying fund interests / shares (similar to the digital twin) • A third-party intermediary / custodian / SPV acquires underlying, intermediary issues a token that contains rights linked to that underlying. • Legal rights not mirrored (even if features, like liquidity, are intended to be) – legal nature of token may be different to holding the underlying.	• JPM TCN Custodial Wrap • Archax / Lloyds / Aberdeen (ISIN: LU0966092131, DTI: RBFBLQJD3 represents this asset on Algorand) • BNY/GS

c. Impact of legal Form on collateral use

Why Legal Structure Matters

For any tokenized asset to be accepted as collateral under standard legal and regulatory frameworks, its legal structure must be clear, enforceable, and compatible with existing collateral documentation and applicable regulatory frameworks. This is especially true under standard CSA arrangements, where enforceability, title transfer, and rights on insolvency are paramount. Specifically, it influences:

- **Legal Title Transfer**

  In a standard ISDA title transfer CSA arrangement, title to collateral must be capable of being transferred with full legal effect such that all right, title and interest to the collateral vests in the collateral taker free and clear of any liens, claims, charges or encumbrances or any other interest of the collateral provider or of any third person (other than a lien routinely imposed on all securities in a relevant clearance system)

  If the token does not itself constitute a valid legal interest in the MMF (or give rise to the relevant rights intended as a result of the structure e.g. due to poor linkage with the fund's register of ownership interests in the fund, in the case of the digital twin or asset-backed tokenization structures), transfer of the title to the underlying fund interest (or the entitlement to the relevant rights in respect of fund interest) may not be valid or legally effective, meaning that the collateral taker will not be effectively collateralized

  There will also be additional legal considerations around the constitution of valid legal rights and enforceability, the precise nature of which will depend on the particular structure of the TMMF, including any formality requirements arising under applicable law[37]

- **Recognition by Custodians, Agents, and Regulators**

  Market infrastructure providers such as custodians, tri-party agents, and regulations applicable to market participants require collateral to meet recognized legal and operational standards. If the legal form is non-standard (e.g., synthetic exposure with no underlying title) or does not give rise to a valid entitlement to the MMF (as explored above), these entities may refuse to hold or process the asset as collateral

- **Eligibility under Internal Policies and Prudential Frameworks**

  Even where legal transfer is theoretically possible, banks and institutional counterparties often have internal eligibility criteria tied to asset class, legal considerations including legal certainty, settlement process, regulatory treatment (including, eligibility as regulatory margin and regulatory capital treatment). It will be important to ensure that the TMMF is structured in order to receive the equivalent regulatory capital treatment as a non-tokenized MMF[38] and also that the TMMF constitutes eligible collateral under EMIR[39]

- **Treatment on Default or Insolvency**

  In the event of a default or insolvency, the collateral taker must be able to realize the collateral without legal challenge. If the token does not reflect a legally recognized interest in the asset it purports to represent, then the rights of the collateral taker may be uncertain, contested, or unenforceable.

In short, even if a TMMF is technologically functional, it must align with legal form expectations to be viable in a collateral use case.

[37] Additional detail on these matters is set out in the section on "Legal Considerations" below.
[38] Currently, this would mean falling within group 1a of the Basel Committee on Banking Supervision's Cryptoasset Standard.
[39] The European Market Infrastructure Regulation, (EU) No 648/2012

Table 5. Candidate Legal Structures Overview

Mapping to Tokenization Structure	Legal Structure	Description	Option
Digitally Native	Digitally native (registered) share	Fund issues dematerialized units directly on-chain; the TA's on-chain register will be primary evidence of the holders' rights and transfers of TMMFs is affected by updating records using smart contracts.	1
Digital Twin	Evidence of Title (Shadow)	Simple cryptographic receipt: full legal title stays on the traditional paper register, the DLT will merely be evidence of title.	2
	Beneficial Interest Trust (Nominee)	Intermediary (TA or affiliate) holds legal title to token and provides self-custody wallet so that the customer controls private key enabling control of that token. Customer holds an equitable beneficial interest in the token.[40]	3
Asset Backed Tokens	Custodial Account Arrangement	Custodian is registered owner of underlying MMF interest (which could be tokenized or traditional), it maintains DLT-based account records reflecting allocation of underlying amongst account holders. Depending on jurisdiction and terms governing the custody arrangements, customer may be the beneficiary of a custodial trust or have an unsecured contractual claim against the custodian.	4
	Third-Party Nominee - Beneficial Interest Trust	External nominee (not TA group) is shareholder of record and maintains DLT sub-register. Customers hold an equitable beneficial interest in the nominee's shareholding which would constitute the TMMF.	5
	Depository Receipt (ADRs/GDRs)	Depository bank issues DR-style tokens backed by locked fund units. Customer holds the tokenized DRs which are financial instruments.	6
	Pooled Investment Vehicle	SPV (e.g. Cayman segregated portfolio) aggregates shares; issues passthrough tokens.	7

[40] Other nominee and beneficial interest type arrangements may potentially be used. This is a summary of an example.

The categorization of legal structures presented above provides a foundation for assessing the collateral readiness of TMMFs.

To ensure the analytical output could serve as a decision-support tool for sandbox participants, and broader industry pilots, the WG engaged directly with the receiving banks involved in sandbox simulations.

These institutions provided detailed feedback on the attributes they considered most important when evaluating tokenized assets for use as collateral. Across these discussions, three core dimensions emerged as critical to determining whether a TMMF could be accepted in practice:

- **Legal Considerations (including legal certainty):** Can legal title to the fund interest (or ownership of the relevant rights intended as a result of the TMMF structure) be established with confidence? Can title be transferred in connection with use of the assets as collateral (in particular, through interaction with an English law governed CSA), and can relevant legal rights be enforced with clarity across jurisdictions? Is it clear which law applies to govern that transfer?

- **Access on Insolvency:** Will the collateral taker have reliable access to the fund interest in the event of default, insolvency/ administration of the collateral provider, any intermediary (if applicable) or the MMF (or the issuer of the MMF, if the MMF does not itself have separate legal personality)?

- **Receiving Party Eligibility Criteria:** Does the TMMF meet the commercial and regulatory criteria set out by parties in the CSA agreement?

While a traditional MMF may already satisfy many of these requirements, the tokenization process introduces new considerations that must be evaluated on a case-by-case basis. The frameworks set out in this paper have been developed collaboratively across legal, operational, and regulatory experts within the WG.

APPENDIX B - PDARF insights into TMMF ratings

Recognizing structure-dependent frictions of TMMFs, the research explored whether a complementary analytical tool such as holistic risk-based digital asset ratings could address gaps not covered by traditional credit ratings.

The goal was to evaluate whether such ratings could provide useful insights to management decisions aligned with the distinct and layered eligibility concerns raised by receiving parties. These include the impact of tokenization on regulatory look-through and risk attribution, the reliability of NAV and liquidity verification through on-chain and off-chain mechanisms, as well as the enforceability of rights during collateral events such as substitution or insolvency.

Notably, such dimensions typically fall outside the scope of conventional fund ratings, necessitating a dedicated framework to capture tokenization-specific risks.

To this end, an analysis deployed Particula's Digital Asset Risk Framework (PDARF) which introduces a systematic approach to evaluating tokenization-specific risks beyond the underlying asset.

An overview of how the PDARF provides additional insights into TMMF ratings

Tokenization transforms core product features by embedding ownership, governance, and transaction logic into smart contracts facilitating automated issuance and redemption, oracle-dependent NAV updates, and on-chain compliance mechanisms.

This transformation necessitates a framework capable of capturing risks introduced by design, infrastructure, or governance choices. PDARF addresses this by synthesizing fragmented on-chain and off-chain information such as governance rules, smart contract functionality, legal documentation, and operational attestations into a structured evaluation.

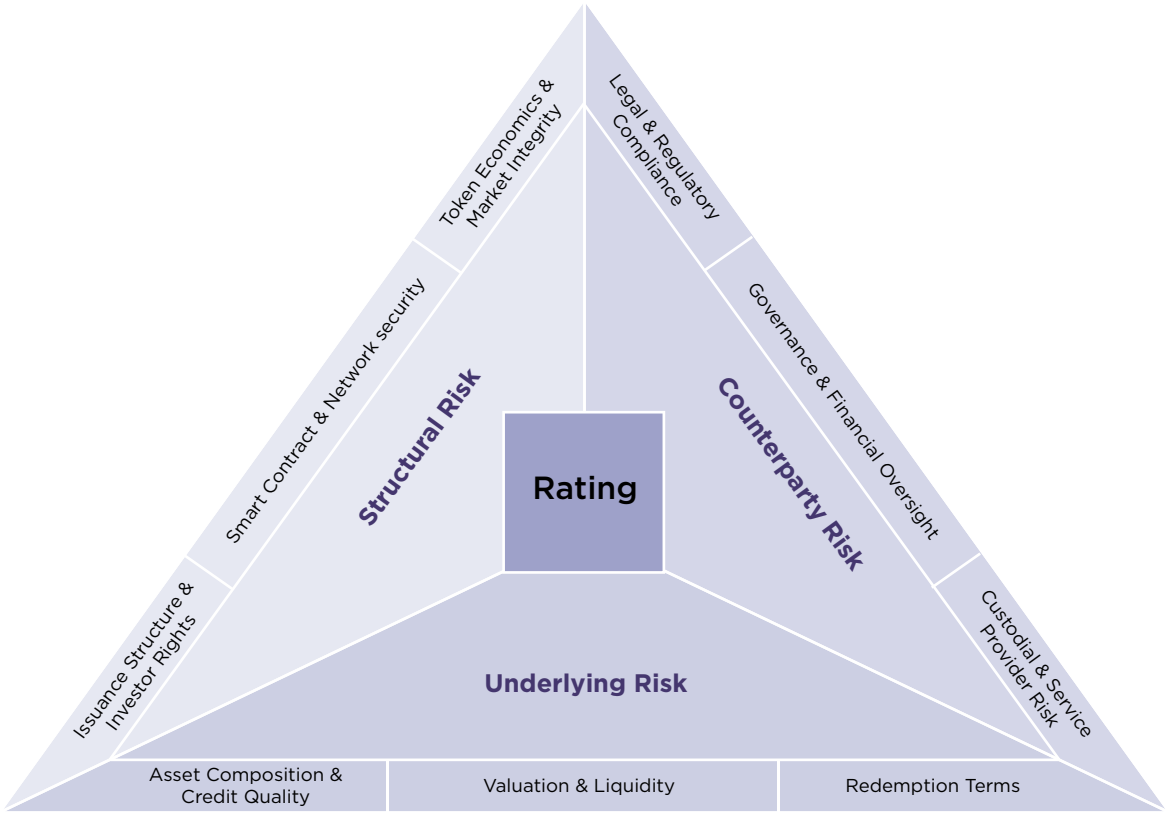

Figure 8 - The PDARF Framework

PDARF is built upon three analytical pillars:

i. Counterparty risk,
ii. Structural risk, and
iii. Underlying risk.

Each pillar draws on more than 100 distinct indicators spanning smart contract permissions, wallet concentration, oracle design, governance models, legal agreements, and audit practices. These indicators are organized into nine risk clusters, enabling transparent scoring and cross-comparison across a diverse range of tokenized fund structures.

This methodology was applied within the sandbox environment to demonstrate how risk-based digital asset ratings can generate actionable insights for receiving parties.

In this context, Particula GmbH, a specialized digital asset rating provider, assessed the BlackRock ICS US Treasury Fund token, issued and distributed by Archax on the Hedera Hashgraph blockchain ecosystem.

Given the controlled and exploratory nature of the sandbox environment and the token's design as a permissioned entitlement instrument, specific methodological exemptions were applied where data availability was constrained. These constraints arose either from structural characteristics of the issuance or were offset by regulatory safeguards.

Subject to the constraints described above, Particula assigned an indicative AAA rating to the issuance of the BlackRock ICS US Treasury Fund token issued and distributed by Archax, a UK-based digital asset exchange and custodian authorized and regulated by the Financial Conduct Authority (FCA). The token provides indirect exposure to a short-duration government MMF through a nominee-based, asset-backed structure.

The rating reflects strong risk mitigants across legal, structural, and operational dimensions, which collectively support a very low probability of impairment. These features also address core eligibility considerations raised by receiving parties, as outlined below:

- **FCA-Regulated Infrastructure and Custody Pathways:** Archax is licensed by the UK FCA for custody, exchange, and brokerage activities. Tokenholder claims are contractually mapped through Archax Nominees Ltd., a legally segregated entity subject to the UK Client Assets Sourcebook (CASS) regime.

Legal enforceability is supported through a Master Services Agreement, with investor entitlements reconciled to the fund's official register. This structure establishes a verifiable and enforceable claim path, even in the event of issuer insolvency.

- **Institutional Operational Controls:** The operational framework relies on native tokenization and internal governance processes such as manual approval workflows, client asset oversight, transfer restrictions, and wallet-level safeguards. These FCA-regulated internal operations incorporate requirements related to cyber security risk management, operational resilience, vulnerability testing, incident response planning, and data security – all in line with the FCA Handbook SYSC framework -and, where applicable, the Senior Management Regime.

  Collectively, these measures mitigate risks around unauthorized transfers and support institutional custody standards. In addition, the presence of formally documented Business Continuity and Disaster Recovery Plans provides assurances regarding operational continuity and settlement predictability.

- **Strong Adherence to Compliance and Risk Frameworks:** Archax implements a comprehensive AML/CTF framework. The framework incorporates risk-based KYC protocols, sanctions screening, and continuous monitoring of transactional activity, thereby contributing to the traceability of asset flows across the token's lifecycle. Oversight is maintained by a dedicated compliance function, which ensures adherence to applicable regulatory obligations across custody, issuance, and transfer processes.

- **Exposure to High Quality Underlying Asset:** The BlackRock ICS US Treasury Fund carries the highest available MMF ratings, AAAm by S&P, Aaa-mf by Moody's, and AAAmmf by Fitch, and invests in short-duration U.S. Treasury obligations. These instruments are backed by the full faith and credit of the US government and are widely regarded as the global benchmark for minimal credit and liquidity risk. The fund also has historically maintained a stable net asset value (NAV), daily liquidity, and transparent portfolio disclosures.

Particula notes that some residual risks persist, primarily due to the limited external visibility into technical implementation details and the absence of publicly disclosed distribution arrangements. These limitations, arising in part from legal and regulatory constraints, reduce the ability of third parties to independently verify certain features of the issuance.

In addition, reliance on centralized infrastructure and internal governance mechanisms introduces potential interoperability and continuity risks. Nonetheless, these exposures are mitigated through contractually defined entitlement structures, documented operational safeguards, FCA regulated risk management requirements and a consolidated compliance framework. The rating assigned to the Archax issuance demonstrates how structured, risk-based ratings can provide receiving parties with the necessary insights into enforceability, asset segregation, and redemption reliability for collateral eligibility assessments.

Three key insights from this analysis stand out:

1. **Structure matters:** The manner in which a TMMF is issued, recorded, and transferred materially affects its eligibility as collateral,
2. **Tokenization introduces new verification points:** Receiving parties must be able to validate key fund characteristics - such as NAV, liquidity, and finality - across both on-chain and off-chain environments (for Options 2-7), and
3. **Firm-level risk thresholds vary:** Even when regulatory eligibility is achieved, firm-level risk policies and commercial constraints may impose stricter internal thresholds for acceptance.

These insights reinforce the importance of careful structuring and documentation when deploying TMMFs in a collateral context and directly inform the sandbox design and simulation focus areas explored in Part V.

APPENDIX C – Key benefit takeaways of tokenized collateral

Key Takeaways for Buy-Side Market Participants

1. **Enhanced Liquidity and Collateral Mobility**
   - Immediate transferability of TMMF units as collateral, removing the need for conversion to cash and eliminating settlement lags, and operational risks
   - Real-time, on-chain ownership verification and instant eligibility screenings minimize operational drag
   - Digitally native TMMFs can be instantly rehypothecated and posted as collateral, supporting high-frequency variation margin movements for derivatives.

2. **Reduced Operational Burden**
   - Automated, programmable settlement via smart contracts leveraging industry-developed data standards, such as the Common Domain Model (CDM), reduces reconciliation and administrative costs
   - Streamlined onboarding (digitized KYC/AML for pre-qualified investors) shortens time to access fund units.

3. **Improved Financial Flexibility**
   - Retains exposure to MMF yield until the exact moment collateral is needed, reducing opportunity cost ("collateral drag")
   - Lower intraday banking fees due to instant collateral transfers; reduces overdraft and exposure charges.

4. **Resilience Under Stress**
   - During market stress, avoids forced asset sales by posting TMMF directly, mitigating fire-sale risks and associated price impacts within traditional MMFs.

Key Takeaways for Sell-Side Participants

1. **Increased Collateral Recirculation and Velocity**
   - TMMFs can be instantly rehypothecated and posted as collateral, supporting high-frequency variation margin movements for derivatives
   - Settlement time compressed from days to minutes, crucial in fast-moving markets.

2. **Capital Efficiency and Reduced Credit Risk**
   - Freed-up collateral can be redeployed, increasing leverage and optimizing balance sheets without liquidity bottlenecks.[41] (i.e. improvements not just in terms of Return on Investment (ROI) but also Return on Capital Employed (RoCE)
   - Shortens counterparty and performance risk horizons to near-zero during stressed periods.[42]

3. **Regulatory and Operational Advantages**
   - Better alignment with regulatory initiatives around real-time settlements, HQLA and digital reporting requirements[43]
   - Supports 24/7 operations for margin and repo settlements, broadening the pool of potential counterparties.

Key Improvements in Collateral Management

1. **Real-Time, 24/7 Transfer and Settlement**
   - *Instant settlement* - TMMF shares that are CNAV or LNAV products can be transferred outside of a valuation point and settled in seconds, versus the 1–3 day cycles typical of traditional MMF transactions63
   - *Always-on liquidity* - Transactions and settlements are no longer limited by business hours or regional cut-off times-collateral can move globally, 24/7/365.

2. **Enhanced Mobility and Programmability**
   - *Seamless collateral posting* - Institutions can move MMF collateral atomically (instantly and as a single, indivisible operation), avoiding the need to redeem to cash and eliminating intermediate settlement lags
   - *Programmable collateral* - TMMF can be integrated into smart contracts, enabling automatic and conditional posting, substitution, or return of collateral.

[41] https://www.marketsmedia.com/collateral-mobility-is-powerful-use-case-for-tokenization/
[42] https://www.fia.org/marketvoice/articles/analysis-enthusiasm-builds-tokenisation-collateral-management
[43] https://www.theia.org/sites/default/files/2024-03/MMF%20Tokenisation%20-%20Collateral%20Opportunities%20%20Mar24.pdf

3. Yield Retention

- *Yield until the moment of use* - Unlike cash buffers, MMF tokens can potentially continue to earn yield until the instant they are posted as collateral, reducing opportunity costs and collateral drag
- *Dual utility* – TMMFs (as well as tokenized cash, bonds and gilts) can serve both as a store of value and as immediately available collateral, supporting strategies that maximize returns while maintaining readiness for margin calls.

4. Operational Streamlining

- *Reduced back-office friction* - On-chain settlement and record-keeping cut down on manual reconciliation, settlement failures, and costly legacy processes
- *Automated margin management* - Smart contracts based on industry-developed digital data standards automate margin calls, substitutions, and top-ups-supporting near-instant response times to market events.

5. Cross-Platform and Regulatory Advancements

- *Interoperability* - Leading platforms are developing solutions to integrate TMMFs with both legacy backbones and next-gen collateral management systems, supporting broad market participation and market infrastructure (system) transformation
- *Regulatory clarity* - New regulations are creating supportive frameworks and removing uncertainty for institutional adoption.

APPENDIX D – Determining the lex situs

In the case of the digitally native (registered) shares held on the TA's on-chain register, one consideration for determining the lex situs is likely to be the jurisdiction in which the on-chain register is located, which may be the jurisdiction of the TA.

By analogy with English law applicable to registered assets, the applicable law for digitally native (registered) shares may be considered to be the location in which the relevant assets can be dealt in, therefore the location of the TA itself (and the TA-controlled register) would be relevant.

However other concepts can contribute to the determination of lex situs including alternative approaches to "control" of a digitally native asset. Minimizing uncertainty which could arise from difficulties in assessing, or potentially conflicting assessments of, the correct lex situs of digitally native assets is an important consideration in structuring any collateral arrangement.

For purposes of this paper, we have assumed that all relevant parties are located in the same jurisdiction, in order to simplify the private international law analysis. But in practice, it is relevant to add some further commentary here in respect of other tokenization legal structures in Table 5 - in respect of the structures labelled Digital Twin and Asset-Backed (options 2-7 in Table 5), the lex situs may be further complicated by the jurisdiction of a relevant third-party intermediary and could be impacted as follows:

- Evidence of title structure (Option 2 in Figure 1) - As the holder's interest will be recorded on the traditional register, the DLT ledger will merely be evidence of title and so the location of the traditional register will also likely be relevant
- Nominee structure (Option 3 in Figure 1) - There will be a split between the legal title (which resides with the nominee) and the beneficial interests, held by the holders. This raises the issue of identifying the primary title and the location of the entity holding that title
- Beneficial interest trust structure (Options 4 and 5 in Figure 1) - Where the holder has a beneficial interest in the TMMF, the location of the custodian or nominee may also be relevant.

Other relevant considerations for lex situs

There have been various efforts to harmonize private international law rules to simplify the task of determining these questions. The Hague Convention on the Law Applicable to Certain Rights in Respect of Securities Held with an Intermediary also provides helpful clarity including that where no law is specified in the account agreement, the governing law will be the law of the jurisdiction in which the intermediary's account is located, or the intermediary's jurisdiction of incorporation. This convention is currently only adopted in a limited number of jurisdictions, although somewhat similar rules apply in many other jurisdictions today.

With a view to establishing a more universally accepted set of principles for digital assets, the Hague Conference on Private International Law is currently engaging in a joint project with the International Institute for the Unification of Private Law (UNIDROIT) to develop coordinated guidance and feasibility of a normative framework on the law applicable to cross-border holdings and the transfers of digital assets. UNIDROIT has also published some principles on digital assets and private law. These developments point to the growing support for the view that the governing law should be that chosen in the digital asset or DLT system and the Financial Markets Law Committee has suggested that the English courts should apply an "elective situs" or chosen governing law rule.

Considerations arising as a result of the Financial Collateral Arrangements (No.2) Regulations 2003 (the FCARs)

A TMMF may be able to be structured to fall within the FCARs. For example, considering the depositary receipt structure (Option 6 in Table 5), given that depositary receipts are financial instruments it is straightforward to see how a TMMF structure employing depositary receipts may be set up to fall within the FCARs.

Other TMMFs may also be structured with the intention of falling within this framework and the treatment of the TMMF under the law of its location will be relevant here (see notes above in relation to Irish legal considerations, where it is noted that the Irish Financial Collateral Arrangements Regulations 2010 contain sufficiently broad definitions to include TMMFs within their scope).

Where TMMFs fall within the FCARs, the regulations could provide additional clarity on some of the considerations highlighted in this report due to their operation in ensuring that close-out netting arrangements take effect in accordance with their terms, even if one of the parties is subject to winding-up or reorganization measures, and may also provide clarity on lex situs matters as a result of the provisions set out in FCARs regulation 19.

However, the path to structuring TMMFs with certainty to fall within the FCARs under English law is not currently entirely clear for market participants and in the UK the Law Commission has recommended that certain statutory amendments are made to the FCARs as currently many digital assets are currently likely to fall outside them, including to ensure that:

i. the characterization of an asset that by itself satisfies the definition of a financial instrument or a credit claim will be unaffected by that asset being merely recorded or registered by a crypto token within a blockchain or DLT-based system (where the underlying is not "linked" or "stapled" by any legal mechanism to the crypto token that records them); and
ii. that where an asset that satisfies the definition of a financial instrument or a credit claim is tokenized and effectively linked or stapled to a crypto token that constitutes a distinct object of personal property rights from the perspective of and vested in the person that controls it, the linked or stapled crypto token itself will similarly satisfy the relevant definition. ■

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